Remedial Investigation
Tidal Area Sites 1, 2, 9, and 11
Naval Weapons Station, Seal Beach Detachment
Concord, California

CLEAN II
Contract No. N62474-94-D-7609
Contract Task Order No. 217
Navy Remedial Project Manager: Clint Fisher

DRAFT
FINAL

Qualitative Ecological Risk Assessment Report
June 1999

Volume 2 of 4

COMPREHENSIVE LONG-TERM ENVIRONMENTAL ACTION NAVY (CLEAN II)
Northern and Central California, Nevada, and Utah
Contract Number N62474-94-D-7609
Contract Task Order 217

Prepared For

DEPARTMENT OF THE NAVY
Clint Fisher, Remedial Project Manager
Engineering Field Activity West
Naval Facilities Engineering Command
San Bruno, California

DRAFT FINAL

QUALITATIVE ECOLOGICAL RISK ASSESSMENT TIDAL AREA SITES

NAVAL WEAPONS STATION, SEAL BEACH DETACHMENT CONCORD, CALIFORNIA

June 1999

Prepared By

TETRA TECH EM INC.
135 Main Street, Suite 1800
San Francisco, CA 94105
(415) 543-4880

Anju Wicke, Project Manager

CONTENTS

Section			Page
ABBREVIATIONS AND ACRONYMS			xxiv
EXECUTIVE SUMMARY			ES-1
1.0	INTRODUCTION		1-1
	1.1	BACKGROUND AND OBJECTIVES	1-1
	1.2	TECHNICAL APPROACH	1-2
		1.2.1 The Framework Approach	1-3
		1.2.2 Summary of the Ecological Risk Assessment Approach for the Tidal Area Sites	1-4
	1.3	OVERVIEW OF REPORT	1-5
2.0	FACILITY BACKGROUND AND SETTING		2-1
	2.1	LOCATION	2-1
	2.2	LAND USE AND TRANSPORTATION	2-1
	2.3	HISTORY	2-2
	2.4	CURRENT OPERATIONS	2-3
	2.5	ENVIRONMENTAL SETTING	2-3
		2.5.1 Physiography and Topography	2-3
		2.5.2 Regional Geology	2-4
		2.5.3 Surface Water Hydrology	2-7
		2.5.4 Climate	2-8
	2.6	TIDAL AREA SITE HISTORIES	2-9
		2.6.1 Site 1: Tidal Area Landfill	2-9
		2.6.2 Site 2: R Area Disposal	2-10
		2.6.3 Site 9: Froid and Taylor Roads	2-11
		2.6.4 Site 11: Wood Hogger	2-12
3.0	ECOLOGICAL CHARACTERIZATION		3-1
	3.1	SUMMARY OF FIELD ASSESSMENT PROCEDURES	3-2
		3.1.1 WESCO Field Assessment: Terrestrial Habitats and Wildlife Survey Procedures	3-2
		3.1.2 WESCO Field Assessment: Aquatic Invertebrates and Water Quality Procedures	3-3
		3.1.3 WESCO Field Assessment: Fish Assemblages Procedures	3-3
		3.1.4 WESCO Field Assessment: On-Site Stressed Vegetation Analysis Procedures	3-4

CONTENTS (Continued)

Section **Page**

3.1.5 WESCO Field Assessment: Wetlands Delineation and Wetlands Functional Assessment 3-4
3.1.6 Field Assessment: California Black Rail Survey Procedures 3-6
3.1.7 Field Assessment: Small-Mammal Trapping Survey Procedures 3-6
3.2 HABITAT TYPES AND TYPICAL SPECIES AT THE TIDAL AREA SITES 3-7
3.2.1 Upland Habitats and Typical Species 3-8
3.2.2 Wetland and Aquatic Habitats and Typical Species 3-10
3.2.3 Benthic and Midwater Invertebrates 3-18
3.2.4 Fish Assemblages 3-19
3.3 SPECIAL STATUS SPECIES 3-21
3.3.1 Special Status Plants 3-22
3.3.2 Special Status Invertebrates 3-23
3.3.3 Special Status Fish 3-23
3.3.4 Special Status Reptiles and Amphibians 3-25
3.3.5 Special Status Birds 3-25
3.3.6 Special Status Mammals 3-29
3.3.7 Summary of Special Status Terrestrial and Wetland Species 3-30
3.4 WETLANDS DELINEATION AND FUNCTIONAL ASSESSMENT 3-31
3.4.1 Soil Nutrient and Water Availability for Plants 3-31
3.4.2 Surface Water 3-32
3.4.3 Primary Productivity 3-34
3.4.4 Habitat Quality 3-36
3.4.5 Stressed Vegetation Observations 3-39

4.0 SAMPLING STRATEGY AND ANALYSIS 4-1
4.1 1995 SAMPLING STRATEGY 4-1
4.1.1 1995 Soil Investigation 4-1
4.1.2 1995 Sediment and Surface Water Investigation 4-3
4.2 1995 SAMPLING PARAMETERS 4-3
4.2.1 Soil/Sediment Parameters 4-3
4.2.2 1995 Surface Water Parameters 4-4
4.2.3 Toxicity Tests 4-5
4.3 1998 SAMPLING STRATEGY 4-5
4.3.1 1998 Soil Investigation 4-5
4.3.2 1998 Sediment and Surface Water Investigation 4-6
4.3.3 1998 Tissue Residue Sampling 4-7

CONTENTS (Continued)

Section | Page

4.4 TOXICITY TESTS 4-9
4.4.1 Sediment-Water Interface Toxicity Test 4-9
4.4.2 Amphipod Toxicity Test 4-10
4.5 IDENTIFICATION AND DOCUMENTATION OF SAMPLES 4-11
4.5.1 Location Identification System 4-11
4.5.2 RI Sample Identification System 4-11
4.6 QUALITY ASSURANCE/QUALITY CONTROL 4-12

5.0 METHODS OF SCREENING CONTAMINANTS 5-1
5.1 SCREENING VALUES FOR CHEMICALS OF POTENTIAL ECOLOGICAL CONCERN 5-1
5.1.1 Ambient Chemical Concentrations 5-1
5.1.2 Regulatory Criteria and Other Screening Values 5-2
5.2 IDENTIFICATION OF CHEMICALS OF ECOLOGICAL CONCERN 5-4
5.2.1 Screening Process for Soil and Sediment (Plants and Invertebrates) 5-4
5.2.2 Screening Process for Soil and Sediment (Birds and Mammals) 5-4
5.2.3 Screening Process for Surface Water (Aquatic Receptors) 5-5
5.3 EVALUATION OF DETECTION LIMITS 5-5

6.0 NATURE AND EXTENT OF CONTAMINATION 6-1
6.1 INORGANIC CONSTITUENTS IN SOIL, SEDIMENT, AND SURFACE WATER SAMPLES 6-2
6.1.1 Inorganic Constituents in Soil and Sediment Samples 6-3
6.1.2 Leachability Evaluations: WET-Acid and WET-DI Extractions 6-30
6.1.3 Inorganic Constituents in Surface Water Samples 6-37
6.1.4 Summary of Inorganic COPECs for the Tidal Area Sites 6-53
6.2 ORGANIC CONSTITUENTS IN SOIL, SEDIMENT, AND SURFACE WATER SAMPLES 6-54
6.2.1 Organic Constituents in Soil and Sediment Samples 6-55
6.2.2 Organic Constituents in Surface Water Samples 6-83
6.2.3 Summary of Organic COPECs for the Tidal Area Sites 6-86
6.3 STATISTICAL EVALUATION OF CHEMICALS OF POTENTIAL ECOLOGICAL CONCERN 6-89
6.3.1 Statistical Evaluation Methods 6-89
6.3.2 Statistical Evaluation Results 6-89
6.3.3 COPECs Eliminated from Further Evaluation 6-93

CONTENTS (Continued)

Section Page

6.4 SUMMARY OF NATURE AND EXTENT OF CONTAMINATION 6-94
6.4.1 Landfill Terrestrial Unit 6-94
6.4.2 R Area Terrestrial and Aquatic Unit 6-94
6.4.3 Froid and Taylor Aquatic Unit 6-95
6.4.4 Wood Hogger Terrestrial Unit 6-95
6.4.5 North and South Otter Sluice Aquatic Units 6-95
6.4.6 All Tidal Area Sites 6-96

7.0 THE CONCEPTUAL SITE MODEL 7-1
7.1 SOURCES OF CONTAMINATION 7-1
7.2 NATURE AND EXTENT OF CONTAMINATION 7-2
7.3 FATE AND TRANSPORT 7-2
7.3.1 Groundwater-Surface Water Interactions 7-3
7.3.2 Surface Transport Pathways 7-4
7.3.3 Biotic Transfer of Contaminants 7-5
7.4 COMPLETE EXPOSURE PATHWAYS 7-5
7.5 ASSESSMENT AND MEASUREMENT ENDPOINTS 7-6
7.5.1 Selection of Assessment Endpoints 7-7
7.5.2 Measurement Endpoints 7-8
7.5.3 Food Web 7-9
7.5.4 Representative Vertebrate Receptors 7-11
7.5.5 Use of Assessment and Measurement Endpoints in Evaluating Risk 7-16

8.0 BIOASSAY AND TISSUE RESIDUE RESULTS 8-1
8.1 MICROTOX TEST 8-1
8.1.1 Methods 8-1
8.1.2 Results 8-2
8.2 CYTOCHROME P450 TEST 8-3
8.2.1 Methods 8-4
8.2.2 Results 8-5
8.3 AMPHIPOD TEST 8-6
8.3.1 Methods 8-7
8.3.2 Results 8-7
8.4 TOPSMELT TEST 8-8
8.4.1 Methods 8-8
8.4.2 Results 8-10
8.4.3 Confounding Factors 8-11

CONTENTS (Continued)

Section | Page

8.5 TISSUE RESIDUE RESULTS 8-12
8.5.1 Rodent Tissue Results 8-12
8.5.2 Pickleweed Tissue Results 8-13
8.5.3 Amphipod Tissue Results 8-13
8.5.4 Clam Tissue Results 8-14
8.5.5 Fish Tissue Results 8-14

9.0 BIOAVAILABILITY 9-1
9.1 PARAMETERS AFFECTING BIOAVAILABILITY 9-1
9.1.1 Total Organic Carbon and Grain Size 9-2
9.1.2 pH (Hydrogen Ion Concentration) 9-4
9.1.3 Oxidation-Reduction Potential (Redox Potential or Eh) 9-5
9.1.4 Hardness 9-6
9.1.5 Salinity 9-7
9.1.6 Temperature 9-8
9.1.7 Biologically Mediated Transformation 9-9
9.2 WASTE EXTRACTION TESTS 9-9
9.3 RATIO OF SIMULTANEOUSLY EXTRACTABLE METALS TO ACID VOLATILE SULFIDES IN SEDIMENTS 9-11
9.4 TISSUE RESIDUES AS INDICATORS OF BIOAVAILABILITY 9-12
9.4.1 Pickleweed Tissue Residues 9-12
9.4.2 Rodent Tissue Residues 9-13
9.4.3 Fish, Clam, and Amphipod Tissue Residues 9-14
9.5 BIOASSAY RESULTS AS INDICATORS OF BIOAVAILABILITY 9-15

10.0 RISK TO PLANTS 10-1
10.1 CHEMICALS OF POTENTIAL ECOLOGICAL CONCERN FOR PLANTS 10-2
10.2 EXPOSURE ASSESSMENT FOR PLANTS 10-3
10.2.1 Chemical Exposure Based on Tissue Residue Data 10-4
10.2.2 Additional Factors Affecting Exposure 10-4
10.3 EFFECTS ASSESSMENT FOR PLANTS 10-7
10.3.1 Comparisons with Benchmark Values 10-7
10.3.2 Additional Factors Contributing to Effects: Plant Nutrients and Trace Elements 10-8
10.3.3 Potential Toxicological Effects of COPECs on Plants 10-10
10.4 RISK CHARACTERIZATION FOR PLANTS 10-15

CONTENTS (Continued)

Section		Page
11.0	RISK TO SOIL BIOTA AND TERRESTRIAL INVERTEBRATES	11-1
11.1	CHEMICALS OF POTENTIAL ECOLOGICAL CONCERN FOR SOIL BIOTA AND TERRESTRIAL INVERTEBRATES	11-2
11.2	EXPOSURE ASSESSMENT FOR SOIL BIOTA AND TERRESTRIAL INVERTEBRATES	11-3
11.2.1	Soil Parameters Affecting Exposure	11-3
11.2.2	Waste Extraction Tests	11-4
11.3	EFFECTS ASSESSMENT FOR SOIL BIOTA AND TERRESTRIAL INVERTEBRATES	11-5
11.3.1	Solid-Phase and Organic-Extraction Microtox	11-5
11.3.2	Cytochrome P450	11-5
11.3.3	Comparisons with Soil Benchmark Values	11-6
11.3.4	Potential Toxicological Effects of COPECs on Soil Biota and Terrestrial Invertebrates	11-7
11.4	RISK CHARACTERIZATION FOR SOIL BIOTA AND TERRESTRIAL INVERTEBRATES	11-13
12.0	RISK TO FISH	12-1
12.1	CHEMICALS OF POTENTIAL ECOLOGICAL CONCERN FOR FISH	12-2
12.2	EXPOSURE ASSESSMENT FOR FISH	12-2
12.3	EFFECTS ASSESSMENT FOR FISH	12-4
12.3.1	Sediment-Water Interface Bioassay	12-4
12.3.2	Potential Toxicological Effects of COPECs on Fish	12-4
12.4	RISK CHARACTERIZATION FOR FISH	12-10
13.0	RISK TO AQUATIC INVERTEBRATES	13-1
13.1	CHEMICALS OF POTENTIAL ECOLOGICAL CONCERN FOR AQUATIC INVERTEBRATES	13-2
13.2	EXPOSURE ASSESSMENT FOR AQUATIC INVERTEBRATES	13-2
13.3	EFFECTS ASSESSMENT FOR AQUATIC INVERTEBRATES	13-4
13.3.1	Amphipod Bioassay – Whole Sediment Test	13-4
13.3.2	Potential Toxicological Effects of COPECs on Aquatic Invertebrates	13-4
13.4	RISK CHARACTERIZATION FOR AQUATIC INVERTEBRATES	13-8
14.0	RISK TO REPTILES AND AMPHIBIANS	14-1
14.1	CHEMICALS OF POTENTIAL ECOLOGICAL CONCERN FOR REPTILES AND AMPHIBIANS	14-2
14.2	EXPOSURE ASSESSMENT FOR REPTILES AND AMPHIBIANS	14-2

CONTENTS (Continued)

Section | Page

14.3 EFFECTS ASSESSMENT FOR REPTILES AND AMPHIBIANS 14-3
14.3.1 Literature Review 14-3
14.3.2 Potential Toxicological Effects of COPECs on Reptiles and Amphibians 14-5
14.4 RISK CHARACTERIZATION FOR REPTILES AND AMPHIBIANS 14-8

15.0 RISK TO BIRDS AND MAMMALS 15-1
15.1 CHEMICALS OF POTENTIAL ECOLOGICAL CONCERN FOR BIRDS AND MAMMALS 15-3
15.2 EXPOSURE ASSESSMENT: FOOD-CHAIN ANALYSIS 15-3
15.2.1 Dose Model 15-3
15.2.2 Exposure Parameters in the Dose Model 15-6
15.3 EFFECTS ASSESSMENT: TOXICITY REFERENCE VALUES AND HAZARD QUOTIENT INTERPRETATION 15-15
15.3.1 Toxicity Reference Values 15-16
15.3.2 Hazard Quotient Approach 15-17
15.3.3 Chemicals Evaluated Qualitatively 15-19
15.4 RISK CHARACTERIZATION 15-19
15.4.1 Potential Risks to Representative Receptors from Chemical Exposures in the Landfill Terrestrial Unit 15-20
15.4.2 Potential Risks to Representative Receptors from Chemical Exposures in the R Area Terrestrial Unit 15-28
15.4.3 Potential Risks to Representative Receptors from Chemical Exposures in the R Area Terrestrial and Aquatic Unit 15-37
15.4.4 Potential Risks to Representative Receptors from Chemical Exposures in the Froid and Taylor Terrestrial Unit 15-38
15.4.5 Potential Risks to Representative Receptors from Chemical Exposures in the Froid and Taylor Aquatic Unit 15-38
15.4.6 Potential Risks to Representative Receptors from Chemical Exposures in the Wood Hogger Terrestrial Unit 15-40
15.4.7 Potential Risks to Representative Receptors from Chemical Exposures in the North Otter Sluice Aquatic Unit 15-48
15.4.8 Potential Risks to Representative Receptors from Chemical Exposures in the South Otter Sluice Aquatic Unit 15-54
15.5 BACK-CALCULATION OF CONCENTRATIONS INDICATING NO RISK 5-62
15.6 IDENTIFICATION OF CHEMICALS OF ECOLOGICAL CONCERN AND AREAS POSING RISK 5-63

CONTENTS (Continued)

Section		Page
16.0	CONCLUSIONS AND RECOMMENDATIONS	16-1
16.1	RISK ASSESSMENT CONCLUSIONS	16-2
16.1.1	Tidal Area Landfill Site	16-2
16.1.2	R Area Disposal Site	16-3
16.1.3	Froid and Taylor Roads Site	16-4
16.1.4	Wood Hogger Site	16-5
16.1.5	Otter Sluice	16-6
16.2	UNCERTAINTY ANALYSIS	16-8
16.2.1	Sampling and Data Analysis	16-8
16.2.2	Screening Values	16-9
16.2.3	Toxicity Tests	16-9
16.2.4	Hazard Quotients and Hazard Indices	16-9
16.2.5	Tissue Residue Data	16-9
16.2.6	Uncertainty Associated with the Evaluation of Risk to Birds and Mammals	16-10
16.3	RECOMMENDATIONS	16-13
REFERENCES		R-1

APPENDICES

Appendix

A	ANALYTICAL DATA TABLES - TIDAL AREA LANDFILL
B	ANALYTICAL DATA TABLES - R AREA DISPOSAL SITE
C	ANALYTICAL DATA TABLES - FROID AND TAYLOR ROADS SITE
D	ANALYTICAL DATA TABLES - WOOD HOGGER SITE
E	ANALYTICAL DATA TABLES - OTTER SLUICE
F	AMBIENT INORGANICS EVALUATION
G	BORING LOGS
H	TIDAL INFLUENCE SURVEY DATA
I	HUMAN HEALTH RISK ASSESSMENT TOXICITY PROFILES
J	REGION IX PRELIMINARY REMEDIATION GOALS
K	QUALITY CONTROL SUMMARY REPORT
L	DATA VALIDATION ISSUES
M	HUMAN HEALTH STATISTICAL SUMMARY TABLES
N	ECOLOGICAL STATISTICAL SUMMARY TABLES
O	SMALL MAMMAL TRAPPING AND CALIFORNIA BLACK RAIL SURVEYS
P	COMPARISON OF DETECTION LIMITS ACHIEVED TO SCREENING VALUES
Q	STATISTICAL EVALUATION FOR OUTLIER AND EXTREME VALUES FOR INORGANIC CONSTITUENTS IN SOIL AND SEDIMENT
R	DESCRIPTIVE STATISTICS FOR WASTE EXTRACTION TESTS, MICROTOX, AND CYTOCHROME P450 FOR INORGANIC CONSTITUENTS
S	TOXICITY REFERENCE VALUES FOR 2,3,7,8-TCDD
T	FOOD-CHAIN MODELING CALCULATIONS FOR RISK TO BIRDS AND MAMMALS

FIGURES

Figure

1-1 VICINITY OF NWS CONCORD

1-2 TIDAL AREA SITES

2-1 TIDAL AREA FEATURES AND VEGETATION, 1995

2-2 SURFACE WATER INUNDATION MAP (WINTER)

2-3 SURFACE WATER INUNDATION MAP (SUMMER)

5-1 SCREENING PROCESS FOR SOIL AND SEDIMENT: SELECTING CHEMICALS OF ECOLOGICAL CONCERN (COEC) FOR INVERTEBRATES AND PLANTS

5-2 SCREENING PROCESS FOR SOIL AND SEDIMENT: SELECTING CHEMICALS OF ECOLOGICAL CONCERN (COEC) FOR BIRDS AND MAMMALS

5-3 SCREENING VALUES SELECTION AND SCREENING PROCESS FOR SURFACE WATER: SELECTING CHEMICALS OF ECOLOGICAL CONCERN (COEC) FOR AQUATIC RECEPTORS

5-4 FOOD-CHAIN MODELING HAZARD QUOTIENT SCREENING PROCESS

6-1A DETECTED CONCENTRATIONS OF ALUMINUM IN THE LANDFILL PERIMETER TERRESTRIAL, FROID AND TAYLOR TERRESTRIAL, FROID AND TAYLOR AQUATIC, R AREA TERRESTRIAL AND AQUATIC, AND NORTH OTTER SLUICE AQUATIC UNITS, SOIL AND SEDIMENT

6-1B DETECTED CONCENTRATIONS OF ALUMINUM IN THE R AREA TERRESTRIAL UNIT, SOIL AND SEDIMENT

6-1C DETECTED CONCENTRATIONS OF ALUMINUM IN THE WOOD HOGGER TERRESTRIAL AND SOUTH OTTER SLUICE AQUATIC UNITS, SOIL AND SEDIMENT

6-2A DETECTED CONCENTRATIONS OF ANTIMONY IN THE LANDFILL PERIMETER TERRESTRIAL, FROID AND TAYLOR TERRESTRIAL, FROID AND TAYLOR AQUATIC, R AREA TERRESTRIAL AND AQUATIC, AND NORTH OTTER SLUICE AQUATIC UNITS, SOIL AND SEDIMENT

6-2B DETECTED CONCENTRATIONS OF ANTIMONY IN THE R AREA TERRESTRIAL UNIT, SOIL AND SEDIMENT

6-2C DETECTED CONCENTRATIONS OF ANTIMONY IN THE WOOD HOGGER TERRESTRIAL AND SOUTH OTTER SLUICE AQUATIC UNITS, SOIL AND SEDIMENT

6-3A DETECTED CONCENTRATIONS OF ARSENIC IN THE LANDFILL PERIMETER TERRESTRIAL, FROID AND TAYLOR TERRESTRIAL, FROID AND TAYLOR AQUATIC, R AREA TERRESTRIAL AND AQUATIC, AND NORTH OTTER SLUICE AQUATIC UNITS, SOIL AND SEDIMENT

6-3B DETECTED CONCENTRATIONS OF ARSENIC IN THE R AREA TERRESTRIAL UNIT, SOIL AND SEDIMENT

FIGURES (Continued)

Figure

6-3C DETECTED CONCENTRATIONS OF ARSENIC IN THE WOOD HOGGER TERRESTRIAL AND SOUTH OTTER SLUICE AQUATIC UNITS, SOIL AND SEDIMENT

6-4A DETECTED CONCENTRATIONS OF BARIUM IN THE LANDFILL PERIMETER TERRESTRIAL, FROID AND TAYLOR TERRESTRIAL, FROID AND TAYLOR AQUATIC, R AREA TERRESTRIAL AND AQUATIC, AND NORTH OTTER SLUICE AQUATIC UNITS, SOIL AND SEDIMENT

6-4B DETECTED CONCENTRATIONS OF BARIUM IN THE R AREA TERRESTRIAL UNIT, SOIL AND SEDIMENT

6-4C DETECTED CONCENTRATIONS OF BARIUM IN THE WOOD HOGGER TERRESTRIAL AND SOUTH OTTER SLUICE AQUATIC UNITS, SOIL AND SEDIMENT

6-5A DETECTED CONCENTRATIONS OF BERYLLIUM IN THE LANDFILL PERIMETER TERRESTRIAL, FROID AND TAYLOR TERRESTRIAL, FROID AND TAYLOR AQUATIC, R AREA TERRESTRIAL AND AQUATIC, AND NORTH OTTER SLUICE AQUATIC UNITS, SOIL AND SEDIMENT

6-5B DETECTED CONCENTRATIONS OF BERYLLIUM IN THE R AREA TERRESTRIAL UNIT, SOIL AND SEDIMENT

6-5C DETECTED CONCENTRATIONS OF BERYLLIUM IN THE WOOD HOGGER TERRESTRIAL AND SOUTH OTTER SLUICE AQUATIC UNITS, SOIL AND SEDIMENT

6-6A DETECTED CONCENTRATIONS OF CADMIUM IN THE LANDFILL PERIMETER TERRESTRIAL, FROID AND TAYLOR TERRESTRIAL, FROID AND TAYLOR AQUATIC, R AREA TERRESTRIAL AND AQUATIC, AND NORTH OTTER SLUICE AQUATIC UNITS, SOIL AND SEDIMENT

6-6B DETECTED CONCENTRATIONS OF CADMIUM IN THE R AREA TERRESTRIAL UNIT, SOIL AND SEDIMENT

6-6C DETECTED CONCENTRATIONS OF CADMIUM IN THE WOOD HOGGER TERRESTRIAL AND SOUTH OTTER SLUICE AQUATIC UNITS, SOIL AND SEDIMENT

6-7A DETECTED CONCENTRATIONS OF CHROMIUM IN THE LANDFILL PERIMETER TERRESTRIAL, FROID AND TAYLOR TERRESTRIAL, FROID AND TAYLOR AQUATIC, R AREA TERRESTRIAL AND AQUATIC, AND NORTH OTTER SLUICE AQUATIC UNITS, SOIL AND SEDIMENT

6-7B DETECTED CONCENTRATIONS OF CHROMIUM IN THE R AREA TERRESTRIAL UNIT, SOIL AND SEDIMENT

6-7C DETECTED CONCENTRATIONS OF CHROMIUM IN THE WOOD HOGGER TERRESTRIAL AND SOUTH OTTER SLUICE AQUATIC UNITS, SOIL AND SEDIMENT

FIGURES (Continued)

Figure

6-8A DETECTED CONCENTRATIONS OF COBALT IN THE LANDFILL PERIMETER TERRESTRIAL, FROID AND TAYLOR TERRESTRIAL, FROID AND TAYLOR AQUATIC, R AREA TERRESTRIAL AND AQUATIC, AND NORTH OTTER SLUICE AQUATIC UNITS, SOIL AND SEDIMENT

6-8B DETECTED CONCENTRATIONS OF COBALT IN THE R AREA TERRESTRIAL UNIT, SOIL AND SEDIMENT

6-8C DETECTED CONCENTRATIONS OF COBALT IN THE WOOD HOGGER TERRESTRIAL AND SOUTH OTTER SLUICE AQUATIC UNITS, SOIL AND SEDIMENT

6-9A DETECTED CONCENTRATIONS OF COPPER IN THE LANDFILL PERIMETER TERRESTRIAL, FROID AND TAYLOR TERRESTRIAL, FROID AND TAYLOR AQUATIC, R AREA TERRESTRIAL AND AQUATIC, AND NORTH OTTER SLUICE AQUATIC UNITS, SOIL AND SEDIMENT

6-9B DETECTED CONCENTRATIONS OF COPPER THE IN R AREA TERRESTRIAL UNIT, SOIL AND SEDIMENT

6-9C DETECTED CONCENTRATIONS OF COPPER IN THE WOOD HOGGER TERRESTRIAL AND SOUTH OTTER SLUICE AQUATIC UNITS, SOIL AND SEDIMENT

6-10A DETECTED CONCENTRATIONS OF LEAD IN THE LANDFILL PERIMETER TERRESTRIAL, FROID AND TAYLOR TERRESTRIAL, FROID AND TAYLOR AQUATIC, R AREA TERRESTRIAL AND AQUATIC, AND NORTH OTTER SLUICE AQUATIC UNITS, SOIL AND SEDIMENT

6-10B DETECTED CONCENTRATIONS OF LEAD IN THE R AREA TERRESTRIAL UNIT, SOIL AND SEDIMENT

6-10C DETECTED CONCENTRATIONS OF LEAD IN THE WOOD HOGGER TERRESTRIAL AND SOUTH OTTER SLUICE AQUATIC UNITS, SOIL AND SEDIMENT

6-11A DETECTED CONCENTRATIONS OF MANGANESE IN THE LANDFILL PERIMETER TERRESTRIAL, FROID AND TAYLOR TERRESTRIAL, FROID AND TAYLOR AQUATIC, R AREA TERRESTRIAL AND AQUATIC, AND NORTH OTTER SLUICE AQUATIC UNITS, SOIL AND SEDIMENT

6-11B DETECTED CONCENTRATIONS OF MANGANESE IN THE R AREA TERRESTRIAL UNIT, SOIL AND SEDIMENT

6-11C DETECTED CONCENTRATIONS OF MANGANESE IN THE WOOD HOGGER TERRESTRIAL AND SOUTH OTTER SLUICE AQUATIC UNITS, SOIL AND SEDIMENT

6-12A DETECTED CONCENTRATIONS OF MERCURY IN THE LANDFILL PERIMETER TERRESTRIAL, FROID AND TAYLOR TERRESTRIAL, FROID AND TAYLOR AQUATIC, R AREA TERRESTRIAL AND AQUATIC, AND NORTH OTTER SLUICE AQUATIC UNITS, SOIL AND SEDIMENT

FIGURES (Continued)

Figure

6-12B DETECTED CONCENTRATIONS OF MERCURY IN THE R AREA TERRESTRIAL UNIT, SOIL AND SEDIMENT

6-12C DETECTED CONCENTRATIONS OF MERCURY IN THE WOOD HOGGER TERRESTRIAL AND SOUTH OTTER SLUICE AQUATIC UNITS, SOIL AND SEDIMENT

6-13A DETECTED CONCENTRATIONS OF MOLYBDENUM IN THE LANDFILL PERIMETER TERRESTRIAL, FROID AND TAYLOR TERRESTRIAL, FROID AND TAYLOR AQUATIC, R AREA TERRESTRIAL AND AQUATIC, AND NORTH OTTER SLUICE AQUATIC UNITS, SOIL AND SEDIMENT

6-13B DETECTED CONCENTRATIONS OF MOLYBDENUM IN THE R AREA TERRESTRIAL UNIT, SOIL AND SEDIMENT

6-13C DETECTED CONCENTRATIONS OF MOLYBDENUM IN THE WOOD HOGGER TERRESTRIAL AND SOUTH OTTER SLUICE AQUATIC UNITS, SOIL AND SEDIMENT

6-14A DETECTED CONCENTRATIONS OF NICKEL IN THE LANDFILL PERIMETER TERRESTRIAL, FROID AND TAYLOR TERRESTRIAL, FROID AND TAYLOR AQUATIC, R AREA TERRESTRIAL AND AQUATIC, AND NORTH OTTER SLUICE AQUATIC UNITS, SOIL AND SEDIMENT

6-14B DETECTED CONCENTRATIONS OF NICKEL IN THE R AREA TERRESTRIAL UNIT, SOIL AND SEDIMENT

6-14C DETECTED CONCENTRATIONS OF NICKEL IN THE WOOD HOGGER TERRESTRIAL AND SOUTH OTTER SLUICE AQUATIC UNITS, SOIL AND SEDIMENT

6-15A DETECTED CONCENTRATIONS OF SELENIUM IN THE LANDFILL PERIMETER TERRESTRIAL, FROID AND TAYLOR TERRESTRIAL, FROID AND TAYLOR AQUATIC, R AREA TERRESTRIAL AND AQUATIC, AND NORTH OTTER SLUICE AQUATIC UNITS, SOIL AND SEDIMENT

6-15B DETECTED CONCENTRATIONS OF SELENIUM IN THE R AREA TERRESTRIAL UNIT, SOIL AND SEDIMENT

6-15C DETECTED CONCENTRATIONS OF SELENIUM IN THE WOOD HOGGER TERRESTRIAL AND SOUTH OTTER SLUICE AQUATIC UNITS, SOIL AND SEDIMENT

6-16A DETECTED CONCENTRATIONS OF SILVER IN THE LANDFILL PERIMETER TERRESTRIAL, FROID AND TAYLOR TERRESTRIAL, FROID AND TAYLOR AQUATIC, R AREA TERRESTRIAL AND AQUATIC, AND NORTH OTTER SLUICE AQUATIC UNITS, SOIL AND SEDIMENT

6-16B DETECTED CONCENTRATIONS OF SILVER IN THE R AREA TERRESTRIAL UNIT, SOIL AND SEDIMENT

FIGURES (Continued)

Figure	
6-16C	DETECTED CONCENTRATIONS OF SILVER IN THE WOOD HOGGER TERRESTRIAL AND SOUTH OTTER SLUICE AQUATIC UNITS, SOIL AND SEDIMENT
6-17A	DETECTED CONCENTRATIONS OF THALLIUM IN THE LANDFILL PERIMETER TERRESTRIAL, FROID AND TAYLOR TERRESTRIAL, FROID AND TAYLOR AQUATIC, R AREA TERRESTRIAL AND AQUATIC, AND NORTH OTTER SLUICE AQUATIC UNITS, SOIL AND SEDIMENT
6-17B	DETECTED CONCENTRATIONS OF THALLIUM IN THE R AREA TERRESTRIAL UNIT, SOIL AND SEDIMENT
6-17C	DETECTED CONCENTRATIONS OF THALLIUM IN THE WOOD HOGGER TERRESTRIAL AND SOUTH OTTER SLUICE AQUATIC UNITS, SOIL AND SEDIMENT
6-18A	DETECTED CONCENTRATIONS OF VANADIUM IN THE LANDFILL PERIMETER TERRESTRIAL, FROID AND TAYLOR TERRESTRIAL, FROID AND TAYLOR AQUATIC, R AREA TERRESTRIAL AND AQUATIC, AND NORTH OTTER SLUICE AQUATIC UNITS, SOIL AND SEDIMENT
6-18B	DETECTED CONCENTRATIONS OF VANADIUM IN THE R AREA TERRESTRIAL UNIT, SOIL AND SEDIMENT
6-18C	DETECTED CONCENTRATIONS OF VANADIUM IN THE WOOD HOGGER TERRESTRIAL AND SOUTH OTTER SLUICE AQUATIC UNITS, SOIL AND SEDIMENT
6-19A	DETECTED CONCENTRATIONS OF ZINC IN THE LANDFILL PERIMETER TERRESTRIAL, FROID AND TAYLOR TERRESTRIAL, FROID AND TAYLOR AQUATIC, R AREA TERRESTRIAL AND AQUATIC, AND NORTH OTTER SLUICE AQUATIC UNITS, SOIL AND SEDIMENT
6-19B	DETECTED CONCENTRATIONS OF ZINC IN THE R AREA TERRESTRIAL UNIT, SOIL AND SEDIMENT
6-19C	DETECTED CONCENTRATIONS OF ZINC IN THE WOOD HOGGER TERRESTRIAL AND SOUTH OTTER SLUICE AQUATIC UNITS, SOIL AND SEDIMENT
6-20A	ANTIMONY IN R AREA DISPOSAL SITE SOIL AND SEDIMENT SAMPLES: BULK CHEMISTRY AND EXTRACTIONS
6-20B	ANTIMONY IN FROID AND TAYLOR ROADS SITE SOIL SAMPLES: BULK CHEMISTRY AND EXTRACTIONS
6-20C	ANTIMONY IN WOOD HOGGER SITE SOIL AND SEDIMENT SAMPLES: BULK CHEMISTRY AND EXTRACTIONS
6-21A	ARSENIC IN R AREA DISPOSAL SITE SOIL AND SEDIMENT SAMPLES: BULK CHEMISTRY AND EXTRACTIONS
6-21B	ARSENIC IN FROID AND TAYLOR ROADS SITE SOIL SAMPLES: BULK CHEMISTRY AND EXTRACTIONS

FIGURES (Continued)

Figure

6-21C ARSENIC IN WOOD HOGGER SITE SOIL AND SEDIMENT SAMPLES: BULK CHEMISTRY AND EXTRACTIONS

6-22A CADMIUM IN R AREA DISPOSAL SITE SOIL AND SEDIMENT SAMPLES: BULK CHEMISTRY AND EXTRACTIONS

6-22B CADMIUM IN FROID AND TAYLOR ROADS SITE SOIL SAMPLES: BULK CHEMISTRY AND EXTRACTIONS

6-22C CADMIUM IN WOOD HOGGER SITE SOIL AND SEDIMENT SAMPLES: BULK CHEMISTRY AND EXTRACTIONS

6-23A COPPER IN R AREA DISPOSAL SITE SOIL AND SEDIMENT SAMPLES: BULK CHEMISTRY AND EXTRACTIONS

6-23B COPPER IN FROID AND TAYLOR ROADS SITE SOIL SAMPLES: BULK CHEMISTRY AND EXTRACTIONS

6-23C COPPER IN WOOD HOGGER SITE SOIL AND SEDIMENT SAMPLES: BULK CHEMISTRY AND EXTRACTIONS

6-24A LEAD IN R AREA DISPOSAL SITE SOIL AND SEDIMENT SAMPLES: BULK CHEMISTRY AND EXTRACTIONS

6-24B LEAD IN FROID AND TAYLOR ROADS SITE SOIL SAMPLES: BULK CHEMISTRY AND EXTRACTIONS

6-24C LEAD IN WOOD HOGGER SITE SOIL AND SEDIMENT SAMPLES: BULK CHEMISTRY AND EXTRACTIONS

6-25A MERCURY IN R AREA DISPOSAL SITE SOIL AND SEDIMENT SAMPLES: BULK CHEMISTRY AND EXTRACTIONS

6-25B MERCURY IN FROID AND TAYLOR ROADS SITE SOIL SAMPLES: BULK CHEMISTRY AND EXTRACTIONS

6-25C MERCURY IN WOOD HOGGER SITE SOIL AND SEDIMENT SAMPLES: BULK CHEMISTRY AND EXTRACTIONS

6-26A NICKEL IN R AREA DISPOSAL SITE SOIL AND SEDIMENT SAMPLES: BULK CHEMISTRY AND EXTRACTIONS

6-26B NICKEL IN FROID AND TAYLOR ROADS SITE SOIL SAMPLES: BULK CHEMISTRY AND EXTRACTIONS

6-26C NICKEL IN WOOD HOGGER SITE SOIL AND SEDIMENT SAMPLES: BULK CHEMISTRY AND EXTRACTIONS

6-27A SELENIUM IN R AREA DISPOSAL SITE SOIL AND SEDIMENT SAMPLES: BULK CHEMISTRY AND EXTRACTIONS

6-27B SELENIUM IN FROID AND TAYLOR ROADS SITE SOIL SAMPLES: BULK CHEMISTRY AND EXTRACTIONS

6-27C SELENIUM IN WOOD HOGGER SITE SOIL AND SEDIMENT SAMPLES: BULK CHEMISTRY AND EXTRACTIONS

FIGURES (Continued)

Figure	
6-28A	SILVER IN R AREA DISPOSAL SITE SOIL AND SEDIMENT SAMPLES: BULK CHEMISTRY AND EXTRACTIONS
6-28B	SILVER IN FROID AND TAYLOR ROADS SITE SOIL SAMPLES: BULK CHEMISTRY AND EXTRACTIONS
6-28C	SILVER IN WOOD HOGGER SITE SOIL AND SEDIMENT SAMPLES: BULK CHEMISTRY AND EXTRACTIONS
6-29A	THALLIUM IN R AREA DISPOSAL SITE SOIL AND SEDIMENT SAMPLES: BULK CHEMISTRY AND EXTRACTIONS
6-29B	THALLIUM IN FROID AND TAYLOR ROADS SITE SOIL SAMPLES: BULK CHEMISTRY AND EXTRACTIONS
6-29C	THALLIUM IN WOOD HOGGER SITE SOIL AND SEDIMENT SAMPLES: BULK CHEMISTRY AND EXTRACTIONS
6-30A	ZINC IN R AREA DISPOSAL SITE SOIL AND SEDIMENT SAMPLES: BULK CHEMISTRY AND EXTRACTIONS
6-30B	ZINC IN FROID AND TAYLOR ROADS SITE SOIL SAMPLES: BULK CHEMISTRY AND EXTRACTIONS
6-30C	ZINC IN WOOD HOGGER SITE SOIL AND SEDIMENT SAMPLES: BULK CHEMISTRY AND EXTRACTIONS
6-31	DETECTED CONCENTRATIONS OF ARSENIC IN SURFACE WATER
6-32	DETECTED CONCENTRATIONS OF CHROMIUM IN SURFACE WATER
6-33	DETECTED CONCENTRATIONS OF COPPER IN SURFACE WATER
6-34	DETECTED CONCENTRATIONS OF LEAD IN SURFACE WATER
6-35	DETECTED CONCENTRATIONS OF MERCURY IN SURFACE WATER
6-36	DETECTED CONCENTRATIONS OF NICKEL IN SURFACE WATER
6-37	DETECTED CONCENTRATIONS OF ZINC IN SURFACE WATER
6-38A	DETECTED CONCENTRATIONS OF TOTAL DDTs IN THE LANDFILL PERIMETER TERRESTRIAL, FROID AND TAYLOR TERRESTRIAL, FROID AND TAYLOR AQUATIC, NORTH OTTER SLUICE AQUATIC, AND R AREA TERRESTRIAL AND AQUATIC UNITS, SOIL AND SEDIMENT
6-38B	DETECTED CONCENTRATIONS OF TOTAL DDTs IN THE R AREA TERRESTRIAL UNIT, SOIL AND SEDIMENT
6-38C	DETECTED CONCENTRATIONS OF TOTAL DDTs IN THE WOOD HOGGER TERRESTRIAL AND SOUTH OTTER SLUICE AQUATIC UNITS, SOIL AND SEDIMENT
6-39A	DETECTED CONCENTRATIONS OF DIELDRIN IN THE LANDFILL PERIMETER TERRESTRIAL, FROID AND TAYLOR TERRESTRIAL, FROID AND TAYLOR AQUATIC, NORTH OTTER SLUICE AQUATIC, AND R AREA TERRESTRIAL AND AQUATIC UNITS, SOIL AND SEDIMENT

FIGURES (Continued)

Figure

6-39B DETECTED CONCENTRATIONS OF DIELDRIN IN THE R AREA TERRESTRIAL UNIT, SOIL AND SEDIMENT

6-39C DETECTED CONCENTRATIONS OF DIELDRIN IN THE WOOD HOGGER TERRESTRIAL AND SOUTH OTTER SLUICE AQUATIC UNITS, SOIL AND SEDIMENT

6-40A DETECTED CONCENTRATIONS OF CHLORDANE IN THE LANDFILL PERIMETER TERRESTRIAL, FROID AND TAYLOR TERRESTRIAL, FROID AND TAYLOR AQUATIC, NORTH OTTER SLUICE AQUATIC, AND R AREA TERRESTRIAL AND AQUATIC UNITS, SOIL AND SEDIMENT

6-40B DETECTED CONCENTRATIONS OF CHLORDANE IN THE R AREA TERRESTRIAL UNIT, SOIL AND SEDIMENT

6-40C DETECTED CONCENTRATIONS OF CHLORDANE IN THE WOOD HOGGER TERRESTRIAL AND SOUTH OTTER SLUICE AQUATIC UNITS, SOIL AND SEDIMENT

6-41A DETECTED CONCENTRATIONS OF TOTAL BHCs IN THE LANDFILL PERIMETER TERRESTRIAL, FROID AND TAYLOR TERRESTRIAL, FROID AND TAYLOR AQUATIC, NORTH OTTER SLUICE AQUATIC, AND R AREA TERRESTRIAL AND AQUATIC UNITS, SOIL AND SEDIMENT

6-41B DETECTED CONCENTRATIONS OF TOTAL BHCs IN THE R AREA TERRESTRIAL UNIT, SOIL AND SEDIMENT

6-41C DETECTED CONCENTRATIONS OF TOTAL BHCs IN THE WOOD HOGGER TERRESTRIAL AND SOUTH OTTER SLUICE AQUATIC UNITS, SOIL AND SEDIMENT

6-42A DETECTED CONCENTRATIONS OF TOTAL PCBs IN THE LANDFILL PERIMETER TERRESTRIAL, FROID AND TAYLOR TERRESTRIAL, FROID AND TAYLOR AQUATIC, NORTH OTTER SLUICE AQUATIC, AND R AREA TERRESTRIAL AND AQUATIC UNITS, SOIL AND SEDIMENT

6-42B DETECTED CONCENTRATIONS OF TOTAL PCBs IN THE R AREA TERRESTRIAL UNIT, SOIL AND SEDIMENT

6-42C DETECTED CONCENTRATIONS OF TOTAL PCBs IN THE WOOD HOGGER TERRESTRIAL AND SOUTH OTTER SLUICE AQUATIC UNITS, SOIL AND SEDIMENT

6-43A DETECTED CONCENTRATIONS OF TOTAL PAHs IN THE LANDFILL PERIMETER TERRESTRIAL, FROID AND TAYLOR TERRESTRIAL, FROID AND TAYLOR AQUATIC, NORTH OTTER SLUICE AQUATIC, AND R AREA TERRESTRIAL AND AQUATIC UNITS, SOIL AND SEDIMENT

6-43B DETECTED CONCENTRATIONS OF TOTAL PAHs IN THE R AREA TERRESTRIAL UNIT, SOIL AND SEDIMENT

FIGURES (Continued)

Figure

6-43C DETECTED CONCENTRATIONS OF TOTAL PAHs IN THE WOOD HOGGER TERRESTRIAL AND SOUTH OTTER SLUICE AQUATIC UNITS, SOIL AND SEDIMENT

7-1 COMPLETE EXPOSURE PATHWAYS

7-2 FOOD WEB

7-3 CONCEPTUAL SITE MODEL, FATE AND TRANSPORT PROCESSES

EXHIBITS

Exhibit

1 TIDAL AREA HABITATS

2 RAIL AND SMALL MAMMAL SURVEY RESULTS

3 RI/QEA SOIL/SEDIMENT AND SURFACE WATER SAMPLE LOCATIONS

4 BIOASSAY AND TISSUE COLLECTION LOCATIONS

5 DETECTED CONCENTRATIONS OF ARSENIC IN SURFACE SOIL AND SEDIMENT

6 DETECTED CONCENTRATIONS OF CADMIUM IN SURFACE SOIL AND SEDIMENT

7 DETECTED CONCENTRATIONS OF COPPER IN SURFACE SOIL AND SEDIMENT

8 DETECTED CONCENTRATIONS OF LEAD IN SURFACE SOIL AND SEDIMENT

9 DETECTED CONCENTRATIONS OF MERCURY IN SURFACE SOIL AND SEDIMENT

10 DETECTED CONCENTRATIONS OF NICKEL IN SURFACE SOIL AND SEDIMENT

11 DETECTED CONCENTRATIONS OF SELENIUM IN SURFACE SOIL AND SEDIMENT

12 DETECTED CONCENTRATIONS OF SILVER IN SURFACE SOIL AND SEDIMENT

13 DETECTED CONCENTRATIONS OF ZINC IN SURFACE SOIL AND SEDIMENT

14 DETECTED CONCENTRATIONS OF TOTAL DDTs (LOW LEVEL METHOD) IN SURFACE SOIL AND SEDIMENT

15 DETECTED CONCENTRATIONS OF TOTAL DDTs (CLP METHOD) IN SURFACE SOIL AND SEDIMENT

16 DETECTED CONCENTRATIONS OF TOTAL LOW LEVEL AND CLP CHLORDANES IN SURFACE SOIL AND SEDIMENT

17 DETECTED CONCENTRATIONS OF DIOXINS (PCDD/Fs) IN SURFACE SOIL AND SEDIMENT

18 SAMPLE LOCATIONS THAT POSE A POTENTIAL RISK (HQ_2 OR $HQ_4 > 1.0$) TO BIRDS AND MAMMALS

19 HAZARD INDICES FOR INORGANIC CHEMICALS IN SURFACE SOIL AND SEDIMENT

20 HAZARD INDICES FOR ORGANIC CHEMICALS IN SURFACE SOIL AND SEDIMENT

TABLES

Table

3-1 TERRESTRIAL AND WETLAND PLANT SPECIES OBSERVED AT THE TIDAL AREA SITES

3-2 TERRESTRIAL AND WETLAND AQUATIC INVERTEBRATES AND FISH OCCURRING OR POTENTIALLY OCCURRING AT THE TIDAL AREA SITES

3-3 TERRESTRIAL AND WETLAND AMPHIBIANS, REPTILES, BIRDS, AND MAMMALS OCCURRING OR POTENTIALLY OCCURRING AT THE TIDAL AREA SITES

3-4 SPECIAL STATUS SPECIES OCCURRING OR POTENTIALLY OCCURRING AT THE TIDAL AREA SITES

4-1 NUMBER OF CHEMISTRY SAMPLES BY SITE AND MATRIX

4-2 NUMBER OF BIOLOGICAL AND TISSUE SAMPLES BY SITE

4-3 ANALYSES PERFORMED ON 1995 RI AND QEA SAMPLES

4-4 ANALYSES PERFORMED ON 1998 RI AND QEA SAMPLES

4-5 SPECIES COMPOSITION OF FISH TISSUE COMPOSITE SAMPLES

4-6 RATIONALE FOR SELECTING RODENT TRAPPING TARGET LOCATIONS AND RODENT TISSUE COMPOSITE SAMPLES

5-1 SCREENING VALUES FOR SOIL AND SEDIMENT

5-2 SCREENING VALUES FOR SURFACE WATER

6-1 TIDAL AREA LANDFILL PERIMETER, SUMMARY OF CHEMICALS IN SOIL AND SEDIMENT COMPARED TO SCREENING VALUES

6-2 TIDAL AREA LANDFILL, SUMMARY OF CHEMICALS IN SURFACE WATER COMPARED TO SCREENING VALUES

6-3 R AREA TERRESTRIAL UNIT, SUMMARY OF CHEMICALS IN SOIL AND SEDIMENT COMPARED TO SCREENING VALUES

6-4 R AREA TERRESTRIAL AND AQUATIC UNIT, SUMMARY OF CHEMICALS IN SOIL AND SEDIMENT COMPARED TO SCREENING VALUES

6-5 R AREA DISPOSAL SITE, SUMMARY OF CHEMICALS IN SURFACE WATER COMPARED TO SCREENING VALUES

6-6 FROID AND TAYLOR ROADS TERRESTRIAL UNIT, SUMMARY OF CHEMICALS IN SOIL AND SEDIMENT COMPARED TO SCREENING VALUES

6-7 FROID AND TAYLOR ROADS AQUATIC UNIT, SUMMARY OF CHEMICALS IN SOIL AND SEDIMENT COMPARED TO SCREENING VALUES

6-8 FROID AND TAYLOR ROADS, SUMMARY OF CHEMICALS IN SURFACE WATER COMPARED TO SCREENING VALUES

TABLES (Continued)

Table

6-9 WOOD HOGGER SITE, SUMMARY OF CHEMICALS IN SOIL AND SEDIMENT COMPARED TO SCREENING VALUES

6-10 WOOD HOGGER SITE, SUMMARY OF CHEMICALS IN SURFACE WATER COMPARED TO SCREENING VALUES

6-11 NORTH OTTER SLUICE AQUATIC UNIT, SUMMARY OF CHEMICALS IN SOIL AND SEDIMENT COMPARED TO SCREENING VALUES

6-12 NORTH OTTER SLUICE AQUATIC UNIT, SUMMARY OF CHEMICALS IN SURFACE WATER COMPARED TO SCREENING VALUES

6-13 SOUTH OTTER SLUICE AQUATIC UNIT, SUMMARY OF CHEMICALS IN SOIL AND SEDIMENT COMPARED TO SCREENING VALUES

6-14 SOUTH OTTER SLUICE AQUATIC UNIT, SUMMARY OF CHEMICALS IN SURFACE WATER COMPARED TO SCREENING VALUES

6-15 SUMMARY OF CONCENTRATIONS OF DETECTED INORGANIC CONSTITUENT CONCENTRATIONS IN SOIL AND SEDIMENT SAMPLES

6-16 SUMMARY OF DETECTED PESTICIDE CONCENTRATIONS IN SOIL AND SEDIMENT SAMPLES

6-17 SUMMARY OF DETECTED PCB CONCENTRATIONS IN SOIL AND SEDIMENT SAMPLES

6-18 SUMMARY OF DETECTED DIOXIN CONCENTRATIONS IN SOIL AND SEDIMENT SAMPLES

6-19 SUMMARY OF DETECTED SVOC CONCENTRATIONS IN SOIL AND SEDIMENT SAMPLES

6-20 SUMMARY OF DETECTED VOA AND AROMATIC CONCENTRATIONS IN SOIL AND SEDIMENT SAMPLES

6-21 SUMMARY OF DETECTED TPH CONCENTRATIONS IN SOIL AND SEDIMENT SAMPLES

6-22 COMPARISON OF WET-ACID AND WET-DI RESULTS TO QEA WATER SCREENING VALUES

6-23 INORGANIC COPECs

7-1 ASSESSMENT AND MEASUREMENT ENDPOINTS AND RATIONALE FOR THEIR SELECTION

7-2 RISK CHARACTERIZATION METHODOLOGY

8-1 MICROTOX AND CYTOCHROME P450 SOIL BIOASSAY RESULTS

8-2 AMPHIPOD (*Eohaustorius estuarius*) SEDIMENT BIOASSAY RESULTS, SURVIVAL AND REBURIAL

8-3 HATCHABILITY OF TOPSMELT EMBRYOS IN THE SEDIMENT-WATER INTERFACE BIOASSAY

TABLES (Continued)

Table

8-4 CORRELATIONS BETWEEN TOPSMELT HATCHABILITY AND TEST CONDITIONS

8-5A CONCENTRATIONS OF CHEMICALS IN PICKLEWEED TISSUE: R AREA

8-5B CONCENTRATIONS OF CHEMICALS IN RODENT TISSUE: R AREA

8-6A CONCENTRATIONS OF CHEMICALS IN AMPHIPOD TISSUE: FROID AND TAYLOR ROADS SITE, LOCATION FTSTI105

8-6B CONCENTRATIONS OF CHEMICALS IN FISH TISSUE: FROID AND TAYLOR ROADS SITE, LOCATION FTSTI103

8-7A CONCENTRATIONS OF CHEMICALS IN PICKLEWEED TISSUE: WOOD HOGGER SITE, LOCATION WHSB021

8-7B CONCENTRATIONS OF CHEMICALS IN RODENT TISSUE: WOOD HOGGER SITE

8-8A CONCENTRATIONS OF CHEMICALS IN CLAM TISSUE: NORTH OTTER SLUICE, LOCATION OSLSL002

8-8B CONCENTRATIONS OF CHEMICALS IN FISH TISSUE: NORTH OTTER SLUICE, LOCATION OSLSL002

8-9A CONCENTRATIONS OF CHEMICALS IN CLAM TISSUE: SOUTH OTTER SLUICE

8-9B CONCENTRATIONS OF CHEMICALS IN FISH TISSUE: SOUTH OTTER SLUICE

8-10 SUMMARY RESULTS: MICROTOX AND CYTOCHROME P450

8-11 SUMMARY MATRICES OF PEARSON CORRELATIONS AMONG SELECTED VARIABLES

8-12 SUMMARY MATRICES OF SPEARMAN RANK CORRELATIONS AMONG SELECTED VARIABLES

9-1 PHYSICAL CHARACTERISTICS OF TIDAL AREA SOILS

9-2 SEM/AVS RATIOS WITH CONCENTRATIONS OF METALS AND SULFIDES

9-3 SEM/AVS RATIOS AND SULFIDE CONCENTRATIONS AFTER METAL BINDING

10-1 IDENTIFICATION OF COPECs FOR PLANTS AND SOIL BIOTA AND TERRESTRIAL INVERTEBRATES, LANDFILL TERRESTRIAL UNIT

10-2 IDENTIFICATION OF COPECs FOR PLANTS AND SOIL BIOTA AND INVERTEBRATES, R AREA TERRESTRIAL UNIT

10-3 IDENTIFICATION OF COPECs FOR PLANTS AND SOIL BIOTA AND INVERTEBRATES, R AREA TERRESTRIAL AND AQUATIC UNIT

10-4 IDENTIFICATION OF COPECs FOR PLANTS AND SOIL BIOTA AND INVERTEBRATES, FROID AND TAYLOR TERRESTRIAL UNIT

10-5 IDENTIFICATION OF COPECs FOR PLANTS AND SOIL BIOTA AND INVERTEBRATES, FROID AND TAYLOR AQUATIC UNIT

10-6 IDENTIFICATION OF COPECs FOR PLANTS AND SOIL BIOTA AND INVERTEBRATES, WOOD HOGGER TERRESTRIAL UNIT

TABLES (Continued)

Table

10-7 POTENTIAL CRITICAL VALUES FOR SELECTED SOIL FACTORS (PHYSICAL AND CHEMICAL) ASSOCIATED WITH POOR VEGETATIVE GROWTH

10-8 SOIL CONCENTRATIONS IN REFERENCE TO PRELIMINARY REMEDIATION GOALS AND TOXICOLOGICAL BENCHMARKS, LANDFILL TERRESTRIAL UNIT

10-9 SOIL CONCENTRATIONS IN REFERENCE TO PRELIMINARY REMEDIATION GOALS AND TOXICOLOGICAL BENCHMARKS, R AREA TERRESTRIAL UNIT

10-10 SOIL CONCENTRATIONS IN REFERENCE TO PRELIMINARY REMEDIATION GOALS AND TOXICOLOGICAL BENCHMARKS, FROID AND TAYLOR TERRESTRIAL UNIT

10-11 SOIL CONCENTRATIONS IN REFERENCE TO PRELIMINARY REMEDIATION GOALS AND TOXICOLOGICAL BENCHMARKS, WOOD HOGGER TERRESTRIAL UNIT

10-12 SUMMARY OF CONCENTRATIONS OF SELECTED PLANT NUTRIENTS IN WESTERN SOILS

12-1 IDENTIFICATION OF COPECs FOR FISH

12-2 COMPARISON OF SITE AND REGIONAL FISH TISSUE

13-1 IDENTIFICATION OF COPECs FOR AQUATIC INVERTEBRATES, R AREA TERRESTRIAL AND AQUATIC UNIT

13-2 IDENTIFICATION OF COPECs FOR AQUATIC INVERTEBRATES, FROID AND TAYLOR AQUATIC UNIT

13-3 IDENTIFICATION OF COPECs FOR AQUATICS, NORTH OTTER SLUICE AQUATIC UNIT

13-4 IDENTIFICATION OF COPECs FOR AQUATIC INVERTEBRATES, SOUTH OTTER SLUICE AQUATIC UNIT

13-5 TISSUE RESIDUES OF CLAMS FROM THE TIDAL AREA COMPARED TO REGIONAL BIVALVE DATA

14-1 IDENTIFICATION OF COPECs FOR REPTILES AND AMPHIBIANS

15-1 BACK-CALCULATED SOIL OR SEDIMENT CONCENTRATIONS WHERE HQ_2 IS EQUAL TO 1.0 FOR ALL TIDAL AREA UNITS

15-2 TERRESTRIAL SAMPLE LOCATIONS AT WHICH CONCENTRATIONS POSE A POSSIBLE RISK TO BIRDS AND MAMMALS (BY UNIT AREA)

15-3 AQUATIC SAMPLE LOCATIONS AT WHICH CONCENTRATIONS POSE A POSSIBLE RISK TO BIRDS AND MAMMALS (BY UNIT AREA)

16-1 WEIGHT-OF-EVIDENCE APPROACH BY HABITAT UNIT

16-2 WEIGHT-OF-EVIDENCE APPROACH BY ASSESSMENT ENDPOINT

ABBREVIATIONS AND ACRONYMS

AhR	Aryl hydrocarbon receptor
ALAD	Amino-levulenic acid dehydratase
ARAR	Applicable or relevant and appropriate requirements
ASTM	American Society for Testing and Materials
ATP	Adenosine triphosphate
ATSDR	Agency for Toxic Substances and Disease Registry
AWQC	Ambient water quality criteria
BAF	Bioaccumulation factor
bgs	Below ground surface
BHC	Hexachlorocyclohexane
BTAG	Biological technical advisory group
BTEX	Benzene, toluene, ethylbenzene, and xylenes
Cal/EPA	California Environmental Protection Agency
CCC	Criteria continuous concentration
CDFG	California Department of Fish and Game
CEC	Cation exchange capacity
CEQA	California Environmental Quality Act
CFR	Code of Federal Regulations
CLP	Contract laboratory program
CLEAN	Comprehensive Long-Term Environmental Action Navy
CNDDB	California Natural Diversity Data Base
CNPS	California Native Plant Society
COEC	Chemical of ecological concern
COPEC	Chemical of potential ecological concern
CTO	Contract task order
CWA	Clean Water Act
DDD	Dichlorodiphenyldichloroethane
DDE	Dichlorodiphenyldichloroethene
DDT	Dichlorodiphenyltrichloroethane
DI	Deionized
DNB	Dinitrobenzene
DTSC	Department of Toxic Substances Control
E&E	Ecology and Environment
EFA WEST	Engineering Field Activity West
EIR	Environmental impact report

ABBREVIATIONS AND ACRONYMS (Continued)

EOD	Explosive ordnance disposal
EPA	U.S. Environmental Protection Agency
ERA	Ecological risk assessment
ER-L	Effects range-low
ER-M	Effects range-median
FAIRS	Florida Agricultural Information Retrieval System
FS	Feasibility study
FSA	Field sampling addendum
FTA	Froid and Taylor Aquatic
FTT	Froid and Taylor Terrestrial
HMW	High molecular weight
HMX	Cyclotetramethylene tetranitramine
HPCDD	Heptachlorodibenzodioxin
HPCDF	Heptachlorodibenzofuran
HQ	Hazard quotient
IAS	Initial assessment study
Ibis	Ibis Environmental Services
IT	IT Corporation
kg/day	Kilograms per day
LFT	Landfill Perimeter Terrestrial
LMW	Low molecular weight
LOAEL	Lowest observed adverse effect level
LOEC	Lowest observed effect concentration
LOEL	Lowest observed effect level
MFO	Mixed-function oxidase
mg/kg	Milligrams per kilogram
mg/L	Milligrams per liter
mL	Milliliters
mm	Millimeter
msl	Mean sea level
Navy	U.S. Department of the Navy
NEESA	Naval Energy and Environmental Support Activity
NFD	Naval Fuel Depot
NFEC	Naval Facilities Engineering Command

ABBREVIATIONS AND ACRONYMS (Continued)

ng/kg	Nanograms per kilogram
NOAA	National Oceanic and Atmospheric Administration
NOAEL	No observed adverse effect level
NOEC	No observed effect concentration
NOSA	North Otter Sluice Aquatic
NWS SBD	Naval Weapons Station, Seal Beach Detachment
OCDD	Octachlorodibenzodioxin
ORNL	Oak Ridge National Laboratory
PAH	Polynuclear aromatic hydrocarbon
PCB	Polychlorinated biphenyls
PCDD	Polychlorinated dibenzodioxin
PCDF	Polychlorinated dibenzofuran
PCP	Pentachlorophenol
PERL	Pacific Eco-Risk Laboratory
PG&E	Pacific Gas and Electric Company
pg/g	Picograms per gram
ppb	Parts per billion
ppm	Parts per million
ppt	Parts per thousand
PRC	PRC Environmental Management, Inc.
PRG	Preliminary remediation goal
PVC	Polyvinyl chloride
QA	Quality assurance
QAPjP	Quality assurance project plan
QC	Quality control
QCSR	Quality control summary report
QEA	Qualitative ecological risk assessment
RAT	R Area Disposal Terrestrial
RATA	R Area Disposal Terrestrial and Aquatic
RCRA	Resource Conservation and Recovery Act
RFA	RCRA facility assessment
RGS	Reporter gene system
RI	Remedial investigation
RLU	Relative light units
RMP	Regional Monitoring Program
ROD	Record of decision
RWQCB	California Regional Water Quality Control Board, San Francisco Bay Region

ABBREVIATIONS AND ACRONYMS (Continued)

SCS	U.S. Soil Conservation Service
SEM/AVS	Simultaneously extractable metals/acid volatile sulfides
SFEI	San Francisco Estuary Institute
SFEP	San Francisco Estuary Project
SI	Site inspection
SOSA	South Otter Sluice Aquatic
SQL	Sample quantitation limit
SUF	Site use factor
SVOC	Semivolatile organic compound
SWI	Sediment-water interface
SWMU	Solid waste management unit
TCDD	Tetrachlorodibenzodioxin
TEF	Toxic equivalency factor
TEQ	Toxic equivalent
TOC	Total organic carbon
TPH-e	Total petroleum hydrocarbons-extractable
TPH-p	Total petroleum hydrocarbons, purgeable
TRV	Toxicity reference value
TtEMI	Tetra Tech EM Inc.
UCB	University of California Berkeley
UCL	Upper confidence limit
USACE	U.S. Army Corps of Engineers
USFWS	U.S. Fish and Wildlife Service
VOC	Volatile organic compound
WES	Waterways Experiment Station
WESCO	Western Ecological Services Company
WET	Waste extraction test
WHO	World Health Organization
WHT	Wood Hogger Terrestrial
μg/g	Micrograms per gram
μg/kg	Micrograms per kilogram
μg/L	Micrograms per liter
μL	Microliters
μm	Micrometer

EXECUTIVE SUMMARY

The U.S. Department of the Navy (Navy) conducted a remedial investigation and feasibility study (RI/FS) at four Tidal Area sites at the Naval Weapons Station, Seal Beach Detachment (NWS SBD) Concord, California. These sites include the Tidal Area Landfill Site (Site 1), R Area Disposal Site (Site 2), Froid and Taylor Roads Site (Site 9), and Wood Hogger Site (Site 11). As part of the RI/FS, the Navy evaluated the ecological risks posed by the Tidal Area sites, including Otter Sluice, which is adjacent to two of the Tidal Area sites. This report, which is Volume II of the RI/FS report, summarizes the results of that qualitative ecological risk assessment (QEA).

OBJECTIVES

The objective of the QEA described in this report was to identify risk to ecological receptors resulting from site activities at the Tidal Area. Ecological risk assessments are by nature complex, as they involve evaluation of field data on population and ecosystem characteristics, as well as media concentrations. Therefore, the methods to establish risk to receptors at the Tidal Area sites were developed by the Navy in consultation with the regulatory agencies.

METHODS

To evaluate risk to receptors, the QEA drew from two data sources: (1) data collected during the 1995 RI and (2) additional data collected in 1998 to fill in specific data gaps that were identified after the draft QEA report was submitted in 1997. Quantitative data that were collected and used to assess exposure to, and potential toxic effects of, chemicals to assessment endpoints included:

- Surveys of flora and fauna to identify key receptors
- Chemical analyses of soil, sediment, surface water, and leachate samples to evaluate the nature and extent of contamination
- Measurements of other parameters such as grain size, pH, and total organic carbon that aid in estimation of bioavailability of chemical stressors
- Bioassays to evaluate direct toxicity to invertebrates
- Chemical analysis of tissue residue of selected plants, invertebrates, and vertebrates to evaluate the potential for bioaccumulation and trophic transfer of chemicals
- Food-chain modeling to determine potential doses received by high level predators.

Literature reviews were also conducted on a variety of topics to facilitate interpretation of site-specific data.

To identify chemicals of potential ecological concern (COPEC) for the Tidal Area, all chemicals that were detected at the Tidal Area were compared to screening values. For soil and sediment, the screening values used to identify COPECs included the following:

- *Ambient values* from site-specific sampling at the Tidal Area and from regional San Francisco Bay studies (only for inorganic chemicals)
- *Effects range-low (ER-L) values*, which are based on the chemical and biological effects that were observed during a wide variety of studies on invertebrates in marine and marine-freshwater sediments

For surface water, the screening values included the following:

- *Ambient water quality criteria (AWQC)*, specifically national chronic saltwater or freshwater ambient values, or the California proposed chronic saltwater or freshwater values
- *San Francisco Bay Basin Plan water quality objectives*, for areas upstream of San Pablo Bay

If criteria were unavailable, the detected chemical was considered a COPEC.

Each COPEC was further evaluated in terms of toxicity and bioaccumulation as part of the risk characterization conducted for each ecological receptor group. Receptor groups included plants, invertebrates, fish, reptiles and amphibians, and birds and mammals. Based on the risk characterization, chemicals of ecological concern (COEC) were then identified.

Risks to each type of receptor were then characterized using a weight-of-evidence approach. As part of the weight-of-evidence approach, several lines of evidence (for example, chemistry data, tissue residue data, and bioassays) were evaluated to determine whether a site poses a risk to ecological receptors. By incorporating all available data, risks can be sufficiently characterized, and a decision whether to conduct further evaluations or conduct a response action can be made.

CONCLUSIONS AND RECOMMENDATIONS

The following subsections summarize the weight-of-evidence approach for evaluating risks to ecological receptors at the Tidal Area sites. Otter Sluice, which is adjacent to two of the Tidal Area

sites is evaluated separately in the following discussions, because it represents a separate, distinct habitat unit.

Tidal Area Landfill Site (Site 1)

The Tidal Area Landfill has progressed to the record of decision phase, based on a presumptive remedy (capping), and is being addressed separately from the other Tidal Area sites. However, the risk from chemicals at the perimeter of the landfill as a potential source of chemicals to the adjacent R Area Disposal Site is evaluated as part of this report.

Elevated concentrations of a few selected metals and organic chemicals were detected in soil, sediment, and surface water. However, they were isolated and not indicative of widespread contamination that could be attributable to site releases. The risk characterization indicated that there were no risks to any of the receptor groups evaluated during the QEA.

Based on the weight of evidence, chemicals from the landfill do not pose a risk to ecological receptors to adjacent Tidal Area sites. Therefore, no further evaluation or response action is recommended for the perimeter of the Tidal Area Landfill.

R Area Disposal Site (Site 2)

Elevated concentrations of selected metals and organic chemicals were detected in soil, sediment, and surface water. However, they were isolated and not indicative of wide-spread contamination that could be attributable to site releases.

Limited risk to soil biota and terrestrial invertebrates was identified; however, this was based on a few limited exceedances of screening values. Pickleweed and rodent tissue were collected from the R Area Disposal Site; some metals, including lead, were detected in the tissue residue. Based on the food-chain modeling results, however, there is no immediate or significant risk to birds and mammals from the chemicals at the R Area Disposal Site.

Based on the weight of evidence, chemicals from the R Area Disposal Site do not pose a risk to ecological receptors. Therefore, no further evaluation or response action is recommended for the R Area Disposal Site.

Froid and Taylor Roads Site (Site 9)

Elevated concentrations of organic chemicals were detected in soil, sediment, and surface water. However, they were generally isolated and may not be indicative of wide-spread contamination that could be attributable to site releases. Chlordane exceeded screening values in four soil and sediment samples. However, chlordane concentrations in fish and amphipods collected from the site were lower than concentrations from regional fish data. Limited risk to soil biota and terrestrial invertebrates was identified; however, this was based on a few limited exceedances of screening values. Based on the food-chain model results, there is no immediate or significant risk to birds and mammals from the chemicals at the Froid and Taylor Roads Site.

Based on the weight of evidence, chemicals from the Froid and Taylor Roads Site do not pose a risk to ecological receptors. Therefore, no further evaluation or response action is recommended for the Froid and Taylor Roads Site.

Wood Hogger Site (Site 11)

Elevated concentrations of inorganic and organic chemicals were detected in soil, sediment, and surface water. Elevated concentrations of chemicals at the Wood Hogger Site are clustered in the southwest corner, near the former incinerator.

Selected inorganic chemicals exceeded soil benchmarks for terrestrial invertebrates, and may pose a risk to organisms living in direct contact with the soil. However, the Wood Hogger is a disturbed site, used for industrial purposes with limited ecological relevance. The habitat quality is poor in the southwest corner of the Wood Hogger due to previous industrial activity.

The field sampling event of 1998 was implemented in part to address concerns that dioxins present at the Wood Hogger Site were being transported into Otter Sluice and taken up by fish. In fact, dioxin levels in fish tissues from Otter Sluice did not differ from those caught in San Francisco Bay. In addition, dioxins were below the detection limits in sediments in Otter Sluice. Based on the food-chain model results, there is no immediate or significant risk to birds and mammals. However, there is a potential risk to birds and mammals from dioxins.

Based on the weight of evidence, chemicals from the Wood Hogger Site pose minimal risk to ecological receptors. Therefore, no further evaluation or response action is recommended for the Wood Hogger Site.

Otter Sluice

Elevated concentrations of selected metals and organic chemicals were detected in sediment and surface water. However, they were generally isolated and not indicative of wide-spread contamination that could be attributable to site releases. Mercury was detected in sediments along a gradient in Otter Sluice near the southwestern boundary of the Wood Hogger Site.

Inorganics and organics were detected in fish and clam tissues; however, concentrations were within the range of reported values for fish or bivalves based on regional data. Based on the food-chain modeling results, there is no immediate or significant risk to birds and mammals.

The sediments from Otter Sluice were also evaluated for toxicity using a sediment-water interface bioassay using topsmelt embryos. Some of the bioassays showed toxicity; however, results were inconclusive due to potential confounding factors. Whole sediment amphipod bioassays were also conducted in Otter Sluice; no sediment samples from Otter Sluice were found to be toxic to amphipods.

Based on the weight of evidence, chemicals pose minimal risk to ecological receptors in Otter Sluice. Therefore, no further evaluation or response action is recommended for Otter Sluice.

Summary of Recommendations

The objectives of the QEA, which were developed in a series of meetings held with the regulatory agencies, were to identify risk to ecological receptors resulting from site activities at the Tidal Area. Based on the weight-of-evidence evaluation, sufficient environmental data exist to support a decision for the Tidal Area. Decisions for a Comprehensive Environmental Response, Compensation, and Liability Act site, such as the Tidal Area, reflect input by all parties involved in the risk assessment process, including the Navy, the U.S. Environmental Protection Agency, the California Environmental Protection Agency (Department of Toxic Substances Control and Regional Water Quality Control Board), the U.S. Fish and Wildlife Service, the California Department of Fish and Game, the National Oceanic and Atmospheric Administration, and the public. The Navy's recommendation is that no further evaluation or response action be required for the Tidal Area sites.

TABLE ES-1

SUMMARY OF PRELIMINARY RECOMMENDATIONS AND CONCLUSIONS FOR REMEDIAL INVESTIGTION

	Human Health Risk Result (RME)[a]	HHRA Risk Drivers	Qualitative Ecological Risk Assessment	Preliminary Conclusions
SITE 1, TIDAL AREA LANDFILL SITE	Residential Risk: 9×10^{-5} HI: 2	Soil: Arsenic present at ambient levels; benzo(a)pyrene comparable to background levels	The site does not pose an immediate risk to ecological receptors.	No HHRA or ERA risk established; however a presumptive remedy to cap the landfill is currently in place.
	Industrial Risk: 1×10^{-5} HI: < 1	Soil: Arsenic present at ambient levels		
SITE 2, R AREA DISPOSAL SITE	Residential Risk: 4×10^{-5} HI: < 1	Soil: Arsenic present at ambient levels, benzo(a)pyrene and dibenz(a, h)anthracene comparable to background levels	The site does not pose an immediate risk to ecological receptors.	No HHRA or ERA risk established. Navy recommends no further action at the site and a Record of Decision be prepared.
	Industrial Risk: 6×10^{-6} HI: < 1	Soil: Arsenic present at ambient levels		
	Surface Water: Risk < 1×10^{-6} HI: < 1	No risk drivers identified		

TABLE ES-1 (Continued)

SUMMARY OF PRELIMINARY RECOMMENDATIONS AND CONCLUSIONS FOR REMEDIAL INVESTIGTION

	Human Health Risk Result (RME)[a]	HHRA Risk Drivers	Qualitative Ecological Risk Assessment	Preliminary Conclusions
SITE 9, FROID AND TAYLOR ROADS SITE	Residential Risk: 3×10^{-6} HI: < 1	Soil: Benzo(a)pyrene at background levels, Lead exceeds residential PRG	The site does not pose an immediate risk to ecological receptors.	No HHRA or ERA risk established. Navy recommends no further action at the site and a Record of Decision be prepared.
	Industrial Risk: $< 1 \times 10^{-6}$ HI: < 1	No risk drivers identified		
	Surface Water: 5×10^{-6} HI: < 1	Surface water: Arsenic		
SITE 11, WOOD HOGGER SITE	Residential Risk: 2×10^{-4} HI: < 1	Soil: Arsenic present at ambient levels; carcinogenic PAHs comparable to background levels; dioxins and furans	The site does not pose an immediate risk to ecological receptors.	No HHRA or ERA risk established. Navy recommends no further action at the site and a Record of Decision be prepared.
	Industrial Risk: 2×10^{-5} HI: < 1	Soil: Arsenic present at ambient levels; benzo(a)pyrene and dibenz(a,h)anthracene comparable to background levels; dioxins and furans		
	Surface Water: Risk $< 1 \times 10^{-6}$ HI: < 1	No surface water risk drivers identified		

TABLE ES-1 (Continued)

SUMMARY OF PRELIMINARY RECOMMENDATIONS AND CONCLUSIONS FOR REMEDIAL INVESTIGTION

Notes:

a Risk assessment results are presented only when the risk exceeds 1E-06. The hazard index is the maximum segregated hazard index. Both surface and subsurface soils were analyzed in the HHRA; the cancer risk and hazard index values presented in the table are for the greater of the two depth intervals.

ERA Ecological risk assessment

HHRA Human health risk assessment

HI Hazard index

PRG EPA Region IX preliminary remediation goals

RME Reasonable maximum exposure

1.0 INTRODUCTION

The U.S. Department of the Navy (Navy), Engineering Field Activity West (EFA WEST) conducted a remedial investigation and feasibility study (RI/FS) at four Tidal Area sites at the Naval Weapons Station, Seal Beach Detachment (NWS SBD) Concord, California (see Figures 1-1 and 1-2). As part of the RI/FS, EFA WEST authorized Tetra Tech EM Inc. (TtEMI), formerly PRC Environmental Management, Inc. (PRC), to evaluate the ecological risks presented by the Tidal Area sites (Tidal Area Landfill, R Area Disposal, Froid and Taylor Roads and Wood Hogger Sites). A qualitative ecological risk assessment (QEA) was conducted at the Tidal Area Sites, and this report, which is Volume II of the RI/FS report, summarizes the results of that QEA.

This QEA identifies the objectives of the assessment, characterizes site conditions, identifies and evaluates chemicals of potential ecological concern (COPEC), and identifies ecological receptors potentially at risk from chemicals in the Tidal Area. In part, this QEA provides a baseline for evaluating whether a response action is warranted to reduce risk to ecological receptors.

1.1 BACKGROUND AND OBJECTIVES

The objective of the QEA was to identify risk to ecological receptors resulting from site activities at the Tidal Area. Ecological risk assessments are by nature complex, as they involve evaluation of field data on population and ecosystem characteristics, as well as media concentrations. Therefore, the methods to establish risk to receptors at the Tidal Area sites were developed in a series of meetings held with the regulatory agencies. The approach for evaluating ecological risks of site chemicals at the Tidal Area sites was initially outlined in the "RI/FS Tidal Area Sites Draft Final Work Plans" (PRC 1994a; 1995a). Volume I of the work plan (PRC 1994a) focused on the RI/FS and Volume II (PRC 1995a) focused on the QEA. The details of initial field sampling procedures were outlined in the "RI/FS Tidal Area Sites Draft Final Field Sampling Plan" (PRC 1995b). Field work for the draft RI and QEA was conducted in 1995 and the draft QEA report was submitted in 1997 (PRC 1997).

As a result of regulatory agency comments on the draft QEA (PRC 1997), it was determined that data gaps existed that required additional sampling and investigation. The additional sampling to fill data gaps was outlined in the "Field Sampling Plan Addendum" (TtEMI 1998a). The objectives of the 1998 field investigation were developed in a series of meetings held with the regulatory agencies in early 1998. It was agreed that the overall objectives would be to focus on following data gaps:

- Characterize the nature, extent, and toxicity of potential contamination in Otter Sluice by collecting sediment, surface water, and tissue samples, and conducting bioassays
- Characterize the nature and extent of dioxins associated with historical incineration near the Wood Hogger, and analyze rodent tissues from this site for metals, pesticides, and dioxins
- Provide site-specific dose estimates of chemicals ingested by birds and mammals for comparison to toxicity reference values (TRV) by analyzing tissues of resident animals
- Document the presence or absence of several special-status species through field surveys

The additional field activities were conducted in June 1998 at three of the four Tidal Area sites: Site 2 (R Area Disposal), Site 9 (Froid and Taylor Roads), and Site 11 (Wood Hogger); additionally, the portion of Otter Sluice that borders the R Area Disposal and the Wood Hogger Sites was also evaluated for risks to ecological receptors. No additional investigations were conducted for Site 1 (Tidal Area Landfill) in 1998. Additionally, the Tidal Area Landfill has progressed to the record of decision (ROD) phase and is being addressed separately. However, the risk from chemicals at the perimeter of the landfill as a potential source of chemicals to the adjacent R Area Disposal Site is evaluated as part of this report.

As a result, the draft final QEA draws information from two field sampling investigations: (1) sampling conducted in the summer of 1995 for the draft RI and QEA and (2) additional field activities conducted in the summer of 1998 to fill data gaps and support the draft final RI and QEA, as mentioned above. Investigation methods for the 1995 draft RI and QEA are detailed in the Tidal Area RI and QEA work plan (PRC 1995). The investigation methods for the additional Tidal Area sampling, are detailed in the 1998 field sampling addendum (FSA) (to the RI work plan [PRC 1994a]) (TtEMI 1998a). Issues related to quality control were presented in the "RI/FS Tidal Area Sites Draft Final Quality Assurance Project Plan" (PRC 1995c).

1.2 TECHNICAL APPROACH

The technical approach presented in the original work plan focused on ecological characterization, including (1) identifying ecological receptors at risk, (2) delineating wetland habitats, (3) identifying chemicals of ecological concern (COEC), (4) formulating a conceptual site model, and (5) evaluating risk to groups of ecological receptors using a weight-of-evidence approach. The original technical approach was supplemented with standard risk assessment guidelines recommended in U.S. Environmental Protection Agency (EPA 1992, 1998) and California Environmental Protection

Agency (Cal/EPA) Department of Toxic Substances Control (DTSC) guidance (DTSC 1996), as well as by American Society for Testing and Materials (ASTM) methods. This report is consistent with a baseline ecological risk assessment (ERA) as described under the Navy's policy for ERAs (Navy 1999). In addition, the Navy has been developing a regional approach to ERAs at naval installations in conjunction with the Biological Technical Advisory Group (BTAG) to ensure that the most appropriate tools and approaches are incorporated into all Navy risk assessments (EFA WEST 1998). One tool identified in the regional approach that was included in this risk assessment is food-chain modeling and evaluation of potential risks to higher-level receptors from dietary intake of chemicals. A brief overview of available guidance and the regional approach are discussed in the following section and should be considered in the context of a refinement of the original work plan.

1.2.1 The Framework Approach

The approach for the QEA at the Tidal Area sites was developed using guidance outlined by EPA and DTSC, including "A Framework for Ecological Risk Assessment" (EPA 1992), Guidelines for Ecological Risk Assessment" (EPA 1998), "Guidance for Ecological Risk Assessment at Hazardous Waste Sites and Permitted Facilities" (DTSC 1996), and "Navy Policy for Conducting Ecological Risk Assessment" (Navy 1999). Regardless of the tools applied to the process, QEAs are generally composed of four basic, interactive steps, which vary as a function of level of effort and the regulatory drivers rather than their conceptual content (EPA 1992). This framework includes four main components:

- **Problem Formulation**: The first step involves identifying key factors to be considered in the QEA and compiling available information and data on the site, the nature and extent of site-specific stressors, and the natural resources at risk. In the preliminary analysis, stressors such as chemicals of potential concern are identified, and biological species and endpoints to be considered in the QEA are determined. This information is used to formulate a conceptual site model and to identify the scope and goals of the QEA.

- **Exposure Assessment**: In the second step, the biological receptors likely to encounter the chemical stressors are identified. The likely exposure routes (for example, dermal contact or ingestion) and the spatial and temporal variation in exposure at the sites are identified. The release, migration, and fate of chemicals of potential concern are evaluated with respect to biotic and abiotic factors that influence exposure of ecological receptors.

- **Ecological Effects Assessment**: The potential adverse effects of exposure to chemical stressors on ecological receptors is then evaluated. The relationship between the degree of exposure and ecological effects is assessed using field measures and available ecotoxicological literature.

- **Risk Characterization**: In the final step, information gained during the exposure assessment and the ecological effects assessment is integrated to evaluate the relationship between environmental stressors and adverse ecological effects. This integration relies primarily on strength of weight-of-evidence arguments developed on the basis of existing information. The degree of confidence in the risk assessment is evaluated by identifying important sources of uncertainty, as well as underlying assumptions used in the analysis. Based on the risk characterization, risk management recommendations can be made.

Whenever possible, quantitative tools were used to describe these relationships.

1.2.2 Summary of the Ecological Risk Assessment Approach for the Tidal Area Sites

This QEA thus represents a synthesis of the best available approaches to conducting risk assessments, reflecting the four components suggested by EPA guidance: (1) problem formulation, (2) exposure assessment, (3) effects assessment, and (4) risk characterization. In addition, this effort went beyond the Tier I level screening assessment to a more rigorous evaluation of data (such as in a Tier II evaluation), where sufficient data were available (Navy 1999). Finally, the risk to high trophic level receptors from dietary intake of chemicals was evaluated in cases where sufficient data were available, consistent with the Navy's regional approach (EFA WEST 1998).

As part of the QEA, quantitative data were collected and used to assess exposure to, and potential toxic effects of, chemicals to assessment endpoints. Specific types of data collected in the QEA for the Tidal Area included:

- Surveys of flora and fauna to identify key receptors
- Chemical analyses of soil, sediment, surface water, and leachate samples to evaluate the nature and extent of contamination
- Measurements of other parameters such as grain size, pH, and total organic carbon (TOC) that aid in estimation of bioavailability of chemical stressors
- Bioassays to evaluate direct toxicity to invertebrates
- Chemical analysis of tissue residue of selected plants, invertebrates, and vertebrates to evaluate the potential for bioaccumulation and trophic transfer of chemicals
- Food-chain modeling to determine potential doses received by high level predators.

Literature reviews were also conducted on a variety of topics to facilitate interpretation of site-specific data.

1.3 OVERVIEW OF REPORT

The technical approach to the QEA is outlined in Section 1.0. Section 2.0 presents the facility background and setting, and describes the physical and environmental setting, site histories, and prior data on chemical contamination.

The ecological setting is characterized in Section 3.0 and includes descriptions of habitats and species likely to occur at the Tidal Area sites. The ecological characterization was used to support the selection of assessment endpoints for the QEA. Section 4.0 discusses the sampling strategy, locations, analytical methods, and quality assurance and quality control (QA/QC). Section 5.0 provides an overview of how chemicals were screened to determine COPECs upon which the QEA was based. The nature and extent of contamination, including analytical results for inorganic and organic constituents and screening of constituents for soil, sediment, leachate extractions, and surface water, are discussed in Section 6.0.

Section 7.0 presents the conceptual site model including stressors, assessment and measurement endpoints, complete exposure pathways, and potential fate and transport processes. Section 8.0 presents the biological data, including tissue residues and results of the bioassays (Microtox, Cytochrome P450, amphipod, and sediment-water interface [SWI] topsmelt). Section 9.0 discusses the bioavailability of chemicals based on bioaccumulation measured in tissue and on physicochemical factors affecting bioavailability.

The exposure and effects assessment and risk characterization is presented by receptor group, and is focused on plants (Section 10.0), soil biota and terrestrial invertebrates (Section 11.0), aquatic fish (Section 12.0), aquatic invertebrates (Section 13.0), reptiles and amphibians (Section 14.0), and birds and mammals (Section 15.0). The risk characterization was based on a weight-of-evidence approach whereby all relevant data were included in the evaluation of risk.

All of the information from the preceding sections is synthesized in Section 16.0. This section summarizes the risk at the four Tidal Area sites and Otter Sluice. Section 16.0 also includes an uncertainty analysis, identifies potential confounding noncontaminant stressors that may affect the evaluation of risk, and discusses data limitations. Preliminary recommendations for the Tidal Area, in terms of identifying and reducing risk to ecological receptors from the COECs at the site, are also presented in Section 16.0; these preliminary recommendations represent points for discussion with the regulatory and trustee agencies.

2.0 FACILITY BACKGROUND AND SETTING

The following sections describe the general setting, land use, transportation, facility history, current operations, environmental setting, and Tidal Area site history. Physical characteristics of the specific investigation sites, such as physical setting, geology, hydrology, and contaminant distribution, are discussed in the RI report contained in Volume I.

2.1 LOCATION

NWS SBD Concord is located in the north-central portion of Contra Costa County, California, about 30 miles northeast of San Francisco. The facility, which encompasses about 13,000 acres, is bounded by Suisun Bay to the north and by the City of Concord to the south and west (see Figure 1-1). Currently, the facility contains three main separate land holdings: the Tidal Area, the Inland Area, and a radiography facility in Pittsburg, California. The RI/FS addressed the following four sites, located within the Tidal Area:

- Site 1: Tidal Area Landfill
- Site 2: R Area Disposal
- Site 9: Froid and Taylor Roads
- Site 11: Wood Hogger

Because a separate ROD is being prepared for the Tidal Area Landfill, this QEA only addresses the risk from contaminants at the perimeter of the landfill as a potential source of contaminants to the adjacent R Area Disposal Site. The portion of Otter Sluice that borders the R Area Disposal Site and the Wood Hogger Site was also investigated as part of the RI/FS, and is discussed in detail throughout the remainder of this report. The Tidal Area encompasses about 6,800 acres, and consists primarily of wetlands. The Tidal Area boundary is shown on Figures 1-1 and 1-2.

2.2 LAND USE AND TRANSPORTATION

Land use in the vicinity of NWS SBD Concord is diverse, characterized by a mixture of industrial and residential areas, rangeland, and open space. The land-use plan is intended to ensure continuing development of each of the Tidal Area sites (Naval Facilities Engineering Command [NFEC] 1978).

Los Medanos Hills (see Figure 1-1) separates the Tidal and Inland Areas of NWS SBD Concord. This land is privately owned and is leased to the Pacific Gas and Electric Company (PG&E) and to ranchers for cattle grazing. Fifteen miles southeast of NWS SBD Concord is the 7,004-acre Mount Diablo State Park and State Game Refuge. NWS SBD Concord is bordered on the south by residential sections of the City of Concord. The Concord Pavilion, a public entertainment facility, is located on Kirker Pass Road near the facility's southern boundary. The City of Concord operates a large water treatment plant and the Mallard Reservoir about 1,500 feet west of Port Chicago Highway.

Land north of State Route 4 (see Figure 1-1) and west of NWS SBD Concord is zoned for industrial development. Several industrial firms have located there, particularly along Port Chicago Highway near the main gate of NWS SBD Concord. Tosco Avon Refinery Company and Monsanto Chemical Company maintain facilities along Solano Way near Waterfront Road.

Access to NWS SBD Concord is through guarded gates, and private vehicles provide local transportation. No organized public transportation system is available at the station. Access to the Tidal Area is through a gate off Port Chicago Highway west of the main entrance to the Inland Area.

2.3 HISTORY

The NWS SBD Concord Tidal Area stands on a site originally occupied by the Pacific Coast Shipbuilding Company. The original name of the area was Bay Point. The shipping yard occupied the area north of what is now the R Area Disposal Site. At that time, Johnson Road was the only major route into the Tidal Area. In 1927, the Navy chose the site for naval ordnance operations because it was remote from populated areas and for the presence of three major rail lines. In January 1942, construction of the waterfront handling facilities began, and in April, the facility was commissioned as Naval Magazine Port Chicago. The name Bay Point was changed to Port Chicago. Since then, the Inland Area, located in the Diablo Creek Valley, was acquired and linked to the Tidal Area by the Port Chicago and Clayton railroads. In 1963, the base was officially renamed Naval Weapons Station Concord.

On July 7, 1944, an explosion occurred at two munitions ships docked along a pier by the Tidal Area. Both ships and the pier were destroyed, and 320 people were killed. Nearby residents of the town of Port Chicago were injured. To protect the civilian population, Congress authorized the Navy to acquire all land within a 2-mile radius of the loading piers. Between 1968 and 1972, the towns of Port

Chicago and Nichols were purchased and demolished by the U.S. Government to provide a safety zone. The former sites of these two towns are now part of the Tidal Area.

The transformation of the Tidal Area from the time it was acquired by the Navy to the present has been documented by aerial photographs. The maps are based on information from aerial photographs of NWS SBD Concord. The changes in site features over time illustrate the surface impact of Navy activities on the wetlands. In addition, the surface features of the site affect the potential surface and subsurface transport of chemicals from the sites. Maps illustrating changes in Tidal Area features over time are presented in the RI in Volume I.

2.4 CURRENT OPERATIONS

NWS SBD Concord is the major naval explosive ordnance transshipment facility on the West Coast. The facility provides storage, maintenance, and technical support for ordnance operations. Most station facilities in the Tidal Area are dedicated to ordnance operations. The 17,000 linear feet of waterfront contains three explosives-handling piers, a barge pier, lighter moorings, and a tug basin. Barricaded rail car siding, rail car classification yards, and a large unbarricaded truck holding lot are inland from the waterfront area and about 1,000 feet east of the Tidal Area Landfill Site.

In addition to the pier facilities, ordnance is handled in the segregation complex (R Area Disposal) and in two transfer facilities. Most of the land in the Tidal Area is encumbered by Explosive Separation-Quantity Distance arcs required as safety perimeters by ordnance operations. Ten buildings in the Tidal Area are used for inert storage, bulk storage, or general warehousing. Limited public works support facilities and administrative facilities are also present. An additional 1,675 acres are leased for rangeland.

2.5 ENVIRONMENTAL SETTING

Sections 2.5.1 through 2.5.4 describe the regional environmental setting of NWS SBD Concord, including physiography and topography, geology, hydrology, and climate.

2.5.1 Physiography and Topography

Contra Costa County consists of four general physiographic regions: the highlands of the Coast Range, the intermountain valleys, the San Francisco Bay depression, and the Sacramento-San Joaquin Delta. The intercoastal highlands (Diablo Range) are smooth rolling hills and relatively rugged mountains

ranging from about 100 feet above mean sea level (msl) along the San Francisco Bay depression to 3,849 feet above msl at Mount Diablo. The intermountain valleys and San Francisco Bay depression consist of early flat flood plains and low terraces with gently rolling fans and old terrace remnants adjacent to the uplands. NWS SBD Concord lies about 10 miles west of the confluence of the Sacramento and San Joaquin rivers. This confluence forms the Delta region, which contains more than 600 miles of interconnected and meandering tidal waterways. Most of the low-lying river-delta lands have been reclaimed by protective dikes and drainage ways to form islands ranging from 30 to 7,000†acres in size. Drainage from NWS SBD Concord is exclusively into Suisun Bay.

The Tidal Area originally consisted of three distinct land formations: wetlands along the shore of Suisan Bay, the upland colluvial slope, and the sandstone hills farthest from the water. A large section of the wetlands was modified by the addition of large amounts of fill when NWS SBD Concord was originally constructed. Almost all existing Naval facilities were built on these filled areas (IT Corporation [IT] 1992). Between the Tidal Area and Los Medanos Hills is a band of colluvial slope material that is about 0.5 miles wide. This colluvial slope is the most suitable terrain for development because of its higher elevation and gentle slope. Los Medanos Hills are characterized by steeply sloping terrain, beginning at the 100-foot elevation and rising to more than 600 feet.

2.5.2 Regional Geology

The information presented in this section is based on data provided in the Tidal Area site investigation report (IT 1992), geotechnical borings obtained from the Navy, and available published material.

NWS SBD Concord is located within the geologically complex and tectonically active California Coast Range, approximately 30 miles east of San Francisco Bay. The Tidal Area of NWS SBD Concord is located in the southern part of a structural trough that is partially occupied by Suisun Bay (see Figure 1-1). The trough is partially filled with a significant thickness of unconsolidated and undeformed late Pleistocene and Holocene sediments. Glacial advances and retreats during the Quaternary period caused sea level fluctuations and changed the depositional sedimentary environment. Historically, glacial advances caused the sea level to drop 300 to 400 feet below its present level. The drop in sea level resulted in the disappearance of estuarine depositional environments, such as the current Suisun Bay, and the incision of the Sacramento River Valley. In contrast, during times of glacial retreats (similar to current conditions) the sea level rose high enough to flood the area of Suisun Bay. As a result, sediments beneath Suisun Bay consist of estuarine sediments deposited during

high sea level stands, alternating with alluvial and fluvial sediments that were deposited during low sea-level stands. These Quaternary sediments underlie the Bay Mud and younger alluvium. The depositional environments of the Bay Mud and alluvium are discussed in Section 2.5.3 of the RI report (TtEMI 1999).

The southern part of the Tidal Area at NWS SBD Concord includes the northwest-southeast trending Los Medanos Hills. Los Medanos Hills are predominantly composed of folded and faulted Tertiary bedrock. The early- to mid-Tertiary rocks are primarily marine in origin and consist of interbedded sandstones and mudstones. The marine formations include the Markley and Neroly Formations (Brabb and others 1971; Sims and others 1973; Dibblee 1980a, 1980b, 1980c, 1981) and generally strike in a northwesterly direction and dip 30 to 40 degrees northeast. The Wolfskill Formation (also called Los Medanos Formation) overlies the Tertiary marine formations and is present along the northeastern edge of Los Medanos Hills.

Gently deformed Quaternary sediments are present in the Inland Area of NWS SBD Concord and overlie the Tertiary sediments. These units consist primarily of interbedded clay, silt, sand, and gravel of probable alluvial origin and are identified as Quaternary older alluvium.

Several active or potentially active major faults are present in the vicinity of NWS SBD Concord. The Concord fault is a northwest-trending, right-lateral strike-slip fault located about 1 mile southwest of the Inland Area of NWS SBD Concord. The fault is interpreted to be the northward extension of the Calaveras Fault, which is a major branch of the San Andreas Fault system (La Voilette and Wigginton 1983; Weaver and Hill 1979). The fault displays surface creep (Sharp 1973; Galehouse and others 1982) and reportedly experienced a magnitude 5.5 earthquake in October 1955. The Clayton Fault lies within the Inland Area of NWS SBD Concord near the southwestern base of Los Medanos Hills. The fault generally strikes northwest, dips northeast, and is interpreted to have significant dip slip separation (Dibblee 1980a, 1980b, 1980c, 1981; Sims and others 1973). No major earthquakes are known to have occurred on the Clayton Fault; however, this fault has been interpreted to be the northwestern extension of the Greenville Fault, which has shown geomorphic evidence of Holocene displacements and experienced an earthquake with surface rupture in the eastern part of the Livermore Valley in January 1980 (Earth Science Associates 1982). The northwest-trending Antioch Fault is located about 10 miles east of NWS SBD Concord. No documented earthquakes have occurred on the fault; however, the 1889 Collinsville earthquake may have produced surface rupture in the City of Antioch (Toppozada and others 1981).

2.5.2.1 Site Geologic Setting

The geologic setting of the Tidal Area sites is characterized by fine-grained sediments that consist chiefly of Bay Mud with isolated lenses of peat and silty sand, which is overlain by discrete areas of artificial fill material. Site geology is discussed in detail in Section 5.1 of the RI report (TtEMI 1999) and is summarized below.

Bay Mud is a dark gray to black silty clay that contains a high proportion of organic material in the Tidal Area. Bay Mud typically exhibits low permeability, restricting movement of groundwater and causing low recharge in wells screened in the formation.

Approximately one-half of the total area of the Tidal Area sites is overlain by fill material. Almost all of the material that is currently elevated above sea level is likely to be fill, because the original surface of the tidal marsh was probably close to sea level. Fill material underlies all of the roads, railroad tracks, and buildings near the Tidal Area sites and much of the Wood Hogger Site. The fill material is typically a mixed lithology that contains varying proportions of clay, silt, sand, and gravel. Wood chips were used as fill material over large portions of the Wood Hogger Site.

2.5.2.2 Site Hydrogeologic Setting

Groundwater conditions in the Tidal Area sites are discussed in detail a technical memorandum, "Confirmation Groundwater Sampling in the Tidal Area Sites" (TtEMI 1998b), and are briefly summarized in this section. Groundwater in the NWS SBD Concord Tidal Area occurs in a shallow unconfined water-bearing zone that is predominantly composed of silty clays. As NWS SBD Concord developed, site drainage was modified by digging drainage channels and filling both natural and manmade channels with sandy fill materials and silty clays, leaving a complex subsurface characterized by silty clays and linear bodies of sandy fill material. The linear fill bodies are discontinuous and do not appear to act as preferential groundwater flow pathways. Consequently, the primary mode of shallow groundwater movement at the Tidal Area sites appears to be flow through the silty clay materials that dominate the subsurface.

Groundwater is a few feet below grade throughout the year. Groundwater elevations are higher at the margins of the Tidal Area sites, indicating that groundwater flows from the edges of the Tidal Area sites toward the center. During both wet and dry seasons, groundwater flows radially toward depressions in the water table in the R Area Disposal Site. Groundwater does not appear to discharge

to Suisun Bay via subsurface flow or groundwater/surface water interaction, although tidal influence studies have shown that limited groundwater/surface water interaction occurs along a narrow strip adjacent to Otter Sluice.

The most probable cause of the closed depressions in the water table in the center in the R Area Disposal Site is excessive evapotranspiration from wetland plants. This phenomenon, known as phreatophytic pumping, is a common feature of wetlands in semiarid climates and allows groundwater to discharge directly to the atmosphere (Freeze and Cherry 1979). Because only water is lost through evapotranspiration, the residual groundwater that is not discharged to the atmosphere becomes enriched in dissolved solids. Therefore, phreatophytic pumping may also account for the elevated dissolved solids concentrations that have been measured in the R Area Disposal Site.

2.5.3 Surface Water Hydrology

The large-scale physical modifications to the Tidal Area have created a complex hydrological environment. The Tidal Area is a highly modified physical environment consisting of low-lying areas interrupted by elevated features constructed of artificial fill, such as levees, road beds, building pads, and disposal areas. These elevated features act as barriers to surface flow and create closed basins with limited surface water drainage pathways. With the exception of the Tidal Area Landfill, surface water is present at all sites during the rainy season (see Figure 2-2). Surface water is also present continuously at selected areas in the R Area Disposal and Wood Hogger Sites (see Figure 2-3).

The primary surface water feature at the Tidal Area sites is Otter Sluice, a manmade channel that was constructed to drain water from the wetlands to Suisun Bay. Otter Sluice is fitted with a tidal gate at the point where the sluice enters Suisun Bay. The tidal gate is a one-way flow gate designed to allow water to drain from the sluice during low tides but to prevent water from flooding the sluice during high tides. The tide gate leaks; therefore, surface water levels in Otter Sluice are strongly influenced by tidal variations in Suisun Bay. In turn, surface water levels in ponded areas that are connected with Otter Sluice are tidally influenced.

Otter Sluice is connected to the R Area Disposal Site via two culverts that run underneath Baker Road at the western boundary of the R Area Disposal Site (see Figure 2-3). During high tides, surface water from Otter Sluice enters and drains from the R Area Disposal Site through the two culverts. During extreme tidal events (for example, when spring tides coincide with storms), surface water from Otter Sluice flows overland across Baker Road into the R Area Disposal Site and subsequently drains into

Otter Sluice through the two culverts. Surface water exchange between the R Area Disposal Site and Otter Sluice is most prevalent during the rainy season. In fact, tidal inundation of the R Area Disposal Site during the dry season is limited to a small wetland near the western boundary of the site.

Surface water from Otter Sluice also enters the northwest and south portions of the Wood Hogger Site. These areas lie at low elevations and form semipermanent wetlands, with water level variations that mimic those in Otter Sluice. Otter Sluice is not directly connected with the Froid and Taylor Roads Site, but water flows from the sluice into the site during extreme wet season tides.

2.5.4 Climate

Contra Costa County normally experiences dry, warm summers and cool, moderately wet winters. The mean annual precipitation for NWS SBD Concord is 14 inches (Ecology & Environment [E&E] 1983). As in most of northern California, about 84 percent of the rainfall occurs from November through March. Throughout the region, rainfall may vary from 13 inches in the eastern portion of Contra Costa County to more than 30 inches on the upper slopes of Mount Diablo.

The average local temperature varies from 45 °F in January to 75 °F in August. Record highs and lows of 106 °F and 16 °F have been recorded near NWS SBD Concord.

Prevailing winds blow from the west through the wind gap formed by the San Francisco Bay and Carquinez Strait. As a result, the Pacific Ocean and Suisun Bay moderate the microclimate of NWS SBD Concord and the vicinity. These westerly winds are particularly dominant during the summer months and minimal from November through February. Wind directions and speed are monitored at a PG&E power plant in Pittsburg, a few miles east of the facility. The wind blows from southwest to west-northwest at a mean wind speed of 12 miles per hour 65 percent of the time.

The geographic and urban settings of NWS SBD Concord make the area prone to urban air pollution. Temperature inversion (an increase in ambient temperature with altitude) is common. Temperature inversion prevents airborne pollutants from dispersing vertically into the upper atmosphere, causing concentrations at ground level to rise. The most common pollutants are sulfur dioxide, carbon monoxide, and particulates. Contra Costa County does not currently meet federal Clean Air Act guidelines for carbon monoxide, particulates, and opacity (haze effect).

2.6 TIDAL AREA SITE HISTORIES

This section describes the Tidal Area sites, discusses their operational history, and provides results from previous investigations.

2.6.1 Site 1: Tidal Area Landfill

The Tidal Area Landfill Site is shown on Figure 1-2. For this QEA, only the perimeter of the landfill was evaluated since a separate ROD is being prepared for this site. This section presents the history of operations at the Tidal Area Landfill Site and the results of previous environmental investigations.

Site Description and Operational History

The Tidal Area Landfill Site is located along the western side of Johnson Road, just north of Froid Road (see Figure 1-3). The landfill covers about 13 acres and reportedly contains about 33,000 tons of waste (IT 1992). The landfill served as the major disposal area for NWS SBD Concord from approximately 1944 to 1979. Historical aerial photographs indicate that, based on the growth of the landfill perimeter, most of the waste was deposited in the landfill between 1959 and 1974. Household garbage from NWS SBD Concord and surrounding communities was disposed of at the landfill. In addition, the landfill reportedly received solvents, acids, paint cans, creosote-treated timbers, asphalt, concrete, asbestos, and ordnance materials, including inert munitions (E&E 1983). Shipboard wastes and the tritanol filler from one 750-pound, general-purpose bomb were reported to have been buried in the landfill (E&E 1983).

Historical aerial photographs indicate that the Tidal Area Landfill was created by the progressive disposal of soil and debris outward from Johnson Road. The soil and debris were placed on native soil; apparently no soil was excavated before the waste was disposed of. A waste thickness of up to 10 feet was estimated from topographic evaluation; however, the waste may be unevenly distributed, and the undocumented ratio of waste to soil cover in the fill may be variable (IT 1992). There is no record of the degree of landfill subsidence due to consolidation or displacement of the underlying Bay Mud. The origin of the soil cover is unknown. Currently, the edge of the landfill along Johnson Road is bordered by a fence. The surface of the landfill has a soil cover, and metal and wood debris protrude from the surface. Animal burrows and differential subsidence have resulted in a highly uneven surface.

Results of previous investigations conducted for the Tidal Area Landfill are presented in Section 2.0 of the RI, contained in Volume I.

2.6.2 Site 2: R Area Disposal

The location of the R Area Disposal Site is shown on Figure 1-2. This section presents the history of operations at the R Area Disposal Site and the results of previous environmental investigations.

Site Description and Operational History

In 1939, before the Navy owned the site, a major slough trending from east to west flowed across the wetlands and marsh lands of the present R Area Disposal Site. The slough also flowed through the present Froid and Taylor Roads and the Wood Hogger Sites of the Tidal Area (see Figure 2-1). An artificial sluice was constructed to channel water from the R Area Disposal Site to Suisun Bay. During the construction of NWS SBD Concord, the sluice, now known as Otter Sluice, was backfilled and rerouted around the Wood Hogger and R Area Disposal Sites.

From the late 1940s until about 1976, the area along the eastern side of Baker Road between the Segregation Areas (R buildings) and the Inert Storage Area (S buildings) was used to dispose of materials generated during segregation of conventional munitions returned from Pacific operations (E&E 1983). The disposal area was named the R Area Disposal Site and was reported in the initial assessment study (IAS) to be about 800 feet long, 10 feet wide (east of Baker Road), and at least 5 feet deep. During the Tidal Area site inspection (SI), the estimated size was expanded to about 800 feet long, 600 feet wide (east of Baker Road), and at least 5 feet deep. For the RI, the eastern boundary of Site 2 was moved farther east, to encompass the area up to the Tidal Area Landfill boundary.

No records exist that document the quantity of waste disposed of at the site; however, the quantity has been estimated at 650 tons (E&E 1983). During the RI, ordnance-related waste, including casings and cans, were present on the ground surface and beneath the water along Baker Road. Piles of asphalt paving, metal casings, and mattress springs were also present on the ground surface. The amount of debris decreased with distance from Baker Road, except along the northern site boundary where metal containers were observed along Pickett Road.

Results of the previous investigations conducted for the R Area Disposal Site are presented in Section 2.0 of the RI, contained in Volume I.

2.6.3 Site 9: Froid and Taylor Roads

The location of the Froid and Taylor Roads Site is shown on Figure 1-2. This section presents the history of operations at the Froid and Taylor Roads Site and the results of previous environmental investigations.

Site Description and Operational History

The Froid and Taylor Roads Site is a triangular area about 800 feet long and 300 feet wide. The site is bordered by Taylor Boulevard to the east, Froid Road to the north, the Wood Hogger Site to the south, and an unnamed dirt and asphalt road to the west. The Froid and Taylor Roads Site has changed significantly from 1939 to the present with the development of NWS SBD Concord. Aerial photographs taken in 1939 indicate little activity in the vicinity of the Froid and Taylor Roads Site (see Figure 2-1). By 1950, the site was encompassed by Taylor and Froid Roads. One small road that cut through the Froid and Taylor Roads Site is apparent from 1950 aerial photographs and can still be observed. The slough that once passed through the Tidal Area was partially filled in the vicinity of the Froid and Taylor Roads Site to construct roads and buildings. A curved portion of the slough can still be seen, and a tidal fluctuation of 2 inches was measured during the tidal influence study conducted in July 1994.

During the IAS, a piece of ordnance was found on the shoulder of Froid Road near its intersection with Taylor Boulevard. This piece of ordnance was later identified by explosive ordnance disposal (EOD) personnel as a spent 5-inch white phosphorus rocket round. An investigation of the surrounding area revealed scrap metal and other debris south of the intersection of the two roads. The IAS also noted that the site was subject to tidal action; however, it presented no information to justify this statement. Although no specific incidents of hazardous materials disposal were linked directly to this site, its proximity to the Tidal Area Landfill, R Area Disposal, and Wood Hogger Sites made it an area of concern during the IAS (E&E 1983).

Results of the previous investigations conducted for the Froid and Taylor Roads Site are presented in Section 2.0 of the RI, contained in Volume I.

2.6.4 Site 11: Wood Hogger

The location of the Wood Hogger Site is shown on Figure 1-2. This section presents the history of operations at the Wood Hogger Site and the results of previous environmental investigations.

Site Description and Operational History

The Wood Hogger Site is bordered by Otter Sluice to the west and south, Froid Road to the north, and an unnamed dirt and asphalt road to the east. The site, as defined in the SI, has been expanded in the RI to include other areas contiguous to the immediate area of Wood Hogger operation. Historically, the Wood Hogger Site has been used as a dunnage and wood scrap area. In 1939, before the Navy owned the site, aerial photographs indicate little activity in the present Wood Hogger Site (see Figure 2-1). A major slough trending from east to west channeled through the present areas of the R Area Disposal Site, Tidal Area Landfill Site, Froid and Taylor Roads Site, and into the Wood Hogger Site. The slough was backfilled during construction of NWS SBD Concord, and Otter Sluice was constructed around the Wood Hogger and the R Area Disposal Sites to channel water to Suisun Bay. By 1950, with ongoing NWS SBD Concord development, the fill (suspected to consist of wood chips) was extended across the Wood Hogger Site from the northeastern corner to the southwestern corner of the site, forming the storage yard at the Wood Hogger Site.

An incinerator was used to burn wood from the early 1950s to the early 1970s on the southwestern corner of the Wood Hogger Site. The incinerator is shown on the 1952 and 1959 aerial photographs (see RI report, Volume I, Figures 2-3 through 2-4). The concrete foundation of the incinerator remains at the site. According to aerial photographs from 1952 and 1959, a conveyor system was used to move scrap and dunnage material from the storage yard to the incinerator.

Between 1969 and 1973, dunnage and other wood scrap from Tidal Area operations were chipped using a wood hogging operation (IT 1992). Until about 1972, the chips were sold to the Fiberboard Company in Antioch, California (E&E 1983). When a market for the chips could no longer be found, they were deposited on the ground adjacent to the hogger. The chips were estimated to cover a 10-acre area at a thickness of up to 3.5 feet (IT 1992).

Some of the wood scrap chipped at the site came from ordnance crates returned from Vietnam. Most ammunition shipping crates used by the Marines in Vietnam and some crates used by the Army were treated with pentachlorophenol (PCP), a wood preservative. The total amount of PCP-treated wood

that may have been chipped and undergone disposal at the site was estimated at 20 tons (E&E 1983). This estimate is based on the total amount of munitions shipped from NWS SBD Concord, and on the amount of munitions returned to NWS SBD Concord during retrograde operations (E&E 1983). The Wood Hogger Site was identified in the IAS because of the on-site burial of wood chips suspected to contain PCP.

The storage yard now contains scrap metal and wood, and portable wood hoggers are in operation at the site. The wood hogger used from 1969 to 1973 is no longer in operation but remains on site. No treated or preserved wood is currently stored or handled at the site.

The site consists of a paved dunnage or materials storage yard aligned from southwest to northeast across the site, with unimproved open areas (that is, unpaved and with no constructed roads) north and south of the storage yard. A railroad spur is located at the northern edge of the storage yard. Aerial photographs from 1952 show this storage yard in use, with railroad tracks providing access to the storage yard from the northeastern corner of the site. Current storage practices and historical photographs indicate that a variety of wood and metal materials have been stored in sections of the yard at various times. Because of the variety of materials disposed of over a long period of time, residual sources of chemicals in soil and groundwater may not be associated with current materials storage. The storage yard was identified as solid waste management unit (SWMU) 37 during the Resource Conservation and Recovery Act (RCRA) facility assessment (RFA) in 1992 (see Section 2.6.4.2). Locations adjacent to this SWMU were investigated as part of the RI to assess it as a potential source of chemicals to the site.

The open areas north and south of the storage yard consist of bare soil covered by intermittently sparse and dense vegetation. The bare soil areas just off the asphalt pavement contain some debris, the result of stored materials that were windblown or deposited in these areas. Less debris is present farther from the asphalt storage yard.

The open area to the south is bordered by the former Scott Road, and Otter Sluice runs parallel to the southern side of the road. This open area was observed to drain to the south into a location north of the road; this location is apparently a permanent pond that is directly connected to Otter Sluice by a culvert. Observations during site visits suggest that the water level in the pond is about the same as in Otter Sluice and may reflect groundwater levels. Small fish and birds were observed to be active in ponds and channels in the southeastern corner of the open area.

The northern open area appears to drain toward the west to Otter Sluice. In April 1993, standing water was observed in the northern open area along the eastern side of the levee separating Otter Sluice from this area. A culvert connects the sluice and the standing water ponds; the presence of a water flow control mechanism, such as a culvert gate between the sluice and ponds, was not identified. Several large carp (about 18 inches long) were observed in these ponds during the April 1993 visit.

Results of the previous investigations conducted for the Wood Hogger Site are presented in Section 2.0 of the RI, contained in Volume I.

3.0 ECOLOGICAL CHARACTERIZATION

As part of the problem formulation phase, ecological characterization involves identifying ecological receptors (plants and animals) that may be at risk at the site. A qualitative characterization of habitat and receptors at the Tidal Area of NWS SBD Concord was conducted by Western Ecological Services Company (WESCO) between May and July 1994 (WESCO 1995). The assessment documented the nature and composition of aquatic and terrestrial plant and animal communities in the study area. The characterization consisted of the following study elements:

- Describing the nature and composition of the plant and animal communities in the study area
- Evaluating the potential habitat value of each terrestrial and aquatic community
- Delineating wetland and aquatic habitats in accordance with U.S. Army Corps of Engineers (USACE) and U.S. Fish and Wildlife Service (USFWS) guidelines
- Conducting a wetland functional assessment
- Observing wildlife species, their habitats, and key food organisms in the study area
- Compiling basic information on federal or state rare, threatened, or endangered species in the study area
- Recording indicators of stress to vegetational communities and suggesting possible physical, biological, or climatic stressors

Based on the findings of the WESCO report, additional surveys were conducted in fall and summer 1998 for two special status species in the Tidal Area: the salt marsh harvest mouse (*Reithrodontomys raviventris*) and the California Black Rail (*Laterallus jamaicensis coturniculus*). The surveys of California Black Rails and salt marsh harvest mice are described in Sections 3.1.6 and 3.1.7 and in reports by Ibis Environmental Services (Ibis) (1999) and H.T. Harvey and Associates (1998) (see Appendix O). The data from the rail and mouse surveys are shown on Exhibit 2. In addition, wildlife and plant communities were characterized for NWS SBD Concord by the University of Arizona during 1998 (University of Arizona 1999). Relevant results from the surveys are incorporated into this report. The WESCO report, University of Arizona report, 1998 field surveys, 1996 walkabout surveys, and other sources (for example, University of California at Berkeley [UCB] 1994; The Nature Conservancy 1994), provided the bulk of information available for the ecological characterization of the Tidal Area sites.

Section 3.1 summarizes field assessment procedures. Section 3.2 presents habitat types and typical species observed during the surveys. Section 3.3 discusses special status species that are known or expected to occur at the Tidal Area sites. The wetland delineation and functional assessment are presented in Section 3.4. Section 3.5 presents an analysis of the existing habitat and receptor information and discusses observations during site visits conducted in 1996 and 1998.

3.1 SUMMARY OF FIELD ASSESSMENT PROCEDURES

The field assessment procedures employed as part of the qualitative habitat and receptor characterization are summarized below. The results of the assessments are presented in subsequent sections.

3.1.1 WESCO Field Assessment: Terrestrial Habitats and Wildlife Survey Procedures

As reported by WESCO (1995), general vegetative cover types were initially delineated on aerial photographs (Pacific Aerial Surveys, AV-4230-20-3, 7-7-92, 1:2400) using standard photo-interpretive techniques in combination with information from previous site visits and from past wetland surveys at NWS SBD Concord (E&E 1983; Waterways Experiment Station [WES] 1986, 1988a). The nature and composition of each habitat were described by conducting field transect surveys, and the aerial photographs served as working maps for both the habitat assessment transects and for the subsequent wetland delineation process. Linear transects were surveyed by a team consisting of a botanist and wildlife biologist. Data collected along each transect included the following:

- Dominant plant species and other component plant species
- Vegetation structure (for example, observations of numbers and heights or strata, plant diversity, homogeneity of cover, and density)
- Habitat quality and evidence of fauna (direct observations of fauna or observation of faunal signs [for example, scat, nests, and burrows])
- Evidence of disturbance or stress (for example, chlorosis, die-off, and barren areas or areas with sparse vegetation)

During the WESCO terrestrial wildlife survey, six wildlife observation points were located to take advantage of existing high berms that border the Tidal Area. Observations were conducted from the approximate midpoint of the marshward slopes of the berms. Early morning, mid-day, sunset, and nocturnal observations were made by conducting time-area counts to assess the presence of birds and

larger mammals. To supplement this information, the field biologists walked a meandering transect through each site during noncounting periods to look for signs of inconspicuous or wide-ranging wildlife that may not have been visible or present during the timed counts. Cover (debris, vegetation) was examined and general and specific habitat features (percent cover, depth of vegetation, burrows, perching and roosting sites) were noted.

3.1.2 WESCO Field Assessment: Aquatic Invertebrates and Water Quality Procedures

Twenty sampling stations were established in 1994 to collect sediment and water column samples (see WESCO report for locations). Because of seasonal salinity shifts in this transition zone, the estuary can support both marine or freshwater biota. Samples were collected to examine freshwater fauna in the spring and salinity-tolerant species in July. Benthic and midwater invertebrates were identified and water samples were evaluated for dissolved oxygen, pH, salinity, electrical conductivity, temperature, and odors.

An Ekman dredge (6 inches square) was used to collect two replicate benthic samples at each station from a sediment depth of 6 inches. One replicate was sieved using a 0.5-millimeter (mm) screen and most of the organisms were identified to at least the family level, with some identified to genus and species. However, some organisms could not be identified beyond the level of order. The other replicate was used for the analysis of percent organic matter and particle size of the sediment.

The midwater samples were collected with a 0.25-inch mesh dip net and invertebrates were identified to order or family level. Mud flats within the habitats were also visually examined for the presence of epibenthic organisms such as crabs. Baited minnow traps used for fish sampling also served to sample epibenthic organisms.

3.1.3 WESCO Field Assessment: Fish Assemblages Procedures

Sampling stations used for the aquatic invertebrate characterization were also sampled for fish to represent winter/spring freshwater conditions and summer/early fall saline conditions. The fish were sampled by one or more of the following methods: (1) 1/4-inch mesh dip net, (2) 3/8-inch, 50-foot seine, or (3) baited minnow trap lined with a 0.5 mm screen to facilitate the capture of epibenthic organisms. The minnow trap was fished for at least a 6-hour period that encompassed a high tide. The Otter Sluice stations were fished overnight for a period of 12 to 17 hours.

3.1.4 WESCO Field Assessment: On-Site Stressed Vegetation Analysis Procedures

Information from the habitat characterization transects was also used to identify any indications of vegetational stress. If such indications were observed, additional field surveys were conducted in the areas of stress. Evidence of stress was derived from the two levels of indicators noted below:

- **Community level indicators:** Species presence/absence data. Are certain key indicator species either present or not present in the approximate abundances expected for the particular community, and does the presence of certain indicator species suggest community-wide stress? For example, coastal marshes, above the mean high waterline subject to regular tidal influence, are usually dominated by pickleweed (*Salicornia virginica*). A general paucity of *Salicornia* could indicate shorter than normal hydroperiods and disruption of normal tidal regimes. If an exotic species of thistle such as *Salsola soda* is found to displace *Salicornia*, the community may also be subject to biotic stresses associated with invasive exotic species.

- **Physiological indicators:** Physical condition of plants. Do the physical conditions of plants within the community suggest certain biotic or abiotic stresses? Common examples are chlorosis, death, and wilting or leaf drop from twig and branch extremities.

Possible stressors were erosion, hypersalinity, flooding, chemical contamination, hydric stress, nutrient enrichment, soil disturbance, invasive exotic vegetation, stagnation of surface waters, diseases, and senescence. Stressors can also be synergistic or cumulative: for example, flooding can make plants more susceptible to fungal diseases.

3.1.5 WESCO Field Assessment: Wetlands Delineation and Wetlands Functional Assessment

Wetlands at the Tidal Area sites were classified by both the USFWS "Classification of Wetlands and Deepwater Habitats of the United States" (Cowardin and others 1979) and the USACE wetland delineation procedures (USACE 1987) in compliance with Title 40 Code of Federal Regulations (CFR) Part 230. A Routine Level 2 jurisdictional wetland determination (areas larger than 5 acres) was employed, in accordance with procedures generally acceptable to the San Francisco District USACE. Most wetland/upland boundaries were well defined because they occurred at the limits of fill. In the Wood Hogger, the Tidal Area Landfill, and the R Area Disposal Sites, large areas were previously filled with silty clay, sands, and other fill materials. Therefore, typical soil properties and criteria such as low chroma, mottling, and other characteristics of hydric soils may not be valid indicators of current hydric/nonhydric conditions in these filled areas.

A qualitative functional assessment was conducted for the wetlands in the Tidal Area sites (WESCO 1995). The assessment provides a general summary of the biotic and nonbiotic values of the wetlands based on field observations from the surveys, wildlife observations, and other background information resources (Nichols 1977; USFWS 1981; Jones and Stokes 1982; E&E 1983; WES 1986, 1988a, 1988b; Cuneo 1987; Herbold and Moyle 1989; Nichols and Pamatmat 1988; San Francisco Estuary Project [SFEP] 1990, 1991, 1992).

The assessment consisted of a series of matrix evaluations in which wetland habitat quality was evaluated using the following five functional values:

- **Habitat quality** was evaluated for key faunal species and species groups (migratory waterfowl, raptors, fish, and small mammals), as well as special status species with respect to fundamental requirements such as food, cover, and potential nesting, roosting, and feeding areas. Resident, regional, and migratory species were considered.
- **Primary productivity** for local and regional food chains was evaluated on both a macrophytic and microalgal basis. The primary productivity evaluation included detrital export and herbivore grazing potential.
- **Disturbance** of habitats was evaluated, with emphasis on long-term sustainability, isolation of habitats, and physical and biological alterations that have occurred.
- **Hydrologic/hydraulic features** of the wetland habitats were assessed with regard to stormwater and groundwater retention and recharge potential, tidal exchange, nutrient uptake capacity, and watershed area.
- **Public benefits** the Tidal Area can provide were evaluated with regard to recreation, public education, and habitat support for other nearby publicly used areas.

Each of the five functional values was divided into several component criteria. Wetland habitats were rated on a scale of 1 (worst) to 4 (best) under each of the component criteria. For example, the primary productivity functional value for a given habitat was the sum of the individual ratings for the following criteria: macrophytic productivity, microalgal productivity, detrital export potential, herbivore grazing potential, future productivity potential, and fish nursery potential.

Specific parameters for assigning rating values under each component criteria are detailed in the WESCO report (1995). Rating values for the component criteria were summed for each wetland habitat, and wetland habitats were then ranked based on the total sum of all ratings.

3.1.6 Field Assessment: California Black Rail Survey Procedures

Field surveys were conducted during the California Black Rail breeding season in June 1998 to assess the presence and abundance of California Black Rails in the marshes along the west side of Otter Sluice, the portion of the Tidal Area with potential rail habitat. Three morning and three evening surveys were conducted along two transects adjacent to the marshes (see Exhibit 2). Each transect was composed of a series of stations where observers looked and listened for rails in all directions. Recorded California Black Rail "kik-kik-kerr" calls were played from a cassette player and amplified speaker system for a 5-minute period at each station. Following the broadcasts, observers remained at the station for an additional 5 minutes and recorded any rail detections. When a black rail was detected, the time, station number, type of call, compass bearing, and estimated distance to the calling bird were recorded. Simultaneous vocalizations and distances between call locations were used to distinguish individuals. Weather conditions, including wind speed and direction, air temperature, and cloud cover were recorded at the beginning and end of each survey. Surveys were not conducted when wind speeds exceeded 25 knots.

Calculations of black rail breeding-season abundance are based on detections determined only from "kik-kik-kerr" calls of the male. "Gurr" and "keurr" calls are used by both males and females, so they were not used to calculate abundance. California Black Rails are apparently monogamous and have a 1 to 1 sex ratio (Harvey and Associates 1998), so this survey estimated abundance for both sexes by doubling the value obtained for the detected male abundance. Additional survey details and maps can be found in the H.T. Harvey and Associates report (1998) (see Appendix O).

3.1.7 Field Assessment: Small-Mammal Trapping Survey Procedures

Small mammal trapping surveys were conducted in several portions of the Tidal Area during the fall of 1998 to (1) document the presence of the salt marsh harvest mouse, a state and federally listed endangered species, and (2) collect tissue samples from resident small mammals for food chain modeling. The R Area Disposal (Site 2) and the Wood Hogger (Site 11) were the focus of the small mammal trapping surveys. Trapping transects are shown on Exhibit 2.

Thirty Sherman live traps were set for 5 nights and 128 traps were set for 4 nights between September 3 and September 8, 1998. Traps were baited with a mixture of walnut meat and bird seed and were supplied with cotton bedding material. Bait was replaced daily and bedding was replaced as

needed. Traps were opened at dusk and checked at dawn the following day. Traps were closed from dawn to dusk every day.

Captured mice were removed each morning from the trap and identified to the species level. Salt marsh harvest mice were measured and scored according to standard methods (Shellhammer 1989) and released at the trap site after an identifying mark was made with ink on the tail. Morphological characteristics, such as tail length, tail dorsal/ventral contrast, color of ventral tail hairs, tail tip and taper, belly coloration, tail length/body length ratio, presence of orange ear tufts, and behavior were used to distinguish salt marsh harvest mice from western harvest mice (*Reithrodontomys megalotis*). The breeding condition of captured mice was also recorded. Additional detail and maps can be found in the Ibis report (1999) (see Appendix O).

3.2 HABITAT TYPES AND TYPICAL SPECIES AT THE TIDAL AREA SITES

The following sections summarize observations primarily from the terrestrial transects and wildlife surveys completed by WESCO (1995); however, surveys conducted by the University of Arizona (1999) and incidental wildlife observations from field sample collection efforts during the summer of 1998 are also included. Observations are presented by habitat type. Exhibit 3 shows the habitat types at the Tidal Area sites. Additional detail and original maps can be found in the WESCO report (1995).

The WESCO report (1995) lists all plant and animal species observed during the study, as well as faunal species expected to occur based on habitat characterization studies and a review of the literature for individual species (Zeiner and others 1988, 1990a, 1990b; Laudenslayer and others 1991). General field observations noted that physical alterations to the Tidal Area sites and environs, most notably the construction of dikes, roads, and railroad beds, have influenced the quality of habitat at each of the sites (PRC 1995d).

Each terrestrial habitat was classified and numbered in accordance with the California Natural Diversity Data Base (CNDDB) classification system (Holland 1986). The USFWS wetland classification (Cowardin and others 1979) was applied to all wetland and aquatic habitats. The ecological characterization is organized into the following sections:

- Upland Habitats and Typical Species
- Wetland and Aquatic Habitats and Typical Species

- Benthic and Midwater Invertebrates
- Fish Assemblages

Table 3-1 lists terrestrial and wetland plant species observed at the Tidal Area sites. Table 3-2 presents the invertebrates and fish occurring or potentially occurring at the Tidal Area sites, and Table 3-3 lists terrestrial and wetland amphibians, reptiles, birds, and mammals.

3.2.1 Upland Habitats and Typical Species

Upland habitat areas were distinguished from wetlands using two broad criteria. First, upland areas failed to have at least one of the three wetland identification criteria (soils, hydrology, or hydric vegetation). Second, upland areas exhibited few or none of the functional values associated with wetlands (for example, habitat for wetland-dependent species, surface water storage, or groundwater recharge). Experienced field biologists noted that terrestrial wildlife (both invertebrate and vertebrate) was incidentally observed, including spoor of resident small mammals, large canids, and other carnivores (for example, skunk), regurgitation pellets from raptors bearing small mammal bone fragments, and raptors in soaring flight over the site (PRC 1995d).

3.2.1.1 Annual/Ruderal Upland Complex

(CNDDB Community Type: Non-native annual grassland [Element Code 42200]; USFWS Classification: Uplands)

The annual/ruderal complex at the Tidal Area occurs in areas dominated by species associated with drier and higher topography. Upland habitats include the border of the landfill, portions of the R Area Disposal Site, berm slopes, and areas within the Froid and Taylor Roads and Wood Hogger Sites that are not seasonally inundated. Characteristic plant species are non-native annual grasses and forbs typical of a California non-native annual grassland. Plant species associated with this habitat include grasses such as soft chess (*Bromus hordeaceus*), ripgut brome (*Bromus diandrus*), perennial and annual ryegrass (*Lolium perenne* and *L. multiflorum*, respectively), wild oats (*Avena fatua* and *A. barbata*), Mediterranean and hare barley (*Hordeum marinum* spp. *gussoneanum* and *H. m.* spp. *leporinum*, respectively), and smilo grass (*Piptatherum miliaceum*).

Ruderal forb species that occur in this habitat include black mustard (*Brassica nigra*), prickly lettuce (*Lactuca serriola*), birdfoot trefoil (*Lotus corniculatus*), wild radish (*Raphanus sativus*), Italian thistle

(*Carduus pycnocephalus*), yellow star thistle (*Centaurea solstitialis*), and fennel (*Foeniculum vulgare*). There are also large patches of perennial peppergrass (*Lepidium latifolium*) in upland portions of the R Area Disposal Site. Scattered small stands of coyote brush (*Baccharis pilularis*), a native shrub, and saltgrass (*Distichlis spicata*), a native grass species, also occur in some of the upland sites.

Vegetation height varies with species mix. Areas dominated by annual grasses such as the bromes, oats, and ryegrasses tend to have heights from 1 to 2 feet. Areas with the larger forbs such as fennel, perennial peppergrass, and Italian thistle have heights ranging from 3 to 6 feet. One location in the southeast corner of the landfill in the R Area Disposal Site is dominated by smilo grass and fennel with some scattered artichoke thistle (*Cynara cardunculus*). These plants range from 4 to 6 feet high, with the same understory of annual grasses.

Annual/ruderal uplands provide foraging areas and cover for a variety of common wildlife in the Tidal Area. Raptors such as Northern Harriers (*Circus cyaneus*) and Black-shouldered Kites (*Elanus caerulens*) also forage for small mammals in these areas and may roost or nest in the tall grasses or trees and shrubs that grow in these areas. The Northern Harrier is a special status species that is discussed further in Section 3.3. Northern Harriers were sighted in all areas of the Tidal Area sites except the Froid and Taylor Roads Site. Grassy uplands in the Tidal Area sites located adjacent to water-filled ponds and ditches are particularly important to species of ducks such as mallards (*Anas platyrhynchos*) and teal (*Anas* spp). Mallards build their nests in the grassy uplands near water that can be used by the young ducklings. Upland areas that support shrubs, such as coyote brush, provide nesting sites, roosts, and perches above ground level.

The upland areas also provide dry soils where mammals such as gray foxes (*Urocyon cinereoargenteus*) and red foxes (*Vulpes vulpes*) can dig dens, and small rodents such as California voles (*Microtus californicus*) can burrow (see Table 3-3). Upland areas adjacent to marshes provide a refuge for marsh-dwelling species during periods of high tides or flooding. A refuge is particularly important for the salt marsh harvest mouse that inhabits the brackish and salt marshes of the R Area Disposal Site. The salt marsh harvest mouse, a special status species, is discussed further in Section 3.3.

The uplands provide habitat not only for native species but for alien species such as the feral cat (*Felis cattus*), red fox, the house mouse (*Mus musculus*), and likely the Norway rat (*Rattus norvegicus*). These alien species are effective predators and competitors and can adversely affect native wildlife populations. The landfill area, in particular, has an abundance of dens that are used by the red fox.

Red foxes are an efficient predator that can have a significant effect on ground nesting birds and their eggs. Two red foxes were observed near potential denning sites during the nocturnal survey.

3.2.1.2 Nonvegetated Uplands

(CNDDB Community Type: NA; USFWS Classification: Uplands)

Nonvegetated uplands occur mainly on paved and dirt roads, railroad track beds, and intensively used fill areas. Disposal areas at the Wood Hogger Site are included in this habitat, although there are a few scattered weedy forbs and grasses. A large concrete slab in the Froid and Taylor Roads Site is surrounded by wetlands.

Nonvegetated uplands are used by wildlife as foraging areas, denning sites, nesting sites, perches, and travel corridors. Structures in these areas provide roosting and nesting sites. For example, at the Wood Hogger Site, the wood hogging equipment, wood shed, and other buildings provide nest sites for Cliff and Barn Swallows (*Hirundo pyrrhonota* and *Hirundo rustica*, respectively). During the WESCO survey, a Loggerhead Shrike (*Lanius ludovicianus*) was observed perched on a fence along Otter Sluice bordering the emergent brackish marsh. During the fall 1998 small mammal trapping effort, Loggerhead Shrikes were observed daily at the Wood Hogger Site (Ibis 1999). The Loggerhead Shrike is a special status species and is discussed further in Section 3.3.

During the nocturnal survey, a gray fox with three or four pups was found in the southwestern corner of the R Area Disposal Site. The pups immediately retreated to cover under nearby wood piles. This area likely provides an abundance of prey such as house mice in and around the wood piles. Other species likely to use the nonvegetated uplands for foraging include Barn Owls (*Tyto alba*), Great Horned Owls (*Bubo virginianus*), raccoons (*Procyon lotor*), coyotes (*Canis latrans*), red fox, and feral cats.

3.2.2 Wetland and Aquatic Habitats and Typical Species

The USFWS wetland classification is hierarchical, progressing from systems to classes, subclasses, and dominance habitats. There are five major systems: marine, estuarine, riverine, lacustrine, and palustrine. These systems can be further broken down into subsystems; for example, the estuarine system within the Tidal Area sites is classified in the intertidal subsystem.

Class describes the general appearance of the habitat in terms of the dominant vegetation or substrate habitat. Classes may be further divided into subclasses, dominance habitats, and modifiers. Disturbed or modified (for example, channelized, filled, or concrete lined) wetland habitats within the Tidal Area sites do not always clearly fall into a USFWS wetland classification, so they have been classified into the systems and subsystems that most clearly fit them.

As explained in field observations made during site visits in October 1996, the Tidal Area sites are composed of disturbed wetlands that occupy approximately 100 acres. The soil surface and vegetation indicate relatively disturbed conditions, with soils being periodically inundated, then dried to cracking (PRC 1995d). Wetland and aquatic habitats in the Tidal Area sites can be grouped in either the estuarine or palustrine systems, based primarily on their degree of inundation and connection to the adjacent estuarine waters. Tidal Area wetlands in the estuarine categories tended to be self-evident due to the presence of tidally connected surface waters and unquestionable dominance by wetland vegetation (obligate or facultative wetland species). Palustrine areas were a more challenging wetland identification type. In some instances, palustrine areas are a complex mosaic of several vegetative associations. Each association required careful interpretation of aerial photographs and data points taken in the field (WESCO 1995). A habitat map is shown on Exhibit 3.

3.2.2.1 Nonvegetated Aquatic Habitats -- Brackish Ponds

(CNDDB Community Type: NA; USFWS Classification: PUB3F; System Palustrine/Class: Unconsolidated bottom/Subclass: Mud/Modifiers: Semipermanently flooded)

Nonvegetated aquatic habitats are areas where the water is generally deep enough to prevent the growth of emergent vegetation. This habitat type is divided into naturally occurring and artificially created areas (see "Nonvegetated Aquatic Habitats-Created Ponds and Ditches" below). The naturally occurring aquatic habitat consists of the brackish ponds in the R Area Disposal Site. The ponds are connected to Otter Sluice via flapgated culverts and are therefore potentially subject to tidal influence. They are surrounded by emergent vegetation such as cattails (*Typha* sp.) and bulrushes (*Scirpus* sp.) that are associated with brackish marshes.

The brackish ponds support populations of *Corophium* spp., a brackish water amphipod, which is prey of bottom feeding fish and, to a lesser extent, of waterfowl and shorebirds. Population densities of other aquatic invertebrates suggest that these ponds are good feeding habitat. Ducks and geese, herons, shorebirds, Black-necked Stilts (*Himantopus mexicanus*), Dowitchers (*Limnodromus* sp.), Willets

(*Catoptrophorus semipalmatus*), Yellowlegs (*Tringa* sp.), and American Avocets (*Recurvirostra americana*) forage in the shallow water overlying mud in the brackish ponds (see Table 3-3).

The brackish ponds provide expanses of exposed mud as they dry. Species such as Killdeer (*Charadrius vociferus*) and Black-necked Stilts use these exposed, flat areas for nesting. Other species using the ponds and the unvegetated pond margins include Blue-winged Teal (*Anas discors*), Cinnamon Teal (*Anas cyanoptera*), Gadwall (*Anas strepera*), Great Blue Herons (*Ardea herodias*), Snowy Egrets (*Egretta thula*), Black-crowned Night Herons (*Nycticorax nycticorax*), American Coots (*Fulica americana*), and raccoons.

Western pond turtles (*Clemmys marmorata*) were observed basking on the edges of the brackish ponds as well as in the artificial aquatic habitats described below. Both subspecies of the western pond turtle, *Clemmys marmorata marmorata* and *Clemmys marmorata pallida*, are special status species described further in Section 3.3.

3.2.2.2 Nonvegetated Aquatic Habitats – Created Ponds and Ditches

(CNDDB Community Type: NA; USFWS Classification: PUBFr/System: Palustrine/Class: Unconsolidated bottom/Modifiers: Semipermanently flooded, artificial bottom-fill)

All of the excavated ditches within the R Area Disposal and Froid and Taylor Roads Sites are classified as created ponds and ditches. The western portion of the R Area Disposal Site ditch (that is, the ditch that lies predominantly west of the pipeline) is in limited connection to Otter Sluice and Suisun Bay via a flapgated culvert, and maintains shallow surface waters year-round under normal hydrological conditions. The eastern ditches (those lying east of the pipeline) are in very limited tidal connection and are normally dry during the late summer and early fall. This dichotomy in hydrology corresponds to habitat quality differences. The western ditch provides a more permanent feeding habitat and is functionally equivalent to natural brackish ponds. Like the brackish ponds, the western R Area Disposal Site ditch is an important habitat for waterbirds such as ducks, geese, and shorebirds. The eastern ditches and the Froid and Taylor Roads Site ditch support smaller, less diverse invertebrate and fish populations and therefore provide fewer feeding opportunities for wildlife.

In addition to providing foraging habitat, ditches also form aquatic travel corridors. Birds such as ducks, coots, and herons use these waterways to move about the site. Mammals such as muskrats

(*Ondatra zibethicus*), river otters (*Lutra canadensis*), beavers (*Castor canadensis*), and Norway rats may also use the ditches to move around the site (see Table 3-3).

3.2.2.3 Nonvegetated Swales

(CNDDB Community Type: NA; USFWS Classification: PUBJr/System: Palustrine/Class: Unconsolidated bottom/Modifiers: Intermittently flooded, artificial bottom-fill)

The nonvegetated swale is a single area within the Wood Hogger Site that is intermittently inundated. Soils are compacted fill material that act like a clay pan when the water collects on top of the soil rather than filtrating down. Ponding occurs as a result of both limited tidal connection with the nearby sluice and from runoff from rainfall. The sparse, scattered vegetation is of low stature and consists mostly of small patches of pickleweed; however, flooding and compacted soils keep the area mostly devoid of vegetation.

The nonvegetated swale has limited value as a habitat separate from the surrounding marsh vegetation. One species that may use this area is the Killdeer, which nests on exposed, dry mud and gravel such as edges of ponds, flat gravely areas, levees, and roadsides.

3.2.2.4 Aquatic Habitat – Otter Sluice

(CNDDB Community Type: NA; USFWS Classification: E1UB3h/System: Estuarine/Subsystem: Subtidal/Class: Unconsolidated bottom/Subclass: Mud/Modifiers: Partially impounded)

Otter Sluice, together with the adjacent brackish marsh (see "Emergent Brackish Marsh," below), provides some of the best wetland habitat within the Tidal Area sites. It consists of a permanently inundated channel that connects the R Area Disposal and Wood Hogger Sites to Suisun Bay via a gated culvert structure. Because the culvert structure does not always work properly, tidal exchange is only partially attenuated, and the sluice is subject to regular tidal influxes.

Areas along the edge of the sluice are dominated by a mosaic of open water and dense stands of emergent brackish marsh vegetation such as cattails and California bulrush (*Scirpus californicus*). This mosaic provides excellent foraging habitat for ducks, grebes, pelicans, and other water birds. The sluice provides a relatively large expanse of open water habitat for wildlife along the west and southern boundaries of the study area. The channel is deeper than many of the ponds in the study area and provides foraging habitat for diving as well dabbling ducks.

Otter Sluice has the potential to support a large number of fish. During the May field survey (WESCO 1995), three-spine stickleback (*Gasterosteus aculeatus*), tule perch (*Hysteracarpus traski*), striped bass (*Morone saxatilis*), and yellowfin goby (*Acanthogobius flavimanus*) were trapped. During the July 1998 fish and invertebrate tissue collection, sculpin, stickleback, mosquito fish (*Gambusio affinis*), and tule perch were caught (see Table 3-2). This type of habitat is characterized by high primary productivity in the form of planktonic algae, creating a food base for juvenile fishes.

Aquatic habitats, primarily Otter Sluice and the adjacent wetlands, were consistent with the characterizations of WESCO (1995), and casual observations found assorted wetland, upland, and aquatic invertebrates present (see Tables 3-2 and 3-3). Both Cliff and Barn Swallows were observed foraging over the sluice, as were American White Pelicans (*Pelecanus erythrorhynchos*). Large mammals also inhabit the waterway. River otters were observed in the sluice during the wildlife surveys, benthic sampling, and fish sampling events. This species forages for fish and large invertebrates in the sluice and uses the adjacent marsh as well. Other mammals likely occurring in the sluice are beavers and muskrats, although neither was directly observed during the wildlife surveys. However, a beaver skull was found approximately 75 feet from the sluice at the northwestern corner of the R Area Disposal Site. No beaver lodge was observed along the banks of the sluice. Muskrats were not observed on site, but they have been reported from nearby areas and likely occur in the Tidal Area.

3.2.2.5 Emergent Brackish Marsh

(CNDDB Community Type: Coastal Brackish Marsh [Element Code 52200]; USFWS Classification: E2EM1Ph/System: Estuarine/Subsystem: Intertidal/Class: Emergent/Subclass: Persistent/Modifiers: Irregularly flooded, diked)

Emergent brackish marsh occurs along the Otter Sluice channel, in ponded areas with tidal connection in the southeastern corner of the Wood Hogger Site, and on the western edge of the R Area Disposal Site. Some emergent marsh also occurs in the Froid and Taylor Roads Site adjacent to and within the created pond area in the northeastern corner. Coastal brackish marsh communities have very high wildlife value and perform many important wetland functions such as toxicant and sediment reduction, water quality improvement, and shoreline stabilization. Vegetation in this habitat is dominated by cattails and California bulrush. These species occur in the deeper water areas and stand 4 to 10 feet tall. Emergent marsh areas that are less frequently inundated with water also support alkali bulrush (*Scirpus robustus*). These areas support species associated with salt marshes, such as saltgrass,

jaumea (*Jaumea carnosa*), pickleweed, and spearscale (*Atriplex triangularis*). Plant heights in these mixed areas range from less than 1 foot to 2 feet.

Special status species potentially occurring in this habitat at the Tidal Area sites are the Suisun marsh aster (*Aster lentus*), delta tule pea (*Lathyrus jepsonii* ssp. *jepsonii*), Mason's quillwort (*Lilaeopsis masonii*), and delta mudwort (*Limosella subulata*) (see Table 3-4). Each of these special status plant species is described in Section 3.3.

Many wildlife species use both the emergent brackish marsh and adjacent aquatic habitats (see "Aquatic Habitat – Otter Sluice," above). This habitat is important to marsh-dwelling birds such as Marsh Wrens (*Cistothorus palustris*), Suisun Song Sparrows (*Melospiza melodia maxillaris*), and Common Yellowthroat (*Geothlypis trichas*). WESCO assigned the Yellowthroats in this area (1995) to the Western Common Yellowthroat subspecies (*Geothlypis trichas occidentalis*), but individuals of the Salt Marsh subspecies (*G. t. sinuosa*), a California species of special concern, may have been observed. The Suisun Song Sparrow and the Salt Marsh Yellowthroat are special status species, as described in Section 3.3. These species forage and nest in the vegetation directly along Otter Sluice and the brackish ponds. Suisun Song Sparrows were observed at the Wood Hogger and R Area Disposal Sites, and along Otter Sluice.

Western pond turtles in Otter Sluice and the Wood Hogger and R Area Disposal Sites also rely on the vegetation afforded by the emergent marsh for cover while they are basking on the exposed banks of the ponds and channels.

With its dense vegetation of cattails and bulrushes, this habitat provides cover for ducks, herons, and rails as they forage along the banks of the channels and ponds. It also provides cover for animals emerging from the water such as ducklings, muskrats, and otters. Northern Harriers, White-tailed Kites, and Red-tailed Hawks were observed foraging over the marshes bordering Otter Sluice as well.

3.2.2.6 Seasonal Brackish/Salt Marsh Mosaic

(CNDDB Community Type: Northern Coastal Salt Marsh [Element Code 52110] and Coastal Brackish Marsh [Element Code 52200]; USFWS Classification: E2EM1Ph/System: Estuarine/Subsystem: Intertidal/Class: Emergent Subclass: Persistent/Modifiers: Irregularly flooded, diked)

The seasonal brackish/salt marsh mosaic occurs primarily in the R Area Disposal Site and is characterized by limited tidal connection and irregular (probably seasonal) flooding. Plant composition

includes species associated with both northern coastal salt marsh and coastal brackish marsh. Included within this habitat type is a remnant tidal slough, which tends to be dominated by brackish marsh vegetation. One small area in the northwestern part of the R Area Disposal Site and two small areas in the Wood Hogger Site are isolated from any tidal connection; the hydrology of the area is related primarily to rainfall and runoff.

Dominant plant species within this habitat include vegetation associated with both brackish and salt marsh conditions. These associations are described as follow:

- **Northern Coastal Salt Marsh:** As described by Holland (1986), this habitat consists of highly productive, herbaceous and suffructescent salt-tolerant hydrophytes forming moderate to dense cover up to 3 feet tall. These areas have tidal connection due to their proximity to the R Area Disposal Site ditch and brackish pond culverts. Species include pickleweed, dodder (*Cuscuta salina*), saltgrass, jaumea, spearscale, alkali bulrush, brass buttons (*Cotula coronopifolia*), baltic rush (*Juncus balticus*), and annual beard grass (*Polypogon monspeliensis*).

- **Coastal Brackish Marsh:** This habitat is dominated by perennial, emergent, herbaceous monocots up to 6 feet tall. Cover is often complete and dense. Because this association has a slightly higher elevation than the salt marsh association, soil and surface water salinities are probably somewhat lower and may vary considerably depending on the extent of tidal influence (Holland 1986). Species include saltgrass, baltic rush, pickleweed, alkali bulrush, and cattails.

The vegetation of the marsh mosaic habitat typically provides good cover for birds, mammals, and amphibians. The Pacific treefrog (*Hyla regilla*) was the only amphibian directly observed (by call) within the study area. Treefrogs were heard calling primarily from the marsh mosaic habitat in the Wood Hogger, Froid and Taylor Roads, and R Area Disposal Sites, typically near ponds or channels. Other species observed in the marsh mosaic habitat included Northern Harriers, Loggerhead Shrikes, Suisun Song Sparrows, Mallards, Killdeer, Rock Doves (*Columba livia*), Mourning Doves (*Zenaida macroura*), Cliff and Barn Swallows, Northern Mockingbirds (*Mimus polyglottos*), Western Meadowlarks (*Sturnella neglecta*), Red-winged Blackbirds (*Agelaius phoeniceus*), black-tailed hares (*Lepus californicus*), California voles, and raccoons. These species use the marsh variously as foraging, nesting, and burrowing habitat.

Black-tailed hares were abundant in this habitat type and appear to forage extensively on the grasses and forbs that grow in the marsh. Although a number of hares were observed during the surveys, the fecal pellets (scat) were the most obvious sign of this species' presence in the R Area Disposal and Wood Hogger Sites. Fecal pellets were commonly observed throughout these sites, particularly in

areas where the vegetation was sparse. Another species that was apparently common on site, based on observation of their signs (such as tracks), were raccoons. Raccoon tracks were found throughout the R Area Disposal and Wood Hogger Sites. It is likely that they prey upon the eggs of the ducks and other ground-nesting birds in these areas. Due to the large number of tracks, it is likely that raccoons exert a significant predation pressure on ground-nesting birds in the marsh. Other mammalian carnivores observed using the marsh mosaic habitat included gray fox, red fox, coyote, and striped skunk (*Mephitis mephitis*).

3.2.2.7 Salt Marsh

(CNDDB Community Type: Northern Coastal Salt Marsh [Element Code 52110]; USFWS Classification: E2EM1Ph/System: Estuarine/Subsystem: Intertidal/Class: Emergent/Subclass: Persistent/Modifiers: Irregularly flooded, diked)

Salt marsh typically occurs along San Francisco Bay from below the mean tidal level to above the mean high water line (Josselyn 1983). It has a distinctive zonation pattern related to inundation period and salinity level, in which Pacific cordgrass (*Spartina foliosa*) dominates the lower elevations and pickleweed and saltgrass dominate the higher areas (Josselyn 1983). Only the pickleweed/saltgrass zone is found within the Tidal Area sites, primarily in the R Area Disposal Site. Typical for much of the remaining salt marsh along the bay, the Tidal Area salt marsh is enclosed by levees and is in only limited tidal connection with Otter Sluice. It is irregularly (seasonally) flooded. Other species associated with this habitat include alkali heath (*Frankenia salina*), saltgrass, jaumea, alkali bulrush, and annual beard grass.

Northern coastal salt marsh is a highly productive habitat forming a moderate to dense cover with plant heights ranging from less than 1 foot to 3 feet tall (Holland 1986). The marsh supports plant species including Suisun thistle (*Cirsium hydrophilum* var. *hydrophilum*), soft bird's beak (*Cordylanthus mollis* ssp. *mollis*), small spikerush (*Eleocharis parvula*), and marsh gumplant (*Grindelia stricta* var. *angustifolia*). The Suisun thistle and the soft bird's beak are both special status species, as discussed in Section 3.3.

Salt marsh is often interspersed with the seasonal brackish/salt marsh mosaic habitat type, and species discussed under the marsh mosaic habitat type will likely also be found in the salt marsh habitats of the R Area Disposal Site. The salt marsh harvest mouse is a state and federally listed endangered species that occurs in marshes dominated by pickleweed but may also be found in marshes with saltgrass and

alkali heath. Trapping studies during September 1998 confirm the presence of salt marsh harvest mice in the R Area Disposal Site and a portion of the Wood Hogger (Ibis 1999). Results of the trapping study are discussed further in Section 3.1.7.

3.2.3 Benthic and Midwater Invertebrates

A brief description of and the relative abundances, locations, and habitat requirements of each of the invertebrate taxa observed by WESCO in 1994 is summarized below (WESCO 1995).

3.2.3.1 R Area Disposal Site

In spring 1994, chironomid larvae and water boatman were collected at some locations in the R Area Disposal Site. Again, linkage to Otter Sluice apparently contributed to differences in species composition; isolated interior ponds contained no benthic organisms, but large numbers of water boatman were found in midwater samples, while locations near Otter Sluice exhibited amphipods and water boatman.

Benthic invertebrate samples were not collected in mid-summer at locations that were dry. Selected locations independent of Otter Sluice that consisted of saturated mud contained moderate to large numbers of the Hydrophilid water beetle (*Tropisternis* spp.) and limited numbers of other shallow-water invertebrates (WESCO 1995).

3.2.3.2 Froid and Taylor Roads Site

No benthic invertebrates were observed in the sediments during either of the two 1995 sampling periods, but surface-dwelling invertebrates (water boatman, *Trichocorixa reticulata*) were captured in mid-water sampling in July. Amphipods were collected during the June 1998 sampling event. During 1995 sampling, sulfidic and crankcase oil odors were observed in the fine sediments of this site.

3.2.3.3 Wood Hogger Site

Samples collected at the Wood Hogger Site in May 1994 contained shells of numerous dead snails of the family Hydrobiidae (primarily freshwater snails), *Trichocorixa reticulata* (water boatman), as well as moderate numbers of chironomid larvae. In July 1994, samples included water boatman, small numbers of dead and live snails identified as *Fontelicella stearnsiana*, limited numbers of soldierfly larvae of the genera *Odontomyia* or *Hedriodiscus*, and a water beetle (*Tropisternis* spp.). The snail,

water boatman, and an occasional chironomid larvae comprised the invertebrate groups consistently observed at the Wood Hogger Site.

3.2.3.4 Otter Sluice

In May 1994, low to moderate numbers of three chironomid larvae species were observed in the highly organic silty sediments of Otter Sluice. WESCO also noted a native clam (*Macoma balthica*) (1995) at most sampling stations. The most abundant epibenthic invertebrate captured and observed at nearly all Otter Sluice sampling stations was the amphipod, *Anisogammarus confervicolus*. This amphipod was common at all but the least tidally influenced sampling location. *A. confervicolus* favors banks, plant roots and stems, and other structures within channels that have a significant tidal current. In July 1995, the amphipods and clams remained numerous; live and dead gastropods (*Fontelicella steransiana*), an isopod (*Gnorisphaeroma oregonensis*), and a polychaete worm (*Nereis limnicola*) were also observed (WESCO 1995). In June 1998, clams (*Macoma balthica*) were collected for invertebrate tissue residue analysis (TtEMI 1998c).

3.2.4 Fish Assemblages

The WESCO report (1995) provides detailed characterization of fish assemblages at the Tidal Area sites. Findings from both WESCO and the 1998 fish tissue sampling effort are briefly summarized below and shown in Table 3-2.

Variation between sampling periods in May and July 1994 was clearly evident in the sampling completed by WESCO (1995). At the Froid and Taylor Roads Site, for example, species typical of ephemeral surface waters were collected, including staghorn sculpin (*Leptocottus armatus*), topsmelt (*Atherinops affinis*), mosquitofish, and three-spine stickleback (*Gasterosteus aculeatus*), while July collection efforts yielded no fish. During the June 1998 fish tissue sampling, sculpin, stickleback, and mosquito fish were collected. The differences between sampling results may be attributed to poor water quality conditions, especially oxygen depletion of available surface water.

Otter Sluice, in contrast, provides year-round water, and collections by WESCO reflect that condition. Early in 1994, staghorn sculpin and stickleback were collected from the upper reach of Otter Sluice, while collections downstream toward the tidal gate exhibited higher diversity, including tule perch and yellowfin goby (*Acanthogobius flavimanus*). Stickleback was the most common species at the

uppermost sampling stations, while staghorn sculpin was the most common species collected in May at downstream locations.

Not surprisingly, fish sampling in July 1994 at Otter Sluice yielded fewer fish and fewer species than in May. Diminished habitat quality was probably the primary reason for this decline, since sampling locations were frequently covered by aquatic plants and algae, and water depth had been reduced to 0.5 feet. Mosquitofish and stickleback were captured in moderate numbers along with an occasional staghorn sculpin. Amphipods (*Anisogammarus confervicolus*) were coincidentally trapped during the fish sampling efforts and were abundant during this period. Several striped bass fry (*Morone saxatilis*) were also collected at some locations in Otter Sluice during the July sampling. Fish collected in Otter Sluice during the June 1998 sampling effort consisted of sculpin, stickleback, tule perch, and mosquito fish.

The increased salinity in this portion of Suisun Bay typically causes a temporary drop in the number and diversity of aquatic species in July. In addition, during the winter before the surveys, the flapgates at the mouth of Otter Sluice were repaired and may have significantly limited the number of fish entering the sluice. Limited recruitment, seasonal migration, and predation may have also contributed to the reduction of fish in the sluice.

Fish abundance observed at the R Area Disposal Site tracks the seasonal availability of surface water. During the collection period in May, stickleback and mosquitofish were captured at various locations. During July, in contrast, many sampling stations were either dry or reduced to saturated mud. Fish were absent from many locations in the R Area Disposal Site at this time, which may be attributable to increased predation and poor water quality. Where water depth and quality were not limiting, mosquitofish and stickleback occurred in moderately large numbers, even in July.

Abundances of fish at the Wood Hogger Site were similar to other sites in the Tidal Area. During May, stickleback and mosquitofish were collected at Wood Hogger stations; stickleback was the most abundant species captured. Topsmelt were also captured near the station that has a close connection to Otter Sluice via a flapgate. Fish sampling in midsummer yielded a pattern of capture success similar to that at the R Area Disposal Site. Aquatic plant and algae growth covered up to 75 percent of the water surface area at this time, but when water depth and quality were adequate, mosquitofish and stickleback were caught.

In WESCO's preliminary characterization (WESCO 1995), fish diversity and abundance varied across the Tidal Area sites, both spatially and seasonally. The tide gate at the mouth of Otter Sluice is assumed to impede fish movement from Suisan Bay into the Tidal Area, but most fish occurring seasonally in Suisun Bay could be found in Otter Sluice. The WESCO report lists potentially occurring species, largely based on WES (1986). Additionally, WESCO's previous work (WESCO 1979) in nearby Hastings Slough yielded steelhead trout (*Oncorhynchus mykiss*), striped bass, Sacramento blackfish (*Orthodon microlepidotus*), Sacramento splittail (*Pogonichtys macrolepidotus*), yellowfin goby, American shad (*Alosa sapidissima*), and threadfin shad (*Dorosoma petenense*). The Sacramento splittail is a special status species, as described in Section 3.3. Although habitats at the Tidal Area sites bordering Otter Sluice are highly disturbed compared to Hastings Slough, such species could occur there if habitat conditions were suitable.

3.3 SPECIAL STATUS SPECIES

Special status species are plants and animals that are legally protected under the state and federal Endangered Species Acts or other regulations, and species that are considered rare by the scientific community (see Table 3-4). Special status species are defined as:

- Plants and animals that are listed or proposed for listing as threatened or endangered under the California Endangered Species Act, the federal Endangered Species Act, or both
- Plants and animals that are designated special species of concern by the state or federal government
- Plants and animals that meet the definition of rare or endangered under the California Environmental Quality Act (CEQA), which may include species not necessarily found on state or federal endangered species lists
- Plants occurring on lists 1A, 1B, 2, 3, and 4 of the California Native Plant Society's (CNPS) Inventory of Rare and Endangered Vascular Plants of California (Smith and Berg 1988); the California Department of Fish and Game (CDFG) recognizes that lists 1A, 1B, and 2 of the CNPS inventory contain plants that, in the majority of cases, would qualify for state listing, and CDFG requests their inclusion in environmental impact reports (EIR) as necessary. Plants occurring on CNPS lists 3 and 4 are "plants about which more information is necessary," and "plants of limited distribution," respectively (Smith and Berg 1988), and may be included as special status species on the basis of local significance or recent biological information
- Animals that are designated "Species of Special Concern" by CDFG (1998)

- Animals that are designated "Species of Concern" by USFWS
- Animal species that are "fully protected" in California by the CDFG code

The following sections identify special status species plants and animals expected or observed at the Tidal Area sites based on the WESCO report (1995) and surveys conducted during 1998 (Ibis 1999; Harvey and Associates 1998). The special status species were compiled from CNDDB (1999) records for the Vine Hill, Honker Bay, Benicia, Briones Valley, Walnut Creek, Clayton, Cordelia, Fairfield South, and Denverton quadrangles, and the CNPS inventory (Smith and Berg 1988). Table 3-4 summarizes the special status species expected or observed at the Tidal Area sites.

3.3.1 Special Status Plants

In 1994, habitat requirements were assessed for each of the 66 special status plant species listed in the CNPS inventory as occurring in Contra Costa County and for each of the special status species identified by CNDDB as potentially occurring in the vicinity. The potential occurrence of these species on the site was based on this assessment, observations of existing habitat conditions in the study area, and habitat preference information provided by CNPS (1994) and Hickman (1993) (see Table 3-4). As explained in field observations during site visits in October 1996, the vegetation appears to be of relatively low diversity for a wetland, with a large proportion of the cover being invasive weedy species composed primarily of exotic grasses and forbs (PRC 1995d).

The only special status plant that may have been observed in the study area is the marsh gumplant (*Grindelia stricta* var. *angustifolia*), a member of the sunflower family. Marsh gumplant is a shrub that stands from 3 to 5 feet tall and produces yellow flowers between August and October. Plants identified as *Grindelia* sp. were recorded for the Tidal Area sites but, due to the lack of flowers, identification to the species level was not possible during the survey. Marsh gumplant grows in coastal salt marsh and is on the county list of special status plants; however, no CNDDB records exist for this species in the nine quadrangles surrounding the Tidal Area sites.

The following special status species have not been observed at the Tidal Area sites, but may occur in the Tidal Area sites based upon the habitat type (see Table 3-4):

- **Suisun marsh aster** (*Aster lentus*) is on CNPS list 1B. List 1B species are rare, threatened, or endangered in California and elsewhere. This species has been observed in the Litigation Area of NWS SBD Concord (PRC 1996b).

- **Suisun thistle** (*Cirisium hydrophilum* var. *hydrophilum*) is proposed for federal listing as endangered and is on CNPS list 1B. The only known occurrence for this species is on Grizzly Island in Suisun Marsh. Suisun thistle is not included on the Contra Costa County special status plant list and is recorded only from Solano County. However, this species does occur in coastal marsh, a habitat type in the study area. Records in CNDDB are from the Fairfield South quadrangle.

- **Soft bird's beak** (*Cordylanthus mollis* spp. *mollis*) is state-listed as rare on CNPS list 1B. This species is currently known from fewer than 10 occurrences. CNDDB has records for this species in the Benicia, Vine Hill, Denverton, and Honker Bay quadrangles. This species has been observed in the Litigation Area of NWS SBD Concord (PRC 1996b).

- **Delta tule pea** (*Lathyrus jepsonii* spp. *jepsonii*) is on CNPS list 1B. Delta tule pea was observed at NWS SBD Concord approximately 0.5 miles east of Belloma Slough along the shore of Suisun Bay, and in the Litigation Area of NWS SBD Concord (PRC 1996b).

- **Mason's quillwort** (*Lilaeopsis masonii*) is state listed as rare and is on CNPS list 1B. Mason's quillwort was observed at NWS SBD Concord adjacent to the location of the delta tule pea; it generally occurs in brackish or freshwater marshes.

- **Delta mudwort** (*Limosella subulata*) is on CNPS list 2, which includes plants that are rare, threatened, or endangered in California, but more common elsewhere. However, this species is not protected under the state or federal Endangered Species Acts. It is known from several occurrences in the delta (CNPS 1994).

- **Small spikerush** (*Eleocharis parvula*) is on CNPS list 4, which is a watch list of species of limited distribution that are not protected under the state or federal Endangered Species Acts. Small spikerush occurs in coastal salt marsh and is on the county list of special status plants; however, no CNDDB records exist for this species in the nine quadrangles surrounding the Tidal Area sites.

3.3.2 Special Status Invertebrates

No special status invertebrates were observed during WESCO's 1994 aquatic invertebrate study, nor are any considered to potentially occur at the Tidal Area sites.

3.3.3 Special Status Fish

No special status fish were caught or observed at the Tidal Area sites during the study. However, three special status fish species and one fish species of special concern could occur in Otter Sluice based on the habitat type (see Table 3-4). Based on WESCO (1995), the fish are discussed in terms of the likelihood that each would occur given habitat preferences and migratory habits.

- **Winter-run chinook salmon** (*Oncorhynchus tshawytscha*) is listed by both the federal government and the State of California as endangered (CDFG 1998). Adult fish of this run of chinook salmon pass upstream through Suisun Bay from January through June (USFWS 1981), are unlikely to stray into Otter Sluice, and may have difficulty getting through the flapgates at the mouth of the sluice. Winter-run smolt migrating toward the ocean pass through Suisun Bay from January through March. If the winter-run smolt behave in a manner similar to the fall-run chinook smolt, they move downstream at a rate of 4 to 20 miles per day, occupy the upper 6 meters at the water column, and utilize strong outgoing currents to pass quickly through large embayments (USFWS 1981). It is possible, but unlikely, for a winter-run smolt to be drawn into Otter Sluice through an opening in the tidegate. Smolts are generally found in the stronger downstream currents, assuring that they pass rapidly through Suisun Bay. Fall-run chinook salmon juveniles have been observed in the ungated tidal sloughs at the Litigation Area of NWS SBD Concord (PRC 1996b).

- **Delta smelt** (*Hypomesus transpacificus*) is both a federal and state threatened species (CDFG 1998). The delta smelt spawns in fresh water but has been found in salinities up to 14 parts per thousand (ppt). Juvenile smelt favor the freshwater-saltwater interface, where salinities are 2 ppt (USFWS 1994). Delta smelt spawn from December through early July (mostly February and March) in shallow, fresh or slightly brackish waters, typically in tidally influenced backwater sloughs and channels. Spawning location varies year to year, and includes Delta sloughs and the north side of Suisun Bay in Montezuma and Suisun Sloughs and their tributaries (USFSW 1994). This species historically congregated in upper Suisun Bay and Montezuma Slough primarily during March to mid-June when Delta outflow was high. Because of low Delta outflows since 1981, the zone of 2 ppt salinity is now most frequently upstream of Suisun Bay, and the delta smelt is now rare in its historical habitats in Suisun Bay and its northern marshes (Federal Register 1993). Should suitable salinity conditions of 2 ppt occur in Otter Sluice during the spring, it is possible that delta smelt might find their way through the tidegate and into the Tidal Area. However, the historical Suisun Bay habitat for this species is the northern side of this embayment, not the southern side where the Tidal Area is located. This species has been observed in the tidal slough at the Litigation Area of NWS SBD Concord (PRC 1996b).

- **Sacramento splittail** (*Pogonichthys macrolepidotus*) is proposed for federal threatened status and is a California Species of Special Concern (CDFG 1998). The splittail is a large (more than 12 inches) cyprinid that occurs in the Delta, Suisun Bay, Suisun Marsh, and Napa Marsh. Splittail spawning typically peaks in March through May, and occurs over flooded vegetation in tidal freshwater and euryhaline sloughs (sloughs with a wide range of salinity) and marshes (USFWS 1994). Larval splittail remain in shallow, weedy areas close to spawning sites and move into deeper waters as they mature. Because they require flooded vegetation for spawning and rearing, splittail are frequently found in areas subject to flooding. During WESCO's 1978 quarterly monitoring of tidal sloughs in West Pittsburg, splittail 5 to 10 inches long were captured in several of these sloughs, including Hastings Slough 1.5 miles west of Otter Sluice. Disregarding physical restrictions to entry posed by the tidegate, the splittail may occur in Otter Sluice, as this species has been found in adjacent tidal sloughs.

- **Longfin smelt** (*Spirinchus thaleichthys*) is a state and federal species of special concern found in the Delta, Suisun Bay, San Pablo Bay, and Central San Francisco Bay (Federal Register 1993; CDFG 1998). It is an anadromous euryhaline species that can tolerate salinities ranging from freshwater to pure sea water. Spawning occurs in freshwater from November through June, with peak spawning from February to April. The principal nursery habitat for longfin smelt larvae is the waters of Suisun and San Pablo Bays. Adults are found primarily in Suisun, San Pablo, and San Francisco Bays, but their distribution shifts upstream into the Delta in years of low outflow. The species may seasonally occur in Otter Sluice, but the tidegate and the smelt's apparent preference for open embayments rather than sloughs makes it unlikely that longfin smelt use the Tidal Area in a significant way.

3.3.4 Special Status Reptiles and Amphibians

The Western pond turtle (*Clemmys marmorata*) was the only special status reptile observed at the Tidal Area sites (see Table 3-4). Northwestern and Southwestern pond turtles (*Clemmys marmorata marmorata* and *Clemmys marmorata pallida*) are classified by the federal government and CDFG as a Northern California species of special concern (CDFG 1998). The turtles forage for fish and invertebrates in the ponds and the brackish marshes. They use the upland areas adjacent to the ponds for nest building and egg laying. Therefore, both open aquatic and wetland habitats must be considered potential habitat for this species. The turtles were observed in the Wood Hogger, R Area, and Otter Sluice.

No special status amphibian species were observed in the Tidal Area. The California tiger salamander (*Ambystoma tigrium californiense*) could occur in the Tidal Area sites; however, suitable freshwater habitat is limited. The California tiger salamander inhabits grasslands with underground retreats (such as rodent burrows) near breeding ponds (for example, seasonal wetlands, vernal pools, slow-moving streams, or ponds) that do not support fish (USFWS 1992a). California red-legged frogs (*Rana aurora draytonii*) also require freshwater habitats, specifically dense shrubby or emergent vegetation associated with fresh, permanent, and deep, still or slow-moving water (USFWS 1992b). This habitat is not available in the Tidal Area sites. No California red-legged frogs have been observed in the Tidal Area (University of Arizona 1999).

3.3.5 Special Status Birds

A number of special status bird species were documented or observed at Tidal Area sites during field surveys completed by WESCO (1995), Harvey and Associates (1998), and Ibis (1999) (see Table 3-4):

- **Northern Harrier** (*Circus cyaneus*) is a California species of special concern (CDFG 1998). They were observed flying over the Wood Hogger and Tidal Area Landfill Sites and over Otter Sluice and Hastings Marsh. Northern harriers are found mostly in flat or hummocky open areas of marshlands, grasslands, meadows, and desert sinks. Northern harriers could visit each of the Tidal Area sites and forage there year-round.

- **Loggerhead Shrike** (*Lanius ludovicianus*) is a California species of special concern (CDFG 1998). Shrikes were observed foraging in the Wood Hogger Site. Shrikes require open habitats with sparse shrubs and trees or other suitable perches, bare ground, and low or sparse herbaceous cover. Like the Northern Harrier, Loggerhead Shrikes could be found at any of the Tidal Area sites.

- **Suisun Song Sparrow** (*Melospiza melodia maxillaris*) is a federal species of concern and a California species of special concern (CDFG 1998). They were observed in the R Area Disposal Site and in Hastings Marsh bordering Otter Sluice. Suisun Song Sparrows occupy the brackish water marshes and sloughs surrounding Suisun Bay, where they inhabit areas of cattails, tules, sedges, and pickleweed.

- **California Black Rail** (*Laterallus jamaicensis coturniculus*) is federally listed as a species of concern and state listed as threatened (CDFG 1998). Surveys conducted during July 1998 confirmed the presence of Black Rails in a small portion of the Tidal Area along Otter Sluice. The Black Rail survey is discussed in greater detail below.

- **California Clapper Rail** (*Rallus longirostris obsoletus*) is endangered at the federal and state levels (CDFG 1998). Potential habitat for this species occurs in the extensive marshes west of the site and along Otter Sluice. This species is discussed in greater detail below.

Other special status birds could occur at the Tidal Area sites, based on habitat type or observations in the vicinity of the Tidal Area sites (WESCO 1995; University of Arizona 1999); these birds are discussed below:

- **Golden Eagle** (*Aquila chrysaetos*) is a California species of special concern (CDFG 1998). Potential habitat for this species varies widely but generally contains open terrain. This species has been observed flying over NWS SBD Concord, but not at the Tidal Area sites.

- **Merlin** (*Falco columbarius*) is a California species of special concern (CDFG 1998). Potential habitat for this species includes coastlines, open grasslands, savannahs, woodlands, lakes, and wetlands. This species has been observed at NWS SBD Concord, but not at the Tidal Area sites.

- **California Gull** (*Larus californicus*) is a California species of special concern (CDFG 1998). Potential habitat for this species is sandy beaches, mudflats, and rocky intertidal and saline emergent wetlands. This species has been observed at NWS SBD Concord, but not at the Tidal Area sites.

- **White-faced Ibis** (*Plegadis chihi*) is a federal and California species of special (CDFG 1998). Potential habitat includes fresh emergent wetland, shallow lacustrine waters, and muddy ground of wet pastures. This species has been observed at NWS SBD Concord, but not at the Tidal Area sites.

- **Burrowing Owl** (*Athene cunicularia*) is a federal and California species of special concern (CDFG 1998). Potential habitat for this species includes open, dry, level grassland, prairie, and desert floor. This species is a subterranean nester that generally uses existing mammal burrows, but will also excavate its own burrows. The only area potentially suitable for this species at the Tidal Area sites is the top of the landfill, which is slated for remediation. The nearest recorded presence of burrowing owls is in the Inland Area (University of Arizona 1999).

- **Short-eared Owl** (*Asio flammeus*) is a California species of special concern (CDFG 1998). Potential habitat for this species includes grasslands, prairies, dunes, meadows, irrigated lands, and saline and fresh emergent wetlands. This species has not been observed at the Tidal Area sites but occurs in the general vicinity (University of Arizona 1999).

- **Salt Marsh Common Yellowthroat** (*Geothlypis trichas sinuosa*) is a federal subspecies of concern and a California subspecies of special concern (CDFG 1998). Common yellowthroats (*Geothlypis trichas*) were observed in the emergent brackish marsh habitat in the study area. Because the individuals observed in this study occurred east of the Carquinez Straits, they have been assigned to the more common western subspecies (*G. t. occidentalis*) (Hobson and others 1985). However, due to the proximity of the study site to the eastern edge of the Common Yellowthroat's range, Yellowthroats observed along Otter Sluice may belong to the salt marsh subspecies. To determine with certainty the subspecies identity of the Yellowthroats observed along Otter Sluice, birds would have to be captured.

3.3.5.1 California Black Rail Survey

California Black Rails were surveyed along the eastern shore of Otter Sluice during the breeding season (June 1998) in an area thought to contain the most suitable habitat for this species. Survey methods are briefly described in Section 3.1.6; a more thorough description of methods is included in the H.T. Harvey and Associates report (1998).

The estimated density of male California Black Rails for the Otter Sluice area was 0.086 rails per hectare. Assuming that each male was paired with one female, the population density was estimated to be 0.172 birds per hectare. These are minimum estimates, because it is likely that not all of the males responded on each survey. A total of 14 detections of California Black Rails were recorded during the surveys. A "detection" for the purposes of the survey was defined as a record of a California Black Rail on a particular survey of a particular station. Because the same California Black Rail heard calling

from two different stations represents two detections, the number of California Black Rails actually heard during these surveys may have been less than 14.

California Black Rails were detected only in a small portion of the survey area, between the west end of Froid Road and mouth of Otter Sluice. Most California Black Rails were on the west side of Otter Sluice, but three detections were made on the east side of Otter Sluice, at the extreme southwest corner of Site 2. No rails were detected within the Wood Hogger Terrestrial Unit (H.T. Harvey and Associates 1998). Locations where California Black Rails were detected are shown on Exhibit 2.

The low abundance of California Black Rails during the breeding season of 1998 in the Otter Sluice Area is likely to be attributable to two factors. First, due to physical access constraints survey routes were placed so that most stations were more than 30 meters from the nearest suitable rail habitat. Most of the suitable habitat lies off site, west of Otter Sluice. This placement may have resulted in negative bias in the density counts because it was necessary to estimate densities based on detections recorded at distances up to 60 meters. It has been shown from previous rail surveys conducted at the Concord Litigation Area in 1997 that rails are less likely to respond to calls from longer distances compared to rails at shorter distances (H.T. Harvey and Associates 1998). Second, the patchiness of rail habitat in the Otter Sluice area may have contributed to the low density of rails. Most of the wetlands in the transect along the Wood Hogger Terrestrial Unit consisted of cattail dominated marshes that, in many locations, had deeper water than is typical of occupied California Black Rail habitat. California Black Rails at Otter Sluice were detected primarily in more heterogeneous vegetation that included peppergrass, bulrushes, and pickleweed, consistent with California Black Rail detections in the Litigation Area (H.T. Harvey and Associates 1997).

3.3.5.2 California Clapper Rail

The Tidal Area was not surveyed for the California Clapper Rail (*Rallus longirostris obsoletus*), a state and federally listed endangered species, because the small amount of potential habitat for this species in the marshes west of the site and along Otter Sluice was not expected to support these birds. No California Clapper Rails were heard during the California Black Rail surveys (H.T. Harvey and Associates 1998). However, California Clapper Rails were heard in the brackish marsh west of Otter Sluice by field crews conducting the small mammal trapping survey during September 1998 (Ibis 1999). These incidental observations by Ibis staff were not confirmed with formal surveys. During the small mammal trapping survey field effort, at least three individual California Clapper Rails

were heard calling in the marsh immediately west of Rhodes Road, off site. Another individual (possibly two) was heard calling in the off-site marsh west of Otter Sluice just west of the western border of the R Area.

3.3.6 Special Status Mammals

The following special status mammal has been documented to occur in the Tidal Area based on field surveys conducted in 1994 and 1998 (see Table 3-4):

- **Salt marsh harvest mouse** (*Reithrodontomys raviventris*) is a federal endangered species and has been known to occur in the Tidal Area. Results of surveys are discussed below.

Other special status mammals that may occur at the Tidal Area sites based on habitat type or occurrence in the vicinity include (see Table 3-4):

- **Suisun ornate shrew** *(Sorex ornatus)* is a California species of special concern (CDFG 1998). Its optimum habitats are valley foothill and montane riparian, but it also occurs in a wide variety of woodland, chaparral, grassland, and emergent wetland habitats. They may nest in wood, shrubs, and burrows, but no shrews have been observed at the Tidal Area (Zeiner and others 1990a).

- **Townsend's big-eared bat** (*Plecotus townsendii*) is a federal species of concern and a state species of special concern (CDFG 1998). They may roost in buildings of the Tidal Area and forage over the site; however, no bats have been observed at the Tidal Area (UCB 1994; EFA WEST 1997; University of Arizona 1999). These bats prefer habitats near water, but roost in caves, mines, tunnels, buildings, or other human-made structures.

- **Pallid bat** (*Antrozous pallidus*) is a state species of special concern (CDFG 1998). They may roost in buildings of the Tidal Area and forage over the sites; however, no bats have been observed at the Tidal Area (UCB 1994; EFA WEST 1997; University of Arizona 1999). Pallid bats are most common in open, dry habitats with rocky areas for roosting. They roost in caves, crevices, mines, hollow trees, and buildings.

3.3.6.1 Salt Marsh Harvest Mouse

The only special status mammal species observed by WESCO during the 1994 field surveys at the Tidal Area sites was the salt marsh harvest mouse, a state and federally listed endangered species. The presence of the salt marsh harvest mouse in the Tidal Area was further characterized during small-mammal trapping surveys conducted in September 1998.

Salt marsh harvest mice inhabit the salt marshes around San Francisco, San Pablo, and Suisun Bays. They typically occur in salt marshes dominated by pickleweed, but may also be found in marshes

supporting a mix of salt marsh plants such as spearscale and saltgrass. Although salt marsh harvest mice are most closely associated with the salt marsh, they also use uplands adjacent to the marshes as refuge during high tides or heavy rains, when the marshes become inundated.

An objective of the small mammal trapping effort conducted during September 1998 was to determine whether the salt marsh harvest mouse is present in areas with suitable habitat in the Tidal Area. WESCO (1995) reported that a single harvest mouse was observed in the R Area Disposal Site pickleweed marsh, but was not positively identified. WESCO (1995) also reported that salt marsh harvest mice were documented in the R Area Disposal Site in the late 1980s (WES 1988b, cited in WESCO 1995).

During the 1998 surveys, 13 salt marsh harvest mice were captured from the Tidal Area sites, processed, and released. Locations of salt marsh harvest mouse captures are shown on Exhibit 2. Twelve mice were captured in the R Area, a site with extensive pickleweed cover; other plant species present where salt marsh harvest mice were captured include salt grass, other unidentified grasses, curly dock (*Rumex crispus*), peppergrass, alkali heath, brass buttons, goosefoot, marsh rosemary (*Limonium californicum*), and an unknown composite (see Table 3-1). Complete details for the small mammal trapping effort can be found in Ibis 1999.

One salt marsh harvest mouse was captured in the southern portion of the Wood Hogger Area in upland habitat containing 75 percent trefoil and 25 percent unidentified annual grasses. The nearest pickleweed to the Wood Hogger capture site was about 300 feet away, but the site was situated on the edge of a brackish marsh.

3.3.7 Summary of Special Status Terrestrial and Wetland Species

Table 3-4 is a list of special status species observed, expected, or known to occur at or in the vicinity of the Tidal Area sites (modified and adapted from WESCO 1995). For example, the Long-billed Curlew, American White Pelican, Caspian Tern, and California Least Tern were removed from the WESCO (1995) list because only their breeding habitats or nesting colonies are of special concern and none breed at the Tidal Area sites. The Salt Marsh Common Yellowthroat was also reevaluated. Originally, Grinnell and Miller (1944) showed the range of this subspecies did not extend eastward to include the Tidal Area, but the CNDDB notes that the subspecies occurs on Roe and Ryer islands, which are farther east than Grinnell and Miller's original range. Consequently, the Salt Marsh Common Yellowthroat has been included on the current list of special status species.

3.4 WETLANDS DELINEATION AND FUNCTIONAL ASSESSMENT

WESCO (1995) completed a jurisdictional wetland delineation and functional assessment as part of the field survey. The assessment was based on field observations, a review of background literature relating to the San Francisco Bay ecosystem, other work at NWS SBD Concord (Jones and Stokes 1982; E&E 1983; WES 1986, 1988a, 1988b), and the professional judgment of WESCO biologists. Additional information on soil characteristics and surface water hydrology provided by WESCO is also summarized here. The WESCO report (1995) can be reviewed for details on the wetlands delineation and assessment, but the following summaries provide information pertinent to the problem formulation for Tidal Area sites.

3.4.1 Soil Nutrient and Water Availability for Plants

The native soils in the project area consist mainly of the Omni and Joice muck series as mapped by the U.S. Soil Conservation Service (SCS) and confirmed by WESCO (WESCO 1995). These soils are associated with lowland tidal areas and are subject to frequent inundation by tidal action or seasonal runoff. The other dominating soil feature in the project area is urban fill as mapped by SCS and confirmed by WESCO. These areas consist of urban landfill or road and structural fill and are marked by a distinct change of elevation.

The Omni series is silty clay alluvium poorly drained on less than 2 percent slopes. It is moderately saline and subject to ponding, or surface water runs off very slowly. The potential for erosion is very low. Permeability is low with the available water-holding capacity at about 4 to 8 inches (SCS 1977). The "Hydric Soils of the United States" (SCS 1991) lists the Omni series as a hydric soil. The Omni series is found along the Wood Hogger Site in undisturbed areas near Otter Sluice.

The Joice muck is poorly drained with nearly level slopes and is found in brackish marshes. The Joice series has a high organic content and moderate to high salinity. These soils are subject to both very high tides and freshwater flooding. The permeability is moderate because of the high organic matter content, and the available water holding capacity is about 4 to 10 inches. The Joice series is listed as hydric in "Hydric Soils of the United States" (SCS 1991). This series is dominant in the R Area Disposal Site.

The physical characteristics of a soil and its pH are two factors mediating nutrient availability. Organic soils contain a readily available supply of hydrogen ions from carboxyl, phenolic, and other organic

groups that supply the cation exchange sites necessary for nutrient uptake by plants. Also, various types of clays provide chemical nutrients with available bonding sites. In general, clay content in soils is critical in determining mineral nutrition in plants. For example, soil nutrient status is the net result of the nature of the parent soil materials (including physicochemical properties such as pH and cation exchange capacity), as well as the ambient temperature and moisture regimes and the plant-soil interactions (such as the extent of solute uptake by the plant root and physical leaching). Information from the natural resources conservation service (Welch 1977) clearly suggests that interactions between soil organic matter and clay content may influence plant nutrition in some soils in Contra Costa County. However, without site-specific data, casual field observations are the only source of information regarding vegetation and habitat quality in the Tidal Area sites.

The Omni silty clay contains montmorillonite clay, which has a cation exchange capacity of approximately 60 to 100 milliequivalent/100g (Hausenbuiller 1978). The Joice muck has a high organic content which has a cation exchange capacity of approximately 100 to 300 milliequivalent/100g (Hausenbuiller 1978). This relatively high cation exchange capacity increases nutrient availability. The nutrient supply can be reduced by alkaline soils because of the high concentration of sodium ions. Extreme acidity can also decrease nutrients to plants by limiting the available nutrient exchange sites within the soil material. The Joice muck can be highly alkaline in some areas, limiting the ability of the soil to supply nutrients to surrounding plants.

3.4.2 Surface Water

In this region, the wet season is commonly regarded as mid-November through mid-April. Sacramento-San Joaquin River Delta outflow follows a similar pattern, but reflects the lag time in basin runoff and water management practices. The period of maximum Delta outflow into Suisun Bay is typically December through May, with the spring duration extending through June in wet years and diminishing in April during dry years (CDFG 1987). This seasonal variation in the salinity of Suisan Bay ranges from less than 2 ppt during the wet season to greater than 10 ppt during summer and early fall (Conomos 1979; CDFG 1987). In addition to tidal inflow, the salinity of the surface waters are strongly influenced by local runoff in the rainy season, evaporation of ponded water during the summer, and the salinity of the underlying soils. In field notes for October 1996, biologists observed that Otter Sluice and the margins of the R Area Disposal and Wood Hogger Sites were the only significant surface water habitats at the time of the visits; however, across the Tidal Area sites, seasonal

inundation was clearly indicated, especially through the appearance of soils and vegetation (PRC 1995d).

3.4.2.1 R Area Disposal Site

WESCO (1995) noted that portions of the R Area Disposal Site held ponded water during May 1994, but were dry in July 1994. During these ponded-water periods, general surface water quality parameters, including salinity, depth, temperature, dissolved oxygen, pH, and electrical conductivity, were similar across interconnected ponds. Highest salinity (29 ppt) was measured during May in a remnant tidal slough, where low spots on the mudflats tended to concentrate salts as the waters evaporated. The lowest salinities in the R Area (8.2 ppt) occurred during periods of open water in the tidally influenced ditch at the western side of the site. Salinities nearly doubled in the R Area Disposal Site (reaching 15 ppt) during drier times of the year (July). Other sampling locations surveyed by WESCO (1995) indicated that surface waters, when present, were hypersaline shallow ponds during July (salinities greater than 50 ppt).

3.4.2.2 Froid and Taylor Roads Site

The Froid and Taylor Roads Site receives tidal inflow only during very high tides, so its water surface elevation decreases (approximately 1.5 feet from May to July 1994) through evaporation and its salinity increases (20 to 53 ppt for May and July). In spring 1994, water quality parameters were within normal bounds, but in July 1994, the water was extremely turbid and virtually depleted of dissolved oxygen (WESCO 1995). When disturbed, the sediment released an odor reminiscent of crankcase oil. What appeared to be a petroleum residue spread across the water as the sediment sample was washed. In Froid and Taylor Roads sediments, one sample contained an elevated concentration of total polynuclear aromatic hydrocarbons (PAH) (see Section 6.0).

3.4.2.3 Wood Hogger Site

During May 1994, salinities for the four Wood Hogger stations ranged from 8 to 9 ppt at locations near Otter Sluice and other permanent surface water; salinities in shallow ponded areas that receive tidal inflow only during very high tides were measured at 10 ppt (WESCO 1995). A similar pattern was evident during the July 1994 survey period. Sampling locations that are tidally connected via Otter Sluice exhibited salinities similar to Otter Sluice (14 to 16 ppt). In contrast, sampling locations that are not tidally connected to Otter Sluice exhibited relatively elevated salinity (18 ppt).

3.4.2.4 Otter Sluice

The uppermost reaches of Otter Sluice consist of a broad shallow pool, 0.5 to 2 feet deep. It has the least tidal influence of any part of the sluice and no noticeable tidal current. In field notes for October 1996, biologists observed that Otter Sluice is tidally influenced, although the tidal flapgates severely restrict the connections between the Tidal Area sites and Otter Sluice and Suisun Bay (PRC 1995d). During the July 1994 sampling, 50 percent of the water surface at this station was covered with pondweed (*Potamogeton filiformis*), and the dissolved oxygen level was depressed to 1.6 milligrams per liter (mg/L). Salinity readings for this site were similar to other Otter Sluice stations in both spring (8 ppt) and summer (15 ppt) (WESCO 1995). Other Otter Sluice stations exhibited strong tidal currents and similar salinity. However, their proximity to the flapgate may occasionally result in greater freshwater outflow from the west end of the R Area marsh and subsequently reduce salinity in Otter Sluice.

3.4.3 Primary Productivity

WESCO (1995) summarized the primary productivity functions of the Tidal Area sites. Two major levels of primary production occur in the marshes of San Francisco Bay macrophytic (vascular plants and benthic macroalgae) and microalgal (periphyton and benthic microalgae) (Josselyn 1983). This productivity has significant effects on the food webs both within and outside the marshes in adjacent estuarine waters. Assessments of the productivity of bay marshes must therefore consider both external and internal relationships.

External productivity relationships between the bay and its adjacent marshes are not well understood. The prevailing evidence suggests that the bay ecosystem dependent largely on seasonal phytoplanktonic blooms occurring in open bay waters, rather than on marsh productivity (Spiker and Schemel 1979). With respect to the Tidal Area sites, the northern San Francisco Bay ecosystem is characterized by primary productivity driven by massive phytoplankton blooms in Suisun Bay in the late summer and early fall (Arthur and Ball 1979; Peterson and others 1975). These blooms may provide annual inputs of primary productivity into the Tidal Area marshes during high tides.

The Tidal Area sites can export productivity in the form of dissolved or small-particle carbon and detrital matter ("material flux") into the bay (Josselyn 1983). This export would likely provide a small increment in the contribution of nutrients in support of entrapment zone phytoplankton blooms. However, the ability of the Tidal Area sites to export productivity to the bay has become greatly

limited by the extensive system of levees that isolate the marshes from the bay. Historically, direct export of carbon and detritus to the bay was via a network of small and large tidal creeks and channels during outgoing tides (Josselyn 1983). The placement of levees and upland fill around the Tidal Area sites has constricted this transport network and has locked up a large part of the marsh's productivity potential, thereby reducing the marsh's significance to the bay ecosystem.

The emergent marshes adjacent to Otter Sluice retain the best tidal connection through the partially inoperative tide gates at the sluice's downstream end. These marshes therefore still provide some carbon and detrital flux capability. Marshes in the R Area Disposal and Froid and Taylor Roads Sites have indirect tidal connection to Otter Sluice via flapgated culverts and so provide limited productivity export.

The levee system in the Tidal Area sites has probably alter internal macrophytic and microalgal biomass and species compositions in the marshes. This alteration has almost certainly changed external productivity benefits with respect to grazing opportunities. The primary basis for these changes has been alteration of seasonal salinity levels in marsh waters and soils caused by isolation from bay waters. Altered hydroperiods have probably also played a role. During the summer, drydowns within isolated marshes lead to hypersaline conditions. During the winter and spring, storm water and runoff from adjacent uplands can maintain abnormally low salinities.

The Tidal Area marshes also support primary productivity in the bay by providing direct grazing opportunities for herbivores associated with the bay ecosystem. However, changes in salinity alter marsh vegetational composition in San Francisco Bay (Pearcy and others 1981; Balling and Resh 1983). Hypersalinity at the Tidal Area sites has probably promoted the expansion of pickleweed in some locations such as the R Area Disposal Site, while brackish trends have likely supported expansion of baltic rush, cattails, and willow in other locations. Pickleweed expansion may have increased grazing opportunities for herbivores such as the salt marsh harvest mouse, Yellowthroat, and terrestrial arthropods (Cameron 1972).

The isolation of tidal creeks and channels by the levee system may also have limited the robustness and density of pickleweed. Pickleweed tends to be most productive along watercourses where sediments are regularly flushed (Balling and Resh 1983). Wrack lines consisting of macrodetrital debris enhance marsh expansion by providing sites for seeds of marsh vegetation to germinate. The Tidal Area's levee

system and adjacent filled uplands have prevented expansion by confining the landward extent of the marsh, and by cutting off tidal influxes that contribute to wrack line deposition.

Tidal marshes also contribute to estuarine productivity by providing nursery habitat for many species of fish. Primary productivity in the form of algae and detritus supports large populations of invertebrates. These, in turn, provide food for fish such as topsmelt and gobies in the marshes in the Tidal Area sites, with the exception of those along Otter Sluice. These nursery benefits have likely been greatly reduced because access to adjacent estuarine waters has been interrupted by flapgated culverts and levees.

The wildlife observations and habitat assessments in the Tidal Area sites suggest that the Tidal Area's wetlands, although functionally impaired, nevertheless offer feeding opportunities to primary consumers (for example, water boatman, chironomid midges, topsmelt, salt marsh harvest mouse) and predators (for example, egrets, herons, pintail [*Anas acuta*], and wading birds).

3.4.4 Habitat Quality

Estimates of the habitat value of the wetlands in the Tidal Area sites were based on field observations. Although WESCO's field data reflect differences between the wet and dry seasons, they are not adequate to predict long-term population dynamics based on conditions likely to prevail over several seasons. For example, the limited number of wildlife observations provides only a partial view of wildlife usage of the Tidal Area sites. Therefore, greater credence should be given to "presence" data than to "absence" data. Given these limitations, habitat quality assessment relies, in large part, on the probable faunal usage of the Tidal Area sites over the long term (that is, over several years in which the normal range of climatic and hydrological conditions occur).

Otter Sluice and the adjacent emergent brackish marsh areas provide the best overall habitat quality in the Tidal Area (Habitat Class 1-Open Water-Brackish Marsh Complex). A total of 18 wildlife species were observed in these two habitat types during the faunal surveys, even though the surveys missed the peak season of avian usage (winter to early spring). During the winter and early spring months, Bay Area marshes support a greater diversity of waterfowl, shorebirds, and wading birds. The open water-brackish marsh complex also provides potential habitat for more special status species, including the western pond turtle, Northern Harrier, and the Suisun Song Sparrow, than any of the other wetland habitats in the Tidal Area.

Overall, the habitat quality of these wetlands is attributable to several factors. There is a high availability of cover, feeding, and nesting opportunities, particularly where marsh and open water habitat intermix—for example, along both sides of the sluice where bulrushes and cattails predominate. Otter Sluice and the adjacent brackish marshes also benefit from their proximity to Hastings Slough. Otter Sluice supports a large number of fishes, including stickleback, tule perch, striped bass, and yellowfin goby (see Table 3-2). Primary productivity in the form of planktonic algae supports large populations of invertebrates, which in turn provide food for fishes and birds. This potential, however, may have been reduced by the recent repair of the flapgates at Suisun Bay, which may limit the recruitment of some species of fish.

The sluice and the adjacent marshes have the best tidal connection of any of the Tidal Area wetlands because the tide gates at the end of the sluice are partially open. This tidal connection allows for limited influxes of phytoplankton, zooplankton, and estuarine species from Suisun Bay during high tides, as well as inputs of nutrient and sediments. The proximity of Otter Sluice to Suisun Bay may be particularly significant. Suisun Bay is a major source of phytoplankton productivity in the San Francisco Bay ecosystem because it is the normal location for the seasonal null zone/entrapment zone phenomenon (Peterson and others 1975). During periods of entrapment (August to September in normal rainfall years), Otter Sluice may receive large influxes of zone-induced phytoplankton blooms during high tides, thereby providing support for the marsh food web.

The habitats of the R Area Disposal and the Froid and Taylor Roads Sites (Habitat Class 2-Diked Salt Marsh Habitats: Salt Marsh and Salt Marsh/Seasonal Brackish Marsh Mosaic) are rated slightly lower in quality than Otter Sluice and the habitat immediately adjacent to the sluice. These areas consist of pickleweed/saltgrass dominant salt marsh, and a complex mosaic dominated by pickleweed/saltgrass and emergent marsh species. Wildlife surveys documented the presence of 32 species. Relatively dense stands of emergent vegetation provide protective cover and nesting habitat. The abundance of alkali bulrush and brass buttons is significant because these species are food sources for waterfowl. These marshes also support a number of other good food plants, including pickleweed, saltgrass, and cattail, all of which are eaten by ducks, passerines, and small mammals.

Despite the human impact evident at both the R Area Disposal and Froid and Taylor Roads Sites, their habitats received strong ratings from WESCO (1995). These ratings were based in part on the substantial heterogeneity in vegetational associations and dense cover provided by vigorous growths of emergent plants in both habitats. The surrounding wetlands may support an array of wildlife not

typically associated with salt marshes, another habitat dimension unique to the diked salt marshes. These habitats tend to be dry in the summer because they are not tidally influenced. In the winter months, the combination of rainfall and runoff and possibly some tidal inputs creates standing water that may last several months. This hydrological pattern is consistent with other diked salt marshes in nearby Hastings Slough (O'Neil 1988).

The seasonal nature of these wetlands makes them valuable as supplemental feeding habitat for migratory bird populations during winter months. During the winter, regional bird populations are at their highest, and many species depend on seasonal wetland areas, such as the diked brackish marshes, for food (SFEP 1992). The diked salt marsh habitats are known to support the endangered salt marsh harvest mouse (Ibis 1999). The habitat quality of these areas for the harvest mouse is enhanced by the presence of adjacent uplands, which are important for high tide refuge.

Various nonvegetated aquatic habitats occur within the R Area Disposal, Froid and Taylor Roads, and Wood Hogger Sites (Habitat Class 3-Tidally Connected Aquatic Habitats: Brackish Ponds, R Area Disposal Site Ditch). All are excavated habitats with either mud or fill bottoms. The value of these habitats depends primarily on their cycle of inundation and the extent to which they are isolated. Those that remain permanently inundated under normal hydrological circumstances and have regular tidal influence (Habitat Class 3) are somewhat better habitats than those that become dry in the summer and have limited tidal connections (Habitat Class 4).

Habitat Class 3 consists of small brackish ponds occurring in the western portion of the R Area Disposal Site and the 8-foot-wide R Area Disposal Site ditch that lies generally west of the pipeline. Both features are connected to Otter Sluice via flapgated culverts and receive some regular tidal influence. These seasonal ponds support populations of *Corophium* spp., a brackish water amphipod that is consumed by bottom feeding fish and, to a lesser degree, by waterfowl and shorebirds. Populations of other aquatic invertebrates, including water boatman, amphipods, and diving beetles, as well as fish species (stickleback and mosquitofish), were also observed (see Table 3-2). These ponds provide good feeding habitat for wading birds, waterbirds, and shorebirds such as Phalaropes, Least Sandpipers (*Calidris minutilla*), and Avocets (Anderson 1970). The quality of these aquatic habitats results from their proximity to and interconnection with the surrounding salt marsh habitat. During wet periods, these small open waterways may inoculate the surrounding marshland with aquatic species when surface waters reappear.

The ponds and ditches in the R Area Disposal, Froid and Taylor Roads, and Wood Hogger Sites represent isolated aquatic habitats WESCO identified (1995) as Habitat Class 4 areas. These habitats have very poor tidal connection and do not remain inundated on a permanent basis. They include the Froid and Taylor Roads ditch, the shallow ponded area in the Wood Hogger Site, and the 20-foot wide ditch in the eastern portion of the R Area Disposal Site. Due to their annual drydowns, they do not sustain sizable populations or diversity of aquatic invertebrates or fish. They offer limited feeding and foraging opportunities, and tend to have low dissolved oxygen.

3.4.5 Stressed Vegetation Observations

In the WESCO report (1995), two categories of stressed vegetation were reported throughout the Tidal Area sites. The first category involved stress (or apparent stress) readily attributable to normal phenological or physiological processes of the particular plant species. The locations for plants in this category were not mapped since they tended to occur at numerous locations throughout the area, and in any event, did not warrant further investigation.

Observed vegetation stress related to normal phenological or physiological processes include the following:

- Several patches of apparently dead brass buttons were observed in various locations in the Tidal Area sites. Brass buttons are perennial plants that do not tolerate extended periods of drought and typically die each year in Bay Area marshes after water levels recede. When moisture conditions improve, it rapidly responds with new growth.
- Large bands of chlorotic perennial peppergrass were observed along the levee road on the wets side of the R Area Disposal Site and at numerous locations in the R Area Disposal Site. Perennial peppergrass, despite its name, is an annual or biennial species that typically dies back each year or every 2 years. Chlorotic growth would be expected as this species enters its die-off phase. This explanation is also supported by the presence of healthy individuals of other plant species growing next to and among the peppergrass.
- Several patches of dead dock were observed. Dead vegetation consists of the previous year's growth, and is normal. Subsequent growth was healthy.

The second category of vegetational stress is attributable to environmental stress. With one exception, suggested environmental stresses were based on a preponderance of observed evidence and on the best professional judgment of project biologists (WESCO 1995). Site contamination could have contributed solely to the observed stress, acted synergistically with natural causes of stress, or be unrelated to observed stress. Vegetation stress in the Tidal Area sites related to environmental causes primarily

involved dead or largely dead patches of pickleweed. Previous studies in similar wetlands at NWS SBD Concord Litigation Area sites found several large stands of pickleweed with high percentages of dead stems (O'Neil 1988). Evidence at these sites suggested that bioaccumulation of metals was impairing pickleweed growth and health and promoting an expansion of the parasitic vine, dodder. Other potential causes for pickleweed stress include frequency of flooding, competition from other plants, and parasitism (O'Neil 1988).

Frequency and duration of flooding can be a primary cause for major diebacks of pickleweed and other middle and high marsh plants. Pickleweed is well adapted to a cycle of frequent tidal submergence and emergence associated with marsh areas above the mean high waterline (Josselyn 1983). It also grows well in the drier, nontidal conditions in diked salt marshes because of its tolerance for high salinities. However, pickleweed is not well adapted to long periods of submergence, and will not survive tidal regimes where the daily period of submergence exceeds the daily period of emergence (Hinde 1954). Long periods of submergence can cause pickleweed die-offs by several mechanisms. First, pickleweed is a poor light absorber and requires relatively high light intensities for photosynthesis. Light reduction while submerged can greatly reduce its photosynthetic capabilities (Josselyn 1983). Second, pickleweed may leach nutrients and organic compounds when it is submerged (Mahall and Park 1976). The combination of photosynthetic inhibition and nutrient losses will limit or stop pickleweed growth. Third, pickleweed can be shaded-out by dense layers of wrack and periphyton algal mats. Wrack materials consist of plant matter (primarily dead pondweed in the Tidal Area sites) and other debris concentrated by tidal action or winds in particular locations in the marsh. Periphyton algal mats consist of dense associations of macrophytic algae that tend to grow in areas where standing water occurs. Within some diked marshes, the algal mats and wrack materials may float or be pushed by winds into certain regions of the marsh, where they effectively blanket the pickleweed. These materials appear to inhibit light penetration to the pickleweed. When water levels drop, the dead and dying algal mats and wrack materials cause further stress by draping over the pickleweed growth. Pickleweed death caused by deposition of wrack materials is normal in tidal marshes (Josselyn 1983), and dieback from periphyton blanketing has been observed in diked salt marshes in south San Francisco Bay (WESCO 1993).

At the Tidal Area sites, six locations contained single or multiple large patches of dead pickleweed varying in size from less than 2,000 square feet to several acres. These areas are described below:

- One area of stressed vegetation occurred near the intersection of Froid and Taylor Roads (designated as Area 1). This approximately 3,000 square-foot zone of dead or dying pickleweed was roughly in the center of the Froid and Taylor Roads Site. Here, dense patches of dead or dying pickleweed were interspersed with zones of barren ground or very sparse dead pickleweed. Soils exhibited an unnatural blackened or stained appearance very different from the gray to darkened soil matrix colors typical of Bay Muds. Scrap wood and debris are found throughout the zone, suggesting that some sort of surface debris disposal may have occurred here.

  No evidence of flooding or periphyton/wrack draping was found; rather, a fairly distinct boundary between the dead or dying pickleweed zone and adjacent healthy stands of pickleweed existed. Within this boundary, pickleweed transitioned from completely dead in the interior, to dying in the middle, and healthy in the outer boundary. This boundary was not defined by any obvious changes in elevation that could be related to differences in inundation periods. Whether this boundary has been expanding over time is unknown.

  The pickleweed plants in this area were dying from the bottom up. The upper portions of the stems still had living chlorotic tissue, while the bottom stem portions were dead. Succulent plants can typically maintain living tissue within the extremities for a period of time after the root system and lower stems have died.

  No concentrations of dodder vine were observed in this area. Although this pickleweed die-back could have resulted from a plant pathogen, no overt evidence of disease in plants in the die-off zone was observed.

  Petroleum odor was detected and surface water sheen were noted adjacent to the stressed pickleweed stand during the July 1994 benthic sampling in the pond habitat in the Froid and Taylor Roads site. The odor and sheen prompted subsequent analysis of sediments, which revealed high concentrations of hydrocarbons.

- Three related areas of stressed vegetation occurred near the Tidal Area Landfill and in the center of the R Area Disposal Site (Areas 2, 3, and 4). Area 2 included an approximately 8,000 square-foot, low-lying patch adjacent to the south corner of the Tidal Area Landfill Site. Area 3 included an approximately 10,000 square-foot, low-lying area located along the northwestern side of the landfill. Area 4 occurred in a low-lying pocket (approximately 3,000 square feet) in the central portion of the R Area Disposal Site itself, adjacent to a remnant tidal slough.

  Area 2 had an extensive cover of dead periphyton/wrack material and a crusty soil surface indicating a past extended period of inundation. The height of the dead periphyton mat on the edge of the adjacent landfill vegetation suggests that all the pickleweed in this location had been completely submerged. Areas 3 and 4 had less periphyton/wrack cover but nevertheless had clearly been subjected to extensive prior inundation. Extensive inundation of all three areas was likely during the extremely wet winter and spring of 1992 to 1993, which is the probable cause of pickleweed death noted in the WESCO field surveys (WESCO 1995).

Area 3 is bounded on three sides by uplands or higher ground and sits in a depression that would naturally collect floating periphyton and wrack debris during long periods of inundation. Similarly, Areas 2 and 4, although not as isolated by uplands, occupy low-lying pockets that would also be expected to experience a longer period of inundation than surrounding lands.

All three areas also show evidence of pickleweed regeneration, particularly around the edges, where periphyton/wrack deposits are less thick or absent. Furthermore, in some locations saltgrass is also regenerating. Saltgrass is less tolerant of excessive submergence than pickleweed and would also dieoff during the flooding.

- Area 5 covers much of the north-central portion of the R Area Disposal Site. This north-central portion of stressed vegetation consisted of various large and small patches of dead or chlorotic pickleweed growing in a previously plowed, low-lying marsh area covering several acres. Periphyton wrack draping was not a major problem here, but extended submergence was still clearly the cause of the dieback. All of this area shows evidence of pickleweed and saltgrass regeneration.

- While the previous areas of stressed vegetation lie outside of the seasonal brackish/salt marsh mosaic, Area 6 lies within this habitat type. Here, an approximately 20-foot wide zone (less than 2,000 square feet) of dead bulrushes, saltgrass, and pickleweed occurs primarily in the low-lying remnant tidal slough in the R Area Disposal Site (WESCO 1995). Although prolonged inundation is the apparent cause of saltgrass and pickleweed dieback in this location, the death of bulrush cannot be attributed solely to this cause. Bulrushes are far more tolerant of prolonged inundation than are saltgrass and pickleweed; the more likely explanation for bulrush death is increased salinity. Although *S. robustus* is more tolerant of high salinities than are other bulrushes, it still cannot tolerate excessively long periods of concentrated salinities (Josselyn 1983). Because this stressed area is located in a low-lying portion of a remnant tidal slough that maintains limited tidal influence, salinity may have built up. This hypothesis is supported by the water quality results, which showed that the remnant tidal slough had the highest salinities within the R Area Disposal Site (WESCO 1995). In any event, both the bulrush and saltgrass in this area were showing new growth.

4.0 SAMPLING STRATEGY AND ANALYSIS

The following sections present summary descriptions of the Tidal Area RI and QEA sampling strategy and analytical methods that are described in detail in the RI work plan (PRC 1994), Section 3.0 of the draft RI (PRC 1997), and the FSA to the RI work plan (TtEMI 1998a). Sections 4.1 and 4.2 present the sampling strategy and analytical methods for sampling conducted in the summer of 1995 for the draft RI (PRC 1997). Sections 4.3 and 4.4 present the strategy and analyses for the additional sampling conducted in the summer of 1998 to fill data gaps and to address regulatory agency comments on the draft QEA. Section 4.5 presents the sample identification system and Section 4.6 describes the QA/QC measures used and discusses the data quality for this project.

Table 4-1 presents a summary of the number of chemistry samples collected in the Tidal Area for the 1995 and 1998 investigations. The table summary is divided by sample type (matrix) and location, between 1995 samples (CLEAN I Contract Task Orders [CTO] 281 and 283, and CLEAN II CTO 033), and 1998 samples (CLEAN II CTO 217). Table 4-2 is a summary of the number of biological and tissues samples collected in the Tidal Area for the 1995 and 1998 investigations. Tables 4-3 and 4-4 list each sample location, depth, and type of analysis conducted against the matrix and site for the 1995 and 1998 investigations.

4.1 1995 SAMPLING STRATEGY

The sampling strategy for the draft RI, including the draft QEA for the Tidal Area sites and one solid waste management unit (SWMU) site 37 (SWMU 37), included as part of the Wood Hogger), is described in the following sections. The sampling strategy for the draft RI was discussed in working meetings with the regulatory agencies and was presented in the field sampling plan for the RI (PRC 1995b) and the QEA work plan (PRC 1995a). Environmental media sampled as part of the draft RI included soil, sediment, and surface water. In addition, waste extraction tests (WET) and toxicity tests using Microtox and P450 were performed on a subset of samples. The samples collected during the 1995 investigation and their analyses are listed by location in Table 4-3 and are shown on Exhibit 3.

4.1.1 1995 Soil Investigation

The RI soil investigation conducted in summer 1995 involved collecting 303 soil samples from four sites. Of these samples, 251 were collected from a soil depth interval between 0 and 3.0 feet below

ground surface (bgs). The other 52 soil samples were collected from depths greater than 3.0 feet bgs, with maximum sampling depth not exceeding 10 feet bgs at most locations. For this QEA, the soil between 0 and 3.0 feet bgs is referred to as "surface soil," and soil at depths greater than 3.0 feet is referred to as "subsurface soil." These soil depth designations differ from the RI report, which designated surface soil between 0 and 0.5 feet bgs and subsurface soil was that soil below 0.5 feet bgs. The soil sample depth intervals for each sample at each location are presented in Table 4-3.

The majority of soil samples were collected from the surface because overland flow of dissolved or particulate-sorbed chemicals was anticipated to be the dominant transport process of concern at the Tidal Area sites. Subsurface transport of contaminants was determined to be the least significant means of contaminant transport based on the results of previous investigations, which indicated that the sites were underlain by Bay Muds with very low permeabilities.

Soil sampling locations are shown on Exhibit 3. Purposive samples were collected in areas of known disposal in all four sites to assess the nature and extent of contaminants. The purposive (biased) sampling provided specific information for assessing whether contamination had migrated from the landfill or from other areas where disposal was suspected based on site observations. Soil samples were also collected uniformly along grids in the R Area Disposal and Wood Hogger Sites to provide overall unbiased sampling. In addition, unbiased "buddy" samples were collected about 10 feet away from randomly selected grid samples. The buddy samples were collected to assess spatial variation in concentrations on a smaller scale than was provided by the grid spacing. An evaluation of the buddy samples is presented in Volume I of the draft RI report (PRC 1997).

Nearly all surface and subsurface soil samples were collected using either handpushing or hammer driving to advance a 2-inch-diameter, stainless steel core barrel sampler to the desired soil depth. Clear acetate sleeves, which were inserted into the stainless steel core barrel, contained the soil samples for visual logging and for submittal to the laboratory, thus minimizing disturbance of the sample. A truck-mounted hydraulic push-probe was used at five locations at the Wood Hogger Site to assist in soil sample collection. The soil at the five locations was saturated and contained buried wood pieces, which made collection of subsurface soil samples by mechanized methods necessary. For these locations, a 2-inch-diameter core barrel with acetate sleeves was attached to the hydraulic push probe, which allowed the collection of soil samples at depths as great as 13 feet bgs.

4.1.2 1995 Sediment and Surface Water Investigation

Limited characterization of Otter Sluice was conducted in 1995, when five sediment samples were collected from Otter Sluice in August 1995 in the areas adjacent to the R Area Disposal and Wood Hogger Sites. Two samples were collected adjacent to the R Area Disposal Site, and three samples were collected adjacent to the Wood Hogger Site (see Exhibit 3). Samples were collected by pushing clean sections of 2-inch-diameter acetate tubing into the sediment and slowly extracting the tubes and sample. The sediment samples were transferred individually to clean 6-inch stainless steel tubes, the ends were covered with Teflon and plastic caps, and the tubes were submitted to the laboratory.

Surface water samples were collected at the R Area Disposal, Froid and Taylor Roads, and Wood Hogger Sites during four quarterly sampling periods: July 1995, October 1995, January 1996, and April 1996 (see Exhibit 3 and Table 4-3). No surface water was present at the Tidal Area Landfill. Surface water elevations were also recorded and used in conjunction with measurements of groundwater elevations to produce water level maps for each sampling period.

Surface water samples were collected by submerging sample containers then adding preservative, if necessary, after the sample was collected. All efforts were made to minimize the amount of sediment collected with the samples. The surface water samples were not filtered; therefore, chemical concentrations reflect total recoverable concentrations. Surface water samples were collected at 17 locations at the R Area Disposal Site, 2 locations at the Froid and Taylor Roads Site, and 6 locations at the Wood Hogger Site. Surface water was collected in Otter Sluice during the 1995 sampling event; however, the sluice samples were associated with the R Area and Wood Hogger Sites (see Exhibit 3).

4.2 1995 SAMPLING PARAMETERS

The following subsections describe the parameters analyzed in soil, sediment, and surface water samples collected at the four Tidal Area sites in 1995.

4.2.1 Soil/Sediment Parameters

Table 4-3 lists the analyses on each 1995 soil and sediment sample. Grid and purposive soil samples were analyzed for semivolatile organic compounds (SVOC), pesticides and polychlorinated biphenyls (PCB), inorganics (total metals), pH, and TOC. Buddy samples were analyzed for inorganics constituents and pH. In addition, selected samples were analyzed for the following constituents:

volatile organic compounds (VOC), extractable total petroleum hydrocarbons (TPH-e), explosive compounds, inorganic compounds (including hexavalent chromium), sulfides, and dioxins and furans. Selected samples were submitted for analysis of the following characteristics: grain size, moisture content, dry density, specific gravity, and permeability.

All 1995 sediment samples were analyzed for inorganic constituents, SVOCs, pesticides and PCBs, TOC, sulfide, pH, WET (metals), and physical properties (permeability and grain size).

SVOCs and PCB/pesticides were analyzed using two methods: the contract laboratory program (CLP) method was used for the majority of soil and sediment samples during the 1995 sampling event. A subset of those samples was also analyzed using a low-level methodology to achieve lower detection limits. The locations and associated analyses conducted are listed in Table 4-3.

Detailed descriptions of the specific methods used in the chemical analyses, physical characteristic determinations, extraction tests, and toxicity tests conducted on the 1995 Tidal Area soil and sediment samples are found in the "Tidal Area RI Quality Assurance Project Plan (QAPjP)" (PRC 1995c).

To aid in estimating the bioavailability of metals at the site, two versions of the WET, one using hydrochloric acid (WET-acid) and the other using deionized water (WET-DI), were conducted on selected sediment and surface soil samples in 1995. The WET extractions approximate the soluble fraction of metals in soil or sediment. The soluble fraction usually represents the fraction of metals most bioavailable to receptors. A total of 15 surface soil and five sediment samples throughout the Tidal Area sites were extracted using 0.5 normal hydrochloric acid (WET-acid) based on the assumption that an acidic solution would leach a larger portion of metals in-soil or sediment compared to using a deionized water solution. The deionized water extraction method (WET-DI) was conducted on a total of 47 surface soil and 5 sediment samples collected throughout the Tidal Area sites. The WET-DI method provides a lower estimate of the bioavailable fraction of metals. The extracts were analyzed for the full suite of CLP metals. The sampling locations are shown on Exhibit 3 and listed in Table 4-3.

4.2.2 1995 Surface Water Parameters

Eighty-one surface water samples were collected from 25 locations across the Tidal Area sites (see Exhibit 3). The following were analyzed for the following constituent samples: VOCs, pesticides and PCBs, explosives, SVOCs, TPH-e, total suspended solids, TOC, and total metals (see Table 4-3).

The QAPjP (PRC 1995c) and the quality control summary report (QCSR) in Appendix K of the RI report discuss each method in detail.

4.2.3 Toxicity Tests

Three toxicity tests (solid phase Microtox, organic extract Microtox, and RGS P450 [also known as Cytochrome P450]) were performed on a total of 49 surface soil samples throughout the Tidal Area sites (see Table 4-3). Exhibit 3 shows the locations where Microtox and Cytochrome P450 samples were collected.

4.3 1998 SAMPLING STRATEGY

The strategy for the additional sampling to better characterize Otter Sluice and fill data gaps identified in the draft QEA is described in the following sections. Soil, sediment, surface water, simultaneously extractable metals/acid volatile sulfide (SEM/AVS) and tissue samples of rodents, fish, clams, amphipods, and pickleweed were collected in June 1998. In addition, two toxicity tests were conducted to directly assess toxicity in Otter Sluice. Exhibit 3 shows the soil, sediment, and surface water sampling locations. Exhibit 4 shows the toxicity test and tissue sampling locations.

4.3.1 1998 Soil Investigation

The chemical results for the 1995 sampling indicated the potential for dioxins in soil at the Wood Hogger Site, and the presence of chlordane at the Froid and Taylor Roads Site. One objective of the June 1998 sampling was to confirm and delineate the extent of the dioxins at the Wood Hogger Site and confirm the presence of chlordane at the Froid and Taylor Roads Site.

Chlordane was detected in a sample from one location at the Froid and Taylor Roads Site during the 1995 sampling. Two surface soil samples (0 to 0.5 feet bgs) were collected for total chlordane analysis in June 1998 to confirm the presence of chlordane in the area. The samples were collected near the original location; Exhibit 3 shows the chlordane sampling locations.

During the 1995 sampling, two samples were analyzed for dioxins due to the historical presence of an incinerator in the southwest corner of the site. As a result of limited detections of dioxins, it was determined that additional samples to confirm and delineate the extent of contamination should be collected. Surface soil (0 to 0.5 feet bgs) samples were collected for dioxin analysis from nine locations, spread across the southwestern corner of the Wood Hogger Site, near the former incinerator

(see Exhibit 3). The locations were selected by drawing concentric arcs across a map of the site, originating at the former incinerator and focused on existing sample locations. In this way, dioxin concentrations could be correlated with results for previously analyzed soil samples. The dioxin results from the nine samples, along with previously reported results, provide data adequate to determine the extent of contamination.

The surface soil samples were collected in precleaned glass jars using a stainless steel hand trowel. The hand trowel was decontaminated between sampling locations by washing with a nonphosphate soap (Alconox), followed by two rinsing steps, first with methanol and then with distilled water.

4.3.2 1998 Sediment and Surface Water Investigation

Additional sediment and surface water samples were collected to better characterize Otter Sluice and the aquatic portion of the Froid and Taylor Roads Site where standing water provides habitat for shorebirds and other receptors that rely on shallow ponded areas. During periods of high water, overland flow can result in flooding of the old slough channel in this area. The channel connects the Froid and Taylor Roads Site to the southeast edge of the Wood Hogger Site, which in turn connects to the main channel of Otter Sluice. North Otter Sluice is connected to the R Area Disposal Site by culverts.

Collocated surface sediment and surface water samples were collected from three locations in North Otter Sluice and six locations in South Otter Sluice (see Exhibit 3). The nine sediment samples were analyzed for total metals, SVOCs, PCBs, and pesticides using CLP methods. The four sediment samples in South Otter Sluice collected nearest the old incinerator were also analyzed for dioxins. Surface water samples were analyzed for total metals, SVOCs, PCBs, and pesticides. At seven of these locations, intact sediment core samples were collected for use in the sediment-water interface (SWI) toxicity test that used topsmelt, as described in Section 4.4.1. Bulk sediment samples from the same seven Otter Sluice locations were used for amphipod toxicity tests as described in Section 4.4.2.

Collocated surface sediment and surface water samples were collected from locations in the old slough channel at the Froid and Taylor Roads Site (see Exhibit 3). These locations are potentially connected to the R Area Disposal Site, the Tidal Area Landfill, and the Wood Hogger Site via surface transport during periods of high water. The three sediment and surface water samples were analyzed for total metals, SVOCs, PCBs, and pesticides.

Bulk sediment samples in Otter Sluice were collected using an Eckman dredge lowered to the sediment from a boat using a hand line. Once a grab sampled was obtained, the sediment was transferred to a stainless steel bowl using stainless steel spoons for compositing (mixing). This procedure was repeated until the required sediment volume for all of the analyses at a given location was obtained. Composited sediment grabs were then transferred to containers for analyses. SEM/AVS sediment samples were collected from undisturbed sediment directly from the dredge. The dredge and utensils were decontaminated between sampling locations by scrubbing away all visible sediment with site water, followed by Alconox (soap) washing, and rinsing with methanol and distilled water. Surface water samples were collected using the methods described in Section 4.1.2

4.3.3 1998 Tissue Residue Sampling

No tissue samples were collected in 1995. Plant (pickleweed), aquatic invertebrate, fish, and rodent tissue samples were collected in 1998 to (1) provide an indicator of bioavailability and bioaccumulation of chemicals to representative receptors and (2) be used in food chain modeling to provide site-specific estimates of chemical doses potentially ingested by vertebrate predators at the sites.

4.3.3.1 Pickleweed

Pickleweed tissue from growing plants was collected near three locations in the R Area Disposal Site (sample locations RADSB106, RADSB007, and RADSB017) and one location in the Wood Hogger Site (sample location WHSB021). These four locations (see Exhibit 4) were chosen based on available information on existing surface soil chemistry, which indicated that these locations had the highest concentrations of inorganic compounds. The soil chemistry for organic compounds was not considered because organics are not expected to accumulate in pickleweed. Pickleweed located closest to the sample location stakes was collected. These pickleweed locations were assumed to provide, or could provide in the future, suitable habitat for the salt marsh harvest mouse.

Pickleweed tissue samples were systematically collected within an approximate 4-meter radius of the sample location stakes. Plant material was collected within a 1-meter radius of the sample location stake and then worked outward in 1-meter increments to the 4-meter radius limit, or until the desired plant mass for residue analysis was collected. Whenever possible, tissues were collected such that the entire 360-degree area around the sampling location stake (and within the specified radius) is represented in the sample. Pickleweed tissue was collected using stainless steel scissors that were decontaminated between sampling locations. Pickleweed samples were stored in sealed plastic bags in

coolers with ice, for shipment to the laboratory for analysis. Pickleweed tissue samples were analyzed for metals only.

4.3.3.2 Invertebrate and Fish Tissues

As part of the characterization of Otter Sluice and the Froid and Taylor Roads Site, and to provide data on the potential bioaccumulation of chemicals, invertebrate and fish tissues from these two sites were analyzed for chemical residues. The invertebrate and fish tissue sample locations are shown on Exhibit 4 and listed with their respective analyses in Table 4-4. Invertebrates and fish may accumulate chemicals in tissues via contact with sediment and water, as well as through ingestion of chemicals in or on food. Invertebrate and fish tissue samples were analyzed for metals, PCBs, and pesticides. The two samples collected nearest the old incinerator at Otter Sluice (OSLTI022 and OSLTI023) (see Exhibit 4) were also analyzed for dioxins.

Invertebrate and fish tissues were collected from five reaches of Otter Sluice distributed across the areas assumed to be influenced by the Wood Hogger and R Area Disposal Sites, and one from seasonally wet area at the Froid and Taylor Roads Site. Collection locations were centered on areas where sediment and surface water samples were collected. A minimum of one composite sample per reach was collected.

For the invertebrate samples, native clams (*Macoma balthica*) were collected preferentially; however, if no clams were available in a location of interest, other invertebrates such as amphipods were collected. Clams were present and were collected at the five Otter Sluice locations. However, at the Froid and Taylor Roads Site, amphipods were far more abundant than clams. Consequently, the two Froid and Taylor Roads Site invertebrate samples consisted of amphipod tissue. Invertebrate samples were collected with dipnets. Specimens were rinsed in surface water to remove external sediment placed in precleaned glass jars.

Fish were collected using baited minnow traps in the same areas where invertebrates were collected. Resident benthic species, such as gobies (Family Gobiidae) or sculpins (Family Cottidae), were the preferred taxa for tissue analysis. Fish collected during June 1998 sampling effort consisted of sculpin, stickleback (*Gasterosteus aculeatus*), and mosquito fish (*Gambusio affinis*). An attempt was made to collect adequate tissue of the same species for each composite; however, at some locations, mixed-species composites were collected. Species composition of each sample is presented in Table 4-5.

4.3.3.3 Rodent Tissue

Concurrent with the small mammal trapping described in Section 3.3.6, several rodent specimens were collected for tissue residue analysis. Individual rodent specimens, collected within close proximity to targeted soil sampling locations in a given area, were pooled to form composite tissue samples (see Table 4-6). Three composite rodent tissue samples were collected from the R Area Disposal Site and three from the Wood Hogger Site (see Exhibit 4). The analyses conducted on each respective composite sample are listed in Table 4-4.

Small mammal trapping was conducted to meet two objectives: (1) to conduct a salt marsh harvest mouse/small mammal survey, and (2) to collect rodent tissue at locations where 1995 soil sample analyses indicate the highest concentrations of chemicals at the site ("hot spots"). Trap locations were focused more on the 'hot spot' objective since capture of a single salt marsh harvest mouse would demonstrate species presence at the site, and this objective was less dependent on the trap location plan. Consequently, the proposed trap locations were based on 1995 soil sample locations with the highest concentrations of organic chemicals and/or inorganic chemicals. These proposed trap locations were modified in the field based on locations of the best quality salt marsh harvest mouse habitat and likelihood of successful trapping. Actual trapping transects covered an area beyond the 'hot spots' (see Exhibit 2).

In order to collect adequate tissue volume for analysis, each tissue sample consisted of a composite of several individuals. Rodent capture data, including the composition of composite samples and target soil samples closest to rodent capture locations are presented listed in Table 4-6.

4.4 TOXICITY TESTS

Bioassays were conducted using sediment from seven locations in Otter Sluice to directly assess toxicity. Two tests were conducted: (1) the SWI test topsmelt (*Atherinops affinis*) and (2) the bulk sediment toxicity test using the amphipod *Eohaustorius estuarius*.

4.4.1 Sediment Water Interface Toxicity Test

The SWI topsmelt (*Atherinops affinis*) embryo toxicity test was selected as an indicator of the effects of sediment on early life stages of fish that may occur in tidal sloughs (Anderson and others 1996).

Sediment samples from three locations in North Otter Sluice and four locations in South Otter Sluice were tested for toxicity to topsmelt embryos. The seven locations were collocated with the sediment and surface water samples described in Section 4.3.2. Three samples from near the Wood Hogger Site, three from near the R Area Disposal Site, and one from the reach of Otter Sluice between these two sites were tested. Sample locations are shown on Exhibit 4.

SWI samples were collected as intact, undisturbed sediment cores with overlying water. The SWI cores were collected in plastic tubes measuring approximately 10 inches long with an outside diameter of approximately 4 inches. SWI samples were collected in the following manner: (1) an empty sample tube was clamped to the end of a 6-foot length of plastic pipe; (2) the pipe and sample tube assembly were lowered to the sediment surface and the sample tube was pushed approximately 3 to 3.5 inches into the sediment surface; (3) the pipe and sample tube assembly was then carefully withdrawn from the sediment and raised to near the water surface without disturbing the extracted sediment sample; (4) the sediment end of the sample was then covered with a polyethylene (plastic) cap before withdrawing it from the water; (5) the sample tube was then carefully unclamped from the pipe, while keeping the tube upright so that the sediment and its overlying water remained undisturbed; and (6) the other end of the SWI sample tube was then covered with Parafilm® and a polyethylene cap, leaving 4 to 6 inches of water overlying the sediment (excess water, if present, was removed with a baster). Individual SWI core samples were packed in an upright position, and delivered to the laboratory.

4.4.2 Amphipod Toxicity Tests

Bulk sediment bioassays were conducted to evaluate the toxicity of contamination sediments from Otter Sluice to the amphipod *Eohaustorius estuarius*. The amphipod bioassay provides a measure of direct effects to organisms relevant to the site-specific food chain. *E. estuarius* was chosen because it tolerates a full range of sediment grain sizes (EPA 1994a); in addition, this species is sensitive to contaminants (MacDonald and Others 1992). Although this species is not common at the site, other amphipods are abundant there.

The same Otter Sluice locations as those sampled for the fish toxicity test were sampled for the amphipod toxicity tests (see Exhibit 4). Two liters of sediment from each sample location was required for the amphipod toxicity tests. The test sediment was collected in 2-liter polyethylene containers using the method described in Section 4.3.2 for collecting sediment samples.

4.5 IDENTIFICATION AND DOCUMENTATION OF SAMPLES

The following sections describe the sample location and laboratory sample identification system.

4.5.1 Location Identification System

The location identification consists of three parts: (1) the site name, (2) the location type (for example, soil boring, sediment, or surface water), and (3) the specific location (for example, grid node or purposive location), as follows:

Site Abbreviation	Location Type Abbreviation	Specific Location
TLS (Tidal Area Landfill Site)	SB (soil boring)	001
RAD (R Area Disposal Site)	SB (soil boring)	A01
WHS (Wood Hogger Site)	SL (sediment)	003
FTS (Froid and Taylor Roads Site)	SW (surface water)	002

The "Site Abbreviation" is a three-letter code identifying the site. The "Location Type Abbreviation" is a two-letter code for the type of location. The "Specific Location" is a three-character code or three-digit number used to identify a specific grid or purposive sampling location. For example, grid node A01 would be located at the intersection of column A and row 01. Purposive locations were identified consecutively (such as 001, 002). Examples of sampling location identifiers follow:

- TLSSB001 - Purposive soil boring number 1 from the Tidal Area Landfill
- RADSBA01 - Soil boring at grid node A01 from the R Area Disposal Site
- WHSSL003 - Sediment sampling location number 3 from the Wood Hogger Site
- FTSSW002 - Surface water sampling station number 2 from the Froid and Taylor Roads Site

All locations were recorded on appropriate forms during field activities to identify the location corresponding to the sample sent to the laboratory.

4.5.2 RI Sample Identification System

The sample identification system was developed so that blind samples could be submitted to the laboratory; therefore, sample names do not contain information about the purpose of the sample. The

sample identification consists of four parts: (1) the CTO number, (2) the site where the sample was collected, (3) the sample type, and (4) the sample number. Examples of the sample identification system and each of its four parts follow:

CTO Number	Site Abbreviation	Sample Type Abbreviation	Sample
281	TLS (Tidal Area Landfill)	SS (soil)	001
281	RAD (R Area Disposal Site)	SS (soil)	002
281	WHS (Wood Hogger Site)	SL (sediment)	006
281	FTS (Froid and Taylor Roads Site)	SW (surface water)	215

The "Site Abbreviation" is the same for both the location and sample identification systems. The "Sample Type Abbreviation" is a two-letter code for the type of sample collected. The "Sample Number" is a three-digit sequential code for each type of sample at each site. Each sample type (soil, sediment, and surface water) was numbered sequentially. Samples collected at different times from the same location (surface water) were differentiated by the date of collection and the sample identification number. For example, during the first quarter, surface water sample identification numbers began with "0;" for the second quarter, sample identification numbers began with "1." Examples of sample identifiers are as follows:

- 281TLSSS001 - Soil sample number 1 collected from the Tidal Area Landfill
- 281RADSS002 - Soil sample number 2 collected from the R Area Disposal Site
- 281WHSSL006 - Sediment sample number 6 from the Wood Hogger Site
- 281FTSSW215 - Surface water sample number 15 collected during the third quarter from the Froid and Taylor Roads Site

4.6 QUALITY ASSURANCE/QUALITY CONTROL

This section briefly summarizes the field QA/QC procedures, the analytical program, and data validation procedures used during the 1995 and 1998 sampling efforts. Field and laboratory QA/QC procedures are presented in detail in Section 3.0 of the RI report (Volume I).

Field QA/QC samples were collected for laboratory analysis to check sampling and analytical precision, accuracy, and representativeness. The results of the QA/QC samples are discussed in the QCSR presented in Appendix K. The QA/QC samples were consistent with guidelines presented in the

Navy QA/QC requirements (Naval Energy and Environmental Support Activity [NEESA] 1988). The types of field samples are presented in detail in Section 3.6 of the RI report.

The analytical program for the NWS SBD Concord Tidal Area sites was designed to provide data users with data of known quality. To achieve this goal, documented procedures were followed for the identification and documentation of all samples collected, containerization and preservation of all samples, sample custody and shipment control, internal quality control checks for field and laboratory analyses, data reduction and reporting, and data validation. Each of these procedures is described in Sections 3.9 and 3.10 of the RI report.

The Tidal Area project chemist reviewed the data validation reports from the validation subcontractor to assess whether chemical measurement data quality objectives were met and to determine whether the data are usable for their intended purpose. Appendix L details any specific data quality problems found with the 1995 and 1998 data. Review of the data indicates that the data are over 99 percent complete and are of high usability.

5.0 METHODS OF SCREENING CONTAMINANTS

All chemicals detected in soil, sediment, and surface water samples at the Tidal Area sites were subject to a screening process to determine COPECs. These COPECs were then further evaluated to identify COECs for various groups of receptors. This section describes the screening process. Section 6.0 presents the results of the screening process for COPECs and discusses the nature and extent of contamination at the Tidal Area sites. The COECs for representative receptor groups are identified in Sections 10.0 through 15.0.

5.1 SCREENING VALUES FOR CHEMICALS OF POTENTIAL ECOLOGICAL CONCERN

As part of the screening process for COPECs, site concentrations were compared to regional ambient conditions and, as appropriate, toxicity-based benchmarks as follows:

- The concentrations of inorganic chemicals in soil or sediment were compared to the ambient values established for the Tidal Area sites (PRC 1996a).
- The concentrations of inorganic and organic chemicals in soil or sediment were compared to the San Francisco Bay ambient values for fine-grained sediment (California Regional Water Quality Control Board, San Francisco Bay Region [RWQCB] 1998).
- The concentrations of inorganic and organic chemicals in soil or sediment were compared to effects range-low (ER-L) and effects range-median (ER-M) values (Long and others 1995; National Oceanic Atmospheric Administration [NOAA] 1991); however, no chemicals were screened out based on ER-Ms.
- The concentrations of inorganic and organic chemicals in surface water were compared to the lowest value from the following sources: EPA national saltwater or freshwater chronic ambient water quality criteria (AWQC) (EPA 1998), EPA California proposed saltwater or freshwater chronic AWQC (EPA 1997), and the San Francisco Bay Basin Plan objectives for waters upstream from the San Pablo Bay (Bay Basin Plan 1986).

These screening values are described in more detail in the following sections.

5.1.1 Ambient Chemical Concentrations

Chemical concentrations for Tidal Area soil and sediment samples were evaluated against ambient concentrations of inorganic and organic chemicals, which are interpreted to represent typical regional conditions. Ambient concentrations may differ from true background concentrations, which are typically defined as levels of naturally occurring, nonanthropogenic chemical concentrations

(RWQCB 1998). However, ambient values provide a point of comparison to focus the investigation of site releases.

The following subsections discuss the site-specific and regional ambient concentrations that were used as screening values for COPECs.

5.1.1.1 Tidal Area Ambient

During the Tidal Area RI at NWS SBD Concord (PRC 1996a), ambient concentrations were established for 17 inorganic chemicals detected in wetland soil and sediment samples; these ambient concentrations were based on 200 subsurface soil samples (collected from 2 to 10 feet bgs). Ambient limits were estimated at the upper 99th percent upper confidence limit (UCL). Tidal Area ambient values were derived for most inorganic chemicals (except silver and selenium). Appendix F provides more information on the development of the ambient values. Tidal Area ambient values are listed in Table 5-1.

5.1.1.2 San Francisco Bay Ambient (RWQCB 1998)

RWQCB (1998) compiled a statistical analysis of ambient concentrations of chemicals in subtidal sediments of San Francisco Bay. The report recommends that the ambient level threshold be set at the 85th percentile for sediment described as 100 percent fines. Above this threshold concentration, a sediment is considered contaminated (RWQCB 1998). RWQCB ambient concentrations are available for 10 inorganic chemicals and the following organic chemicals: PAHs, PCBs, and selected chlorinated pesticides. San Francisco Bay ambient values are listed in Table 5-1.

5.1.2 Regulatory Criteria and Other Screening Values

Chemical concentrations in soil, sediment, and surface water at the Tidal Area sites were compared to available regulatory criteria and guidance values derived from direct toxicity tests or biological effects data. Promulgated values are available for surface water and were used as part of the screening process. Promulgated values are not available for soil and sediment. For sediment, toxicity-based guidance values exist that are in general use; these values were deemed relevant and appropriate for this QEA and were therefore used as part of the screening process. No toxicity-based guidance values area available for soils; however, because of the predominance of wetland and aquatic habitat at the

Tidal Area sites, and because all areas of the site are under water for a portion of each year, the sediment guidance values were used to screen both soil and sediment at the Tidal Area.

5.1.3 Sediment Guidance Values

ER-Ls and ER-Ms are based on chemical and biological effects data from a wide variety of studies on invertebrates in marine and estuarine sediments (Long and others 1995; NOAA 1991). ER-Ls and ER-Ms are presented in Table 5-1. The ER-L represents the lower 10th percentile of the effects data, and the ER-M the 50th percentile or median of the effects data. Concentrations below the ER-L represent levels at which direct adverse biological effects to invertebrates are rarely observed; concentrations between the ER-L and ER-M may occasionally result in adverse biological effects. At concentrations above the ER-M, adverse biological effects are expected. These adverse effects may include mortality or sublethal effects such as reduced growth or reproductive success (Long and others 1995; NOAA 1991).

5.1.2.2 Surface Water Criteria

National AWQC are promulgated by EPA under the Clean Water Act (CWA) Section 304(a)(1) and are described in the National Toxics Rule (EPA 1998). They are intended to "accurately reflect the latest scientific knowledge" on the effects of these analytes on aquatic life. These criteria can provide guidance for determining acceptable conditions for marine and freshwater aquatic life. Currently, California has no statewide water quality goals for the protection of aquatic life; however, the proposed California Toxics Rule is available (EPA 1997).

The AWQC in Table 5-2 include both national AWQC (EPA 1998) and the California proposed AWQC (EPA 1997). EPA promulgated the national AWQC with the intent that individual states would use the criteria as a basis to develop numeric water quality criteria, as mandated in CWA Section 303(c)(2)(B). In 1992, EPA determined that states were not adopting their own standards in a timely fashion and responded by promulgating the National Toxics Rule (EPA 1992). This rule established compliance standards for surface waters in 14 states, including some waters in California. In 1995, EPA amended these regulations to convert many of the metals criteria, which were previously based on total recoverable concentrations, to dissolved concentrations (EPA 1995). The AWQC were updated in December 1998 (EPA 1998) and are shown in Table 5-2.

The surface water samples collected for this assessment were analyzed for total recoverable concentrations of metals. Both the national and California proposed AWQC are reported as dissolved concentrations; therefore, the AWQC were converted to total recoverable concentrations using conversion factors provided by EPA (EPA 1997, 1998). Some AWQC are hardness dependent. No site-specific surface water hardness data were measured; an assumption of a hardness value of 100 mg/L $CaCO_3$ was used to calculate the criteria (EPA 1998).

5.2 IDENTIFICATION OF CHEMICALS OF ECOLOGICAL CONCERN

COECs were identified based on media and receptor groups in order to evaluate ecological effects. The following sections describe how COECs were identified based on this process.

5.2.1 Screening Process for Soil and Sediment (Plants and Invertebrates)

Figure 5-1 illustrates the process for selecting COECs for plants and invertebrates exposed to soils and sediments. As the first step, COPECs were identified. An inorganic COPEC for plants and invertebrates was identified if chemical concentrations (1) exceeded ambient concentrations (Tidal Area and San Francisco Bay ambient values, as available) and (2) exceeded ER-Ls or if no ER-Ls were available. Organic COPECs were identified if chemical concentrations exceeded ER-Ls or if no ER-Ls were available. COECs were then identified based on further statistical evaluations of the data, as well as evaluations of toxicity and bioaccumulation for each receptor group. The identification of COECs for plants is presented in Section 10.0, for soil biota and terrestrial invertebrates in Section 11.0, and for aquatic invertebrates in Section 13.0.

5.2.2 Screening Process for Soil and Sediment (Birds and Mammals)

Figure 5-2 outlines the screening process for identifying COECs for birds and mammals exposed to soils and sediments. Concentrations of inorganic chemicals in soil and sediments were first screened against Tidal Area and San Francisco Bay ambient values to identify COPECs; inorganic chemicals that exceeded both ambient values (if available) were identified as COPECs. All detected organic chemicals were also identified as COPECs and were further evaluated by food-chain modeling. The food-chain model estimates exposure as a site-specific daily dose of the chemical that a bird or mammal receives from ingestion of prey and soil or sediment. The derivation of TRVs and the use of a HQ approach to assess risk to higher vertebrate receptors, was described in detail in a technical memorandum (EFA WEST 1998). COECs were identified based on the HQ screening process shown on Figure 5-4.

Chemicals for which no TRVs were available were also identified as COECs, and were evaluated qualitatively based on the limited available literature.

The food-chain model and methodology of comparing daily doses to TRVs in an HQ approach are described in Section 15.0, as well as the identification of COECs for birds and mammals.

5.2.3 Screening Process for Surface Water (Aquatic Receptors)

Figure 5-3 illustrates the process for selecting COECs for aquatic receptors exposed to surface water. Aquatic receptors include invertebrates, fish, reptiles, and amphibians. Surface waters at the site are characterized as brackish; therefore, the lower of the saltwater or freshwater chronic criteria was used as a screening value. For this assessment, surface water chemistry results were screened against the lowest screening value from the national chronic saltwater or freshwater AWQC, California proposed chronic saltwater or freshwater AWQC, or the San Francisco Bay Basin Plan water quality objectives upstream of San Pablo Bay (Bay Basin Plan 1986). For chemicals that do not have a chronic AWQC but have an acute AWQC, 10 percent of the acute concentration was used as the screening value, as recommended by RWQCB for the San Francisco Bay Region. All chemicals detected in surface water at concentrations that exceeded the lowest screening value were classified as COPECs. If criteria were unavailable, the chemical was also considered a COEC. COECs were then identified based on further statistical evaluations of the data, as well as evaluations of toxicity. The identification of COECs for fish, aquatic invertebrates, and reptiles and amphibians is described in Sections 12.0, 13.0, and 14.0 respectively.

5.3 EVALUATION OF DETECTION LIMITS

If detection limits are higher than screening criteria or values, nondetect data cannot be used to evaluate risk. Detection limits achieved with standard CLP methods for most metals are usually lower than ER-Ls; however, detection limits achieved with CLP methods for organic compounds are often higher than available screening values.

Tidal Area surface soil and sediment samples were analyzed using low detection limit methods for SVOCs, pesticides, and PCBs to achieve detection limits that were below or near screening values. However, as a result of high percent moisture and matrix interference in many samples, the desired detection limits for certain contaminants were not always achieved. These contaminants are discussed

in the identification of COPECs and COECs (see Sections 6.0 through 15.0). As a result, data from both CLP and low detection limit methods were considered in evaluating risk to various receptors.

6.0 NATURE AND EXTENT OF CONTAMINATION

The following sections discuss the analytical results for inorganic and organic constituents detected during the 1995 and 1998 sampling events. To assist in evaluating the nature and extent of contamination in Section 6.0, as well as exposure and effects in subsequent sections, site boundaries were modified to reflect habitat units that are ecologically relevant. The modified site boundaries were characterized on the basis of being aquatic and or terrestrial, and are shown on Exhibit 1. The Tidal Area is comprised mostly of wetlands with limited uplands, plus aquatic habitats. Habitats designated as terrestrial units were those areas that are not inundated with water year-round, and are expected to dry out seasonally. Aquatic units are habitat areas under water year-round or nearly so, and where fish and other aquatic organisms may be found.

Based on this evaluation, the Tidal Area was divided into eight units which reflect habitat types relative to site boundaries, as follows:

- *Landfill Terrestrial Unit (LFT):* represents the perimeter of the Tidal Area Landfill, and consists of eight sampling locations in the R Area Disposal Site that outline the landfill.
- *R Area Terrestrial Unit (RAT):* consists of wetland and upland habitat that is not contiguous with Otter Sluice and is not expected to be under water year-round.
- *R Area Terrestrial and Aquatic Unit (RATA):* a small part of the R Area Disposal Site designated as being both terrestrial and aquatic because it is not contiguous with Otter Sluice, but may be completely submerged under water during wet years.
- *Froid and Taylor Terrestrial Unit (FTT):* the upland habitat in the Froid and Taylor Site.
- *Froid and Taylor Aquatic Unit (FTA):* consists of habitat that has some standing water most of the year.
- *Wood Hogger Terrestrial Unit (WHT):* consists of wetland and upland habitat that is not contiguous with Otter Sluice and is not expected to be under water year-round.
- *North Otter Sluice Aquatic Unit (NOSA):* the western perimeter of the R Area Disposal Site bordering Otter Sluice.
- *South Otter Sluice Aquatic Unit (SOSA):* the western perimeter of the Wood Hogger Site bordering Otter Sluice.

The discussion of nature and extent of contamination in the following subsections reference these habitat units to assist in the data evaluation.

Exhibit 3 shows the sampling locations for surface and subsurface soil samples, sediment samples, and unfiltered surface water samples collected at the Tidal Area sites, including Otter Sluice. Surface soil samples were collected between 0 to 3.0 feet bgs, and subsurface soil samples at depths greater than 3.0 feet bgs. As noted in Section 4.0, most samples were analyzed for metals, SVOCs, pesticides and PCBs, TOC, sulfides, pH, and percent moisture. Several subsurface soil samples were also analyzed for VOCs, TPH-e, TPH as purgeables (TPH-p), explosives, hexavalent chromium, and geophysical parameters. Limited samples from the Wood Hogger site and South Otter Sluice were analyzed for dioxins. Table 4-1 lists the sample types and analyses for each sample.

Sections 6.1 and 6.2 present analytical results for inorganic and organic constituents, and results of the screening process to determine COPECs. The screening process for COPECs is discussed in detail in Section 5.0. Complete data tables presenting the concentrations of chemicals in soil, sediment, and surface water samples are included in Appendices A through E. Appendix N contains ecological statistical summary tables for each site. The summary tables provide average, minimum, and maximum detected concentrations for each soil, sediment, and surface water samples. Appendix P contains summaries of detection limits achieved compared with relevant screening values.

Exhibits 5 through 17 show the concentrations of selected inorganic and organic constituents detected at each soil and sediment sampling location. For sampling locations where both surface and subsurface samples were collected, the exhibits depict a comparison of the higher of the two concentrations of each constituent to screening values.

6.1 INORGANIC CONSTITUENTS IN SOIL, SEDIMENT, AND SURFACE WATER SAMPLES

Metals were analyzed in 258 soil or sediment samples. Of the 258 samples, 225 were collected between 0 and 3.0 feet bgs, and 33 samples were collected at depths greater than 3.0 feet bgs. Section 6.1.1 discusses the results of the soil and sediment analyses.

In addition, two different extractions were used for soil and sediment samples to estimate the labile (weakly bound) fraction of metals and metalloids. Both extractions used a modified WET method: one used 0.5 normal hydrochloric acid (WET-acid), and the other used DI water (WET-DI). WET-acid extractions were performed on 15 surface soil and five sediment samples, and WET-DI extractions

were performed on 47 surface soil and five sediment samples. Section 6.1.2 discusses the results for the soil and sediment extractions.

A total of 81 surface water samples were collected over four consecutive quarters during 1996 from 25 sampling stations throughout the Tidal Area sites. An additional set of 13 surface water samples was collected from Tidal Area sites during 1998 (see Exhibit 3). Section 6.1.3 discusses the results for surface water samples.

Section 6.1.1 discusses the inorganic constituents detected in soil and sediment, Section 6.1.2 discusses the inorganic constituents detected in extractions, and Section 6.1.3 discusses the inorganic constituents detected in surface water. Section 6.1.4 summarizes the inorganic constituents that were identified as COPECs in soil, sediment, and surface water based on the screening process discussed in Section 5.0.

6.1.1 Inorganic Constituents in Soil and Sediment Samples

This section discusses the inorganic constituents detected in soil or sediment samples collected from the Tidal Area sites. The discussion in this subsection includes comparisons of the data of the results to ambient and regulatory criteria and guidance, including Tidal Area ambient concentrations (see Appendix F), San Francisco Bay ambient values (RWQCB 1998), and ER-Ls and ER-Ms (Long and others 1995; NOAA 1991); these values are presented in Table 5-1. As discussed in Section 5.0, only the ambient and ER-L values were used to screen inorganic constituents for COPECs; the ER-Ms are referenced in the following discussions to allow for additional evaluations of the nature and extent of contamination at the Tidal Area sites.

Tables 6-1, 6-3, 6-4, 6-6, 6-7, 6-9, 6-11, and 6-13 summarize soil and sediment results and concentrations that exceed toxicity-based values for the Landfill Terrestrial, R Area Terrestrial, R Area Terrestrial and Aquatic unit, Froid and Taylor Terrestrial, Froid and Taylor Aquatic, Wood Hogger Terrestrial, North Otter Sluice Aquatic, and South Otter Sluice Aquatic units, respectively. Figures 6-1 through 6-19 plot soil and sediment concentrations of inorganic constituents against screening values. A summary of inorganic constituents detected in soil and sediment is included Section 6.1.1.20.

Essential nutrients or minerals such as sodium, potassium, iron, calcium, and magnesium are not national priority pollutants and were not screened further. Their effects on vegetative growth are discussed in Section 10.0.

6.1.1.1 Aluminum in Soil and Sediment

Aluminum was detected in all 258 soil or sediment samples analyzed for metals. No San Francisco Bay ambient or effects range value is available for aluminum; therefore, aluminum concentrations are presented below in reference solely to the Tidal Area ambient value (27,300 milligrams per kilogram [mg/kg]). Figures 6-1A through 6-1C compare the concentrations of aluminum detected in soil and sediment to screening values.

- **Landfill Perimeter Terrestrial Unit:** Aluminum was detected in all eight surface and eight subsurface samples collected in the Landfill Terrestrial unit at concentrations ranging from 9,580 mg/kg to 29,400 mg/kg (see Figure 6-1A). The maximum detected concentration in a surface soil or sediment sample was collected at sampling location TLSSB004 (27,400 mg/kg) and in subsurface soil or sediment from sampling location TLSSB003 (29,400 mg/kg) exceeded the Tidal Area ambient value (see Table 6-1).

- **R Area Terrestrial Unit:** Aluminum was detected in all 94 surface and five subsurface soil or sediment samples collected from R Area Terrestrial unit at concentrations ranging from 4,420 to 33,700 mg/kg (see Figure 6-1B). Results for nine of the 94 surface samples exceeded the Tidal Area ambient value (27,300 mg/kg), including sampling locations RADSBF05 (33,700 mg/kg), RADSBE06 (33,500 mg/kg), RADSBF07 (32,900 mg/kg), RADSBG06 (32,700 mg/kg), RADSBE03 (32,500 mg/kg), RADSBJ04 (30,400 mg/kg), RADSB107 (29,400 mg/kg), RADSBD06 (28,800 mg/kg), and RADSBG07 (28,000 mg/kg). No results for subsurface samples collected in the R Area Terrestrial unit exceeded screening values (see Table 6-3).

- **R Area Terrestrial and Aquatic Unit:** Aluminum was detected in all three surface sediment samples collected from the R Area Terrestrial and Aquatic unit at concentrations ranging from 4,420 to 33,700 mg/kg; no detected concentrations of aluminum exceeded the Tidal Area ambient value (27,300 mg/kg) (see Table 6-4).

- **Froid and Taylor Terrestrial Unit:** Aluminum was detected in the one sample collected from the Froid and Taylor Terrestrial unit at a concentration of 14,900 mg/kg, which is below the Tidal Area ambient value (see Table 6-6 and Figure 6-1A).

- **Froid and Taylor Aquatic Unit:** Aluminum was detected in all 11 surface sediment samples collected from the Froid and Taylor Aquatic unit at concentrations ranging from 7,020 to 37,500 mg/kg. The result for sample location FTSSB005 (37,500 mg/kg) exceeded the Tidal Area ambient concentration (see Table 6-7 and Figure 6-1A).

- **Wood Hogger Terrestrial Unit:** Aluminum was detected in all 63 surface and 20 subsurface soil or sediment samples collected from the Wood Hogger Terrestrial unit at concentrations ranging from 3,350 to 32,500 mg/kg (see Figure 6-1C). Only the results for surface soil or sediment sampling locations WHSSB024 (32,500 mg/kg) and WHSSBA08 (32,200 mg/kg) exceeded the Tidal Area ambient value (see Table 6-9).

- **North Otter Sluice Aquatic Unit:** Aluminum was detected in all 19 surface sediment samples collected in the North Otter Sluice Aquatic unit at concentrations ranging from 13,400 to 30,300 mg/kg (see Figure 6-1A). Only the results for sampling locations RADSB004 (30,300 mg/kg), RADSB003 (29,300 mg/kg), RADSL002 (28,700 mg/kg), and RADSBA04 (27,400 mg/kg) exceeded the Tidal Area ambient value (see Table 6-11).

- **South Otter Sluice Aquatic Unit:** Aluminum was detected in all 26 surface sediment samples collected from the South Otter Sluice Aquatic unit at concentrations ranging from 5,130 to 42,700 mg/kg (see Figure 6-1C). The results for sampling locations WHSSB001 (42,700 mg/kg),WHSSL003 (35,200 mg/kg), WHSSBA02 (33,100 mg/kg), WHSSB003 (30,600 mg/kg), WHSSB002 (30,400 mg/kg), WHSSL001 (28,700 mg/kg), WHSSBB05 (28,000 mg/kg), and OSLSL008 (27,900 mg/kg) exceeded the Tidal Area ambient value (see Table 6-13).

In summary, aluminum exceeded the Tidal Area ambient value in samples collected from Landfill Terrestrial unit, R Area Terrestrial unit, Froid and Taylor Aquatic unit, Wood Hogger Terrestrial unit, North Otter Sluice Aquatic unit, and South Otter Sluice Aquatic unit. The highest aluminum concentrations were detected in South Otter Sluice Aquatic unit sampling location WHSSB001 (42,700 mg/kg) and Froid and Taylor Aquatic unit sampling location FTSSB005 (37,500 mg/kg).

6.1.1.2 Antimony in Soil and Sediment

Antimony was detected in 243 of 248 soil or sediment samples at concentrations ranging up to 9.3 mg/kg. Antimony was not detected in Froid and Taylor Terrestrial unit. A San Francisco Bay ambient value is not available for antimony; this section presents antimony concentrations in reference to the Tidal Area ambient value (2.2 mg/kg) and ER-L (2.0 mg/kg); no antimony concentrations exceeded the ER-M (25.0 mg/kg). Figures 6-2A through 6-2A compare the concentrations of antimony detected in soil and sediment to screening values.

- **Landfill Terrestrial Unit:** Antimony was detected in four of seven surface and one of five subsurface soil or sediment samples collected from the Landfill Terrestrial unit at concentrations ranging from 1.6 to 3.1 mg/kg (see Figure 6-2A). The results for surface soil or sediment samples TLSSB007 (3.1 mg/kg) and TLSSB006 (2.5 mg/kg) exceeded the Tidal Area ambient value and ER-L (see Table 6-1).

- **R Area Terrestrial Unit:** Antimony was detected in 64 of 94 surface soil or sediment samples collected from the R Area Terrestrial unit at concentrations ranging from 0.5 to 5.6 mg/kg (see Figure 6-2B); antimony was not detected in subsurface soil samples. Nine concentrations in surface soil or sediment exceeded both the Tidal Area ambient value (2.2 mg/kg) and the ER-L (2.0 mg/kg), including results for sampling locations RADSB008 (5.6 mg/kg), RADSB017 (3.1 mg/kg), RADSBE07 (3.1 mg/kg), RADSB011 (2.9 mg/kg),

RADSBG03 (2.8 mg/kg), RADSBH07 (2.8 mg/kg), RADSBJ04 (2.7 mg/kg), RADSBH05 (2.6 mg/kg), and RADSB106 (2.5 mg/kg) (see Table 6-3).

- **R Area Terrestrial and Aquatic Unit:** Antimony was detected in two of three surface soil or sediment samples collected from the R Area Terrestrial and Aquatic unit at concentrations ranging from 0.6 to 0.9 mg/kg, below the Tidal Area ambient value (see Table 6-4 and Figure 6-2A).

- **Froid and Taylor Aquatic Unit:** Antimony was detected in three of six surface sediment samples collected from the Froid and Taylor Aquatic unit at concentrations ranging from 1.1 to 2.2 mg/kg; no results exceeded the Tidal Area ambient value (see Table 6-7 and Figure 6-2A).

- **Wood Hogger Terrestrial Unit:** Antimony was detected in 44 of 63 surface and 6 of 20 subsurface soil or sediment samples collected from the Wood Hogger Terrestrial unit at concentrations ranging from 0.4 to 7.1 mg/kg (see Figure 6-2C). Results for 12 of the 63 surface soil or sediment samples exceeded both the Tidal Area ambient value (2.2 mg/kg) and the ER-L (2.0 mg/kg), including sampling locations WHSSB014 (7.1 mg/kg), WHSSB016 (7.0 mg/kg), WHSSBI02 (6.2 mg/kg), WHSSBE04 (5.7 mg/kg), WHSSBE08 (5.7 mg/kg), WHSSB013 (4.9 mg/kg), WHSSBK06 (4.6 mg/kg), WHSSBB07 (3.7 mg/kg), WHSSBG02 (3.2 mg/kg), WHSSB009 (2.9 mg/kg), WHSSB024 (2.8 mg/kg), and WHSSBA08 (2.5 mg/kg). In subsurface soil or sediment, only the result for sampling location WHSSBK06 (5.7 mg/kg) exceeded both the Tidal Area ambient value and the ER-L (see Table 6-9).

- **North Otter Sluice Aquatic Unit:** Antimony was detected in eight of 18 surface soil or sediment samples collected from the North Otter Sluice Aquatic unit at concentrations ranging from 1.1 to 7.1 mg/kg (see Figure 6-2A). Results for sample locations RADSBA07 (7.1 mg/kg), RADSBA03 (3.1 mg/kg), and RADSB003 (3.0 mg/kg) exceeded the Tidal Area ambient value and the ER-L (see Table 6-11).

- **South Otter Sluice Aquatic Unit:** Antimony was detected in 18 of 26 surface soil or sediment samples collected from the South Otter Sluice Aquatic unit at concentrations ranging from 0.7 to 9.3 mg/kg (see Figure 6-2C). Results for sample locations OSLSL008 (9.3 mg/kg), WHSSB002 (2.9 mg/kg), WHSSBA02 (2.8 mg/kg) and WHSSB004 (2.4 mg/kg) exceeded the Tidal Area ambient value and the ER-L (see Table 6-13).

In summary, antimony exceeded the Tidal Area ambient value in samples collected from the Landfill Terrestrial, R Area Terrestrial, Wood Hogger Terrestrial, North Otter Sluice Aquatic, and South Otter Sluice Aquatic units. South Otter Sluice Aquatic unit sampling location OSLSL008 (9.3 mg/kg), North Otter Sluice Aquatic unit sampling location RADSBA07 (7.1 mg/kg), and Wood Hogger Terrestrial unit sampling location WHSSB014 (7.1 mg/kg) contained the highest antimony concentrations in soil or sediment.

6.1.1.3 Arsenic in Soil and Sediment

Arsenic was detected in all 258 samples analyzed for metals. No arsenic concentrations exceeded the ER-M (70.0 mg/kg). Figures 6-3A through 6-3C compare the concentrations of arsenic in soil and sediment to the Tidal Area ambient value (27.0 mg/kg) and ER-L (8.2 mg/kg); detected concentrations are presented in comparison to the Tidal Area ambient value. Exhibit 5 shows the concentrations of arsenic detected in soil and sediment samples compared to screening values.

- **Landfill Terrestrial Unit:** Arsenic was detected in all eight surface and eight subsurface soil or sediment samples collected from the Landfill Terrestrial unit at concentrations ranging from 5.8 to 57.6 mg/kg (see Table 6-1 and Figure 6-3A). Results for sample locations TLSSB007 (57.6 mg/kg), TLSSB008 (42.7 mg/kg), and TLSSB004 (27.7 mg/kg) exceeded the Tidal Area ambient value. No subsurface soil or sediment concentrations exceeded the Tidal Area ambient value (see Table 6-1).

- **R Area Terrestrial Unit:** Arsenic was detected in all 94 surface and five subsurface soil or sediment samples collected from the R Area Terrestrial unit at concentrations ranging from 3.8 to 42.0 mg/kg (see Figure 6-3B). Results for five surface soil or sediment samples exceeded the Tidal Area ambient value and included sampling locations RADSBJ04 (42.0 mg/kg), RADSBH06 (40.1 mg/kg), RADSBH07 (30.9 mg/kg), RADSBE03 (29.9 mg/kg), and RADSB012 (28.1 mg/kg). No concentrations in subsurface samples exceeded screening values (see Table 6-3).

- **R Area Terrestrial and Aquatic Unit:** Arsenic was detected in all three surface sediment samples collected from the R Area Terrestrial and Aquatic unit at concentrations ranging from 4.3 to 25.1 mg/kg, below the Tidal Area ambient value (see Table 6-4 and Figure 6-3A).

- **Froid and Taylor Terrestrial Unit:** Arsenic was detected at a concentration (4.5 mg/kg) below the Tidal Area ambient value (see Table 6-6 and Figure 6-3A).

- **Froid and Taylor Aquatic Unit:** Arsenic was detected in all 11 surface sediment samples collected from the Froid and Taylor Aquatic unit at concentrations ranging from 4.9 to 26.6 mg/kg, below the Tidal Area ambient value (see Table 6-7 and Figure 6-3A).

- **Wood Hogger Terrestrial Unit:** Arsenic was detected in 59 of 63 surface and 19 of 20 subsurface soil or sediment samples collected from the Wood Hogger Terrestrial unit at concentrations ranging from 2.0 to 37.0 mg/kg (see Figure 6-3C). Only results for surface sampling location WHSSBG02 (27.1 mg/kg) and subsurface sampling location WHSSBK06 (37.0 mg/kg, collected at 4.5 feet bgs) exceeded the Tidal Area ambient value (see Table 6-9).

- **North Otter Sluice Aquatic Unit:** Arsenic was detected in all 19 surface sediment samples collected from the North Otter Sluice Aquatic unit at concentrations ranging from 6.3 to 47.2 mg/kg (see Figure 6-3A). Results for sample locations RADSBA07 (47.2 mg/kg), RADSB006 (33.2 mg/kg), and RADSB003 (28.0 mg/kg) exceeded the Tidal Area ambient value (see Table 6-11).

- **South Otter Sluice Aquatic Unit:** Arsenic was detected in all 26 surface sediment samples collected from the South Otter Sluice Aquatic unit at concentrations ranging from 1.3 to 25.9 mg/kg, below the Tidal Area ambient value (see Table 6-13 and Figure 6-3C).

In summary, arsenic exceeded the Tidal Area ambient value in samples collected from the Landfill Terrestrial, R Area Terrestrial, Wood Hogger Terrestrial, and North Otter Sluice Aquatic units. Sample location TLSSB007 (57.6 mg/kg) collected from the Landfill Terrestrial unit contained the highest arsenic concentration.

6.1.1.4 Barium in Soil and Sediment

Barium was detected in all 258 soil or sediment samples. No San Francisco Bay ambient or effects range values are available for barium; therefore, barium concentrations are evaluated solely in reference to the Tidal Area ambient value (530.0 mg/kg). Figures 6-4A through 6-4C compare the concentrations of barium in soil and sediment to the Tidal Area ambient value.

- **Landfill Terrestrial Unit:** Barium was detected in all eight surface and eight subsurface soil or sediment samples collected from the Landfill Terrestrial unit at concentrations ranging from 48 to 436 mg/kg; no barium concentrations exceeded the Tidal Area ambient value (see Table 6-1 and Figure 6-4A).

- **R Area Terrestrial Unit:** Barium was detected in all 94 surface and 5 subsurface soil samples collected from the R Area Terrestrial unit at concentrations ranging from 38 to 7,705 mg/kg (see Figure 6-4B). Sample location RADSBE07 (7,705 mg/kg) was the only result that exceeded the Tidal Area ambient value (see Table 6-3).

- **R Area Terrestrial and Aquatic Unit:** Barium was detected in all three surface soil or sediment samples collected from the R Area Terrestrial and Aquatic unit at concentrations ranging from 159 to 174 mg/kg; no barium concentrations exceeded the Tidal Area ambient value (see Table 6-4 and Figure 6-4A).

- **Wood Hogger Terrestrial Unit:** Barium was detected in all 63 surface and 20 subsurface soil or sediment samples collected from the Wood Hogger Terrestrial unit; only the result for sampling location WHSSBE08 (546 mg/kg) exceeded the Tidal Area ambient value (see Table 6-9 and Figure 4-C).

- **Froid and Taylor Terrestrial Unit:** Barium was detected at a concentration (165 mg/kg) below the Tidal Area ambient value (see Table 6-6 and Figure 6-4A).

- **Froid and Taylor Aquatic Unit:** Barium was detected in all 11 surface soil or sediment samples collected from the Froid and Taylor Aquatic unit at concentrations ranging from 49 to 234 mg/kg; no barium concentrations exceeded the Tidal Area ambient value (see Table 6-7 and Figure 6-4A).

- **North Otter Sluice Aquatic Unit:** Barium was detected in all 19 surface sediment samples collected from the North Otter Sluice Aquatic unit at concentrations ranging from 53 to 196 mg/kg; no barium concentrations exceeded the Tidal Area ambient value (see Table 6-11 and Figure 6-4A).

- **South Otter Sluice Aquatic Unit:** Barium was detected in all 26 surface sediment samples collected from the South Otter Sluice Aquatic unit at concentrations ranging from 37 to 353 mg/kg; no barium concentrations exceeded the Tidal Area ambient value (see Table 6-13 and Figure 6-4C).

In summary, barium concentrations exceeded the Tidal Area ambient value (530 mg/kg) in samples collected from the R Area Terrestrial and Wood Hogger Terrestrial units. The surface soil sample collected from location RADSBE07 in the south-central portion of the R Area Disposal Site contained the highest concentration of barium (7,705 mg/kg); the maximum concentration of barium in all other soil samples was 546 mg/kg, slightly above the Tidal Area ambient value.

6.1.1.5 Beryllium in Soil and Sediment

Beryllium was detected in 63 of 258 soil or sediment samples. Beryllium was not detected in samples collected from the R Area Terrestrial and Aquatic or Froid and Taylor Terrestrial units. No San Francisco Bay ambient or effects range values are available for beryllium; therefore, beryllium is discussed in comparison to the Tidal Area ambient value (0.18 mg/kg) below. Figures 6-5A through 6-5C show the range of beryllium concentrations in soil and sediment.

- **Landfill Terrestrial Unit:** Beryllium was detected in three of eight surface soil or sediment samples collected from the Landfill Terrestrial unit at concentrations ranging from 0.16 to 0.56 mg/kg (see Figure 6-5A). Results for surface sampling locations TLSSB004 (0.56 mg/kg) and TLSSB003 (0.51 mg/kg) exceeded the Tidal Area ambient value (0.18 mg/kg). Beryllium was not detected in subsurface soil or sediment samples (see Table 6-1).

- **R Area Terrestrial Unit:** Beryllium was detected in 16 of 94 surface soil or sediment samples collected from the R Area Terrestrial unit at concentrations ranging from 0.11 to 0.57 mg/kg (see Figure 6-5B). Results for surface soil or sediment samples exceeded the

Tidal Area ambient value (0.18 mg/kg) and included sampling locations RADSB025 (0.57 mg/kg), RADSB022 (0.41 mg/kg), RADSBH05 (0.39 mg/kg), RADSB021 (0.37 mg/kg), RADSBJ07 (0.34 mg/kg), RADSB029 (0.34 mg/kg), RADSBE05 (0.29 mg/kg), RADSBJ04 (0.26 mg/kg), RADSBK02 (0.23 mg/kg), and RADSBA08 (0.21 mg/kg). Beryllium was not detected in subsurface samples (see Table 6-3).

- **Froid and Taylor Aquatic Unit:** Beryllium was detected in one of 11 surface soil or sediment samples collected from the Froid and Taylor Aquatic unit at a concentration of 0.35 mg/kg (sampling location FTSSL103), above the Tidal Area ambient value (see Table 6-7 and Figure 6-5A).

- **Wood Hogger Terrestrial Unit:** Beryllium was detected in 20 of 63 surface and 6 of 20 subsurface soil or sediment samples collected from the Wood Hogger Terrestrial unit at concentrations ranging from 0.06 to 0.52 mg/kg (see Figure 6-5C). Results for eight surface samples exceeded the Tidal Area ambient value (0.18 mg/kg), including sampling locations WHSSB011 (0.52 mg/kg), WHSSBI08 (0.46 mg/kg), WHSSB006 (0.41 mg/kg), S37-07 (0.36 mg/kg), WHSSB007 (0.36 mg/kg), WHSSBG06 (0.22 mg/kg), WHSSBC06 (0.21 mg/kg), and WHSSB008 (0.19 mg/kg). The result for subsurface sampling location S37-08 (0.25 mg/kg collected at 5 feet bgs) also exceeded the Tidal Area ambient value (see Table 6-9).

- **North Otter Sluice Aquatic Unit:** Beryllium was detected in three of 19 surface sediment samples collected from the North Otter Sluice Aquatic unit at concentrations ranging from 0.20 to 0.22 mg/kg (see Figure 6-5A). Results for sample locations OSLSL002 (0.22 mg/kg), OSLSL003 (0.21 mg/kg), and OSLSL001 (0.2 mg/kg) slightly exceeded the Tidal Area ambient value (see Table 6-11).

- **South Otter Sluice Aquatic Unit:** Beryllium was detected in 20 of 26 surface sediment samples collected from the South Otter Sluice Aquatic unit at concentrations ranging up to 0.94 mg/kg (see Figure 6-5C). Results for eighteen samples exceeded the Tidal Area ambient value for beryllium (0.18 mg/kg) (see Table 6-13). The highest beryllium concentrations were found in sampling locations OSLSL008 (0.94 mg/kg), WHSSB001 (0.84 mg/kg), and WHSSB002 (0.81 mg/kg) (see Table 6-13).

In summary, beryllium was detected at concentrations above the Tidal Area ambient value (0.18 mg/kg) in samples collected from the Landfill Terrestrial, R Area Terrestrial, Wood Hogger Terrestrial, Froid and Taylor Aquatic, North Otter Sluice Aquatic, and South Otter Sluice Aquatic units. The highest beryllium samples were detected in South Otter Sluice Aquatic unit sampling locations OSLSL008 (0.94 mg/kg), WHSSB001 (0.84 mg/kg), and WHSSB002 (0.81 mg/kg).

6.1.1.6 Cadmium in Soil and Sediment

Cadmium was detected in 52 of 258 soil or sediment samples analyzed for metals. Cadmium was not detected in soil or sediment samples collected from the R Area Terrestrial and Aquatic unit

(see Table 6-4). Figures 6-6A through 6-6C compare the concentrations of cadmium detected in soil to the Tidal Area ambient value (1.9 mg/kg), ER-L (1.2 mg/kg), and ER-M (9.6 mg/kg). Exhibit 6 shows the concentrations of cadmium detected in soil and sediment samples compared to screening values. Cadmium concentrations are compared by unit in the Tidal Area ambient value and ER-M below.

- **Landfill Terrestrial Unit:** Cadmium was detected in five of eight surface soil or sediment samples collected from the Landfill Terrestrial unit at concentrations ranging from 0.74 to 5.8 mg/kg (TLSSB002) (see Figure 6-6A). Results for sample locations TLSSB002 (5.8 and 2.6 mg/kg at 0.5 and 2.5 feet bgs, respectively), TLSSB005 (3.2 mg/kg), and TLSSB003 (2.6 mg/kg) exceeded the Tidal Area ambient value; no results exceeded the ER-M. Cadmium was not detected in subsurface soil or sediment samples (see Table 6-1).

- **R Area Terrestrial Unit:** Cadmium was detected in three of 94 surface soil samples collected from the R Area Terrestrial unit at concentrations ranging from 0.4 to 0.8 mg/kg, all below the Tidal Area ambient value (see Figure 6-6B). Cadmium was not detected in subsurface soil samples (see Table 6-3).

- **Froid and Taylor Terrestrial Unit:** Cadmium was detected at a concentration (0.4 mg/kg) below the Tidal Area ambient value (see Table 6-6 and Figure 6-6A).

- **Froid and Taylor Aquatic Unit:** Cadmium was detected in seven of 11 surface sediment samples collected from the Froid and Taylor Aquatic unit at concentrations ranging from 0.3 to 1.9 mg/kg; all results were below the Tidal Area ambient value (see Table 6-7 and Figure 6-6A).

- **Wood Hogger Terrestrial Unit:** Cadmium was detected in 24 of 63 surface and two of 20 subsurface soil or sediment samples collected from the Wood Hogger Terrestrial unit at concentrations ranging from 0.05 to 20.8 mg/kg (see Figure 6-6C). Results for surface soil or sediment sampling locations WHSSBI02 (20.8 mg/kg), WHSSB050 (19.9 mg/kg) and WGSSBE04 (16.2 mg/kg) exceeded the ER-M (9.6 mg/kg). Results for sample locations WHSSBH03 (5.4 mg/kg), WHSSB009 (4.7 mg/kg), WHSSBF03 (4.1 mg/kg), WHSSB013 (3.3 mg/kg), WHSSB016 (2.4 mg/kg), and WHSSB014 (2.1 mg/kg) exceeded the Tidal Area ambient value (1.9 mg/kg). No subsurface soil or sediment samples exceeded the Tidal Area ambient value (see Table 6-9).

- **North Otter Sluice Aquatic Unit:** Cadmium was detected in five of 19 surface sediment samples collected from the North Otter Sluice Aquatic unit at concentrations ranging from 0.4 to 0.8 mg/kg, all below the Tidal Area ambient value (see Table 6-11 and Figure 6-6A).

- **South Otter Sluice Aquatic Unit:** Cadmium was detected in 13 of 26 surface sediment samples collected from the South Otter Sluice Aquatic unit at concentrations ranging from 0.25 to 4.2 mg/kg (see Figure 6-6C). Results for sample locations WHSSB002 (4.2 mg/kg) and WHSSBA02 (3.9 mg/kg) exceeded the Tidal Area ambient value for cadmium (1.9 mg/kg). No results exceeded the ER-M (9.6 mg/kg) (see Table 6-13).

In summary, cadmium concentrations exceeded the Tidal Area ambient value in Landfill Terrestrial, Wood Hogger Terrestrial, and South Otter Sluice Aquatic unit samples. The highest cadmium concentrations were in samples from the Wood Hogger Site; results for soil or sediment sampling locations WHSSBI02 (20.8 mg/kg), WHSSB050 (19.9 mg/kg), and WGSSBE04 (16.2 mg/kg) exceeded the ER-M (9.6 mg/kg).

6.1.1.7 Chromium in Soil and Sediment

Total chromium was detected in 249 soil or sediment samples. Chromium VI was detected in one surface sample from the Wood Hogger Site. No samples contained chromium concentrations that exceeded the ER-M (370.0 mg/kg). Figures 6-7A through 6-7C compare the concentrations of chromium detected in soil and sediment samples to the ER-L (81.0 mg/kg), ER-M, Tidal Area ambient value (82.1 mg/kg), and San Francisco Bay ambient value (112.0 mg/kg).

- **Landfill Terrestrial Unit:** Total chromium was detected in all eight surface and seven of eight subsurface soil samples collected from the Landfill Terrestrial unit at concentrations ranging from 27.3 to 92.5 mg/kg, all below the San Francisco Bay ambient value (112.0 mg/kg) (see Table 6-1 and Figure 6-7A).

- **R Area Terrestrial Unit:** Total chromium was detected in 89 of 94 surface and four of five subsurface soil samples collected from the R Area Terrestrial unit at concentrations ranging from 18.1 to 101.0 mg/kg, all below the San Francisco Bay ambient value (see Table 6-3 and Figure 6-7B).

- **R Area Terrestrial and Aquatic Unit:** Total chromium was detected in all three surface soil or sediment samples collected from the R Area Terrestrial and Aquatic unit at concentrations ranging from 27.7 to 65.5 mg/kg, below the San Francisco Bay ambient and the Tidal Area ambient values (see Table 6-4 and Figure 6-7A).

- **Froid and Taylor Terrestrial Unit:** Total chromium was detected at a concentration of 34.2 mg/kg (sampling location FTSSB001) below the Tidal Area ambient value (see Table 6-6 and Figure 6-7A).

- **Froid and Taylor Aquatic Unit:** Total chromium was detected in all 11 surface sediment samples collected from the Froid and Taylor Aquatic unit at concentrations ranging from 25.1 to 106.0 mg/kg, below the San Francisco Bay ambient value (see Table 6-7 and Figure 6-7A).

- **Wood Hogger Terrestrial Unit:** Total chromium was detected in all 63 surface and all 20 subsurface soil samples collected from the Wood Hogger Terrestrial unit at concentrations ranging from 7.0 to 122.0 mg/kg (see Figure 6-7C). Only the result for surface soil sampling location WHSSB014 (122.0 mg/kg) exceeded the San Francisco Bay ambient value (112.0 mg/kg). No samples exceeded the ER-M (370.0 mg/kg). No results

for subsurface soil or sediment samples exceeded the San Francisco Bay ambient (see Table 6-9). Chromium VI was detected in one of two surface soil samples at a concentration of 60.0 mg/kg (sampling location WHSSBE08); no screening values are available for chromium VI.

- **North Otter Sluice Aquatic Unit:** Total chromium was detected in all 19 surface sediment samples collected from the North Otter Sluice Aquatic unit at concentrations ranging from 46.3 to 319.0 mg/kg (see Figure 6-7A). Only the result for sampling location RADSBA07 (319.0 mg/kg) exceeded the San Francisco Bay ambient value (112.0 mg/kg). No concentrations exceeded the ER-M (370.0 mg/kg) (see Table 6-11).

- **South Otter Sluice Aquatic Unit:** Total chromium was detected in all 26 surface sediment samples collected from the South Otter Sluice Aquatic unit at concentrations ranging from 21.6 to 122.0 mg/kg (see Figure 6-7C). Only the result for sampling location WHSSB001 (122.0 mg/kg) exceeded the San Francisco Bay ambient value (112.0 mg/kg) and the ER-L (81.0 mg/kg). No concentrations exceeded the ER-M (370.0 mg/kg) (see Table 6-13).

In summary, chromium concentrations exceeded the San Francisco Bay ambient value (112.0 mg/kg) and ER-L (81.0 mg/kg) in one sample collected from the Wood Hogger Terrestrial, North Otter Sluice Aquatic, and South Otter Sluice Aquatic units. Chromium concentrations were highest in North Otter Sluice Aquatic unit sampling location RADSBA07 (319.0 mg/kg); the maximum concentration of chromium detected in all other samples was 122 mg/kg.

6.1.1.8 Cobalt in Soil and Sediment

Cobalt was detected in all 258 soil or sediment samples. Figures 6-8A through 6-8C compare the concentrations of cobalt in soil or sediment samples to ambient values. No San Francisco Bay ambient or effects range values are available for cobalt; therefore, cobalt concentrations are presented solely in comparison to the Tidal Area ambient value (36.0 mg/kg) below.

- **Landfill Terrestrial Unit:** Cobalt was detected in all eight surface and eight subsurface soil or sediment samples at concentrations ranging from 5.5 to 33.5 mg/kg; no results exceeded the Tidal Area ambient value (36.0 mg/kg) (see Table 6-1 and Figure 6-8A).

- **R Area Terrestrial Unit:** Cobalt was detected in all 94 surface and five subsurface soil or sediment samples collected from the R Area Terrestrial unit at concentrations ranging from 7.9 to 108.0 mg/kg (see Figure 6-8B). Only the results for surface sampling locations RADSBH06 (108.0 mg/kg) and RADSB108 (49.1 mg/kg) exceeded the Tidal Area ambient concentration (36.0 mg/kg) (see Table 6-3).

- **R Area Terrestrial and Aquatic Unit:** Cobalt was detected in all three surface soil or sediment samples collected from the R Area Terrestrial and Aquatic unit at concentrations ranging from 15.3 to 21.9 mg/kg; no results exceeded the Tidal Area ambient value (see Table 6-4 and Figure 6-8A).

- **Froid and Taylor Terrestrial Unit:** Cobalt was detected in sampling location FTSSB001 (12.9 mg/kg) at a concentration below the Tidal Area ambient value (see Table 6-6 and Figure 6-8A).

- **Froid and Taylor Aquatic Unit:** Cobalt was detected in all 11 surface soil or sediment samples collected from the Froid and Taylor Aquatic unit at concentrations ranging from 4.7 to 20.6 mg/kg, below the Tidal Area ambient value (see Table 6-7 and Figure 6-8A).

- **Wood Hogger Terrestrial Unit:** Cobalt was detected in all 63 surface and 20 subsurface soil or sediment samples ranging from 3.4 to 35.6 mg/kg; all cobalt concentrations in samples from the Wood Hogger Terrestrial unit were below the Tidal Area ambient value (see Table 6-9 and Figure 6-8C).

- **North Otter Sluice Aquatic Unit:** Cobalt was detected in all 19 surface sediment samples collected from the North Otter Sluice Aquatic unit at concentrations ranging from 7.2 to 31.5 mg/kg, all below the Tidal Area ambient value (see Table 6-11 and Figure 6-8A).

- **South Otter Sluice Aquatic Unit:** Cobalt was detected in all 26 surface sediment samples collected from the South Otter Sluice Aquatic unit at concentrations ranging from 2.4 to 39.3 mg/kg. Only the result for sampling location WHSSB022 (39.3 mg/kg) exceeded the Tidal Area ambient value (see Table 6-13 and Figure 6-8C).

In summary, results for the samples collected from sampling locations RADSBH06 (108.0 mg/kg) and RADSB108 (49.1 mg/kg) in the R Area Terrestrial unit and sampling location WHSSB022 in the South Otter Sluice Aquatic unit exceeded the Tidal Area ambient value (36.0 mg/kg).

6.1.1.9 Copper in Soil and Sediment

Copper was detected in 254 of 258 soil or sediment samples. Figures 6-9A through 6-9C compare the concentrations of copper in soil and sediment to screening values. Exhibit 7 shows the concentrations of copper detected in soil and sediment samples compared to the Tidal Area ambient value (81.0 mg/kg), ER-L (34.0 mg/kg), and ER-M (270.0 mg/kg).

- **Landfill Terrestrial Unit:** Copper was detected in all eight surface and eight subsurface soil or sediment samples collected from the Landfill Terrestrial unit at concentrations ranging from 27.0 to 264.0 mg/kg (see Figure 6-9A). Results for surface soil or sediment sampling locations TLSSB007 (264.0 mg/kg), TLSSB002 (117.0 mg/kg), and TLSSB004 (101.0 mg/kg) exceeded the Tidal Area ambient value and the ER-L. No samples exceeded the ER-M (see Table 6-1).

- **R Area Terrestrial Unit:** Copper was detected in all 94 surface and five subsurface soil or sediment samples collected from the R Area Terrestrial unit at concentrations ranging from 17.3 to 87.8 mg/kg (see Figure 6-9B). Only the results for sampling locations RADSBE07 (87.8 mg/kg) and RADSB017 (85.5 mg/kg) exceeded the Tidal Area ambient value and ER-L (see Table 6-3).

- **R Area Terrestrial and Aquatic Unit:** Copper was detected in all three surface soil or sediment samples collected from the R Area Terrestrial and Aquatic unit at concentrations ranging from 25.6 to 55.3 mg/kg; all results were below the Tidal Area ambient value (see Table 6-4 and Figure 6-9A).

- **Froid and Taylor Terrestrial Unit:** Copper was detected at sampling location FTSSB001 (30.3 mg/kg) at a concentration below the Tidal Area ambient value (see Figure 6-9A).

- **Froid and Taylor Aquatic Unit:** Copper was detected in all 11 surface soil or sediment samples collected from the Froid and Taylor Aquatic unit at concentrations ranging from 25.3 to 92.0 mg/kg (see Figure 6-9A). Results for sample locations FTSSL102 (92.0 mg/kg) and FTSSB005 (86.0 mg/kg) exceeded the Tidal Area ambient value and ER-L. No sample results exceeded the ER-M (see Table 6-7).

- **Wood Hogger Terrestrial Unit:** Copper was detected in 60 of 63 surface and all 19 subsurface soil or sediment samples collected from the Wood Hogger Terrestrial unit at concentrations ranging from 4.6 to 607.0 mg/kg (see Figure 6-9C). Surface sampling location WHSSBH03 (607.0 mg/kg) was the only result that exceeded the ER-M. Results for samples that exceeded the Tidal Area ambient value and ER-L include the following locations: WHSSBI02 (228.0 mg/kg), WHSSBE04 (173.0 mg/kg), WHSSBD03 (103.0 mg/kg), WHSSB009 (102.0 mg/kg), WHSSB024 (102.0 mg/kg), S37-10 (86.0 mg/kg), WHSSB016 (84.3 mg/kg), and WHSSBB07 (82.5 mg/kg) (see Table 6-9).

- **North Otter Sluice Aquatic Unit:** Copper was detected in all 19 surface sediment samples collected from the North Otter Sluice Aquatic unit at concentrations ranging from 40.1 to 272.0 mg/kg (see Figure 6-9A). Sample location RADSBA07 (272.0 mg/kg) was the only result that exceeded the ER-M (270.0 mg/kg). Results for sample locations RADSBA03 (98.0 mg/kg) and RADSB003 (83.4 mg/kg) exceeded the Tidal Area ambient value and ER-L (see Table 6-11).

- **South Otter Sluice Aquatic Unit:** Copper was detected in all 26 surface sediment samples collected from the South Otter Sluice Aquatic unit at concentrations ranging from 16.7 to 105.0 mg/kg, below the ER-M (see Figure 6-9C). Results for sampling locations WHSSBA02 (105.0 mg/kg), WHSSB002 (104.0 mg/kg), OSLSL008 (101.0 mg/kg), WHSSB001 (96.0 mg/kg), WHSSB022 (89.0 mg/kg), WHSSBB05 (85.1 mg/kg), and WHSSB023 (82.9 mg/kg) exceeded the Tidal Area ambient value and ER-L (see Table 6-13).

In summary, copper concentrations are highest in the Wood Hogger Terrestrial unit at sampling location WHSSBH03 (607.0 mg/kg) where concentrations exceeded the ER-M. Tidal Area units with copper concentrations in samples above the Tidal Area ambient value include the Landfill Terrestrial,

R Area Terrestrial, Froid and Taylor Aquatic, North Otter Sluice Aquatic, and South Otter Sluice Aquatic units; no concentrations exceeded the ER-M in these units.

6.1.1.10 Lead in Soil and Sediment

Lead was detected in 255 of 258 soil or sediment samples collected from the Tidal Area sites. Figures 6-10A through 6-10C compare the concentrations of lead in soil and sediment samples to screening values. Exhibit 8 shows the concentrations of lead detected in soil and sediment samples compared to the Tidal Area ambient value (95.0 mg/kg), ER-L (46.7 mg/kg), and ER-M (218.0 mg/kg).

- **Landfill Terrestrial Unit:** Lead was detected in all eight surface and seven of eight subsurface soil or sediment samples collected from the Landfill Terrestrial unit at concentrations ranging from 5.8 to 156.0 mg/kg, all below the ER-M (see Figure 6-10A). Results for sample locations TLSSB007 (156.0 mg/kg) and TLSSB002 (152.0 mg/kg) exceeded the Tidal Area ambient value and the ER-L (see Table 6-1).

- **R Area Terrestrial Unit:** Lead was detected in all 94 surface and five subsurface soil or sediment samples collected from the R Area Terrestrial unit at concentrations ranging from 6.9 to 1,160.0 mg/kg (see Figure 6-10B). Results for sampling locations RADSBG08 (1,160.0 mg/kg), RADSB020 (300.0 mg/kg), RADSB106 (285.0 mg/kg), RADSB007 (275.0 mg/kg), and RADSBE07 (235.0 mg/kg) exceeded the ER-M. Results for 19 samples exceeded the Tidal Area ambient value and the ER-L (see Table 6-3).

- **R Area Terrestrial and Aquatic Unit:** Lead was detected in all three surface soil or sediment samples collected from the R Area Terrestrial unit at concentrations ranging from 8.7 to 41.0 mg/kg; all results were below the Tidal Area ambient value (see Table 6-4 and Figure 6-10A).

- **Froid and Taylor Terrestrial Unit:** Lead was detected in sampling location FTSSB001 (72.0 mg/kg) at a concentration below the Tidal Area ambient value (95.0 mg/kg) (see Table 6-6 and Figure 6-10A).

- **Froid and Taylor Aquatic Unit:** Lead was detected in all 11 surface sediment samples collected from the Froid and Taylor Aquatic unit at concentrations ranging from 14.3 to 515.0 mg/kg (see Figure 6-10A). The result for sample location FTSSB002 (515.0 mg/kg) exceeded the ER-M; results for sampling locations FTSSB003 (211.0 mg/kg), FTSSB006 (157.0 mg/kg), FTSSB009 (143.0 mg/kg), and FTSSB005 (115.0 mg/kg) exceeded the Tidal Area ambient value and the ER-L (see Table 6-7).

- **Wood Hogger Terrestrial Unit:** Lead was detected in all 63 surface and 20 subsurface soil or sediment samples collected from the Wood Hogger Terrestrial unit at concentrations ranging from 1.8 to 728.0 mg/kg (see Figure 6-10C). Results for subsurface sampling location WHSSBF03 (728.0 mg/kg, collected at a depth of 4.5 feet bgs) and surface sampling locations WHSSB014 (598.0 mg/kg), WHSSBE04 (593.0 mg/kg), WHSSBE08 (320.0 mg/kg) and WHSSB013 (226.0 mg/kg) exceeded the ER-M. Results for 10 additional surface samples exceeded the Tidal Area ambient value and the ER-L (see Table 6-9).

- **North Otter Sluice Aquatic Unit:** Lead was detected in all 19 surface sediment samples at concentrations ranging from 16.3 to 182.0 mg/kg (see Figure 6-10A). Results for sample locations RADSBA02 (182.0 mg/kg), RADSBA01 (128.0 mg/kg), and RADSBA07 (106.0 mg/kg) exceeded the Tidal Area ambient value and the ER-L. No sample results exceeded the ER-M (see Table 6-11).

- **South Otter Sluice Aquatic Unit:** Lead was detected in all 26 surface sediment samples collected from the South Otter Sluice Aquatic unit at concentrations ranging from 5.4 to 99.5 mg/kg (sampling location WHSSB002) (see Figure 6-10C). The result for sample location WHSSB002 (99.5 mg/kg) was the only concentration that exceeded the Tidal Area ambient value and the ER-L. No samples exceeded the ER-M (see Table 6-13).

In summary, lead is of highest concern in the R Area Terrestrial, Wood Hogger Terrestrial, and Froid and Taylor Aquatic units where detected concentrations exceeded the ER-M. Lead concentrations exceeded the Tidal Area ambient in the Landfill Terrestrial, North Otter Sluice Aquatic, and South Otter Sluice Aquatic units.

6.1.1.11 Manganese in Soil and Sediment

All 258 soil or sediment samples contained manganese. San Francisco Bay ambient and effects range values are not available for manganese; therefore, the following text discusses manganese in comparison to the Tidal Area ambient value (1,500 mg/kg) only. Figures 6-11A through 6-11C compare the concentrations of manganese in soil and sediment to ambient values.

- **Landfill Terrestrial Unit:** Manganese was detected in all eight surface and eight subsurface soil or sediment samples collected from the Landfill Terrestrial unit at concentrations ranging from 129 to 1,000 mg/kg; all sample results were below the Tidal Area ambient value (see Table 6-1 and Figure 6-11A).

- **R Area Terrestrial Unit:** Manganese was detected in all 94 surface and five subsurface soil or sediment samples collected from the R Area Terrestrial unit at concentrations ranging from 59 to 6,300 mg/kg (see Figure 6-11B). Surface sampling location RADSBI08 (6,300 mg/kg) was the only sample that exceeded the Tidal Area ambient value (see Table 6-3).

- **R Area Terrestrial and Aquatic Unit:** Manganese was detected in all three surface soil or sediment samples collected from the R Area Terrestrial and Aquatic unit at concentrations ranging from 525 to 859 mg/kg; all results were below the Tidal Area ambient value (see Table 6-4 and Figure 6-11A).

- **Froid and Taylor Aquatic Unit:** Manganese was detected in all 11 surface soil or sediment samples at concentrations ranging from 135 to 3,530 mg/kg. Only the result at sampling location FTSSL104 (3,530 mg/kg) exceeded the Tidal Area ambient value (see Table 6-7 and Figure 6-11A).

- **Froid and Taylor Terrestrial Unit:** Manganese was detected in surface soil sample FTSSB001 (608 mg/kg) at a concentration below the Tidal Area ambient value (see Table 6-6 and Figure 6-11a).

- **Wood Hogger Terrestrial Unit:** Manganese was detected in all 63 surface and 20 subsurface soil or sediment samples collected from the Wood Hogger Terrestrial unit at concentrations ranging from 53 to 1,470 mg/kg; all manganese concentrations were below the Tidal Area ambient value (see Table 6-9 and Figure 6-11C).

- **North Otter Sluice Aquatic Unit:** Manganese was detected in all 19 surface soil or sediment samples at concentrations ranging from 144 to 897 mg/kg; all manganese concentrations were below the Tidal Area ambient value (see Table 6-11 and Figure 6-11A).

- **South Otter Sluice Aquatic Unit:** Manganese was detected in all 26 surface soil or sediment samples at concentrations ranging from 55 to 1,270 mg/kg; all manganese concentrations were below the Tidal Area ambient value (see Table 6-13 and Figure 6-11C).

In summary, manganese exceeded the Tidal Area ambient value in one R Area Terrestrial unit and one Froid and Taylor Aquatic unit sample. The highest concentration of manganese was detected in the surface and subsurface soil samples collected from sampling location RADSBI08 (6,300 mg/kg) in the south-central portion of the R Area.

6.1.1.12 Mercury in Soil and Sediment

Mercury was detected in 163 soil or sediment samples collected from the Tidal Area sites. Mercury was not detected in soil or sediment samples collected from the R Area Terrestrial and Aquatic unit. Figures 6-12A through 6-12C compare the concentrations of mercury in soil and sediment samples to screening values. Exhibit 9 shows the concentrations of mercury detected in soil and sediment samples compared to the ER-L (0.15 mg/kg), ER-M (0.71 mg/kg), and San Francisco Bay ambient value (0.43 mg/kg).

- **Landfill Terrestrial Unit:** Mercury was detected in three of eight surface soil or sediment samples collected from the Landfill Terrestrial unit at concentrations ranging from 0.09 to 0.48 mg/kg (see Figure 6-12A). Sample location TLSSB004 (0.48 mg/kg) was the only result that exceeded the San Francisco Bay ambient value and the ER-L. No sample results exceeded the ER-M. Mercury was not detected in any of the eight subsurface samples collected from the Landfill Terrestrial unit (see Table 6-1).

- **R Area Terrestrial Unit:** Mercury was detected in 74 of the 94 surface and one of five subsurface soil or sediment samples collected from the R Area Terrestrial at concentrations ranging from 0.05 to 0.58 mg/kg (see Figure 6-12B). Results for sampling locations RADSB012 (0.58 mg/kg), RADSBF06 (0.54 mg/kg), RADSB020 (0.47 mg/kg), and RADSBG05 (0.46 mg/kg) exceeded the San Francisco Bay ambient value and the ER-L. No sample results exceeded the ER-M (see Table 6-3).

- **Froid and Taylor Terrestrial Unit:** Mercury was detected in sampling location FTSSB001 (0.25 mg/kg) at a concentration below the San Francisco Bay ambient value (see Table 6-6 and Figure 6-12A).

- **Froid and Taylor Aquatic Unit:** Mercury was detected in eight of 11 surface soil or sediment samples collected from the Froid and Taylor Aquatic unit at concentrations ranging from 0.07 to 0.49 mg/kg. Sample location FTSB006 (0.49 mg/kg) was the only result that exceeded the San Francisco Bay ambient value and ER-L. No sample results exceeded the ER-M (see Table 6-7 and Figure 6-12A).

- **Wood Hogger Terrestrial Unit:** Mercury was detected in 43 of 63 surface and 4 of 20 subsurface soil or sediment samples collected from the Wood Hogger Terrestrial unit at concentrations ranging from 0.1 to 7.1 mg/kg. Results for surface sampling locations WHSSB024 (7.1 mg/kg), WHSSBM06 (7.0 mg/kg), WHSSBA06 (5.6 mg/kg), WHSSBE04 (0.82 mg/kg), and WHSSBI02 (0.79 mg/kg) exceeded the ER-M. Results for eight additional surface samples exceeded the San Francisco Bay ambient value and ER-L. No subsurface sample results exceeded ambient values (see Table 6-9 and Figure 6-12C).

- **North Otter Sluice Aquatic Unit:** Mercury was detected in 14 of 19 surface soil or sediment samples collected from the North Otter Sluice Aquatic unit at concentrations ranging from 0.27 to 1.6 mg/kg (see Figure 6-12A). Results for sample locations RADSL001 (1.6 mg/kg), RADSBA04 (0.92 mg/kg), and RADSB004 (0.79 mg/kg) exceeded the ER-M. Results for six additional samples exceeded the San Francisco Bay ambient value and the ER-L, including sampling locations RADSBA01 (0.56 mg/kg), RADSBA06 (0.56 mg/kg), RADSB003 (0.55 mg/kg), RADSBA07 (0.51 mg/kg), RADSL002 (0.51 mg/kg), and RADSBA05 (0.44 mg/kg) (see Table 6-11).

- **South Otter Sluice Aquatic Unit:** Mercury was detected in 19 of 26 surface sediment samples collected from the South Otter Sluice Aquatic unit at concentrations ranging from 0.03 to 18.5 mg/kg (see Figure 6-12C). Results for sample locations WHSSB022 (18.5 mg/kg), WHSSB018 (10.0 mg/kg), and WHSSBB05 (0.82 mg/kg) exceeded the ER-M. Results for sampling locations WHSSL003 (0.51 mg/kg), and WHSSB001 (0.49 mg/kg exceeded the San Francisco Bay ambient value and the ER-L (see Table 6-13).

In summary, the highest mercury concentrations were detected in the Wood Hogger Terrestrial, North Otter Sluice Aquatic, and South Otter Sluice Aquatic units where samples from concentrations exceeded the ER-M. The highest concentrations (up to 18.5 mg/kg) were found in samples from South Otter Sluice Aquatic unit. Mercury concentrations exceeded ambient values in the Landfill Terrestrial, R Area Terrestrial, and Froid and Taylor Aquatic units.

6.1.1.13 Molybdenum in Soil and Sediment

Molybdenum was detected in 79 of 258 soil or sediment samples. Molybdenum was not detected in samples collected from the R Area Terrestrial and Aquatic and Froid and Taylor Terrestrial units. San Francisco Bay ambient and effects range values are not available for molybdenum; therefore, molybdenum concentrations are discussed solely in comparison to the Tidal Area ambient value (6.6 mg/kg). Figures 6-13A through 6-13C compare the concentrations of molybdenum in soil and sediment to the ambient value.

- **Landfill Terrestrial Unit:** Molybdenum was detected in four of eight surface and two of eight subsurface sediment samples collected from the Landfill Terrestrial unit at concentrations ranging from 1.5 to 4.2 mg/kg; all results were below the Tidal Area ambient value (see Table 6-1 and Figure 6-13A).

- **R Area Terrestrial Unit:** Molybdenum was detected in 27 of 94 surface and four of five subsurface soil or sediment samples collected from the R Area Terrestrial unit at concentrations ranging from 0.32 to 17.8 mg/kg (see Figure 6-13B). Results for surface sampling locations RADSBH06 (17.8 mg/kg) and RADSBH07 (10.3 mg/kg) exceeded the Tidal Area ambient value. No other surface or subsurface sample results exceeded ambient (see Table 6-3).

- **Froid and Taylor Aquatic Unit:** Molybdenum was detected in six of 11 surface soil or sediment samples collected from the Froid and Taylor Aquatic unit at concentrations ranging from 0.2 to 4.3 mg/kg; all results were below the Tidal Area ambient value (see Table 6-7 and Figure 6-13A).

- **Wood Hogger Terrestrial Unit:** Molybdenum was detected in 19 of 63 surface and eight of 20 subsurface soil or sediment samples collected from the Wood Hogger Terrestrial unit at concentrations ranging from 0.25 to 12.9 mg/kg. Only the result for sampling location WHSSBH07 (collected at 4.0 feet bgs) exceeded the Tidal Area ambient value (see Table 6-9 and Figure 6-13C).

- **North Otter Sluice Aquatic Unit:** Molybdenum was detected in two of 19 surface sediment samples collected from the North Otter Sluice Aquatic unit at concentrations ranging from 2.5 to 53.7 mg/kg (see Figure 6-13A). The result for sample location

RADSBA07 (53.7 mg/kg) was the only concentration that exceeded the Tidal Area ambient value (see Table 6-11).

- **South Otter Sluice Aquatic Unit:** Molybdenum was detected in 18 of 26 surface sediment samples collected from the South Otter Sluice Aquatic unit at concentrations ranging from 0.5 to 5.2 mg/kg; all results were below the Tidal Area ambient value (see Table 6-13 and Figure 6-13C).

In summary, two soil or sediment samples from the R Area Terrestrial unit and one sample from the Wood Hogger Terrestrial and North Otter Sluice Aquatic units exceeded the Tidal Area ambient value. North Otter Sluice Aquatic unit sampling location RADSBA07 (53.7 mg/kg) contained the highest molybdenum concentration. No results for samples collected in the other five Tidal Area units exceeded ambient values.

6.1.1.14 Nickel in Soil and Sediment

Nickel was detected in 257 of 258 soil or sediment samples at the Tidal Area sites. Figures 6-14A through 6-14C compare the concentrations of nickel in soil and sediment to screening values. Exhibit 10 shows the concentrations of nickel detected in soil and sediment samples compared to the ER-L (20.9 mg/kg), ER-M (51.6 mg/kg), the San Francisco Bay ambient value (112.0 mg/kg), and Tidal Area ambient value (120.0 mg/kg). It should be noted that the Tidal Area ambient value is significantly higher than the ER-M.

- **Landfill Terrestrial Unit:** Nickel was detected in all eight surface and subsurface soil or sediment samples collected from the Landfill Terrestrial unit at concentration ranging from 30.1 to 131.0 mg/kg (see Figure 6-14A). The result for sample location TLSSB002 (131.0 mg/kg) was the only concentration that exceeded the Tidal Area ambient value. Results for all eight surface and six of eight subsurface samples exceeded the ER-M (see Table 6-1).

- **R Area Terrestrial Unit:** Nickel was detected in all 94 surface and five subsurface soil or sediment samples collected from the R Area Terrestrial unit at concentrations ranging from 29.4 to 242.0 mg/kg (see Figure 6-14B). Results for surface sampling locations RADSBH06 (242.0 mg/kg), RADSBF06 (146.0 mg/kg), RADSBJ04 (126.0 mg/kg), and RADSB026 (124.0 mg/kg) exceeded the Tidal Area ambient value. Almost all surface sample results exceeded the ER-M. No subsurface sample results exceeded ambient values (see Table 6-3).

- **R Area Terrestrial and Aquatic Unit:** Nickel was detected in all three surface soil or sediment samples collected from the R Area Terrestrial and Aquatic unit at concentrations ranging from 29.0 to 89.7 mg/kg, all below the Tidal Area ambient value (see Table 6-4 and Figure 6-14A).

- **Froid and Taylor Terrestrial Unit:** Nickel was detected in surface sampling location FTSSB001 (38.0 mg/kg) collected from the Froid and Taylor Terrestrial unit at a concentration below the Tidal Area ambient value (see Table 6-6 and Figure 6-14A).

- **Froid and Taylor Aquatic Unit:** Nickel was detected in all 11 surface sediment samples the collected from the Froid and Taylor Aquatic unit at concentrations ranging from 22.7 to 90.9 mg/kg, below the Tidal Area ambient value (see Table 6-7 and Figure 6-14A).

- **Wood Hogger Terrestrial Unit:** Nickel was detected in 62 of 63 surface and all 20 subsurface soil or sediment samples collected from the Wood Hogger Terrestrial unit at concentrations ranging from 7.0 to 119.0 mg/kg; all nickel concentrations were below the Tidal Area ambient value (see Table 6-9 and Figure 6-14C).

- **North Otter Sluice Aquatic Unit:** Nickel was detected in all 19 surface soil or sediment samples collected from the North Otter Sluice Aquatic unit at concentrations ranging from 32.0 to 140.0 mg/kg. The result for sampling location RADSBA07 (140.0 mg/kg) was the only concentration that exceeded the Tidal Area ambient value (see Table 6-11 and Figure 6-14A).

- **South Otter Sluice Aquatic Unit:** Nickel was detected in all 26 surface soil or sediment samples collected from the South Otter Sluice Aquatic unit at concentrations ranging from 23.6 to 123.0 mg/kg. The result for sample location WHSSB001 was the only concentration that exceeded the Tidal Area ambient value (see Table 6-13 and Figure 6-14C).

In summary, nickel exceeded the Tidal Area ambient concentration in samples collected from the Landfill Terrestrial, R Area Terrestrial, North Otter Sluice Aquatic, and South Otter Sluice Aquatic units. Concentrations in samples from these units also exceeded the ER-M. The highest concentration of nickel was detected in the subsurface soil sample collected from location RADSBH06 (242.0 mg/kg) in the central portion of the R Area Terrestrial unit.

6.1.1.15 Selenium in Soil and Sediment

Selenium was not detected in any soil or sediment samples collected from the Landfill Terrestrial, R Area Terrestrial and Aquatic, and Froid and Taylor Terrestrial units. Detected concentrations from R Area Terrestrial, Froid and Taylor Aquatic, Wood Hogger Terrestrial, North Otter Sluice Aquatic, and South Otter Sluice Aquatic units are discussed in comparison to the ER-M (1.4 mg/kg) and ER-L (0.7 mg/kg) below. Figures 6-15A through 6-15C and Exhibit 11 compare the concentrations of selenium in soil and sediment to screening values.

- **R Area Terrestrial Unit:** Selenium was detected in 2 of 94 surface and 1 of 5 subsurface soil or sediment samples collected from the R Area Terrestrial unit at concentrations ranging from 1.0 to 2.8 mg/kg (see Figure 6-15A). Only the result for subsurface sampling location RADSBG08 (2.8 mg/kg collected at 4.0 feet bgs) exceeded the ER-M. Results for surface sampling locations RADSB029 (1.3 mg/kg) and RADSBL03 (1.0 mg/kg) exceeded the ER-L (see Table 6-3).

- **Froid and Taylor Aquatic Unit:** Selenium was detected in two of the 11 soil or sediment samples collected from the Froid and Taylor Aquatic unit at concentrations ranging from 1.2 to 1.5 mg/kg (see Figure 6-15B). The result for sample location FTSSL104 (1.5 mg/kg) slightly exceeded the ER-M, and the result for sampling location FTSSL102 (1.2 mg/kg) exceeded the ER-L (see Table 6-7).

- **Wood Hogger Terrestrial Unit:** Selenium was detected in four of 63 surface and none of 20 subsurface soil or sediment samples collected from the Wood Hogger Terrestrial unit at concentrations ranging from 0.7 to 4.8 mg/kg (see Figure 6-15C). The result for sampling location WHSSBC02 (4.8 mg/kg) exceeded the ER-M. Results for sample locations WHSSB013 (1.2 mg/kg), and WHSSB015 (0.9 mg/kg) exceeded the ER-L (see Table 6-9).

- **North Otter Sluice Aquatic Unit:** Selenium was detected in one of 19 surface soil or sediment samples collected from the North Otter Sluice Aquatic unit at a concentration of 1.2 mg/kg (sampling location OSLSL001), which exceeds the ER-L (see Table 6-11 and Figure 6-15B).

- **South Otter Sluice Aquatic Unit:** Selenium was detected in 5 of 26 surface soil or sediment samples collected from the South Otter Sluice Aquatic unit at concentrations ranging from 1.2 to 3.5 mg/kg (see Figure 6-15C). Sample results from locations WHSSB001 (3.5 mg/kg) and OSLSL004 (1.5 mg/kg) exceeded the ER-M. Samples WHSSL003 (1.3 mg/kg), OSLSL007 (1.3 mg/kg), and OSLSL005 (1.2 mg/kg) exceeded the ER-L (see Table 6-13).

In summary, selenium concentrations exceeded the ER-M (1.4 mg/kg) in samples collected from the R Area Terrestrial, Froid and Taylor Aquatic, Wood Hogger Terrestrial, and South Otter Sluice Aquatic units; concentrations exceeded the ER-L (0.7 mg/kg) in samples from the North Otter Sluice Aquatic unit. The highest concentrations were detected in Wood Hogger Terrestrial unit sampling location WHSSBC02 (4.8 mg/kg), South Otter Sluice Aquatic unit sampling location WHSSB001 (3.5 mg/kg), and R Area Terrestrial unit sampling location RADSBG08 (2.8 mg/kg, collected at 4.0 feet bgs). Selenium was not detected in samples from the Landfill Terrestrial, R Area Terrestrial and Aquatic, and Froid and Taylor Terrestrial units.

6.1.1.16 Silver in Soil and Sediment

Silver was not detected in soil or sediment samples collected from the R Area Terrestrial and Aquatic and Froid and Taylor Terrestrial units. Detected concentrations from all other units are discussed in comparison to the ER-M (3.7 mg/kg) and ER-L (1.0 mg/kg) below. Figures 6-16A through 6-16C and Exhibit 12 compare the concentrations of silver in soil to screening values.

- **Landfill Terrestrial Unit:** Silver was detected only in one of eight surface soil or sediment samples collected from the Landfill Terrestrial unit at a concentration of 1.2 mg/kg (sampling location TLSSB007), which exceeds the ER-L (see Table 6-1 and Figure 6-16A).

- **R Area Terrestrial Unit:** Silver was detected in eight of 94 surface soil or sediment samples collected from the R Area Terrestrial unit at concentrations ranging from 0.21 to 0.72 mg/kg; all silver concentrations were below the ER-L. Silver was not detected in the five subsurface soil or sediment samples (see Table 6-3 and Figure 6-16B).

- **Froid and Taylor Aquatic Unit:** Silver was detected in seven of 11 surface sediment samples collected from the Froid and Taylor Aquatic unit at concentrations ranging from 0.15 to 0.63 mg/kg; all silver concentrations were below the ER-L (see Table 6-7 and Figure 6-16A).

- **Wood Hogger Terrestrial Unit:** Silver was detected in 10 of 63 surface soil or sediment samples collected from the Wood Hogger Terrestrial unit at concentrations ranging from 0.16 to 4.4 mg/kg (see Figure 6-16C). The result for sample location WHSSB013 (4.4 mg/kg) exceeded the ER-M; results for sampling locations WHSSB014 (2.3 mg/kg), WHSSB009 (1.6 mg/kg), S37-10 (1.3 mg/kg), and WHSSB016 (1.1 mg/kg) exceeded the ER-L. Silver was not detected in subsurface soil or sediment samples (see Table 6-9).

- **North Otter Sluice Aquatic Unit:** Silver was detected in three of 19 surface soil or sediment samples collected from the North Otter Sluice Aquatic unit at concentrations ranging from 0.32 to 0.62 mg/kg; all silver concentrations were below the ER-L (see Table 6-11 and Figure 6-16A).

- **South Otter Sluice Aquatic Unit:** Silver was detected in four of 26 surface soil or sediment samples collected from the South Otter Sluice Aquatic unit at concentrations ranging from 0.3 to 0.6 mg/kg (sampling location OSLSL006); all silver concentrations were below the ER-L (see Table 6-13 and Figure 6-16C).

In summary, silver concentrations exceeded the ER-L in several Wood Hogger Terrestrial unit samples and one Landfill Terrestrial unit sample; the result for one sample from the Wood Hogger Terrestrial unit exceeded the ER-M. No other units of the Tidal Area contained silver at concentrations that exceeded the ER-L.

6.1.1.17 Thallium in Soil and Sediment

Thallium was detected in all units of the Tidal Area except the R Area Terrestrial and Aquatic unit. Thallium concentrations are discussed below in comparison to the Tidal Area ambient value (2.2 mg/kg); no San Francisco Bay ambient or effects range values are available for thallium. Figures 6-17A through 6-17C compare the concentrations of thallium in soil to ambient values.

- **Landfill Terrestrial Unit:** Thallium was detected in two of eight surface and one of the eight subsurface sediment samples collected from the R Area Terrestrial unit at concentrations ranging from 1.2 to 2.2 mg/kg; all results were below the Tidal Area ambient value (see Table 6-1 and Figure 6-17A).

- **R Area Terrestrial Unit:** Thallium was detected in seven of 94 surface and one of five subsurface soil or sediment samples at concentrations ranging from 0.66 to 5.4 mg/kg (see Figure 6-17B). Only the results for surface soil or sediment sampling locations RADSBI08 (5.4 mg/kg) and RADSBC05 (2.4 mg/kg) exceeded the Tidal Area ambient value (2.2 mg/kg); no other sample results exceeded ambient values (see Table 6-3).

- **Froid and Taylor Terrestrial Unit:** Thallium was detected in sampling location FTSSB001 (0.64 mg/kg) collected from the Froid and Taylor Terrestrial unit at a concentration below the Tidal Area ambient value (2.2 mg/kg) (see Table 6-6 and Figure 6-17A).

- **Froid and Taylor Aquatic Unit:** Thallium was detected in three of 11 surface soil or sediment samples collected from the Froid and Taylor Aquatic unit at concentrations ranging from 1.1 to 3.8 mg/kg. Only the result for sampling location FTSSL104 (3.8 mg/kg) exceeded the Tidal Area ambient value (see Table 6-7 and Figure 6-17A).

- **Wood Hogger Terrestrial Unit:** Thallium was detected in ten of 63 surface and one of 20 subsurface soil or sediment samples collected from the Wood Hogger Terrestrial unit at concentrations ranging from 0.69 to 2.4 mg/kg. Only the result for sampling location WHSSBD03 (2.4 mg/kg) exceeded the Tidal Area ambient value (see Table 6-9 and Figure 6-17C).

- **North Otter Sluice Aquatic Unit:** Thallium was detected in three of 19 sediment samples collected from the North Otter Sluice Aquatic unit at concentrations ranging up to 1.8 mg/kg (sampling location OSLSL001), below the Tidal Area ambient value (see Table 6-11 and Figure 6-17A).

- **South Otter Sluice Aquatic Unit:** Thallium was detected in four of 26 surface soil or sediment samples at concentrations ranging from 1.5 to 2.8 mg/kg. The result for sample location OSLSL007 (2.8 mg/kg) was the only concentration that exceeded the Tidal Area ambient value (see Table 6-13 and Figure 6-17C).

In summary, the highest thallium concentrations were detected in samples collected from the R Area Terrestrial, Froid and Taylor Aquatic, Wood Hogger Terrestrial, and South Otter Sluice Aquatic units, where detected concentrations exceeded the Tidal Area ambient value (2.2 mg/kg). The highest concentration detected was 5.4 mg/kg from the R Area Terrestrial unit.

6.1.1.18 Vanadium in Soil and Sediment

Vanadium was detected in soil or sediment samples collected from all units of the Tidal Area. Vanadium concentrations are discussed below in comparison to the Tidal Area ambient value (96.0 mg/kg); no San Francisco Bay ambient or effects range values are available for vanadium. Figures 6-18A through 6-18C compare the concentrations of vanadium in soil and sediment to the Tidal Area ambient value.

- **Landfill Terrestrial Unit:** Vanadium was detected in all eight surface and eight subsurface soil or sediment samples collected from the Landfill Terrestrial unit at concentrations ranging from 44.8 to 108.0 mg/kg (see Figure 6-18A). Only the results for surface sampling location TLSSB006 (108.0 mg/kg) and subsurface sampling location TLSSB003 (100.0 mg/kg collected at a depth of 4.5 feet bgs) slightly exceeded the Tidal Area ambient value (see Table 6-1).

- **R Area Terrestrial Unit:** Vanadium was detected in all 94 surface and five subsurface soil or sediment samples collected from the R Area Terrestrial unit at concentrations ranging from 32.3 to 130.0 mg/kg (see Figure 6-18B). Results for surface sampling locations RADSBE03 (130.0 mg/kg), RADSBG06 (107.0 mg/kg), RADSBK01 (99.3 mg/kg), and RADSB107 (96.3 mg/kg) exceeded the Tidal Area ambient value. No subsurface sample results exceeded ambient (see Table 6-3).

- **R Area Terrestrial and Aquatic Unit:** Vanadium was detected in all three surface soil or sediment samples collected from the R Area Terrestrial and Aquatic unit at concentrations ranging from 54.2 to 94.7 mg/kg; all results were below the Tidal Area ambient value (see Table 6-4 and Figure 6-18A).

- **Froid and Taylor Terrestrial Unit:** Vanadium was detected in sampling location FTSSB001 (54.7 mg/kg) from the Froid and Taylor Terrestrial unit at a concentration below the Tidal Area ambient value (see Table 6-6 and Figure 6-18A).

- **Froid and Taylor Aquatic Unit:** Vanadium was detected in all 11 surface soil or sediment samples collected from the Froid and Taylor Road Aquatic unit at concentrations ranging from 38.4 to 136.0 mg/kg. Results for sample locations FTSSB008 (136.0 mg/kg) and FTSSB005 (113.0 mg/kg) exceeded the Tidal Area ambient value (see Table 6-7 and Figure 6-18A).

- **Wood Hogger Terrestrial Unit:** Vanadium was detected in all 63 surface and 20 subsurface soil or sediment samples collected from the Wood Hogger Terrestrial unit at concentrations ranging from 14.8 to 163.0 mg/kg (see Figure 6-18C). Results for surface sampling locations WHSSBE08 (163.0 mg/kg), WHSSB024 (139.0 mg/kg), WHSSBA08 (102.0 mg/kg), WHSSBC02 (99.7 mg/kg), and WHSSBI02 (99.0 mg/kg) exceeded the Tidal Area ambient value; all other surface and subsurface sample results were below ambient (see Table 6-9).

- **North Otter Sluice Aquatic Unit:** Vanadium was detected in all 19 surface sediment samples collected from the North Otter Sluice Aquatic unit at concentrations ranging from 52.1 to 105.0 mg/kg (see Figure 6-18A). Results for sample locations RADSL002 (105.0 mg/kg), RADSB003 (102.0 mg/kg), RADSB005 (99.0 mg/kg), RADSB004 (96.8 mg/kg), RADSBA07 (96.8 mg/kg), and RADSBA04 (96.1 mg/kg) slightly exceeded the Tidal Area ambient value; all other sample results were below ambient (see Table 6-11).

- **South Otter Sluice Aquatic Unit:** Vanadium was detected in all 26 surface sediment samples at concentrations ranging from 41.4 to 139.0 mg/kg (see Figure 6-18C). Results for sample locations WHSSB001 (139.0 mg/kg), WHSSB022 (136.0 mg/kg), WHSSB002 (120.0 mg/kg), WHSSL003 (119.0 mg/kg), WHSSB018 (112.0 mg/kg), WHSSB003 (109.0 mg/kg), WHSSBA02 (109.0 mg/kg), OSLSL008 (106.0 mg/kg), WHSSL001 (103.0 mg/kg) exceeded the Tidal Area ambient value; all other sample results were below ambient (see Table 6-13).

In summary, vanadium concentrations exceeded the Tidal Area ambient value (96.0 mg/kg) in samples collected from the Landfill Terrestrial, R Area Terrestrial, Froid and Taylor Aquatic, Wood Hogger Terrestrial, North Otter Sluice Aquatic, and South Otter Sluice Aquatic units. The highest concentrations of vanadium were detected in samples collected from the Wood Hogger Terrestrial, Froid and Taylor Aquatic, South Otter Sluice Aquatic, and R Area Terrestrial units.

6.1.1.19 Zinc in Soil and Sediment

Zinc concentrations are discussed below in comparison to the Tidal Area ambient value (264.0 mg/kg), ER-L (150.0 mg/kg), and ER-M (410.0 mg/kg). Figures 6-19A through 6-19C and Exhibit 13 compare the concentrations of zinc in soil and sediment to screening values.

- **Landfill Terrestrial Unit:** Zinc was detected in all eight surface and seven of eight subsurface soil or sediment samples collected from the Landfill Terrestrial unit at concentrations ranging from 56 to 743 mg/kg (see Figure 6-19A). The result for sample TLSSB002 (743 mg/kg) exceeded the ER-M; sampling location TLSDSB005 (307 mg/kg) exceeded the Tidal Area ambient value (see Table 6-1).

- **R Area Terrestrial Unit:** Zinc was detected in all 94 surface and five subsurface soil or sediment samples collected from the R Area Terrestrial unit at concentrations ranging from 47 to 959 mg/kg (see Figure 6-19B). The results for samples RADSB017 (959 mg/kg) and RADSBG08 (488 mg/kg) exceeded the ER-M; results for sampling locations RADSB009 (371 mg/kg), RADSB007 (290 mg/kg) and RADSB008 (266 mg/kg) exceeded the Tidal Area ambient value (see Table 6-3).

- **R Area Terrestrial and Aquatic Unit:** Zinc was detected in all three surface soil or sediment samples collected from the R Area Terrestrial and Aquatic unit at concentrations ranging from 62.5 to 424 mg/kg. The result for sample RASDB013 was the only concentration that exceeded the ER-M; no other sample results exceeded any of the screening criteria (see Table 6-4 and Figure 6-19A).

- **Froid and Taylor Terrestrial Unit:** Zinc was detected in sampling location FTSSB001 (106 mg/kg) at a concentration below the Tidal Area ambient value(see Table 6-6 and Figure 6-19A).

- **Froid and Taylor Aquatic Unit:** Zinc was detected in all 11 surface soil or sediment samples collected from the Froid and Taylor Aquatic unit at concentrations ranging from 59 to 436 mg/kg. Only the result for sampling location FTSSB002 (426 mg/kg) exceeded the ER-M; no other sample results exceeded the Tidal Area ambient value (see Table 6-7 and Figure 6-19A).

- **Wood Hogger Terrestrial Unit:** Zinc was detected in 57 of 63 surface and 19 of 20 subsurface soil or sediment samples collected from the Wood Hogger Terrestrial unit at concentrations ranging from 29 to 3,010 mg/kg (see Figure 6-19C). Results for 10 surface soil or sediments samples and one subsurface soil or sediment sample exceeded the ER-M, including locations WHSSBI02 (3,010 mg/kg), WHSSBH03 (2,540 mg/kg), WHSSB009 (746 mg/kg), WHSSB050 (723 mg/kg), WHSSBD07 (593 mg/kg), WHSSBE04 (544 mg/kg), WHSSB016 (515 mg/kg), WHSSB013 (467 mg/kg), WHSSB014 (426 mg/kg), and WHSSBD03 (417 mg/kg). The result for subsurface soil or sediment sampling location WHSSBF03 (1,440 mg/kg, collected at a depth of 4.5 feet bgs) also exceeded the ER-M. Concentrations in five additional surface samples exceeded the Tidal Area ambient value (see Table 6-9).

- **North Otter Sluice Aquatic Unit:** Zinc was detected in all 19 surface sediment samples collected from the South Otter Sluice Aquatic unit at concentrations ranging from 89 to 496 mg/kg (see Figure 6-19A). The result for sample locations RADSBA07 (496 mg/kg) and RADSB006 (474 mg/kg) exceeded the ER-M. In addition, results for sample locations RADSB003 (309 mg/kg), RADSBA03 (305 mg/kg), and RADSB001 (304 mg/kg) exceeded the Tidal Area ambient value; all other sample results were below the Tidal Area ambient value (see Table 6-11).

- **South Otter Sluice Aquatic Unit:** Zinc was detected in all 26 surface soil or sediment samples collected from the South Otter Sluice Aquatic unit at concentrations ranging from 48 to 605 mg/kg (see Figure 6-19C). Results for sampling locations WHSSB002 (605 mg/kg) and WHSSBA02 (568 mg/kg) exceeded the ER-M; results for sample locations WHSSB003 (394 mg/kg), WHSSB023 (322 mg/kg), OSLSL008 (285 mg/kg), and WHSSB001 (268 mg/kg) exceeded the Tidal Area ambient value (see Table 6-13).

In summary, zinc concentrations from the Landfill Terrestrial, R Area Terrestrial, R Area Terrestrial and Aquatic, Froid and Taylor Aquatic, Wood Hogger Terrestrial, North Otter Sluice Aquatic, and South Otter Sluice Aquatic units exceeded the ER-M (410 mg/kg). The highest concentrations of zinc were found in samples collected from surface and subsurface soil samples at the Wood Hogger Site (up to 3,010 mg/kg).

6.1.1.20 Summary of Inorganic Constituents in Soil and Sediment

The following table summarizes the inorganic constituents detected above screening values; an "X" indicates that the maximum detected concentration of the inorganic constituent exceeded the higher of ambient values or the ER-L. Tables 6-1, 6-3, 6-4, 6-6, 6-7, 6-9, 6-11, and 6-13 provide more detailed information regarding the chemicals detected in soil and sediment for each habitat unit as compared to the screening values.

SUMMARY OF INORGANIC CONSTITUENTS EXCEEDING SCREENING VALUES IN SOIL AND SEDIMENT

Inorganic Chemical	Landfill Terrestrial Unit	R Area Terrestrial Unit	R Area Terrestrial and Aquatic Unit	Froid and Taylor Terrestrial Unit	Froid and Taylor Aquatic Unit	Wood Hogger Terrestrial Unit	North Otter Sluice Aquatic Unit	South Otter Sluice Aquatic Unit
Aluminum	X	X			X	X	X	X
Antimony	X	X				X	X	X
Arsenic	X	X				X	X	
Barium		X				X		
Beryllium	X	X			X	X	X	X
Cadmium	X					X		X
Chromium						X	X	X
Cobalt		X						X
Copper	X	X			X	X	X	X
Lead	X	X			X	X	X	X
Manganese		X			X			
Mercury	X	X			X	X	X	X

SUMMARY OF INORGANIC CONSTITUENTS EXCEEDING SCREENING VALUES IN SOIL AND SEDIMENT (Continued)

Inorganic Chemical	Landfill Terrestrial Unit	R Area Terrestrial Unit	R Area Terrestrial and Aquatic Unit	Froid and Taylor Terrestrial Unit	Froid and Taylor Aquatic Unit	Wood Hogger Terrestrial Unit	North Otter Sluice Aquatic Unit	South Otter Sluice Aquatic Unit
Molybdenum		X				X	X	
Nickel	X	X					X	X
Selenium		X			X	X	X	X
Silver	X					X		
Thallium		X			X	X		X
Vanadium	X	X			X	X	X	X
Zinc	X	X	X		X	X	X	X

6.1.2 Leachability Evaluations: WET-Acid and WET-DI Extractions

As part of the QEA, two different extractions were performed on 52 sediment and soil samples to estimate the labile (weakly bound) fraction of metals and metalloids and their bioavailability. Both extractions used a modified WET method: one extraction used a 0.5 normal (0.5N) hydrochloric acid extractant (WET-acid), and the other used a DI water extractant (WET-DI).

WET-acid tests were conducted on 15 soil and five sediment samples, and WET-DI tests were performed on 47 soil and five sediment samples, as shown in the following table:

Site Name	WET-Acid		WET-DI	
	Soil	Sediment	Soil	Sediment
R Area Disposal	7	2	20	2
Froid and Taylor Roads	2	0	9	0
Wood Hogger	6	3	18	3
Total:	**15**	**5**	**47**	**5**

Samples that were extracted were also subject to toxicity testing using Microtox and Cytochrome P450; those results are discussed in Section 8.0. Analytical results for all samples are included in Appendices A through E. Ecological statistical summary tables are presented in Appendix N and include comparisons with relevant screening values (AWQCs). Table 5-2 lists the AWQC values used in the screening process, and Figures 6-20 through 6-30 compare the range of concentrations of selected inorganic constituents detected in extraction samples to the screening values.

The following subsections discuss the analytical results for inorganic constituents detected in the WET extraction tests.

6.1.2.1 Aluminum in Extractions

Aluminum was detected in all 15 WET-acid soil extractions, with an average concentration of 204,000 micrograms per liter (μg/L) and a range of 21,000 to 388,000 μg/L, all above the freshwater criterion continuous concentration (CCC) (87 μg/L). Aluminum was also detected in all five WET-acid sediment extractions at concentrations ranging from 119,900 to 191,000 μg/L, all above the freshwater CCC. Aluminum was detected in 42 of 47 WET-DI soil extractions, with an average concentration of 1,110 μg/L and a range of 22.7 to 350,000 μg/L. Aluminum was also detected in all five WET-DI sediment samples at concentrations ranging from 538 to 1,950 μg/L, all above the freshwater CCC.

6.1.2.2 Antimony in Extractions

No screening values are available for antimony. Figures 6-20A through 6-20C illustrate the range of detected concentrations of antimony in both extractions. Antimony was detected in five of the 15 WET-acid soil extractions, with an average concentration of 5.1 μg/L and a range of 3.1 to 9.4 μg/L. Antimony was also detected in three of five WET-acid sediment samples collected near the Wood Hogger Site in Otter Sluice at concentrations ranging from 7.8 to 11.7 μg/L. Antimony was detected in 16 of the 47 WET-DI soil extractions, with an average concentration of 2.5 μg/L and a range of 2.4 to 11.2 μg/L. Antimony was not detected in WET-DI sediment extractions.

6.1.2.3 Arsenic in Extractions

The arsenic saltwater CCC is 36 μg/L. Figures 6-21A through 6-21C illustrate the range of detected concentrations of arsenic in WET-acid and WET-DI extractions. Arsenic was detected in all 15 WET-acid soil extractions, with an average concentration of 95.3 μg/L and a range of 15.1 to 445 μg/L. Of the 15 detections, 12 exceeded the saltwater CCC. Arsenic was also detected in three of five WET-acid sediment extractions, at concentrations ranging from 28.8 to 52.0 μg/L. Results for two WET-acid sediment extractions exceeded the saltwater CCC. Arsenic was detected in 33 of the 47 WET-DI soil extractions, with an average concentration of 11.7 μg/L and a range of 2.8 to 63.7 μg/L. Of the 33 detections, three exceeded the saltwater CCC. Arsenic was also detected in

three of five WET-DI sediment extractions at concentrations ranging from 13.9 to 40.9 μg/L. None of the WET-DI sediment extraction concentrations exceeded the saltwater CCC.

6.1.2.4 Barium in Extractions

Screening values are not available for barium. Barium was detected in all 15 WET-acid soil extractions, with an average concentration of 6,620 μg/L and a range of 665 to 12,900 μg/L. Barium was also detected in all five WET-acid sediment extractions at concentrations ranging from 1,580 to 5,220 μg/L. Barium was detected in all 47 WET-DI soil extractions, with an average concentration of 819 μg/L and a range of 4.5 to 3,340 μg/L. Barium was also detected all five WET-DI sediment extractions at concentrations ranging from 7.6 to 1,780 μg/L.

6.1.2.5 Beryllium in Extractions

Screening values for beryllium are not available. Beryllium was detected in 10 of 15 WET-acid soil extractions, with an average concentration of 6.1 μg/L and a range 2.3 to 14.4 μg/L. Beryllium was also detected in all five WET-acid sediment extractions at concentrations ranging from 0.26 to 14.1 μg/L. Beryllium was not detected in WET-DI soil or sediment extractions.

6.1.2.6 Cadmium in Extractions

The cadmium surface water CCC is 1.1 μg/L. Figures 6-22A through 6-22C illustrate the range of detected concentrations of cadmium in both extractions. Cadmium was detected in nine of 15 WET-acid soil extractions, with an average concentration of 16.0 μg/L and a range of 1.3 to 39.3 μg/L. Cadmium was also detected in all five WET-acid sediment extractions at concentrations ranging from 7.7 to 41.5 μg/L. Results for all 14 WET-acid extraction concentrations exceeded the surface water CCC. Cadmium was detected in two of the 47 WET-DI soil extractions, with an average concentration of 0.17 μg/L and a range of 0.69 to 1.9 μg/L. One detection exceeded the surface water CCC. Cadmium was also detected in two of five WET-DI sediment extractions of samples from Otter Sluice collected near the Wood Hogger Site, at concentrations of 0.44 and 3.1 μg/L; one detection exceeded the surface water CCC.

6.1.2.7 Chromium in Extractions

The screening value for total chromium is 86 μg/L, according to EPA (1998). Chromium was detected in all 15 WET-acid soil extractions, with an average concentration of 426 μg/L and a range of 141 to 928 μg/L. Chromium was also detected in all five WET-acid sediment extractions at concentrations ranging from 482 to 673 μg/L; all detections exceeded the screening value. Chromium was detected in 11 of the 47 WET-DI soil extractions, with an average concentration of 3.6 μg/L and a range of 4 to 525 μg/L. Most of the detections were in samples collected from the Wood Hogger Site. Of the 11 detections, four exceeded the screening value. Chromium was also detected in the three WET-DI sediment extractions for samples collected from Otter Sluice near the Wood Hogger Site at concentrations ranging from 3.4 to 6.2 μg/L; none of the sediment extraction concentrations exceeded the screening value.

6.1.2.8 Cobalt in Extractions

Screening values are not available for cobalt. Cobalt was detected in all 15 WET-acid soil extractions, with an average concentration of 391 μg/L and a range 3.7 to 903 μg/L. Cobalt was also detected in all five WET-acid sediment extractions at concentrations ranging from 150 to 309 μg/L. Cobalt was detected in 32 of 47 WET-DI soil extractions, with an average concentration of 4.2 μg/L and a range of 0.57 to 220 μg/L. Cobalt was also detected in all five WET-DI sediment extractions at concentrations ranging from 0.74 to 13 μg/L.

6.1.2.9 Copper in Extractions

The copper saltwater CCC is 3.2 μg/L, according to EPA (1998). Figures 6-23A through 6-23C illustrate the range of detected concentrations by site for copper in both extractions. Copper was detected in all 15 WET-acid soil extractions, with an average concentration of 907 μg/L and a range of 153 to 2,420 μg/L. Copper was also detected in all five WET-acid sediment extractions at concentrations ranging from 9.6 to 838 μg/L. All detections exceeded the saltwater CCC. Copper was detected in 43 of the 47 WET-DI soil extractions, with an average concentration of 74.1 μg/L and a range of 3.5 to 2,320 μg/L. Copper was also detected in all five WET-DI sediment extractions at concentrations ranging from 17.4 to 51.8 μg/L. All detections exceeded the saltwater CCC.

6.1.2.10 Lead in Extractions

The lead freshwater CCC is 3.1 μg/L, according to EPA (1998). Figures 6-24A through 6-24C illustrate the range of detected concentrations by site for lead in both extractions. Lead was detected in all 15 WET-acid soil extractions, with an average concentration of 2,200 μg/L and a range of 343 to 11,000 μg/L. Lead was also detected in all five WET-acid sediment extractions at concentrations ranging from 40.2 to 89.5 μg/L. All detections exceeded the freshwater CCC. Lead was detected in 31 of the 47 WET-DI soil extractions, with an average concentration of 77.0 μg/L and a range of 1.8 to 3,630 μg/L; 26 detections exceeded the freshwater CCC. Lead was also detected in all five WET-DI sediment extractions at concentrations ranging from 7.4 to 20.2 μg/L, exceeding the freshwater CCC.

6.1.2.11 Manganese in Extractions

Screening values are not available for manganese. Manganese was detected in all WET-acid soil extractions, with an average concentration of 19,400 μg/L and a range of 2,700 to 45,300 μg/L. Manganese was also detected in all five WET-acid sediment extractions at concentrations ranging from 3,620 to 8,410 μg/L. Manganese was detected in 44 WET-DI soil extractions, with an average concentration of 197 μg/L and a range of 2.4 to 4,440 μg/L. Manganese was also detected in all five WET-DI sediment extractions at concentrations ranging from 31.4 to 441 μg/L.

6.1.2.12 Mercury in Extractions

The mercury surface water CCC is 0.025 μg/L. Figures 6-25A through 6-25C illustrate the range of detected concentrations by site for mercury in both extractions. Mercury was detected in 14 of the 15 WET-acid soil extractions, with an average concentration of 0.66 μg/L and a range of 0.11 to 3.6 μg/L; all 14 detections exceeded the surface water CCC. Mercury was not detected in WET-acid or WET-DI sediment extractions. Mercury was detected in 13 of 47 WET-DI soil extractions, with an average concentration of 0.13 μg/L and a range of 0.09 to 1.2 μg/L; all 13 detections exceeded the surface water CCC.

6.1.2.13 Molybdenum in Extractions

Screening values are not available for molybdenum. Molybdenum was not detected in any of the 15 WET-acid soil extractions; however, it was detected in 20 of the 47 WET-DI soil extractions, with

an average concentration of 6.6 μg/L and a range of 0.91 to 14.4 μg/L. Molybdenum was also detected in four sediment WET-DI extractions at concentrations ranging from 1.8 to 12.7 μg/L.

6.1.2.14 Nickel in Extractions

The nickel saltwater CCC is 8.2 μg/L. Figures 6-26A through 6-26C illustrate the range of detected concentrations by site for nickel in both extractions. Nickel was detected in all 15 WET-acid soil extractions, with an average concentration of 1,210 μg/L and a range of 494 to 3,140 μg/L. Nickel was also detected in all five WET-acid sediment extractions at concentrations ranging from 849 to 1,280 μg/L. All detections exceeded AWQC. Nickel was detected in 34 of 47 WET-DI soil extractions, with an average concentration of 25.7 μg/L and a range of 3.6 to 579 μg/L. Of the 34 detections, 26 exceeded the saltwater CCC. Nickel was also detected in all five WET-DI sediment extractions at concentrations ranging from 4.4 to 34.3 μg/L; three of the five detections exceeded the saltwater CCC.

6.1.2.15 Selenium in Extractions

The selenium freshwater CCC is 5 μg/L. Figures 6-27A and 6-27B illustrate the range of detected concentrations by site for selenium in both extractions. Selenium was not detected in any of the WET-acid soil and sediment extractions. Selenium was detected in three of the 47 WET-DI soil extractions, with an average concentration of 1.9 μg/L and a range of 3.8 to 4.2 μg/L. None of results exceeded the freshwater CCC.

6.1.2.16 Silver in Extractions

The saltwater CCC for silver is 0.22 μg/L, according to EPA (1998). Figures 6-28A through 6-28C illustrate the range of detected concentrations by site for silver in both extractions. Silver was detected in three of the 15 WET-acid soil extractions, with an average concentration of 0.69 μg/L and a range of 1.3 to 2 μg/L; three detections exceeded the saltwater CCC. Silver was not detected in sediment extractions. Silver was detected in eight of the 47 WET-DI soil extractions, with an average concentration of 0.54 μg/L and a range of 0.77 to 2.8 μg/L; eight detections exceeded the saltwater CCC.

6.1.2.17 Thallium in Extractions

Screening values are not available for thallium. Figures 6-29A through 6-29C illustrate the range of detected concentrations by site for thallium in both extractions. Thallium was detected in seven of the 15 WET-acid soil extractions, with an average concentration of 12.9 μg/L and a range of 9.9 to 73.1 μg/L. Thallium was also detected in one WET-acid sediment extraction at a concentration of 4.3 μg/L. Thallium was detected in one of 47 WET-DI soil extractions at a concentration of 4.4 μg/L, and was not detected in WET-DI sediment extractions.

6.1.2.18 Vanadium in Extractions

Screening values are not available for vanadium. Vanadium was detected in all 15 WET-acid soil extractions, with an average concentration of 1,590 μg/L and a range of 730 to 2,850 μg/L. Vanadium was also detected in all five WET-acid sediment extractions at concentrations ranging from 1,360 to 1,790 μg/L. Vanadium was detected in 44 WET-DI soil extractions, with an average concentration of 37.6 μg/L and a range of 0.62 to 1,090 μg/L. Vanadium was also detected in all five WET-DI sediment extractions at concentrations ranging from 2.4 to 85.6 μg/L.

6.1.2.19 Zinc in Extractions

The surface water CCC for zinc is 58 μg/L. Figures 6-30A through 6-30C illustrate the range of detected concentrations by site for zinc in both extractions. Zinc was detected in all 15 WET-acid soil extractions, with an average concentration of 4,680 μg/L and a range of 814 to 15,800 μg/L. Zinc was also detected in all five WET-acid sediment extractions at concentrations ranging from 3,250 to 6,980 μg/L. All detections exceeded the surface water CCC. Zinc was detected in 38 of the 47 WET-DI soil extractions, with an average concentration of 297 μg/L and a range of 2.9 to 8,500 μg/L. Of the 38 detections, eight exceeded the surface water CCC. Zinc was also detected in three of five WET-DI sediment extractions at concentrations ranging from 823 to 1,350 μg/L, exceeding the surface water CCC.

6.1.2.20 Summary of Inorganic Constituents in WET-Acid and WET-DI Extractions

Table 6-22 summarizes results for inorganic constituents that exceeded AWQC in extraction test results. For the WET-DI extractions, several inorganic constituents, including aluminum, arsenic, cadmium, chromium, copper, lead, mercury, nickel, silver, and zinc, exceeded the screening values in

samples collected at some locations. These nine constituents were also detected in the WET-acid extractions at concentrations exceeding screening values. Inorganic chemicals that have not been assigned screening values but were detected in extraction samples include antimony, barium, beryllium, cobalt, manganese, molybdenum, thallium, and vanadium.

6.1.3 Inorganic Constituents in Surface Water Samples

During 1995 and 1996, a total of 81 surface water samples were collected over four consecutive quarters (collected in January, April/May, July, and October) from 25 stations. Some stations were not sampled during every quarter because they were dry. During June 1998, an additional 12 surface water samples were collected. Exhibit 3 depicts the locations of the surface water stations.
The sections below summarize the results for the inorganic constituents detected in surface water samples collected at the Tidal Area sites. Tables 6-2, 6-5, 6-8, 6-10, 6-12, and 6-14 present the detected results in comparison to screening values for the Landfill Terrestrial, R Area Terrestrial and Aquatic, Froid and Taylor Aquatic, Wood Hogger Terrestrial, North Otter Sluice Aquatic, and South Otter Sluice Aquatic units. Figures 6-31 through 6-37 compare concentrations of selected inorganic constituents detected in surface water samples against screening values.

The detection limits for mercury and silver exceeded AWQC. Detection limits for all other inorganic constituents were below screening values. Appendix P contains summaries of detection limits achieved compared with relevant screening values.

6.1.3.1 Aluminum in Surface Water

Aluminum was detected in surface water samples from all units of the Tidal Area. The freshwater CCC for aluminum is 87 μg/L (EPA 1998); detected concentrations are compared to this guidance value below.

- **Landfill Terrestrial Unit:** Aluminum was detected in six of 12 samples collected from the Landfill Terrestrial unit at concentrations ranging from 47.6 to 1,370.0 mg/kg (see Table 6-2). Results for five samples exceeded the freshwater CCC (87.0 μg/L) at sampling locations RADSW016 (1,370 μg/L collected during April/May), RADSW015 (1,220 μg/L collected during April/May), RADSW014 (107.0 μg/L collected during April/May), RADSW014 (349.0 μg/L collected during January), RADSW015 (158 μg/L collected during July) (see Table 6-2).

- **R Area Terrestrial and Aquatic Unit:** Aluminum was detected in 12 of 15 samples collected from the R Area Terrestrial and Aquatic unit at concentrations ranging from 84.2 to 5,570.0 μg/L. Results for 11 samples exceeded the freshwater CCC (87 μg/L) at sampling locations RADSW010 (5,570 and 704 μg/L collected during July and April/May), RADSW012 (682 μg/L during January), RADSW008 (610 and 115 μg/L collected during January and April/May), RADSW007 (323 μg/L collected during January), RADSW011 (678 and 258 μg/L collected during July and January), RADSW013 (184 μg/L collected during January), and RADSW009 (229 and 141 μg/L collected during April/May and January) (see Table 6-5).

- **Froid and Taylor Aquatic Unit:** Aluminum was detected in six of nine samples collected from the Froid and Taylor Aquatic unit at concentrations ranging from 116 to 1,610 μg/L. Results for six samples exceeded the freshwater CCC (87 μg/L) at sampling locations FTSSW001 (1,610 μg/L, 343 μg/L, and 116 μg/L collected during October, July, and April/May), FTSSL104 (461 μg/L collected during June 1998), and FTSSW002 (304 μg/L collected during July) (see Table 6-8).

- **Wood Hogger Terrestrial Unit:** Aluminum was detected in five of eight surface water samples collected from the Wood Hogger Terrestrial unit at concentrations ranging from 166 to 748 μg/L. Results for five samples from two locations exceeded the freshwater CCC (87 μg/L) at sampling locations WHSSW005 (748 and 206 μg/L collected during April/May and January) and WHSSW006 (428, 166, and 332 μg/L collected during October, January, and April/May) (see Table 6-10).

- **North Otter Sluice Aquatic Unit:** Aluminum was detected in all 27 surface water samples collected from the North Otter Sluice Aquatic unit at concentrations ranging from 205 to 37,700 μg/L. All 27 samples contained aluminum at concentrations that exceeded the freshwater CCC (87 μg/L) (see Table 6-12).

- **South Otter Sluice Aquatic Unit:** Aluminum was detected in all 22 surface water samples collected from the South Otter Sluice Aquatic unit at concentrations ranging from 167 to 2,100 μg/L. All sample results contained aluminum at concentrations above the freshwater CCC (87 μg/L) (see Table 6-14).

In summary, all units of the Tidal Area contained concentrations of aluminum in surface water samples at concentrations exceeding the freshwater CCC (87 μg/L). The highest aluminum concentration was in a sample from North Otter Sluice Aquatic unit sampling location RADSW005 (37,700 μg/L).

6.1.3.2 Antimony in Surface Water

Antimony was detected in samples from all units of the Tidal Area except the Landfill Terrestrial, the R Area Terrestrial and Aquatic, and South Otter Sluice Aquatic units. Screening values are not available for antimony. The range of detected antimony concentrations is presented below.

- **Froid and Taylor Aquatic Unit:** Antimony was detected in two of nine samples collected from Froid and Taylor Aquatic unit, from sampling locations FTSSW001 (9.9 μg/L collected during October) and FTSSL102 (1.0 μg/L collected during June) (see Table 6-8).

- **Wood Hogger Terrestrial Unit:** Antimony was detected in two of eight surface water samples collected from the Wood Hogger Terrestrial unit at concentrations ranging from 2.6 to 3.6 μg/L (see Table 6-10).

- **North Otter Sluice Aquatic Unit:** Antimony was detected in one of 27 surface water samples collected from the North Otter Sluice Aquatic unit at a concentration of 3.5 μg/L (location RADSW005) (see Table 6-12).

In summary, antimony was detected in four samples at concentrations ranging from 2.6 μg/L to 9.9 μg/L from the Froid and Taylor Aquatic, Wood Hogger Terrestrial, and Northern Otter Sluice Aquatic units. The highest concentration of antimony was detected in a sample collected at location FTSSW001 in October 1995.

6.1.3.3 Arsenic in Surface Water

Arsenic was detected in samples from all Tidal Area units. Figure 6-31 compares concentrations of arsenic detected in surface water samples to the saltwater CCC of 36.0 μg/L (EPA 1998).

- **Landfill Terrestrial Unit:** Arsenic was detected in eight of 12 samples at concentrations ranging from 1.6 to 16.7 μg/L, all below the saltwater CCC (see Table 6-2).

- **R Area Terrestrial and Aquatic Unit:** Arsenic was detected in 12 of 15 samples collected in the R Area Terrestrial and Aquatic unit at concentrations ranging from 1.5 to 23.9 μg/L, below the saltwater CCC (see Table 6-5).

- **Froid and Taylor Aquatic Unit:** Arsenic was detected in all nine samples collected from the Froid and Taylor Aquatic unit at concentrations ranging from 2.2 to 275.0 μg/L. The result for only one sample collected during October 1995 at location FTSSW001 (275.0 μg/L) exceeded the saltwater CCC (see Table 6-8).

- **Wood Hogger Terrestrial Unit:** Arsenic was detected in three of eight surface water samples collected from the Wood Hogger Terrestrial unit at concentrations ranging from 2.4 to 11.8 μg/L, below the saltwater CCC (see Table 6-10).

- **North Otter Sluice Aquatic Unit:** Arsenic was detected in 12 of 27 surface water samples collected from the North Otter Sluice Aquatic unit at concentrations ranging from 1.8 to 9.7 μg/L; all concentrations were below the saltwater CCC (see Table 6-12).

- **South Otter Sluice Aquatic Unit:** Arsenic was detected in 10 of 22 surface water samples collected from the South Otter Sluice Aquatic unit at concentrations ranging from 2.0 to 4.4 μg/L, below the saltwater CCC (see Table 6-14).

In summary, the result for only one surface water sample the from the Froid and Taylor Aquatic unit (sampling location FTSSW001 at 275.0 μg/L) exceeded the saltwater CCC (36.0 μg/L).

6.1.3.4 Barium in Surface Water

Barium was detected in samples from all Tidal Area units; detected concentrations are presented below. Screening values are not available for barium.

- **Landfill Terrestrial Unit:** Barium was detected in all 12 samples from landfill surface water at concentrations ranging from 49 to 316 μg/L (see Table 6-2).
- **R Area Terrestrial and Aquatic Unit:** Barium was detected in all 15 samples collected from the R Area Terrestrial and Aquatic unit at concentrations ranging from 22.9 to 114.0 μg/L (see Table 6-5).
- **Froid and Taylor Aquatic Unit:** Barium was detected in all nine samples collected from the Froid and Taylor Aquatic unit at concentrations ranging from 106 to 809 μg/L. The highest concentration was in a sample from location FTSSW001, collected during October 1995 (see Table 6-8).
- **Wood Hogger Terrestrial Unit:** Barium was detected in eight of 22 surface water samples collected from the Wood Hogger Terrestrial unit at concentrations ranging from 36.5 to 173.0 μg/L (see Table 6-10).
- **North Otter Sluice Aquatic Unit:** Barium was detected in all 27 surface water samples collected from the North Otter Sluice Aquatic unit at concentrations ranging from 17.7 to 211.0 μg/L (see Table 6-12).
- **South Otter Sluice Aquatic Unit:** Barium was detected in all 22 surface water samples collected from the South Otter Sluice Aquatic unit at concentrations ranging from 19.4 to 1,160.0 μg/L (see Table 6-14).

In summary, the highest concentrations of barium were detected in samples from the South Otter Sluice Aquatic unit collected at sampling location OSLSL009 (1,160 μg/L) and from the Froid and Taylor Aquatic unit at sampling location FTSSW001 (809 μg/L).

6.1.3.5 Beryllium in Surface Water

Beryllium was not detected in any surface water samples collected from the Tidal Area sites.

6.1.3.6 Cadmium in Surface Water

Cadmium was detected in surface water samples collected from all units of the Tidal Area. Cadmium concentrations are compared below to the surface water CCC of 1.1 μg/L (Bay Basin Plan 1986)

- **Landfill Terrestrial Unit:** Cadmium was detected in two of 12 samples from the Landfill Terrestrial unit at concentrations ranging from 0.42 to 1.80 μg/L. Only the result for sampling location RADSW016 (1.80 μg/L) slightly exceeded the surface water CCC (see Table 6-2).

- **R Area Terrestrial and Aquatic Unit:** Cadmium was detected in five of 15 surface water samples collected from the R Area Terrestrial and Aquatic unit at concentrations ranging up to 8.3 μg/L (RADSW010). Results for April surface water sampling locations RADSW010 (8.3 μg/L), RADSW009 (2.8 μg/L), and RADSW008 (2.4 μg/L) and January sampling location RADSW013 (1.8 μg/L) exceeded the surface water CCC (see Table 6-5).

- **Froid and Taylor Aquatic Unit:** Cadmium was detected in one of nine surface water samples collected at the Froid and Taylor Aquatic unit from sampling location FTSSW001 at a concentration equal to the surface water CCC (1.1 μg/L) (see Table 6-8).

- **Wood Hogger Terrestrial Unit:** Cadmium was detected in two of eight surface water samples collected from the Wood Hogger Terrestrial unit at concentrations of 0.54 and 2.5 μg/L. Only the result for sampling location WHSSW005 (2.5 μg/L collected during April/May) exceeded the surface water CCC (see Table 6-10).

- **North Otter Sluice Aquatic Unit:** Cadmium was detected in two of 27 surface water samples collected from the North Otter Sluice Aquatic unit at concentrations ranging from 0.47 to 0.95 μg/L; all results were below the surface water CCC (see Table 6-12).

- **South Otter Sluice Aquatic Unit:** Cadmium was detected in three of 27 surface water samples collected from South Otter Sluice Aquatic unit at concentrations below the surface water CCC (see Table 6-14).

In summary, the highest concentrations of cadmium were detected in samples collected from the central portion of the R Area Terrestrial and Aquatic unit. Six samples (four from the R Area Terrestrial and Aquatic unit and one each from the Wood Hogger Terrestrial and Landfill Terrestrial units) contained cadmium at concentrations exceeding the surface water CCC of 1.1 μg/L. The maximum concentration was 1.8 μg/L at sampling location RADSW013.

6.1.3.7 Chromium in Surface Water

Chromium was detected in surface water samples from all units of the Tidal Area. Figure 6-32 compares the concentrations of chromium detected in surface water samples to the freshwater CCC of 86.0 μg/L (EPA 1998) (see Table 5-1).

- **Landfill Terrestrial Unit:** Chromium was detected in two of 12 samples collected from the Landfill Terrestrial unit at concentrations ranging from 3.2 to 5.5 μg/L; all results were below the freshwater CCC (see Table 6-2).
- **R Area Terrestrial and Aquatic Unit:** Chromium was detected in two of 15 samples collected from the R Area Terrestrial and Aquatic unit at concentrations ranging from 1.4 to 6.3 μg/L; all results were below the freshwater CCC (see Table 6-5).
- **Froid and Taylor Aquatic Unit:** Chromium was detected in two of nine surface water samples collected from the Froid and Taylor Aquatic unit at concentrations ranging from 1.7 to 6.9 μg/L; all results were below the freshwater CCC (see Table 6-8).
- **Wood Hogger Terrestrial Unit:** Chromium was detected in three of eight surface water samples collected from the Wood Hogger Terrestrial unit at concentrations ranging from 1.1 to 1.9 μg/L; all results were below the freshwater CCC (see Table 6-10).
- **North Otter Sluice Aquatic Unit:** Chromium was detected in 18 of 27 surface water samples from the North Otter Sluice Aquatic unit at concentrations ranging from 1.6 to 102.0 μg/L. The result for one sample collected during October from sampling location RADSW005 (102.0 μg/L) slightly exceeded the freshwater CCC (see Table 6-12).
- **South Otter Sluice Aquatic Unit:** Chromium was detected in 13 of 27 surface water samples collected from the South Otter Sluice Aquatic unit at concentrations ranging from 0.6 to 6.1 μg/L; all results were below the freshwater CCC (see Table 6-14).

In summary, the only concentration exceeding the freshwater CCC (86.0 μg/L) was detected in a sample from the North Otter Sluice Aquatic unit collected at location RADSW005 during the October 1995 sampling event (102.0 μg/L).

6.1.3.8 Cobalt in Surface Water

Cobalt was detected in surface water samples from all units of the Tidal Area. Screening values were not available for cobalt.

- **Landfill Terrestrial Unit:** Cobalt was detected in 11 of 12 samples collected from the Landfill Terrestrial unit at concentrations ranging from 2.5 to 9.7 μg/L. The highest concentration of cobalt was detected in sampling location RADSW016 (9.7 μg/L collected during April) (see Table 6-2).

- **R Area Terrestrial and Aquatic Unit:** Cobalt was detected in 14 of 15 surface water samples collected from the R Area Terrestrial and Aquatic unit at concentrations ranging from 0.5 to 129.0 (see Table 6-5).

- **Froid and Taylor Aquatic Unit:** Cobalt was detected in seven of nine surface water samples collected from the Froid and Taylor Aquatic unit at concentrations ranging from 1.2 to 5.1 μg/L. The highest detected concentrations were in samples from location FTSSW001 (5.1 and 3.9 μg/L collected during October and July) (see Table 6-8).

- **Wood Hogger Terrestrial Unit:** Cobalt was detected in five of eight surface water samples collected from the Wood Hogger Terrestrial unit at concentrations ranging from 0.52 to 1.0 μg/L (see Table 6-10).

- **North Otter Sluice Aquatic Unit:** Cobalt was detected in 13 of 27 surface water samples collected from the North Otter Sluice Aquatic unit at concentrations ranging from 0.35 to 27.6 μg/L (see Table 6-12). The maximum concentration was in a sample collected at location RADSW005 during October 1995.

- **South Otter Sluice Aquatic Unit:** Cobalt was detected in 10 of 22 surface water samples collected from the South Otter Sluice Aquatic unit at concentrations ranging from 0.3 to 1.4 μg/L (see Table 6-14).

In summary, the highest concentrations of cobalt were detected in samples collected from the North Otter Sluice Aquatic unit (up to 27.6 μg/L) and the central portion of the R Area Terrestrial and Aquatic unit (locations RADSW008, RADSW009, RADSW010, RADSW011, and RADSW013).

6.1.3.9 Copper in Surface Water

Copper was detected in surface water samples collected from all Tidal Area units. Figure 6-33 compares the concentrations of copper detected in surface water samples to the saltwater CCC (3.2 μg/L) (EPA 1998) (see Table 5-2).

- **Landfill Terrestrial Unit:** Copper was detected in seven of 12 samples collected from the Landfill Terrestrial unit at concentrations ranging from 5.8 to 14.5 μg/L. All seven samples contained copper at concentrations that exceeded the saltwater CCC including samples RADSW014 (14.5 μg/L collected during January 1996; 5.8 μg/L collected during April 1996), RADSW016 (11.8 μg/L collected during January 1996; 9.2 μg/L collected during April 1996), RADSW017 (11.3 μg/L collected during January 1996), and

RADSW015 (10.3 μg/L collected during January 1996; 7.9 μg/L collected during April 1996) (see Table 6-2).

- **R Area Terrestrial and Aquatic Unit:** Copper was detected in nine of 15 surface water samples collected from the R Area Terrestrial and Aquatic unit at concentrations ranging up to 32.0 μg/L (location RADSW010). Results for nine samples exceeded the saltwater CCC from sampling locations RADSW010 (32.0 and 17.9 μg/L collected during July and April/May), RADSW008 (17.0 μg/L collected during January), RADSW007 (13.1 μg/L collected during January), RADSW011 (12.8 and 10.6 μg/L collected during January and July), RADSW012 (10.5 μg/L collected during January), RADSW009 (10.1 μg/L collected during January), and RADSW013 (8.2 μg/L collected during January) (see Table 6-5).

- **Froid and Taylor Aquatic Unit:** Copper was detected in eight of nine surface water samples collected from the Froid and Taylor Aquatic unit at concentrations ranging from 2.9 to 13.4 μg/L. Results for seven samples exceeded the saltwater CCC at locations FTSSW001 (13.4, 12.7, and 10.8 μg/L collected during January, July, and October), FTSSW002 (9.6 and 7.8 μg/L collected during July and January), FTSSL102 (3.8 μg/L collected during June 1998), and FTSSL104 (3.5 μg/L collected during June 1998) (see Table 6-8).

- **Wood Hogger Terrestrial Unit:** Copper was detected in seven of eight surface water samples collected from the Wood Hogger Terrestrial unit at concentrations ranging from 3.0 to 13.7 μg/L. Results for six samples from two locations exceeded the saltwater CCC at sampling locations WHSSW005 (13.7, 11.6, and 5.7 μg/L collected during April/May, July and January, and October) and WHSSW006 (9.5 and 6.1 μg/L collected during July and October) (see Table 6-10).

- **North Otter Sluice Aquatic Unit:** Copper was detected in 20 of 27 surface water samples collected from the North Otter Sluice Aquatic unit at concentrations ranging from 3.0 to 82.0 μg/L. Results for 18 samples exceeded the saltwater CCC. The highest copper concentrations were in samples collected from location RADSW005 (82.0 and 9.7 μg/L, collected during October and July) (see Table 6-12).

- **South Otter Sluice Aquatic Unit:** Copper was detected in 16 of 22 surface water samples collected from the South Otter Sluice Aquatic unit at concentrations ranging from 2.9 to 7.8 μg/L. Results for 13 samples from six locations exceeded the saltwater CCC at sampling locations WHSSW004 (7.8, 7.7, and 6.9 μg/L collected during January, October, and April/May), OSLSL009 (5.6 μg/L collected during June), OSLSL007 (3.6 μg/L collected during June), WHSSW003 (5.3 and 4.2 μg/L collected during January/October and April/May), WHSSW002 (6.2, 6.0, and 4.6 μg/L collected during January, April/May, and October), and WHSSW001 (6.9 and 4.3 μg/L collected during January and October) (see Table 6-14).

In summary, levels of copper exceeded the saltwater CCC (3.2 μg/L) in surface water samples collected from every unit of the Tidal Area. The highest surface water concentrations were in samples collected from locations RADSW005 in the North Otter Sluice Aquatic unit (82.0 μg/L) and RADSW010 (32.0 μg/L) in the R Area Terrestrial and Aquatic unit.

6.1.3.10 Lead in Surface Water

Lead was detected in surface water samples collected from all Tidal Area units. Figure 6-34 compares the concentrations of lead detected in surface water samples to the freshwater CCC (3.1 μg/L) (EPA 1998) (see Table 5-1).

- **Landfill Terrestrial Unit:** Lead was detected in two samples at concentrations ranging from 2.3 to 2.9 μg/L; all results were below the freshwater CCC (see Table 6-2).

- **R Area Terrestrial and Aquatic Unit:** Lead was detected in four of 15 surface water samples collected from the R Area Terrestrial and Aquatic unit at concentrations ranging from 2.3 to 41.5 μg/L. Only results for three samples collected during July 1995 exceeded the freshwater CCC at sampling locations RADSW010 (41.5 μg/L), RADSW011 (7.4 μg/L), and RADSW013 (3.9 μg/L) (see Table 6-5).

- **Froid and Taylor Aquatic Unit:** Lead was detected in one of nine surface water samples collected from the Froid and Taylor Aquatic unit at sampling location FTSSW002 (4.0 μg/L during July) at a concentration slightly above the freshwater CCC (see Table 6-8).

- **Wood Hogger Terrestrial Unit:** Lead was detected in two of eight surface water samples collected from the Wood Hogger Terrestrial unit at concentrations ranging from 2.8 to 3.7 μg/L. The result for sample location WHSSW005 (3.7 μg/L collected during April/May) was the only concentration that exceeded the freshwater CCC (see Table 6-10).

- **North Otter Sluice Aquatic Unit:** Lead was detected in four of 27 surface water samples collected from the North Otter Sluice Aquatic unit at concentrations ranging from 1.5 to 57.3 μg/L. Results for sample locations RADSW005 (57.3 μg/L collected in October) and RADSW004 (21.2 μg/L collected in April/May) exceeded the freshwater CCC (see Table 6-12).

- **South Otter Sluice Aquatic Unit:** Lead was detected in three of 22 surface water samples collected from the South Otter Sluice Aquatic unit at concentrations ranging from 1.3 to 3.1 μg/L; all results were below the freshwater CCC (see Table 6-14).

In summary, lead was detected at concentrations that exceeded the freshwater CCC (3.1 μg/L) in samples collected from the R Area Terrestrial and Aquatic, Froid and Taylor Aquatic, the Wood Hogger Terrestrial, and North Otter Sluice Aquatic units. The highest lead concentrations were detected in North Otter Sluice Aquatic unit sample locations RADSW005 (57.3 μg/L) and RADSW004 (21.2 μg/L) and R Area Terrestrial and Aquatic unit sampling location RADSW010 (41.5 μg/L).

6.1.3.11 Manganese in Surface Water

Manganese was detected in all surface water samples collected from Tidal Area units; manganese concentration ranges are presented by area below. Screening values are not available for manganese.

- **Landfill Terrestrial Unit:** Manganese was detected in all 12 samples collected from the Landfill Terrestrial unit at concentrations ranging from 560 to 3,180 μg/L (see Table 6-2).
- **R Area Terrestrial and Aquatic Unit:** Manganese was detected in all 15 surface water samples collected from the R Area Terrestrial and Aquatic unit at concentrations ranging from 312 to 11,300 μg/L (see Table 6-5).
- **Froid and Taylor Aquatic Unit:** Manganese was detected in all nine surface water samples collected from the Froid and Taylor Aquatic unit at concentrations ranging from 207 to 4,480 μg/L. The highest detected concentrations were in samples from locations FTSSW001 (4,480 μg/L collected during October) and FTSSL102 (1,740 μg/L collected during June 1998) (see Table 6-8).
- **Wood Hogger Terrestrial Unit:** Manganese was detected in all eight surface water samples collected from the Wood Hogger Terrestrial unit at concentrations ranging from 107 to 1,950 μg/L (see Table 6-10).
- **North Otter Sluice Aquatic Unit:** Manganese was detected in all 27 surface water samples collected from the North Otter Sluice Aquatic unit at concentrations ranging from 28.8 to 691.0 μg/L (see Table 6-12).
- **South Otter Sluice Aquatic Unit:** Manganese was detected in all 22 surface water samples collected from the South Otter Sluice Aquatic unit at concentrations ranging from 37.9 to 278.0 μg/L (see Table 6-14).

In summary, manganese concentrations were highest in R Area Terrestrial and Aquatic unit sampling location RADSW010 (11,300 μg/L); no screening values are available for manganese.

6.1.3.12 Mercury in Surface Water

Mercury was detected in eight of 81 surface water samples from all Tidal Area units except the Landfill Terrestrial unit. The median detection limit for mercury was 0.1 μg/L, which is above the surface water CCC for mercury (0.025 μg/L) (see Appendix P). Figure 6-35 compares the concentrations of mercury detected in surface water samples to the surface water CCC (0.025 μg/L) (Bay Basin Plan 1986).

- **R Area Terrestrial and Aquatic Unit:** Mercury was detected in three of 15 surface water samples collected from the R Area Terrestrial and Aquatic unit at concentrations ranging from 0.26 to 0.35 μg/L. Results for all three samples exceeded the surface water CCC at locations RADSW010 (0.35 and 0.3 μg/L collected during July and April/May) and RADSW009 (0.26 μg/L collected during April/May).

- **Froid and Taylor Aquatic Unit:** Mercury was detected in two of nine surface water samples collected from the Froid and Taylor Aquatic unit. Both samples were collected in July from locations FTSSW002 (0.17 μg/L) and FTSSW001 (0.13 μg/L), and the results exceeded the surface water CCC (see Table 6-8).

- **Wood Hogger Terrestrial Unit:** Mercury was detected in one of eight surface water samples collected from the Wood Hogger Terrestrial unit at location WHSSW005 (0.20 μg/L) at a concentration that exceeded the surface water CCC (see Table 6-10).

- **North Otter Sluice Aquatic Unit:** Mercury was detected in one of 27 samples collected from the North Otter Sluice Aquatic unit at a concentration of 0.66 μg/L (location RADSW005), which exceeds the surface water CCC (see Table 6-12).

- **South Otter Sluice Aquatic Unit:** Mercury was detected in one of 22 surface water samples collected from the South Otter Sluice Aquatic unit at location WHSSW002 (0.24 μg/L) at a concentration that exceeded the surface water CCC (see Table 6-14).

In summary, all Tidal Area units except the Landfill Terrestrial unit yielded at least one sample that exceeded the surface water CCC for mercury (0.025 μg/L). The high detection limit (0.1 μg/L) is a source of uncertainty in this risk assessment. The highest detected mercury concentrations were in North Otter Sluice Aquatic unit sampling location RADSW005 (0.66 μg/L) and R Area Terrestrial and Aquatic unit sampling location RADSW010 (0.35 μg/L).

6.1.3.13 Molybdenum in Surface Water

Molybdenum was detected at all Tidal Area units. Screening values are not available for molybdenum; the range of detected molybdenum concentrations is presented by unit below.

- **Landfill Terrestrial Unit:** Molybdenum was detected in nine of 12 samples from the Landfill Terrestrial unit at concentrations ranging from 6.6 to 19.8 μg/L (location RADSW016) (see Table 6-2).

- **R Area Terrestrial and Aquatic Unit:** Molybdenum was detected in four of 15 surface water samples collected from the R Area Terrestrial and Aquatic unit at concentrations ranging from 2.2 to 12.8 μg/L (see Table 6-5).

- **Froid and Taylor Aquatic Unit:** Molybdenum was detected in six of nine surface water samples collected from the Froid and Taylor Aquatic unit at concentrations ranging from 0.92 to 4.6 μg/L (see Table 6-8).

- **Wood Hogger Terrestrial Unit:** Molybdenum was detected in three of eight surface water samples collected from the Wood Hogger Terrestrial unit at concentrations ranging from 1.8 to 7.3 μg/L (see Table 6-10).

- **North Otter Sluice Aquatic Unit:** Molybdenum was detected in 12 of 27 surface water samples collected from the North Otter Sluice Aquatic unit at concentrations ranging from 0.45 to 4.2 μg/L (see Table 6-12).

- **South Otter Sluice Aquatic Unit:** Molybdenum was detected in six of 22 surface water samples collected from the South Otter Sluice Aquatic unit at concentrations ranging from 0.42 to 1.90 μg/L (see Table 6-14).

In summary, molybdenum was detected in samples from all Tidal Area units. The highest molybdenum concentrations were from location RADSW016 (19.8 μg/L) at the Landfill Terrestrial unit and location RADSW009 (12.8 μg/L) in the R Area Terrestrial and Aquatic unit.

6.1.3.14 Nickel in Surface Water

Nickel was detected in samples collected from all sampling locations at concentrations ranging from 2.6 to 211 μg/L. Nickel concentrations are presented below in reference to the saltwater CCC (8.2 μg/L). Figure 6-36 compares the concentrations of nickel detected in surface water samples to the saltwater CCC.

- **Landfill Terrestrial Unit:** Nickel was detected in seven of 12 samples from the Landfill Terrestrial unit at concentrations ranging from 6.6 to 28.6 μg/L. Results for sample locations RADSW016 (28.6 μg/L collected during April/May; 18.5 μg/L collected during January); RADSW014 (26.8 and 18.7 μg/L collected during January and April/May), and RADSW015 (17.8 and 17.2 μg/L collected during January and April/May) exceeded the saltwater CCC (see Table 6-2).

- **R Area Terrestrial and Aquatic Unit:** Nickel was detected in 11 of 15 surface water samples collected from the R Area Terrestrial and Aquatic unit at concentrations ranging from 12.8 to 211.0 μg/L. Results for 11 samples contained nickel concentrations that exceeded the saltwater CCC at locations RADSW010 (211.0, 40.0, and 41.3 μg/L collected during July, April/May, and January), RADSW008 (171.0 and 30.8 μg/L collected during January and April/May), RADSW011 (156.0 and 20.7 μg/L collected during January and April/May), RADSW013 (81.2 μg/L collected during January), RADSW012 (59.8 μg/L collected during January), RADSW009 (51.7 μg/L collected during January), and RADSW007 (12.8 μg/L collected during January) (see Table 6-5).

- **Froid and Taylor Aquatic Unit:** Nickel was detected in six of nine surface water samples collected from the Froid and Taylor Aquatic unit at concentrations ranging from 3.8 to 44.7 μg/L. Results for four samples exceeded the saltwater CCC, including FTSSW001 (44.7 μg/L and 9.1 μg/L collected during October and January and FTSSL104 (11.9 μg/L and 11.2 μg/L collected during June) (see Table 6-8).

- **Wood Hogger Terrestrial Unit:** Nickel was detected in six of eight surface water samples collected from the Wood Hogger Terrestrial unit at concentrations ranging from 2.6 to 6.2 μg/L; all results were below the saltwater CCC (see Table 6-10).

- **North Otter Sluice Aquatic Unit:** Nickel was detected in 16 of 27 surface water samples collected from the North Otter Sluice Aquatic unit at concentrations ranging from 2.6 to 118.0 μg/L. Results for sample locations RADSW005 (118.0 μg/L) and RADSW006 (8.6 μg/L) exceeded the saltwater CCC (see Table 6-12).

- **South Otter Sluice Aquatic Unit:** Nickel was detected in 17 of 22 surface water samples collected from the South Otter Sluice Aquatic unit at concentrations ranging from 2.5 to 7.6 μg/L; all results were below the saltwater CCC (see Table 6-14).

In summary, nickel concentrations exceeded the saltwater CCC (8.2 μg/L) in samples collected from the Landfill Terrestrial, R Area Terrestrial and Aquatic, Froid and Taylor Aquatic, and North Otter Sluice Aquatic units. None of the samples collected from the Wood Hogger Terrestrial or South Otter Sluice Aquatic units exceeded saltwater CCC. The highest nickel concentrations were in R Area Terrestrial and Aquatic unit sampling locations RADSW010 (211.0 μg/L) and RADSW011 (156.0 μg/L), and North Otter Sluice Aquatic unit sampling location RADSW005 (118.0 μg/L).

6.1.3.15 Selenium in Surface Water

Selenium was not detected in water samples collected from the Wood Hogger Terrestrial or North Otter Sluice Aquatic units. Selenium concentrations from all other units of the Tidal Area are presented below in comparison to freshwater CCC (5.0 μg/L).

- **Landfill Terrestrial Unit:** Selenium was detected in one of 12 samples at a concentration below the freshwater CCC (see Table 6-2).

- **R Area Terrestrial and Aquatic Unit:** Selenium was detected in three of 15 surface water samples collected from the R Area Terrestrial and Aquatic unit at concentrations ranging from 2.4 to 4.1 μg/L; all results were below the freshwater CCC (see Table 6-5).

- **Froid and Taylor Aquatic Unit:** Selenium was detected in four of nine surface water samples collected from the Froid and Taylor Aquatic unit at concentrations ranging from 1.0 to 2.4 μg/L; all results were below the freshwater CCC (see Table 6-8).

- **South Otter Sluice Aquatic Unit:** Selenium was detected in three of 22 surface water samples collected from the South Otter Sluice Aquatic unit at concentrations ranging from 0.77 to 1.0 μg/L; all results were below the freshwater CCC (see Table 6-14).

In summary, selenium was detected in samples collected from the Landfill Terrestrial, R Area Terrestrial and Aquatic, Froid and Taylor Aquatic, and South Otter Sluice Aquatic units; however, no selenium concentrations exceeded the freshwater CCC value of 5.0 μg/L.

6.1.3.16 Silver in Surface Water

Silver was detected in two of nine surface water samples collected from FTSSL104 (0.3 μg/L) and FTSSL102 (0.3 μg/L) during June 1998 at a concentration above the saltwater CCC (0.22 μg/L). Silver was not detected in any other surface water samples; however, the range of detection limits (0.26 to 2.5 μg/L) exceeded the screening value (0.22 μg/L).

6.1.3.17 Thallium in Surface Water

Thallium was not detected in surface water samples collected from the Landfill Terrestrial and Wood Hogger Terrestrial units. The range of detected thallium concentrations is presented for all other units below. Screening values are not available for thallium.

- **R Area Terrestrial and Aquatic Unit:** Thallium was detected in two of 15 surface water samples collected from the R Area Terrestrial and Aquatic unit; both samples were from location RADSW013 (8.1 and 4.4 μg/L collected during July and January) (see Table 6-5).

- **Froid and Taylor Aquatic Unit:** Thallium was detected in one of nine surface water samples collected from the Froid and Taylor Aquatic unit at location FTSSW001 (8.4 μg/L), collected during October (see Table 6-8).

- **North Otter Sluice Aquatic Unit:** Thallium was detected in one of 27 surface water samples collected from the North Otter Sluice Aquatic unit at location RADSW002 (2.4 μg/L) (see Table 6-12).

- **South Otter Sluice Aquatic Unit:** Thallium was detected in two of 22 surface water samples collected from the South Otter Sluice Aquatic unit at locations WHSSW003 (2.4 μg/L) and WHSSW004 (2.4 μg/L) (see Table 6-14).

In summary, thallium was detected in five surface water samples, including two from the R Area Terrestrial Aquatic unit and one each from the Froid and Taylor Aquatic, North Otter Sluice Aquatic, and South Otter Sluice Aquatic units. The highest thallium concentrations were from Froid and Taylor

Aquatic unit sampling location FTSSW001 (8.4 μg/L) and R Area Terrestrial and Aquatic unit sampling location RADSW013 (8.1 μg/L).

6.1.3.18 Vanadium in Surface Water

Vanadium was detected in all Tidal Area units. Screening values are not available for vanadium; detected concentrations are presented by unit below.

- **Landfill Terrestrial Unit:** Vanadium was detected in four of 12 samples collected from the Landfill Terrestrial unit at concentrations ranging from 1.8 to 10.50 μg/L.
- **R Area Terrestrial and Aquatic Unit:** Vanadium was detected in seven of 15 surface water samples collected from the R Area Terrestrial and Aquatic unit at concentrations ranging from 2.3 to 33.7 μg/L (see Table 6-5).
- **Froid and Taylor Aquatic Unit:** Vanadium was detected in seven of nine surface water samples collected from the Froid and Taylor Aquatic unit at concentrations ranging from 4.1 to 29.8 μg/L (see Table 6-8).
- **Wood Hogger Terrestrial Unit:** Vanadium was detected in two of eight surface water samples collected from the Wood Hogger Terrestrial unit at concentrations ranging from 5.1 to 10.4 μg/L (see Table 6-10).
- **North Otter Sluice Aquatic Unit:** Vanadium was detected in 21 of 27 surface water samples collected from the North Otter Sluice Aquatic unit at concentrations ranging from 4.7 to 139.0 μg/L (see Table 6-12).
- **South Otter Sluice Aquatic Unit:** Vanadium was detected in 18 of 22 surface water samples collected from the South Otter Sluice Aquatic unit at concentrations ranging from 4.4 to 11.3 μg/L (see Table 6-14).

In summary, the highest detections of vanadium were in North Otter Sluice Aquatic unit sampling location RADSW005 (139 μg/L), R Area Terrestrial and Aquatic unit sampling location RADSW010 (33.7 μg/L), and Froid and Taylor Aquatic unit sampling location FTSSW001 (29.8 μg/L).

6.1.3.19 Zinc in Surface Water

Zinc was detected in samples collected from all Tidal Area units. Zinc concentrations are presented below by unit in comparison to the surface water CCC (58.0 μg/L). Figure 6-37 shows the concentrations of zinc detected in surface water samples in comparison to the surface water CCC.

- **Landfill Terrestrial Unit:** Zinc was detected in four of 12 samples collected from the Landfill Terrestrial unit at concentrations ranging from 11.8 to 48.0 μg/L; all results were below the surface water CCC (see Table 6-2).

- **R Area Terrestrial and Aquatic Unit:** Zinc was detected in all 15 surface water samples collected from the R Area Terrestrial and Aquatic unit at concentrations ranging from 29.4 to 265.0 μg/L. Results for seven samples exceeded the surface water CCC at locations RADSW010 (265.0 μg/L collected during July), RADSW008 (234.0 μg/L collected during January), RADSW011 (169.0 and 101.0 μg/L collected during January and July), RADSW007 (63.1 μg/L collected during July), RADSW013 (111.0 μg/L collected during January), and RADSW009 (81.0 μg/L collected during January) (see Table 6-5).

- **Froid and Taylor Aquatic Unit:** Zinc was detected in two of nine surface water samples collected from the Froid and Taylor Aquatic unit at locations FTSSW002 (95.2 μg/L) and FTSSL102 (21.9 μg/L). Only the result for sampling location FTSSW002 (95.2 μg/L) exceeded the surface water CCC (see Table 6-8).

- **Wood Hogger Terrestrial Unit:** Zinc was detected in six of eight surface water samples collected from the Wood Hogger Terrestrial unit at concentrations ranging from 24.3 to 329.0 μg/L. Results for five samples contained zinc at concentrations that exceeded the surface water CCC at locations WHSSW005 (329.0, 318.0, 160.0, and 110.0 μg/L collected during July, April/May, October, and January) and WHSSW006 (69.8 μg/L collected during July) (see Table 6-10).

- **North Otter Sluice Aquatic Unit:** Zinc was detected in eight of 27 surface water samples collected from the North Otter Sluice Aquatic unit at concentrations ranging from 9.0 to 346 μg/L. Results for samples exceeded the surface water CCC at locations RADSW005 (346.0 and 67.9 μg/L collected during October and July) and RADSW004 (58.5 μg/L collected during April/May) (see Table 6-12).

- **South Otter Sluice Aquatic Unit:** Zinc was detected in nine of 22 surface water samples collected from the South Otter Sluice Aquatic unit at concentrations ranging from 7.1 to 430.0 μg/L. Results for two samples exceeded the surface water CCC at locations WHSSW004 (67.7 μg/L) and OSLSL009 (430.0 μg/L) (see Table 6-14).

In summary, zinc concentrations exceeded the surface water CCC (58.0 μg/L) in samples collected from the R Area Terrestrial and Aquatic, Froid and Taylor Aquatic, Wood Hogger Terrestrial, North Otter Sluice Aquatic, and South Otter Sluice Aquatic units. The highest zinc concentrations were detected in surface water samples from North Otter Sluice location RADSW005 (346.0 μg/L), Wood Hogger location WHSSW005 (329.0 μg/L in July 1995 and 318.0 μg/L in May 1996), and R Area sampling location RADSW010 (265 μg/L).

6.1.3.20 Summary of Inorganic Constituents in Surface Water

The following table summarizes the inorganic constituents detected in surface water that were above screening values; an "X" indicates that the maximum detected concentration of the inorganic constituent exceeded screening values and a "*" indicates inorganic constituents were also present in sediment at the unit at concentrations exceeding the sediment screening values. Tables 6-2, 6-5, 6-8, 6-10, 6-12, and 6-14 provide more detailed information regarding the chemicals detected in surface water as compared to the screening values.

SUMMARY OF INORGANIC CONSTITUENTS EXCEEDING SCREENING VALUES IN SURFACE WATER

Inorganic	Screening Value (μg/L)	Landfill Perimeter	R Area	Froid and Taylor Roads	Wood Hogger	North Otter Sluice	South Otter Sluice
Aluminum	87.0	X*	X*	X*	X*	X*	X*
Arsenic	36.0			X			
Cadmium	1.1	X*	X		X*		
Chromium	86.0					X*	
Copper	3.2	X*	X*	X*	X*	X*	X*
Lead	3.1		X*	X*	X*	X*	
Mercury	0.025		X*	X*	X*	X*	X*
Nickel	8.2	X*	X*	X		X*	
Silver	0.22			X			
Zinc	58.0		X*	X*	X*	X*	X*

With the exception of beryllium and silver, all inorganic constituents were detected in some surface water samples collected from the Tidal Area sites. Aluminum, arsenic, cadmium, chromium, copper, lead, mercury, nickel, and zinc were detected at concentrations exceeding screening values. No screening values are available for evaluation of antimony, barium, cobalt, manganese, molybdenum, thallium, or vanadium.

6.1.4 Summary of Inorganic COPECs for the Tidal Area Sites

Inorganic chemicals detected in soil, sediment, extractions, and surface water samples were screened using methods described in Section 5.0. Chemicals that exceeded screening values and are considered COPECs are listed below:

- Aluminum (based on soil or sediment, extractions, and surface water data)
- Antimony (based on soil or sediment data)
- Arsenic (based on soil or sediment, extractions, and surface water data)
- Barium (based on soil or sediment data)
- Beryllium (based on soil or sediment data)
- Cadmium (based on soil or sediment, extractions, and surface water data)
- Chromium (based on soil or sediment, extractions, and surface water data)
- Cobalt (based on soil or sediment)
- Copper (based on soil or sediment, extractions, and surface water data)
- Lead (based on soil or sediment, extractions, and surface water data)
- Mercury (based on soil or sediment, extractions, and surface water data)
- Manganese (based on soil data)
- Molybdenum (based on soil or sediment data)
- Nickel (based on soil or sediment, extractions, and surface water data)
- Selenium (based on soil or sediment data)
- Silver (based on soil or sediment data, surface water, and extractions)
- Thallium (based on soil or sediment data)
- Vanadium (based on soil or sediment data)
- Zinc (based on soil or sediment, extractions, and surface water data)

6.2 ORGANIC CONSTITUENTS IN SOIL, SEDIMENT, AND SURFACE WATER SAMPLES

Soil, sediment, and surface water samples collected from most locations were analyzed for SVOCs, pesticides, and PCBs; several samples were also analyzed for VOCs, TPH-e, TPH-p, and explosives. Eight soil samples collected from the Wood Hogger Terrestrial unit and two soil samples from the South Otter Sluice Aquatic unit were analyzed for dioxins, and soil samples collected from the Wood Hogger were analyzed for furans. Table 4-1 lists the number of samples collected from each site and

the analyses for each sample. Comprehensive tables presenting the concentrations of organic compounds detected in soil and sediment samples are included in Appendices A through E. Ecological statistical summary tables are presented in Appendix N and include summaries of detection limits and a comparison of site concentrations with ER-L, ER-M, and ambient values.

Section 6.2.1 discusses the organic constituents detected in soil and sediment and Section 6.2.2 discusses the organic constituents detected in surface water. Section 6.2.3 summarizes the organic constituents that were identified as COPECs in soil, sediment, and surface water based on the screening process discussed in Section 5.0.

6.2.1 Organic Constituents in Soil and Sediment Samples

This section summarizes the organic constituents detected in soil and sediment samples collected from each of the Tidal Area units. Soil and sediment sampling locations are shown on Exhibit 1. Tables 6-1, 6-3, 6-4, 6-6, 6-7, 6-9, 6-11, and 6-13 present the maximum detected concentrations in soil and sediment samples for each Tidal Area unit in reference to screening values.

Organic constituents are usually anthropogenic; background values, by definition, are near zero. Some PAHs may occur naturally due to oil deposits, fires, or volcanoes; however, naturally occurring PAHs are not expected to be present at the Tidal Area sites in measurable concentrations. RWQCB (1998) provides ambient concentrations of selected organic compounds in fine-grained sediments, and sediment guidance values (Long and others 1995; NOAA 1991) have been developed for a limited subset of organic contaminants in aquatic habitats. For some groups of constituents, such as PCBs, screening values are available for the group but not for individual constituents. Total DDTs, total hexachlorocyclohexanes (BHC), total chlordanes, total PCBs, and total PAHs are therefore calculated by summing the detected concentrations of analytes in each group.

The discussion in this subsection includes comparisons of the organic analytical results to ambient and regulatory criteria and guidance, including San Francisco Bay ambient values (RWQCB 1998) and ER-Ls and ER-Ms (Long and others 1995; NOAA 1991); these values are presented in Table 5-1. As discussed in Section 5.0, only the ER-L values were used to screen organic constituents for COPECs; the ambient and ER-M values are referenced in the following discussions to allow for additional evaluations of the nature and extent of contamination at the Tidal Area sites.

For many organic compounds, CLP method detection limits are often higher than available screening values. To achieve detection limits below screening values, a subset of surface soil and sediment samples was analyzed using low detection limit methods for SVOCs, pesticides, and PCBs. However, due to high percent moisture in many soil and sediment samples, the desired detection limits were not always achieved. The QCSR in Appendix K contains more information on the detection limits achieved for analyses of Tidal Area samples. Appendix P lists the range of detection limits achieved for the analytes.

Dioxins and furans, pesticides, PCBs, SVOCs, TPH, and VOCs were detected in soil or sediment samples collected from the Tidal Area sites. Results of these analyses are presented in the following subsections.

6.2.1.1 Dioxins and Furans (PCDDs and PCDFs) in Soil and Sediment

Soil samples from the Wood Hogger Terrestrial unit collected near the location of the former incinerator and sediments collected from the South Otter Sluice Aquatic unit were analyzed for polychlorinated dibenzodioxins (PCDD) and polychlorinated dibenzofurans (PCDF).

Two samples from the Wood Hogger were collected and analyzed in 1995. The results are presented below. Of the isomers (or congeners) of chlorinated dibenzodioxins and dibenzofurans included in the analysis, only 1,2,3,4,6,7,8-heptachlorodibenzodioxin (HPCDD), 1,2,3,4,6,7,8-heptachlorodibenzofuran (HPCDF), total HPCDD, total HPCDF, and octachlorodibenzodioxin (OCDD) were detected in the samples. Analytical results were as follows:

Analyte	Sampling Location Concentration (μg/kg)	
	WHSSB019 (0 - 0.5 feet bgs)	WHSSB020 (0 - 0.5 feet bgs)
1,2,3,4,6,7,8-HPCDD	0.0005	ND
1,2,3,4,6,7,8-HPCDF	0.0001	ND
Total HPCDD	0.0008	ND
Total HPCDF	0.0003	ND
OCDD	0.004	0.0004

Notes:

bgs Below ground surface
μg/kg Micrograms per kilogram

Based on the detection of dioxins in these two samples, a more extensive analysis was completed in 1998. The results of this study are presented below. Only four of 12 individual PCDDs and PCDFs were detected in any of the samples. These were 1,2,3,4,6,7,8,9-OCDD and the corresponding furan, and 1,2,3,4,6,7,8-HPCDD and the corresponding furan. The most toxic PCDDs and PCDFs (2,3,7,8-tetrachlorodibenzo-dioxin) was not detected. A conventional way to express the concentration of PCDDs and PCDFs is based on their toxic equivalents (TEQ), which are related to their relative potency in laboratory test animals. The TEQ concentration is the sum of the measured concentrations multiplied by the toxic equivalency factor (TEF). Each type of PCDDs and PCDFs has been assigned a TEF. TEFs from the World Health Organization (WHO) (1996) for mammalian ecological receptors are presented in the table below. TEFs for avian receptors are similar and were used to assess risk to birds at the site (see Section 15.0). The TEQs below include nondetected PCDDs and PCDFs, where a value of one-half the sample quantitation limit (SQL) was substituted as its concentration.

Sample Location	Matrix Type	Total Detected PCDDs and PCDFs (μg/kg)	Total TEQs (μg/kg)
WHSSB007	Soil	0	0.723
WHSSB008	Soil	2	0.730
WHSSB009	Soil	115	1.366
WHSSB010	Soil	0	0.379
WHSSB016	Soil	172	1.53
WHSSB017	Soil	7	0.596
WHSSB018	Soil	4	0.733
WHSSB019	Soil	10	0.621
WHSSB020	Soil	0.4	0.08
WHSSB023	Soil	11.7	0.972
OSLSL005	Sediment	0	0.652
OSLSL007	Sediment	0	0.791
OSLSL008	Sediment	0	2.23

Exhibit 17 shows sampling locations and concentrations of detected PCDDs and PCDFs.

The concentration of dioxins based on TEQs was similar for Otter Sluice sediments and Wood Hogger soils. Because analytical results for most PCDDs and PCDFs were below detection limits, the sum of the nondetects (one-half the SQLs) contributes significantly to the total TEQs. Also, the PCDDs and

PCDFs that were detected are of low toxicity (low TEFs). Other nondetected PCDDs and PCDFs with higher TEFs contribute significantly to the total TEQs. Since every sample has slightly different quantitation limits for each PCDD and PCDF, the variability in TEQs is based on these differences.

Screening values were not available for the detected constituents; PCDDs and PCDFs were considered COECs in the Wood Hogger Terrestrial and South Otter Sluice Aquatic units..

6.2.1.2 Pesticides in Soil or Sediment

A total of 234 pesticides were analyzed for samples collected from the Tidal Area sites. A subset of soil and sediment samples collected between 0 to 3.0 feet bgs were analyzed using the CLP method. Tables 6-1, 6-3, 6-4, 6-6, 6-7, 6-9, 6-11, and 6-13 summarize the detected concentrations of pesticides in soil and sediment samples for each unit of the Tidal Area.

Pesticides were detected in 132 samples. Dichlorodiphenyltrichloroethane (DDT) and its congeners were the most frequently detected pesticides at the Tidal Area sites. analytical results are summarized in the following paragraphs.

DDD in Soil and Sediment

Both 2,4'-dichlorodiphenyldichloroethane (-DDD) and 4,4'-DDD were detected in surface soil samples collected throughout the Tidal Area sites. No screening values are available for 2,4'-DDD. The 4,4'-DDD concentrations are discussed below in comparison to the ER-L (2.0 micrograms per kilogram [μg/kg]) and ER-M (20.0 μg/kg).

- **Landfill Terrestrial Unit:** 2,4'-DDD was detected in five of seven surface soil or sediment samples collected from the Landfill Terrestrial unit at concentrations ranging from 0.7 to 12.0 μg/kg. In addition, 4,4'-DDD was detected in five of seven samples at concentrations ranging from 1.5 to 27.0 μg/kg. The result for sample location TLSSB001 (27.0 μg/kg) exceeded the ER-M. The result for sample locations TLSSB005 (9.3 μg/kg), TLSSB002 (6.1 μg/kg), and TLSSB006 (2.6 μg/kg) exceeded the ER-L (see Table 6-1).

- **R Area Terrestrial Unit:** 2,4'-DDD was detected in 24 of 54 surface soil or sediment samples collected from the R Area Terrestrial unit at concentrations ranging from 0.3 to 6.5 μg/kg. In addition, 4,4'-DDD was detected in 32 of 54 surface soil or sediment samples at concentrations ranging from 0.3 to 26.0 μg/kg. Only the result for sampling location RADSB011 (26.0 μg/kg) exceeded the ER-M. The results for sample locations RASDB010 (20.0 μg/kg), RADSBG04 (11.0 μg/kg), RADSBI04 (8.2 μg/kg), RADSBF03 (6.6 μg/kg), RADSB012 (6.4 μg/kg), RADSBH06 (6.1 μg/kg), RADSBF02 (6.0 μg/kg),

RADSBD05 (5.6 μg/kg), RADSBK07 (3.6 μg/kg), and RADSBC05 (2.5 μg/kg) exceeded the ER-L (2.0 μg/kg) (see Table 6-3).

- **R Area Terrestrial and Aquatic Unit:** 2,4'-DDD was detected in the surface soil or sediment sample collected from the R Area Terrestrial and Aquatic unit at a concentration of 0.72 μg/kg (RADSB013). However, 4,4'-DDD was not detected in samples from the R Area Terrestrial and Aquatic unit (see Table 6-4).

- **Froid and Taylor Terrestrial Unit:** 2,4'-DDD was detected in the surface soil or sediment sample collected from the Froid and Taylor Terrestrial unit using low detection limit (low level) methods at a concentration of 0.3 μg/kg (location FTSSB001). In addition, 4,4'-DDD was detected at a concentration of 4.0 μg/kg, which exceeds the ER-L. Neither 2,4'-DDD or 4,4'-DDD was detected using CLP methods (see Table 6-6).

- **Froid and Taylor Aquatic Unit:** 2,4'-DDD was detected in five of 11 low level surface soil or sediment samples collected from the Froid and Taylor Aquatic unit at concentrations ranging from 0.8 to 7.0 μg/kg. In addition, 4,4'-DDD was detected in eight of 11 low level samples at concentrations ranging from 0.3 to 14.0 μg/kg. Results for sampling locations FTSSL102 (14.0 μg/kg), FTSSL104 (11.0 μg/kg), FTSSB008 (10.0 μg/kg), FTSSB003 (9.0 μg/kg), FTSSL103 (7.0 μg/kg), and FTSSB005 (3.0 μg/kg) exceeded the ER-L (2.0 μg/kg). No sample results exceeded the ER-M (see Table 6-7).

- **Wood Hogger Terrestrial Unit:** 2,4'-DDD was detected in 21 of 37 soil or sediment samples (low level) collected from the Wood Hogger Terrestrial unit at concentrations ranging from 0.3 to 8.0 μg/kg. In samples using low level methods, 4,4'-DDD was detected in 27 of 37 samples at concentrations ranging up to 280.0 μg/kg (location WHSSB009). In samples using CLP methods, 4,4'-DDD was detected in two surface and one subsurface soil or sediment samples at concentrations ranging from 2.4 to 8.8 μg/kg. Results for low level method samples from locations WHSSB009 (280.0 μg/kg), WHSSB013 (50.0 μg/kg), and WHSSB014 (30.0 μg/kg) exceeded the ER-M. Results for 10 additional low level method samples exceeded the ER-L, including locations WHSSBG02 (18.0 μg/kg), WHSSBE06 (16.0 μg/kg), WHSSBD07 (15.0 μg/kg), WHSSB015 (9.0 μg/kg), WHSSB016 (7.0 μg/kg), WHSSBD03 (5.6 μg/kg), WHSSBG06 (4.5 μg/kg), WHSSBE08 (4.0 μg/kg), WHSSBI02 (2.8 μg/kg), and WHSSBB07 (2.6 μg/kg). Results for CLP method samples from locations WHSSBF03 (8.8 μg/kg), WHSSDB07 (7.7 μg/kg), S37-12 (3.7 μg/kg), and S37-11 (2.4 μg/kg) also exceeded the ER-L. No CLP sample results exceeded the ER-M (see Table 6-9).

- **North Otter Sluice Unit:** 2,4'-DDT was detected in seven of 15 soil or sediment samples (low level) collected from the North Otter Sluice Aquatic unit at concentrations ranging from 0.3 to 1.0 μg/kg. In addition, 4,4'-DDD was detected in 11 of 15 samples (low level) at concentrations ranging from 0.4 to 2.3 μg/kg. The result for sample location RADSB002 (2.3 μg/kg) was the only concentration that exceeded the ER-L.

- **South Otter Sluice Aquatic Unit:** 2,4'-DDD was detected in two of 19 surface soil or sediment samples (low level) collected from the South Otter Sluice Aquatic unit at concentrations ranging from 0.43 to 0.67 μg/kg. In addition, 4,4'-DDD was detected in 13 of 19 samples (low level) at concentrations ranging from 0.2 to 2.0 μg/kg. No 4,4'-DDD concentrations exceeded the ER-L (2.0 μg/kg) (see Table 6-13).

In summary, the highest DDD concentrations were found in samples collected from the southwest portion of the Wood Hogger Site (near the wood hogger equipment), the north portion of the Tidal Area Landfill, and the north-central portion of the R Area Disposal Site, as follows:

Surface Soil Sampling Location/Unit	Highest Concentrations (μg/kg)	
	2,4'-DDD	4,4'-DDD
WHSSB009/Wood Hogger Terrestrial Unit	ND	280
WHSSB013/Wood Hogger Terrestrial Unit	4	50
WHSSB014/Wood Hogger Terrestrial Unit	8	30
TLSSB001/Landfill Terrestrial Unit	12	27
RADSB010/R Area Terrestrial Unit	6.5	20
RADSB011/R Area Terrestrial Unit	6.5	26

DDE in Soil and Sediment

No ambient or effects range values are available for 2,4'-dichlorodiphenyldichloroethene (-DDE). The 4,4'-DDE concentrations are presented below in comparison to the ER-L (2.2 μg/kg) and ER-M (27.0 μg/kg); no ambient values are available for 4,4'-DDE.

- **Landfill Terrestrial Unit:** 2,4'-DDE was detected in two of seven surface samples (low level) collected from the Landfill Terrestrial unit at concentrations ranging from 0.59 to 0.93 μg/kg. In addition, 4,4'-DDE was detected in five of seven samples (low level) at concentrations ranging from 1.8 to 5.7 μg/kg. Results for sample locations TLSSB002 (5.7 μg/kg), TLSSB001 (5.6 μg/kg), and TLSSB006 (3.1 μg/kg) exceeded the ER-L (2.2 μg/kg); no sample results exceeded the ER-M (see Table 6-1).

- **R Area Terrestrial Unit:** 2,4'-DDE was detected in 14 of 54 surface samples (low level) collected from the R Area Terrestrial unit at concentrations ranging from 0.3 to 1.2 μg/kg. In addition, 4,4'-DDE was detected in 45 of 54 surface samples (low level) at concentrations ranging from 0.2 to 8.7 μg/kg (location RADSB010). Results for eight samples exceeded the ER-L, including sampling locations RADSB010 (8.7 μg/kg), RADSB011 (6.5 μg/kg), RADSBC05 (4.7 μg/kg), RADSBL03 (4.7 μg/kg), RADSBH06 (4.0 μg/kg), RADSBD05 (2.8 μg/kg), RADSB012 (2.6 μg/kg), and RADSBF03 (2.5 μg/kg). No sample results exceeded the ER-M (see Table 6-3).

- **R Area Terrestrial and Aquatic Unit:** 2,4'-DDE was not detected in surface samples (low level) collected from the R Area Terrestrial and Aquatic unit. However, 4,4'-DDE was detected in sampling location RADSB013 (0.72 μg/kg) at a concentration below the ER-L (see Table 6-4).

- **Froid and Taylor Terrestrial Unit:** 2,4'-DDE was detected in sampling location FTSSB001 (0.5 μg/kg) using low level methods. In addition, 4,4'-DDE was also detected in sampling location FTSSB001 using both low level and CLP methods (15.0 μg/kg, low level; 9.6 μg/kg, CLP). Both low level and CLP method concentrations exceeded the ER-L (2.2 μg/kg). No sample results exceeded the ER-M (27.0 μg/kg) (see Table 6-6).

- **Froid and Taylor Aquatic Unit:** 2,4'-DDE was detected in three of 11 surface samples (low level) collected from the Froid and Taylor Aquatic unit at concentrations ranging from 0.4 to 0.6 μg/kg. In addition, 4,4'-DDE was detected in eight of 11 samples (low level) at concentrations ranging from 0.3 to 7.0 μg/kg. Results for sample locations FTSSL102 (7.0 μg/kg), FTSSL104 (6.0 μg/kg), FTSSB008 (3.0 μg/kg), and FTSSL103 (3.0 μg/kg) exceeded the ER-L. No sample results exceeded the ER-M (see Table 6-7).

- **Wood Hogger Terrestrial Unit:** 2,4'-DDE was detected in six of 37 low level method samples and none of 22 CLP method samples collected from the Wood Hogger Terrestrial unit at concentrations ranging from 0.4 to 3.0 μg/kg. In addition, 4,4'-DDE was detected in 31 of 37 low level method samples and one of 22 CLP method samples at concentrations ranging from 0.2 to 32.0 μg/kg. Results for low level method sampling locations WHSSB016 (32.0 μg/kg) and WHSSB009 (30.0 μg/kg) exceeded the ER-M. Results for eight additional low level method samples exceeded the ER-L, including locations WHSSBE06 (17.0 μg/kg), WHSSB014 (12.0 μg/kg), WHSSBD07 (9.0 μg/kg), WHSSB013 (6.0 μg/kg), WHSSB015 (6.0 μg/kg), WHSSBG02 (3.8 μg/kg), WHSSB007 (3.0 μg/kg), and WHSSBD03 (2.8 μg/kg) (see Table 6-9).

- **North Otter Sluice Aquatic Unit:** 2,4'-DDE was not detected in any of 15 samples (low level) collected from the North Otter Sluice Aquatic unit. However, 4,4'-DDE was detected in 14 of 15 samples (low level) at concentrations ranging from 1.0 to 2.8 μg/kg. Sample locations RADSB002 (2.8 μg/kg), RADSBA07 (2.6 μg/kg), and RADSB006 (2.3 μg/kg) exceeded the ER-L. No sample results exceeded the ER-M (see Table 6-11).

- **South Otter Sluice Aquatic Unit:** 2,4'-DDE was not detected in any of 19 samples (low level) collected from the South Otter Sluice Aquatic unit. However, 4,4'-DDE was detected in 14 of 19 samples at concentrations ranging from 0.3 to 2.3 μg/kg. Only the result for sampling location WHSSB001 (2.3 μg/kg) exceeded the ER-L (see Table 6-13).

In summary, 4,4'-DDE concentrations were highest in samples collected from the Wood Hogger, where some concentrations exceeded the ER-M (27.0 μg/kg). In addition, 4,4'-DDE concentrations exceeded the ER-L in samples collected from the Landfill Terrestrial, R Area Terrestrial, Froid and Taylor Terrestrial, Froid and Taylor Aquatic, North Otter Sluice Aquatic, and South Otter Sluice Aquatic units. The highest concentrations of both 2,4'-DDE and 4,4'-DDE were detected in samples

collected from the southwestern portion of the Wood Hogger Site (near the wood hogger equipment), in the north-central portion of the R Area Disposal Site, and in Froid and Taylor Roads Site as follows:

Surface Soil Sampling Location/Unit	Highest Concentrations (μg/kg)	
	2,4'-DDE	4,4'-DDE
WHSSB009/Wood Hogger Terrestrial Unit	ND	30
WHSSB014/Wood Hogger Terrestrial Unit	3	12
WHSSB016/Wood Hogger Terrestrial Unit	ND	32
RADSB010/R Area Terrestrial Unit	1.2	8.7
WHSSBE06/Wood Hogger Terrestrial Unit	ND	17.0
FTSSB001/Froid and Taylor Terrestrial Unit	0.5	15.0
WHSSBD07/Wood Hogger Terrestrial Unit	ND	9.0
RADSB011/R Area Terrestrial Unit	1.2	6.5

DDT in Soil and Sediment

Both 2,4'-DDT and 4,4'-DDT were detected in surface soil samples collected throughout the four Tidal Area sites except the R Area Terrestrial and Aquatic unit. No screening values are available for 2,4'-DDT. Concentrations of 4,4'-DDT are discussed below in comparison to effects range values (1.0 and 7.0 μg/kg for the ER-L and ER-M); no ambient values are available for 4,4'-DDT.

- **Landfill Terrestrial Unit:** 2,4'-DDT was detected in one of seven samples (low level) collected from the Landfill Terrestrial unit at a concentration of 0.98 μg/kg (sampling location TLSSB001). In addition, 4,4'-DDT was detected in four of seven samples (low level) at concentrations ranging from 0.7 to 2.2 μg/kg. Only the result for sampling location TLSSB001 (2.2 μg/kg) exceeded the ER-L (see Table 6-1).

- **R Area Terrestrial Unit:** 2,4'-DDT was detected in 31 of 54 samples (low level) at concentrations ranging up to 5.0 μg/kg (location RADSB011). In addition, 4,4'-DDT was detected in 38 of 54 samples (low level) at concentrations ranging from 0.2 to 28.0 μg/kg. Results for six samples exceeded the ER-M, including locations RADSB011 (28.0 μg/kg), RADSBK07 (14.0 μg/kg), RADSB010 (12.0 μg/kg), RADSBJ02 (11.0 μg/kg), RADSBL03 (7.5 μg/kg), and RADSBC05 (7.4 μg/kg). Results for 16 additional samples exceeded the ER-L (see Table 6-3).

- **Froid and Taylor Terrestrial Unit:** 2,4'-DDT was detected in sampling location FTSSB001 (2.0 μg/kg, low level). In addition, 4,4'-DDT was detected in sampling location FTSSB001 (19.0 μg/kg, low level; 8.9 μg/kg, CLP) at concentrations above the ER-M (see Table 6-6).

- **Froid and Taylor Aquatic Unit:** 2,4'-DDT was detected in three of 11 low level method samples collected from the Froid and Taylor Aquatic unit at concentrations ranging from 1.0 to 3.0 μg/kg. In addition, 4,4'-DDT was detected in four of 11 low level samples at concentrations ranging from 0.6 to 15.0 μg/kg. Results for sample locations FTSSL102 (15.0 μg/kg) and FTSSB003 (8.0 μg/kg) exceeded the ER-M; the result for sampling location FTSSB002 (4.0 μg/kg) exceeded the ER-L (see Table 6-7).

- **Wood Hogger Terrestrial Unit:** 2,4'-DDT was detected in 16 of 37 samples (low level) collected from the Wood Hogger Terrestrial unit at concentrations ranging from 0.1 to 34.0 μg/kg. In addition,4,4'-DDT was detected in 29 of 37 low level method samples and one of 22 surface and two of 20 subsurface CLP method samples at concentrations ranging from 0.3 to 230.0 μg/kg. Results for nine samples exceeded the ER-M, including low level method surface sampling locations WHSSB016 (230.0 μg/kg), WHSSBE06 (110.0 μg/kg), WHSSB014 (69.0 μg/kg), WHSSBD07 (51.0 μg/kg), WHSSB017 (30.0 μg/kg), WHSSB009 (14.0 μg/kg), WHSSB015 (14.0 μg/kg), and WHSSB007 (8.9 μg/kg) and CLP method subsurface sampling location WHSSBF03 (11.0 μg/kg collected at a depth of 4.5 feet bgs). Results for nine additional samples exceeded the ER-L (see Table 6-9).

- **North Otter Sluice Aquatic Unit:** 2,4'-DDT was detected in two of 15 surface soil or sediment samples (low level) collected from the North Otter Sluice Aquatic unit at concentrations ranging from 0.32 to 0.36 μg/kg. In addition, 4,4'-DDT was detected in five of 15 surface samples (low level) at concentrations ranging from 0.36 to 0.95 μg/kg, all below the ER-L (see Table 6-11).

- **South Otter Sluice Aquatic Unit:** Both 2,4'-DDT and 4,4'-DDT were detected in one of 19 surface soil or sediment samples (low level) from sampling location WHSSBD01 (0.18 and 0.58 μg/kg, respectively) at levels below the screening value (see Table 6-13).

In summary, concentrations of 4,4'-DDT exceeded the ER-M (7.0 μg/kg) in samples collected from the R Area Terrestrial, Froid and Taylor Terrestrial, Froid and Taylor Aquatic, and Wood Hogger Terrestrial units, and exceeded the ER-L in one sample from the Landfill Terrestrial unit. The highest concentrations of DDT were found in the southwestern portion of the Wood Hogger Site (near the wood hogger equipment) and in the north-central portion of the R Area Disposal Site, as follows:

Surface Soil Sampling Location/Unit	Highest Concentrations (μg/kg)	
	2,4'-DDT	4,4'-DDT
WHSSB014/Wood Hogger Terrestrial Unit	11	69
WHSSB016/Wood Hogger Terrestrial Unit	34	230
WHSSB017/Wood Hogger Terrestrial Unit	5	30
WHSSBD07/Wood Hogger Terrestrial Unit	11	51
WHSSBE06/Wood Hogger Terrestrial Unit	ND	110
RADSB011/R Area Terrestrial Unit	5	28

Total DDTs in Soil and Sediment

ER-L, ER-M, and San Francisco Bay ambient values are available for total DDT, which is the sum of DDT, DDD, and DDE. In totaling DDTs, one-half the SQL was used for nondetected results. This approach is conservative, especially for results obtained using CLP methods that have higher detection limits. Figures 6-38A through 6-38C compare total DDTs results to ER-L, ER-M, and ambient values for each site. Exhibit 14 compares the concentration of total DDTs to screening values based on detected results only at each sampling location to highlight areas with significant detected concentrations.

- **Landfill Terrestrial Unit:** Total DDTs were detected in all seven low level surface soil or sediment samples and all eight surface and subsurface CLP soil or sediment samples collected from the Landfill Terrestrial unit at concentrations ranging from 0.6 to 48.1 μg/kg (see Figure 6-38A). Only the result for sampling location TLSSB001 (48.1 μg/kg, low level) exceeded the ER-M (46.1 μg/kg); results for low level sampling locations TLSSB005 (17.43 μg/kg), TLSSB002 (17.13 μg/kg), and TLSSB006 (8.31 μg/kg) exceeded the San Francisco Bay ambient value and ER-L. All CLP surface and subsurface soil or sediment sample results exceeded both ambient values and ER-Ls; however, no CLP sample results exceeded the ER-M (see Table 6-1).

- **R Area Terrestrial Unit:** Total DDTs were detected in all 54 low level surface samples and all 15 surface and five subsurface CLP samples collected from the R Area Terrestrial unit at concentrations ranging from 0.3 to 73.2 μg/kg (see Figure 6-38B). Results for low level sampling locations RADSB011 (73.2 μg/kg) and RADSB010 (50.9 μg/kg) exceeded the ER-M; results for 13 additional low level samples exceeded the San Francisco Bay ambient value. No CLP surface or subsurface sample results exceeded the ER-M. However, results for 10 surface CLP samples and four subsurface samples exceeded ambient values (see Table 6-3).

- **R Area Terrestrial and Aquatic Unit:** Total DDTs were detected in sampling location RADSB013 (1.72 μg/kg, low level) at a concentration below the San Francisco Bay ambient value (see Table 6-4 and Figure 6-38A).

- **Froid and Taylor Terrestrial Unit:** Total DDTs were detected in sampling location FTSSB001 (40.8 μg/kg, low level; 55.0 μg/kg, CLP) at a concentration exceeding the ER-M (46.1 μg/kg) using CLP methods and at a concentration exceeding the San Francisco Bay ambient value using low level methods (see Table 6-6 and Figure 6-38A).

- **Froid and Taylor Aquatic Unit:** Total DDTs were detected in all 11 low level and all eight CLP surface samples at concentrations ranging from 0.3 to 43.2 μg/kg (see Figure 6-38A). No total DDT concentrations exceeded the ER-M. Results for six low level samples and six CLP samples exceeded the San Francisco Bay ambient value (see Table 6-7).

- **Wood Hogger Terrestrial Unit:** Total DDTs were detected in all 37 low level surface samples and 22 CLP surface and 20 subsurface samples at concentrations ranging from 0.3 to 334.5 μg/kg (see Figure 6-38C). In general, concentrations were higher in low level samples. Results for six low level surface samples exceeded the ER-M (46.1 μg/kg), including locations WHSSB009 (334.5 μg/kg), WHSSB016 (310.0 μg/kg), WHSSBE06 (151.1 μg/kg), WHSSB014 (133.0 μg/kg), WHSSBD07 (87.0 μg/kg), and WHSSB013 (65.0 μg/kg); results for eight low level samples exceeded the San Francisco Bay ambient value. Only the result for CLP surface sampling location S37-10 (60.0 μg/kg) exceeded the ER-M. In addition, results for seven additional surface and nine subsurface CLP samples exceeded the San Francisco Bay ambient value (see Table 6-9).

- **North Otter Sluice Aquatic Unit:** Total DDTs were detected in all 15 surface sediment samples (low level) collected from the North Otter Sluice Aquatic unit at concentrations ranging from 1.17 to 7.11 μg/kg (see Figure 6-38A). Only the result for sampling location RADSB002 (7.11 μg/kg) exceeded the San Francisco Bay ambient value (see Table 6-11).

- **South Otter Sluice Aquatic Unit:** Total DDTs were detected in all 19 surface sediment samples (low level) collected from the South Otter Sluice Aquatic unit at concentrations below the San Francisco Bay ambient value (see Table 6-13 and Figure 6-38C).

In summary, most total DDTs concentrations exceeded the ER-L (1.58 μg/kg). Total DDT concentrations exceeded the ER-M (46.1 μg/kg) in Landfill Terrestrial, R Area Terrestrial, Froid and Taylor Terrestrial, and Wood Hogger Terrestrial unit samples. Total DDT concentrations exceeded the San Francisco Bay ambient value (7.0 μg/kg) in samples from the Froid and Taylor Aquatic and South Otter Sluice Aquatic units. In general, total DDT concentrations were higher in low level samples than in CLP samples. The highest concentrations of total DDTs were found in samples collected from the southwestern portion of the Wood Hogger Site (near the wood hogger equipment), the north-central portion of the R Area Disposal Site, and Froid and Taylor Roads Site.

Dieldrin in Soil and Sediment

Figures 6-39A through 6-39C compare the range of concentrations of dieldrin detected in soil or sediment samples to ER-Ls and ER-Ms. Dieldrin was not detected in samples collected from the Froid and Taylor Terrestrial unit or South Otter Sluice Aquatic unit. Dieldrin concentrations are discussed below in comparison to the San Francisco Bay ambient value (0.44 μg/kg) and ER-L (0.02 μg/kg). No sample results exceeded the ER-M (8.0 μg/kg).

- **Landfill Terrestrial Unit:** Dieldrin was detected in three of seven surface soil or sediment samples (low level) collected from the Landfill Terrestrial unit at concentrations ranging from 0.53 to 2.2 μg/kg (see Figure 6-39A). All three dieldrin concentrations exceeded the ER-L and San Francisco Bay ambient value, including results for sampling locations TLSSB001 (2.2 μg/kg), TLSSB002 (1.6 μg/kg), and TLSSB005 (0.53 μg/kg) (see Table 6-1).

- **R Area Terrestrial Unit:** Dieldrin was detected in 16 of 54 soil or sediment samples (low level) collected from the R Area Terrestrial unit at concentrations ranging from 0.18 to 2.0 μg/kg (see Figure 6-39B). Results for 10 samples exceeded the San Francisco Bay ambient value and the ER-L at sampling locations RADSB011 (2.0 μg/kg), RADSBD05 (1.4 μg/kg), RADSBH06 (1.1 μg/kg), RADSBD06 (0.89 μg/kg), RADSB010 (0.89 μg/kg), RADSB009 (0.72 μg/kg), RADSBC05 (0.64 μg/kg), RADSB012 (0.59 μg/kg), RADSBI04 (0.55 μg/kg), and RADSBG04 (0.5 μg/kg). No sample results exceeded the ER-M (see Table 6-3).

- **R Area Terrestrial and Aquatic Unit:** Dieldrin was detected in sampling location RADSB013 (0.37 μg/kg) at a concentration below the San Francisco Bay ambient value but above the ER-L (see Table 6-4 and Figure 6-39A).

- **Froid and Taylor Aquatic Unit:** Dieldrin was detected in two of 11 surface soil or sediment samples collected from the Froid and Taylor Aquatic unit at concentrations ranging from 0.4 to 0.8 μg/kg. The result for sample location FTSSB003 (0.8 μg/kg) exceeded the San Francisco Bay ambient value and the result for sampling location FTSSB002 (0.4 μg/kg) exceeded the ER-L (see Table 6-7 and Figure 6-39A).

- **Wood Hogger Terrestrial Unit:** Dieldrin was detected in 14 of 37 surface soil or sediment samples (low level) collected from the Wood Hogger Terrestrial unit at concentrations ranging from 0.24 to 6.0 μg/kg (see Figure 6-39C). Results for 12 samples exceeded the ambient value (0.44 μg/kg), and results for 14 samples exceeded the ER-L. The highest concentrations were from sampling locations WHSSB015 (6.0 μg/kg) and WHSSB014 (4.0 μg/kg). No sample results exceeded the ER-M (see Table 6-9).

- **North Otter Sluice Aquatic Unit:** Dieldrin was detected in two of 15 surface soil or sediment samples (low level) collected from the North Otter Sluice Aquatic unit. Results for sampling locations RADSBA07 (0.6 μg/kg) and RADSBA05 (0.5 μg/kg) exceeded the San Francisco Bay ambient value and ER-L (see Table 6-11 and Figure 6-39A).

In summary, most detections of dieldrin fell between the ER-L (0.02 μg/kg) and the ER-M (8.0 μg/kg). Dieldrin concentrations exceeded the San Francisco Bay ambient value in samples from the following units: Landfill Terrestrial, R Area Terrestrial, R Area Terrestrial and Aquatic, Froid and Taylor Aquatic, Wood Hogger Terrestrial, and North Otter Sluice Aquatic. The highest concentrations were in samples collected from Wood Hogger Site sampling locations WHSSB014 (4.0 μg/kg) and WHSSB015 (6.0 μg/kg).

Alpha-Chlordane in Soil and Sediment

Alpha-chlordane was detected in 86 soil or sediment samples from all units of the Tidal Area at concentrations ranging from 0.17 to 78.0 μg/kg (see Figures 6-40A thorough 6-40C). No screening values are available for alpha-chlordane. The highest concentrations were detected in the Wood Hogger and Froid and Taylor Roads Sites, as presented in the following table:

Sampling Location/Unit	Sampling Depth (feet bgs)	Alpha-Chlordane Concentration (μg/kg)
WHSSB015/Wood Hogger Terrestrial Unit	0 - 0.5	78
WHSSB009/Wood Hogger Terrestrial Unit	0 - 0.5	50
FTSSB001/Froid and Taylor Terrestrial Unit	0.35 - 1.3	35
WHSSBD07/Wood Hogger Terrestrial Unit	0 - 0.5	23
WHSSBE06/Wood Hogger Terrestrial Unit	0 - 0.5	19
WHSSB014/Wood Hogger Terrestrial Unit	0 - 0.5	17
WHSSB016/Wood Hogger Terrestrial Unit	0 - 0.5	17

Gamma-Chlordane in Soil and Sediment

Gamma-chlordane was detected in all three surface soil or sediment samples (low level) from the Froid and Taylor Aquatic unit at concentrations ranging from 0.4 to 12.0 μg/kg (sampling location FTSSL102). Gamma-chlordane was also detected the one surface soil sample collected from the Froid and Taylor Terrestrial unit (25.0 μg/kg, CLP) and in one of six surface sediment samples collected from the South Otter Sluice Aquatic unit (0.7 μg/kg, low level from sampling location OSLSL006). Screening values are not available for gamma-chlordane. Gamma-chlordane was not detected in samples from any other Tidal Area units.

Total Chlordanes in Soil and Sediment

Total chlordanes were detected in all units of the Tidal Area; the total chlordane concentrations below include nondetected chlordanes, where a value of one-half the SQL was substituted as the concentration (see Figures 6-40A thorough 6-40C). Total chlordane concentrations are presented below by unit in comparison to the San Francisco Bay ambient value (1.1 μg/kg) and ER-M (6.0 μg/kg) and are shown on Figures 6-30A through 6-30C. Most sample results exceeded the ER-L (0.5 μg/kg).

- **Landfill Terrestrial Unit:** Total chlordanes were detected in all seven low level surface samples and eight CLP surface and subsurface samples at concentrations ranging from 0.1 to 9.8 μg/kg (see Figure 6-40A). Results for CLP surface sampling location TLSSB002 (7.9 μg/kg) and CLP subsurface sampling locations TLSSB002 (9.8 μg/kg, collected 4.3 feet bgs), TLSSB007 (8.3 μg/kg, collected at 4.5 feet bgs), and TLSSB001 (7.9 μg/kg, collected at 3.9 feet bgs) exceeded the ER-M. No low level sample results exceeded the ER-M. Results for five of seven low level samples and all eight surface and subsurface CLP samples exceeded the San Francisco Bay ambient value and ER-L (see Table 6-1).

- **R Area Terrestrial Unit:** Total chlordanes were detected in all 54 low level surface, 15 CLP surface, and five CLP subsurface soil or sediment samples collected from the R Area Terrestrial unit at concentrations ranging from 0.05 to 7.2 μg/kg (see Figure 6-40B). Results for CLP surface sampling location RADSBE03 (7.2 μg/kg) and CLP subsurface sampling location RADSBB04 (6.4 μg/kg, collected at 4.0 feet bgs) exceeded the ER-M. Results for seven low level surface samples exceeded the San Francisco Bay ambient value, including sampling locations RADSBD05 (2.5 μg/kg), RADSBH06 (2.3 μg/kg), RADSB011 (2.2 μg/kg), RADSBD06 (1.8 μg/kg), RADSBC05 (1.6 μg/kg), RADSB012 (1.4 μg/kg), and RADSBF02 (1.2 μg/kg). All surface and subsurface CLP sample results exceeded ambient values (see Table 6-3).

- **R Area Terrestrial and Aquatic Unit:** Total chlordanes were detected in sampling location RADSB013 (2.3 μg/kg) at a concentration above the San Francisco Bay ambient value and ER-L (see Table 6-4 and Figure 6-40A).

- **Froid and Taylor Terrestrial Unit:** Total chlordanes were detected in both the low level and CLP samples collected from location FTSSB001 (3.0 and 60.0 μg/kg, respectively). The result for the low level method sample exceeded the San Francisco Bay ambient value; the result for the CLP method sample exceeded the ER-M (see Figure 6-40A). Total chlordane was detected in two additional samples collected from the Froid and Taylor Terrestrial unit from sampling locations FTSSB100 (21.0 μg/kg) and FTSSB101 (190.0 μg/kg) at concentrations exceeding the ER-M. Both were confirmation samples for chlordane detected during the 1995 sampling.

- **Froid and Taylor Aquatic Unit:** Total chlordanes were detected in all 11 low level and eight CLP surface soil or sediment samples collected from the Froid and Taylor Aquatic unit at concentrations ranging from 0.05 to 23.0 μg/kg (see Figure 6-40A). Total chlordane concentrations exceeded the ER-M in low level sampling location FTSSL102 (23.0 μg/kg) and CLP sampling locations FTSSB006 (9.5 μg/kg), FTSSB005 (8.0 μg/kg), and FTSSB008 (7.9 μg/kg). Results for low level sampling locations FTSSL104 (4.0 μg/kg) and FTSSB003 (2.0 μg/kg) exceeded the San Francisco Bay ambient value; all eight CLP sample results exceeded ambient.

- **Wood Hogger Terrestrial Unit:** Total chlordanes were detected in all 37 low level surface, 22 CLP surface, and 20 CLP subsurface soil or sediment samples collected from the Wood Hogger Terrestrial unit at concentrations ranging from 0.05 to 78.0 μg/kg (see Figure 6-40C). Most detected concentrations were above the San Francisco Bay ambient value. Results for seven low level samples exceeded the ER-M, including sampling locations WHSSB015 (78.0 μg/kg), WHSSB009 (50.0 μg/kg), WHSSBD07 (23.0 μg/kg), WHSSBE06 (19.0 μg/kg), WHSSB014 (17.0 μg/kg), and WHSSB016 (17.0 μg/kg), and WHSSB013 (8.0 μg/kg). Results for seven CLP samples also exceeded the ER-M, including S37-10 (20.0 and 19.0 μg/kg at 3.0 and 0.5 feet bgs), WHSSBD03 (13.0, 9.3, and 7.2 μg/kg at 18.0, 1.5, and 4.5 feet bgs), WHSSBC02 (9.8, 9.3, and 8.3 μg/kg at 8.8, 4.0, and 1.3 feet bgs), WHSSBH07 (9.8 and 6.7 μg/kg at 8.0 and 4.0 feet bgs), WHSSBM08 (7.2 μg/kg at 9 feet bgs) (see Table 6-9).

- **North Otter Sluice Aquatic Unit:** Total chlordanes were detected in all 15 surface soil or sediment samples collected from the North Otter Sluice Aquatic unit at concentrations ranging from 0.1 to 1.2 μg/kg, all below the ER-M (see Figure 6-40A). The result for sample location RADSBA07 (1.2 μg/kg) exceeded the San Francisco Bay ambient value (see Table 6-11).

- **South Otter Sluice Aquatic Unit:** Total chlordanes were detected in all 19 surface soil or sediment samples collected from the South Otter Sluice Aquatic unit at concentrations ranging from 0.06 to 1.45 μg/kg (see Figure 6-40C). The result for sample locations OSLSL008 (1.45 μg/kg) and OSLSL006 (1.4 μg/kg) exceeded the San Francisco Bay ambient value; no sample results exceeded the ER-M (see Table 6-13).

In summary, total chlordane concentrations exceeded the ER-M in samples collected from the Landfill Terrestrial, R Area Terrestrial, Froid and Taylor Terrestrial, Froid and Taylor Aquatic, and Wood Hogger Terrestrial units; concentrations exceeded ambient values in samples collected from the R Area Terrestrial and Aquatic, North Otter Sluice Aquatic, and South Otter Sluice Aquatic units. The highest total chlordane concentrations were detected in samples collected from the Wood Hogger and Froid and Taylor Roads Sites as presented below.

Sampling Location/Unit	Sampling Depth (feet bgs)	Total Chlordane Concentration (μg/kg)
WHSSB015/Wood Hogger Terrestrial Unit	0 - 0.5	78
WHSSB009/Wood Hogger Terrestrial Unit	0 - 0.5	50
FTSSB001/Froid and Taylor Terrestrial Unit	0.35 - 1.3	60
WHSSBD07/Wood Hogger Terrestrial Unit	0 - 0.5	23
FTSSL102/Froid and Taylor Aquatic Unit	0 - 0.5	23

Alpha-BHC in Soil and Sediment

Alpha-BHC was only detected in two low level method soil or sediment samples: one from the Froid and Taylor Aquatic unit (sampling location FTSSL102 at 0.7 μg/kg) and one from the South Otter Sluice Aquatic unit (sampling location OSLSL007 at 0.5 μg/kg). No screening values are available for alpha-BHC.

Gamma-BHC in Soil and Sediment

Gamma-BHC was detected in 14 low level method samples collected from the R Area Terrestrial, Froid and Taylor Aquatic, Wood Hogger Terrestrial, and South Otter Sluice Aquatic units. Gamma-BHC was not detected in any samples collected from the Landfill Terrestrial, R Area Terrestrial and Aquatic, Froid and Taylor Terrestrial, or North Otter Sluice Aquatic units. Gamma-BHC concentrations are presented below.

- **R Area Terrestrial Unit:** Gamma-BHC was detected in seven of 54 samples collected from the R Area Terrestrial unit at concentrations ranging from 0.29 to 0.89 μg/kg (see Table 6-3). The highest gamma-BHC concentration was from sampling location RADSBG04.

- **Froid and Taylor Aquatic Unit:** Gamma-BHC was detected in one sample collected from the Froid and Taylor aquatic unit at sampling location FTSSB003 (0.4 μg/kg) (see Table 6-7).

- **Wood Hogger Terrestrial Unit:** Gamma-BHC was detected in three samples collected from the Wood Hogger Terrestrial unit at concentrations ranging from 0.42 to 2.0 μg/kg. Low level sampling locations WHSSB017 (2.0 μg/kg) and WHSSBH07 (0.8 μg/kg) had the highest detected concentrations of gamma-BHC (see Table 6-9).

- **South Otter Sluice Aquatic Unit:** Gamma-BHC was detected in three soil or sediment samples collected from the South Otter Sluice at concentrations ranging from 0.47 to 1.2 μg/kg; sampling location WHSSB002 (1.2 μg/kg) contained the highest concentration of gamma-BHC (see Table 6-13).

The highest gamma-BHC concentrations were in samples collected from the Wood Hogger Terrestrial and South Otter Sluice Aquatic units.

Total BHCs in Soil and Sediment

Total BHCs are the sum of alpha- and gamma-BHC; the total BHC concentrations below include nondetected BHCs, where a value of one-half the SQL was substituted as the concentration. Total BHC concentrations are presented below by unit in comparison to the San Francisco Bay ambient value (0.78 μg/kg) and on Figures 6-41A through 6-41C. No effects range values are available for total BHCs.

- **Landfill Terrestrial Unit:** BHC was not detected in samples from the Landfill Terrestrial unit; all total BHC concentrations in samples from the Landfill Terrestrial unit are based solely on nondetect data (see Figure 6-41A). Total BHC concentrations in all seven low level surface soil or sediment samples ranged from 0.1 to 0.35 μg/kg, below the San Francisco Bay ambient value. Total BHC concentrations in all eight surface and subsurface CLP samples ranged from 5.6 to 19.6 μg/kg, above the San Francisco Bay ambient value.

- **R Area Terrestrial Unit:** One of 54 low level method samples (sampling location RADSBG04 at 0.89 μg/kg) and all 20 CLP method samples exceeded the ambient value for total BHC. Total BHC concentrations from all 54 low level surface, 15 CLP surface, and five CLP subsurface samples ranged from 0.05 to 14.4 μg/kg (see Table 6-3); however, most total BHC concentrations are based solely on nondetect data (see Figure 6-41B).

- **R Area Terrestrial and Aquatic Unit:** BHCs were not detected in the R Area Terrestrial and Aquatic unit (see Table 6-4 and Figure 6-41A). The total BHC concentration for sample RADSB013 (0.07 μg/kg) is below ambient.

- **Froid and Taylor Terrestrial Unit:** BHCs were not detected in the Froid and Taylor Terrestrial unit. The total BHC concentration from sampling location FTSSB001 using CLP (72.0 μg/kg) methods yielded a total BHC concentration that exceeded the San Francisco Bay ambient value (see Table 6-6 and Figure 6-41A); however, this concentration is based on nondetect data.

- **Froid and Taylor Aquatic Unit:** Total BHCs were detected in two samples collected from the Froid and Taylor Aquatic unit at concentrations below ambient values (see Figure 6-41A). Total BHC concentrations in all 11 low level and eight CLP surface soil or sediment samples collected from the Froid and Taylor Aquatic unit ranged

from 0.05 to 19.0 μg/kg; most of these concentrations were based on nondetect data (see Table 6-7 and Figure 6-41A).

- **Wood Hogger Terrestrial Unit:** Total BHCs were detected in three samples collected from Wood Hogger Terrestrial unit. Low level sampling locations WHSSB017 (2.0 μg/kg) and WHSSBH07 (0.8 μg/kg) were the only detected samples that exceeded the San Francisco Bay ambient value (see Figure 6-41C). Total BHC concentrations in all 37 low level surface, 22 CLP surface, and 20 CLP subsurface soil or sediment samples collected from the Wood Hogger Terrestrial unit ranged from 0.05 to 40.0 μg/kg (see Table 6-9); however, many of these concentrations are based solely on nondetect data.

- **North Otter Sluice Aquatic Unit:** No BHCs were detected in samples collected from the North Otter Sluice Aquatic unit. Total BHC concentrations in all 15 surface soil or sediment samples collected from the North Otter Sluice Aquatic unit ranged from 0.08 to 0.8 μg/kg; however all total BHC concentrations are based solely on nondetect data (see Table 6-11 and Figure 6-41A).

- **South Otter Sluice Aquatic Unit:** Total BHCs were detected in four soil or sediment samples collected from the South Otter Sluice Aquatic unit; only sampling location WHSSB002 (1.2 μg/kg) exceeded the San Francisco Bay ambient value (see Table 6-13 and Figure 6-41C). Total BHC concentrations from all 19 surface soil or sediment samples collected from the South Otter Sluice Aquatic unit ranged from 0.05 to 1.8 μg/kg; however, most total BHC concentrations are based solely on nondetect data (see Figure 41C).

In summary, detected total BHC concentrations exceeded the San Francisco Bay ambient value in four samples: one from the R Area Terrestrial unit, two from the Wood Hogger Terrestrial unit, and one from the South Otter Sluice unit. Based on total BHC values summed using nondetect data, all CLP total BHC concentrations exceeded the San Francisco Bay ambient value; most BHC concentrations based on low level method samples were below ambient. The highest total BHC concentrations were from samples collected in the Wood Hogger. Because many individual BHC concentrations were below detection limits, the sum of the nondetects (one-half the SQL) contributes significantly to the total BHC concentration.

Other Pesticides in Soil and Sediment

Several other pesticides were detected in soil and sediment samples collected from all Tidal Area sites, including aldrin, endrin ketone, alpha-BHC, gamma-BHC, heptachlor, heptachlor epoxide, hexachlorobenzene, mirex, methoxychlor, and trans-nonachlor. Concentration ranges for these pesticides are shown below:

Pesticide	Number of Detections	Units Where Detected	Concentration Range (μg/kg)	Location of Maximum Concentration
Aldrin	19 (low level)	Landfill Terrestrial, R Area Terrestrial, R Area Terrestrial and Aquatic, Froid and Taylor Aquatic, and Wood Hogger Terrestrial	0.2 - 1.6	TLSSB001 and TLSSB002
Endrin ketone	1 (CLP)	Wood Hogger Terrestrial	3.7	S37-08
Heptachlor	7 (low level)	Landfill Terrestrial, R Area Terrestrial, Wood Hogger Terrestrial, and South Otter Sluice Aquatic	0.29 - 1.8	WHSSL001
Heptachlor epoxide	12 (low level)	R Area Terrestrial and Wood Hogger Terrestrial	0.18 - 6	WHSSB015
Hexachlorobenzene	30 (low level)	Landfill Terrestrial, R Area Terrestrial, R Area Terrestrial and Aquatic, Froid and Taylor Aquatic, Wood Hogger Terrestrial, North Otter Sluice Aquatic, and South Otter Sluice Aquatic	0.17 - 2	TLSSB001
Mirex	28 (low level)	Landfill Terrestrial, R Area Terrestrial, R Area Terrestrial and Aquatic, Wood Hogger Terrestrial, and North Otter Sluice Aquatic,	0.046 - 5	WHSSB013 and WHSSB014
Methoxychlor	1 (low level)	South Otter Sluice Aquatic	5	OSLSL008
trans-Nonachlor	78 (low level)	All units	0.15 - 65	WHSSB015

All of these pesticides except one were detected in surface soil or sediment samples. One subsurface sample collected from SWMU-37 location S37-8 contained endrin ketone at a concentration of 3.7 μg/kg. Screening values are not available for these pesticides.

Summary of Pesticide Detections

DDT and its congeners were found in samples from a large number of locations at the Tidal Area sites and were the most commonly encountered pesticides. Concentrations of total DDTs in most cases were above the ER-L but below the ER-M (see Figures 6-28A through 6-28C). The highest concentrations of DDTs were found in samples from the southwestern portion of the Wood Hogger Site (near the wood hogger equipment), the northwest portion of the R Area Disposal Site (south of Building S-43), and the Froid and Taylor Terrestrial unit. The presence of DDTs is not surprising given the history of mosquito abatement in the area.

Alpha-chlordane was detected consistently in surface soil samples collected throughout the Tidal Area. Gamma-chlordane was detected in samples collected from the Froid and Taylor Aquatic, Froid and Taylor Terrestrial, and South Otter Sluice Aquatic units. Total chlordanes were detected in samples collected throughout the Tidal Area sites; concentrations were highest in samples collected from the Wood Hogger and Froid and Taylor Roads Site.

Dieldrin was also consistently detected in samples collected throughout the Tidal Area at concentrations below the ER-M. The highest dieldrin concentrations were in samples collected from the Wood Hogger.

Alpha-BHC was detected in only two samples; gamma-BHC was detected in 14 samples. However, total BHCs based on detected and nondetected results occurred throughout the Tidal Area sites; the highest total BHC concentrations were in samples collected from the Wood Hogger. Because many individual BHC concentrations were below detection limits, the sum of the nondetects (one-half the SQL) contributes significantly to total-BHC concentrations.

Trans-nonachlor, hexachlorobenzene, and mirex were detected in samples collected throughout the Tidal Area sites. Heptachlor epoxide was detected in samples from the R Area and the Wood Hogger. Methoxychlor and endrin ketone were each detected in only one sample collected from the South Otter Sluice Aquatic and Wood Hogger Terrestrial units. No screening values are available for these analytes.

6.2.1.3 PCBs in Soil and Sediment

A total of 229 surface soil or sediment samples collected from the Tidal Area sites were analyzed for PCBs. A subset of soil and sediment samples collected from 0 to 0.5 feet bgs were analyzed using a low detection limit method. In addition, 54 surface samples were analyzed using the CLP method that identifies Aroclor isomers only. Soil samples collected deeper than 0.5 feet bgs were analyzed using the CLP method. No PCBs (Aroclors) were detected in the samples analyzed using the CLP method. Twenty PCB isomers were detected in soil or sediment samples collected from the Tidal Area using the low detection limit method. Total PCBs were calculated by summing all Aroclor or PCB isomers for each sample using one-half the SQL for nondetect data. Figures 6-42A through 6-42D compare total PCB results to ER-L (22.7 μg/kg), ER-M (180 μg/kg), and San Francisco Bay ambient (14.8 μg/kg) values for each site. Screening values were not available for individual PCB isomers.

Total PCBs were found in all eight units at concentrations ranging from 1.0 to 73.5 μg/kg. The highest concentrations were found in samples collected from the northeast and southwest portions of the Wood Hogger Site and the north portion of the Landfill Perimeter, as follows:

Sampling Location	Total PCB Concentration (μg/kg)	Location of Highest Detected Concentration
WHSSB009	73.5	Southwestern portion of Wood Hogger Site
WHSSBI02	72.4	Northeastern portion of Wood Hogger Site
WHSSB016	61.0	Site near wood hogger equipment
WHSSB014	59.0	Site near wood hogger equipment
WHSSBE06	54.0	Southwestern portion of Wood Hogger Site
WHSSB013	39.4	Southwestern portion of Wood Hogger Site
WHSSB015	39.0	Site near wood hogger equipment
WHSSBD07	23.0	Southwestern portion of Wood Hogger Site
TLSSB002	32.8	Landfill Perimeter

All concentrations of total PCBs using low level methods were below the ER-L (22.7 μg/kg) except the nine listed above. All concentrations of total PCBs were below the ER-M (180.0 μg/kg).

6.2.1.4 VOCs in Soil and Sediment

A total of 100 subsurface soil samples collected from the Tidal Area sites were analyzed for VOCs. Sediment samples were not analyzed for VOCs. Six VOCs were detected in 29 soil samples, as follows (screening values are not available for any of the six VOCs):

- **2-Butanone:** Six samples contained 2-butanone at concentrations ranging from 20 to 720 μg/kg. The highest concentration was detected in a sample from location WHSSBK06.
- **4-Methyl-2-Pentanone:** The subsurface soil sample collected from location FTSSB005 contained 4-methyl-2-pentanone at a concentration of 27 μg/kg.
- **Acetone:** Three subsurface soil samples collected from locations TLSSB007, TLSSB008, and WHSSBF03 contained acetone at concentrations ranging from 240 to 580 μg/kg.
- **Carbon Disulfide:** Nineteen subsurface soil samples contained carbon disulfide at concentrations ranging from 7 to 290 μg/kg. The highest concentration of carbon disulfide was detected in a sample collected at location WHSSBD03.

- **Chloromethane:** Four subsurface soil samples collected from the Tidal Area Landfill and R Area Disposal Sites contained chloromethane at concentrations ranging from 14 to 48 μg/kg.

- **Xylene:** Xylene was detected in two soil samples collected from location WHSSBC02 at concentrations of 26 and 54 μg/kg.

6.2.1.5 SVOCs in Soil and Sediment

A total of 234 soil or sediment samples collected from the Tidal Area sites were analyzed for SVOCs. A subset of soil and sediment samples collected between 0 and 0.5 feet bgs were analyzed using a low level method. Soil samples collected at deeper than 0.5 feet bgs were analyzed using the CLP method. Thirty-four SVOCs were detected in soil and sediment samples. Tables 6-1, 6-3, 6-4, 6-6, 6-7, 6-9, 6-11, and 6-13 summarize the results for SVOCs by habitat unit.

Most of the detected SVOCs are PAHs. Screening values are available for 19 SVOCs. Table 5-1 lists the screening values for several PAHs detected in samples collected at the Tidal Area sites. Figures 6-43A through 6-43C compare total PAH results to ER-L, ER-M, and San Francisco Bay ambient values for each site.

Twenty-five PAHs were detected among the soil and sediment samples collected from the Tidal Area sites. Tables 6-1, 6-3, 6-4, 6-6, 6-7, 6-9, 6-11, and 6-13 summarize the maximum detected concentrations and number of detections for each PAH and for total PAHs in comparison to screening values. Effects-range screening values are not available for 2,4-dimethylphenol, 2,6-dimethylnaphthalene, 4-methylphenol, benzo(b)fluoranthene, benzo(e)pyrene, benzo(g,h,i)perylene, benzo(k)fluoranthene, benzoic acid, bis(2-ethylhexyl)phthalate, butylbenzylphthalate, carbazole, dibenzothiophene, diethylphthalate, dibenzofuran, indeno(1,2,3-cd)pyrene, isophorone, perylene, and phenol. Total low molecular weight (LMW), high molecular weight (HMW), and total PAH values were summed using one-half the SQL for nondetect data.

- **Landfill Terrestrial Unit:** Sixteen SVOCs were detected in the seven Landfill Terrestrial unit surface soil or sediment samples. Screening values are available for 13 of the SVOCs detected. Sample TLSSB004 (30.0 μg/kg) contained 2,6-dimethylnapthalene at a concentration exceeding the San Francisco Bay ambient value (12.1 μg/kg). Pyrene was detected in three surface soil or sediment samples at concentrations ranging from 78 to 1,300 μg/kg; the result for sampling location TLSSB004 (1,300 μg/kg) exceeded the ER-L (665 μg/kg) (see Table 6-1).

Detected total PAH concentrations ranged from 150 to 1,300 μg/kg, all below the ER-M (44,792 μg/kg) (see Table 6-19). No total PAH or total HMW PAH concentrations based on detected data exceeded the ER-L. Results for two low level method and 11 CLP method samples exceeded the ER-M (3,160 μg/kg) for total LMW PAHs; however, detected total LMW PAH concentrations ranged from 32 to 41 μg/kg, below screening values. Detected HMW PAH results ranged from 150 to 1,300 μg/kg, all below the ER-L (see Table 6-19).

- **R Area Terrestrial Unit:** Twenty-five SVOCs were detected in the 54 low level method samples, and 17 SVOCs were detected in the 15 CLP method samples collected from the R Area Terrestrial unit. No low level method SVOC sample concentrations exceeded the ER-M; however, several CLP method SVOCs exceeded the ER-M from sampling location RADSBG08, including acenaphthene, anthracene, benzo(a)anthracene, fluorene, phenanthrene, and pyrene. SVOCs that exceeded the San Francisco Bay ambient value or ER-L in CLP or low level method samples include: 1-methylphenanthrene, benzo(b)fluoranthene, benzo(k)fluoranthene, benzo(g,h,i)perylene, chrysene, dibenz(a,h)anthracene, fluoranthene, indeno(1,2,3-cd)pyrene, and naphthalene (see Table 6-3).

  Total PAH concentrations summed using one half the SQL ranged from 357 to 28,075 μg/kg (see Figure 6-43B). No total PAH concentrations using low level or CLP methods exceeded the ER-M (44,792 μg/kg); Detected concentrations from low level method sampling location RADSB007 (4,092 μg/kg) and CLP method sampling location RADSBG08 (23,100 μg/kg) exceeded the ER-L (4,022 μg/kg) (see Table 6-19 and Figure 6-43B). Total LMW PAH concentrations exceeded the ER-M (3,160 μg/kg) in six CLP samples; no low level method total LMW PAH concentrations exceeded the ER-M. Detected HMW PAH concentrations ranged from 34 to 18,770 μg/kg. Detected sample RADSBG08 (18,770 μg/kg) exceeded the ER-M and samples RADSB007 (4,164 μg/kg), RADSB008 (3,387 μg/kg), RADSBB08 (2,180 μg/kg), and RADSB012 (1,731 μg/kg) exceeded the ER-L (see Table 6-19).

- **R Area Terrestrial and Aquatic Unit:** Eleven SVOCs were detected in surface soil or sediment sampling location RADSB013 collected from the R Area Terrestrial and Aquatic unit. No individual PAHs exceeded screening values. No detected total LMW PAH, HMW PAH, or total PAH exceeded screening values (see Table 6-19).

- **Froid and Taylor Terrestrial Unit:** Five SVOCs were detected in sampling location FTSSB001 collected from the Froid and Taylor Terrestrial unit; no individual SVOC concentrations exceeded screening values. However, both the total CLP method total LMW PAH (2,520 μg/kg) and total PAH (6,120 μg/kg) concentrations summed using one half the SQL exceeded the ER-L (552 and 4,022 μg/kg, respectively). The detected total LMW PAH, total HMW PAH, and total PAH results summed using only detected data were below screening values (see Table 6-19).

- **Froid and Taylor Aquatic Unit:** Twenty-five SVOCs were detected in the eight low level method surface soil or sediment samples and five SVOCs were detected in the 11 CLP method samples collected from the Froid and Taylor Aquatic unit. The compounds 1-methylnaphthalene and 2-methylnaphthalene (30 and 46 μg/kg from location FTSSB002) were the only SVOC results that exceeded ambient; no SVOC results exceeded the ER-L. All other results for SVOCs were below screening values.

  Total PAH concentrations ranged from 431 to 13,600 μg/kg. No total PAH concentrations summed based on detected values exceeded ambient (3,390 μg/kg); however, one low level method and eight CLP method samples summed using one half the SQL for nondetects exceeded the ER-L (4,022 μg/kg). All total PAH concentrations were below the ER-M (44,792 μg/kg). However, three CLP method total LMW PAH concentrations summed using one half the SQL exceeded the ER-M (3,160 μg/kg); total LMW PAH concentrations ranged from 185 to 5,600 μg/kg. Total HMW PAH concentrations ranged from 246 to 8,000 μg/kg; three of eight low level method samples and all 10 CLP method samples exceeded the ER-L (1,700 μg/kg).

- **Wood Hogger Terrestrial Unit:** Twenty-five SVOCs were detected in the 37 low level method samples, and seven SVOCs were detected in the 21 CLP samples. Anthracene, benzo(a)anthracene, benzo(a)pyrene, chrysene, dibenz(a,h)anthracene, fluoranthene, phenanthrene, and pyrene were detected in at least one sample at a concentration exceeding the ER-M. In addition, 1-methylphenanthrene, acenaphthene, acenaphthylene, benzo(b)fluoranthene, benzo(e)pyrene, benzo(g,h,i)perylene, benzo(k)fluoranthene, fluoranthene, fluorene, indeno(1,2,3-cd)pyrene, phenanthrene, and perylene were all detected at concentrations above the ER-L or San Francisco Bay ambient (see Table 6-9).

  Total PAH concentrations ranged from 368 to 231,000 μg/kg (see Figure 6-42C). Only sampling location WHSSBC06 (46,270 μg/kg) summed using detected concentrations of PAH exceeded the ER-M (44,792 μg/kg); sampling locations WHSSB008 (5,230 μg/kg), WHSSB013 (5,450 μg/kg), WHSSB016 (15,700 μg/kg), and WHSSBE06 (6,650 μg/kg), exceeded the ER-L (4,022 μg/kg). Four total PAH concentrations summed using one half the SQL for nondetects exceeded the ER-M. Total LMW PAH concentrations ranged from 158 to 99,000 μg/kg; eighteen low level method samples and 11 CLP method samples exceeded the ER-M (3,160μg/kg) for total LMW PAH. Total HMW PAH concentrations ranged from 210 to 132,000 μg/kg; eight low level method surface samples exceeded the ER-M (9,600 μg/kg) and almost all CLP and low level method samples exceeded the ER-L (1,700 μg/kg).

- **North Otter Sluice Aquatic Unit:** Twenty SVOCs were detected in the 12 low level method samples and five SVOCs were detected in three CLP method samples from the North Otter Sluice Aquatic unit. Acenaphthene, fluorene, and naphthalene exceeded the ER-L; 2,6-dimethylnaphthalene and perylene exceeded the ambient. All other SVOC concentrations were below screening values except for 4-methylphenol and benzoic acid, for which no screening values are available. Total PAH concentrations ranged from 1,523 to 11,050 μg/kg; results for three CLP samples and 4 low level method samples were above the ER-L (4,022 μg/kg); however, those three are based solely on nondetect data (see Figure 6-43A). Total LMW PAH concentrations ranged from 468 to 4,550 μg/kg; results for four low level method samples and two CLP method samples exceeded the

ER-M (3,160 μg/kg). Total HMW PAH concentrations ranged from 660 to 6,500 μg/kg; all results were below the ER-M (9,600 μg/kg). Six of 12 low level method and all 12 CLP method samples exceeded the ER-L (1,700 μg/kg).

- **South Otter Sluice Aquatic Unit:** Thirteen SVOCs were detected in the 13 low level method samples, and three SVOCs were detected in the six CLP method samples collected from the North Otter Sluice Aquatic unit. In addition, results for 2-6-dimethlynaphthalene and benzo(k)fluoranthene exceeded the San Francisco Bay ambient value; no other SVOCs exceeded effects-range screening values.

  Total PAH concentrations ranged from 431 to 24,160 μg/kg (see Figure 6-43C); results for five low level method samples and all six CLP method samples exceeded the ER-L (4,022 μg/kg); however, those five concentrations are based solely on nondetect data. Total LMW PAH concentrations ranged from 174 to 10,500 μg/kg; results for all six CLP samples and one of 13 low level samples exceeded the ER-M (3,160 μg/kg). Total HMW PAH concentrations ranged from 246 to 13,660 μg/kg; CLP results at sampling locations OSLSL008 (13,660 μg/kg) and OSLSL009 (11,000 μg/kg) exceeded the ER-M (9,600 μg/kg). Most samples exceeded the ER-L (1,700 μg/kg).

In summary, PAHs were detected in soil and sediment samples collected throughout the Tidal Area sites. As shown in Tables 6-1, 6-3, 6-4, 6-6, 6-7, 6-9, 6-11, and 6-13, most samples contained PAHs at concentrations lower than the screening values; however, results for several samples exceeded the ambient values, ER-L, or ER-M. In general, the highest concentrations of PAHs were found in the samples from the Wood Hogger and R Area Disposal Sites. SVOCs detected at concentrations that exceeded the ambient, ER-L, or ER-M include the following:

- 1-Methylnaphthalene
- 2-Methylnaphthalene
- 1-Methylphenanthrene
- 2,6-Dimethylnaphthalene
- Acenaphthene
- Acenaphthylene
- Anthracene
- Benzo(a)anthracene
- Dibenz(a,h)anthracene
- Benzo(a)pyrene
- Benzo(b)fluoranthene
- Benzo(e)pyrene
- Benzo(g,h,i)perylene
- Benzo(k)fluoranthene
- Chrysene
- Fluorene
- Fluoranthene
- Indeno(1,2,3-cd)pyrene
- Naphthalene
- Phenanthrene
- Pyrene

Total PAH concentrations ranged from 357 to 231,000 μg/kg; the highest concentrations were detected in samples collected from the Wood Hogger Site. Only sampling location WHSSBC06 (59,175 μg/kg) contained a detected concentration of total PAH that exceeded the ER-M (44,792 μg/kg); samples from the Wood Hogger Terrestrial and R Area Terrestrial units exceeded the ER-L (4,022 μg/kg) (see Table 6-19).

Detected total LMW PAH concentrations exceeded the ER-M (3,160 μg/kg) and ER-L (552 μg/kg) in samples collected from the Wood Hogger Terrestrial and R Area Terrestrial units. Total LMW PAH concentrations that exceeded the ER-M and ER-L summed using only detected results include Wood Hogger Terrestrial unit samples WHSSBC06 (5,730 μg/kg) and WHSSB016 (4,000 μg/kg) and R Area Terrestrial unit sample RADSBG08 (8,660 μg/kg) (see Table 6-19).

Total HMW PAH concentrations ranged from 204 to 132,000 μg/kg throughout the Tidal Area. Total HMW PAHs exceeded the ER-M (9,600 μg/kg) in surface samples collected from the R Area Terrestrial, Wood Hogger Terrestrial, and South Otter Sluice Aquatic units. Total HMW PAH results exceeded the ER-L (1,700 μg/kg) in samples collected from all Tidal Area units; however, many of the results are based solely on nondetect data.

6.2.1.6 TPH in Soil and Sediment

All 18 soil samples collected from the Froid and Taylor Terrestrial unit and seven soil samples collected from the Wood Hogger Terrestrial unit were analyzed for petroleum hydrocarbons. The samples from the Wood Hogger Terrestrial unit were collected in areas where a petroleum odor or oily sheen was observed during field sampling. TPH-motor oil was the most frequently detected compound (in 17 of 25 samples); TPH-diesel was detected in one sample, and TPH-gasoline was detected in two samples. The highest concentrations of TPH-motor oil were detected in surface and subsurface soil samples collected from the northern portion of the Froid and Taylor Roads Site where Froid Road intersects the site. TPH-motor oil and TPH-diesel were also detected in samples collected from the southern portion of the Wood Hogger Site. Analytical results for detected TPH are discussed below and are summarized in Tables 6-1, 6-3, 6-4, 6-6, 6-7, 6-9, 6-11, and 6-13.

Petroleum products are a complex mixture of many hundreds of chemicals, some of which are more toxic than others. The volatile aromatic hydrocarbons, such as benzene, toluene, ethylbenzene, and

xylenes (BTEX) and semivolatile aromatic hydrocarbons such as PAHs are generally considered the most toxic components. Analyzing samples for TPH evaluates the extent of contamination; however, risk characterization based on TPH concentrations is difficult because no toxicity values for the mixtures are available. In addition, extensive weathering and degradation of petroleum products often reduces the environmental concentration of the more volatile toxic components (ASTM 1995). Contaminant screening and risk characterization related to the motor oil and diesel found at the sites thus focused on the PAH and BTEX constituents. The TPH results were used identify to locations that may have significant concentrations of PAHs and BTEX.

- **TPH-Diesel:** One sample collected at 3.5 feet bgs (location WHSSB030) in the southwestern corner of the Wood Hogger Terrestrial unit contained 2,300 mg/kg of TPH-diesel. No other samples contained TPH-diesel.

- **TPH-Gasoline:** TPH-gasoline was detected in subsurface soil samples collected from Wood Hogger Terrestrial unit locations WHSSBD07 (0.47 mg/kg) and WHSSB030 (26 mg/kg). No other samples contained TPH-gasoline.

- **TPH-Motor Oil:** Seventeen soil samples contained TPH-motor oil at concentrations ranging from 9 to 23,000 mg/kg. Fifteen of the 18 soil samples collected from the Froid and Taylor Terrestrial unit contained TPH-motor oil, with the highest concentrations detected in surface and subsurface soil samples collected from locations FTSSB001 (9,200 mg/kg), FTSSB002 (7,800 mg/kg), and FTSSB003 (23,000 mg/kg) in the northern portion of the site. The subsurface soil samples collected from Wood Hogger Terrestrial unit locations WHSSBD07 and WHSSB030 also contained TPH-motor oil at concentrations of 640 and 8,900 mg/kg. Screening values are not available for TPH-motor oil.

In summary, TPH-motor oil was the most common petroleum product detected at the Froid and Taylor Terrestrial and Wood Hogger Terrestrial unit. The source of the TPH-motor oil at the Froid and Taylor Terrestrial unit is unknown. The TPH detected at the Wood Hogger ~~Terrestrial unit~~ appears to be localized, since no other soil samples in the area exhibited an oily sheen or petroleum odor.

6.2.1.7 Explosives in Soil and Sediment

Across the Tidal Area, 78 soil or sediment samples were analyzed for explosives. Explosives were only detected in two sampling locations; 1,3-dinitrobenzene (1,3-DNB) was detected at 130 μg/kg at sampling location S37-03, and cyclotetramethylene tetranitramine (HMX) (high melting explosives) was detected at 357 μg/kg at sampling location WHSSBH07 in the Wood Hogger Terrestrial unit. Ambient, ER-L, and ER-M values are not available for explosive compounds. The concentrations detected were compared to ecological screening values developed by Oak Ridge National Laboratory

(ORNL). These concentrations are far below known effects levels in terrestrial receptors according to a report on the ecological effects of these chemicals by ORNL (Talmage and Opresko 1996) and were thus not considered COPECs for any receptor group and were not evaluated further.

1,3-DNB has a low potential for bioaccumulation and is readily metabolized and excreted in birds and mammals, and in wildlife; no observed adverse effect levels (NOAEL) for effects in rodents are on the order of greater than 0.4 mg/kg concentrations required in their feed (much higher dose than incidental soil ingestion of the concentration detected in soil in the Wood Hogger) (Talmage and Opresko 1996). No benchmarks are available for avian species, plants, soil biota, or heterotrophic processes (Talmage and Opresko 1996).

HMX is poorly absorbed in human and animal gastrointestinal tracts (Talmage and Opresko 1996). One benchmark for mammalian wildlife is greater than 5.0 mg/kg in food (Talmage and Opresko 1996). No benchmarks are available for avian species, plants, soil biota, or heterotrophic processes (Talmage and Opresko 1996).

6.2.1.8 Summary of Organic Constituents in Soil and Sediment

VOCs were detected infrequently in the soil and sediment samples, at low concentrations. Conversely, pesticides, PCBs, and SVOCs (specifically PAHs) were frequently detected in samples collected throughout the Tidal Area sites. Concentrations of some pesticides were above the ER-L and ambient concentration, but rarely exceeded the ER-M. Levels of DDTs, chlordanes, mirex, dieldrin, aldrin, and other chlorinated pesticides often exceeded ER-Ls.

Most total PCB concentrations were below the ~~ER-L; total PCBs did not exceed~~ ER-Ms at locations where the low detection limit method of analysis was used. The highest concentrations of total PCBs were found in the northeast and southwest portions of the Wood Hogger Site and the north portion of the Landfill Perimeter.

Most total PAH concentrations were below the ER-L; however, sampling location WHSSBC06 (46,270 μg/kg) at the Wood Hogger Terrestrial unit exceeded the ER-M. Total PAH concentrations exceeded the ER-L in samples from the Wood Hogger Terrestrial unit and R Area Terrestrial unit. The greatest number of ER-M exceedances of LMW PAHs using the low detection limit method was in the North Otter Sluice Aquatic unit (four of 12 sediment samples exceeded the ER-M). The greatest

number of ER-M exceedances of HMW PAHs using the low detection limit method was in the Wood Hogger Terrestrial and South Otter Sluice Aquatic units.

Most PCDDs and PCDFs detected were below detection limits. Octachlorinated PCDDs and PCDFs are the most prevalent in the environment; this was the case for the Tidal Area samples. Nine soil samples collected at the Wood Hogger Site and three sediment samples collected from Otter Sluice were analyzed for dioxins and furans. Dioxins are ubiquitous in the environment due to global atmospheric transport and their environmental persistence. Dioxins exist in the environment at very low concentrations in soil and sediment, and are relatively difficult and expensive to detect. As a result, local soil and sediment data are not available for comparison with site concentrations to indicate potential input from site activities. No ecological screening values exist for dioxins and furans. However, since dioxins bioaccumulate, dioxins are more often reported in fish tissues where they are more likely to be detected. Fish tissue concentrations of dioxin from the Tidal Area were therefore compared with regional fish tissue data in Section 12.0.

6.2.2 Organic Constituents in Surface Water Samples

The sections below summarize the organic constituents detected in surface water samples collected at the Tidal Area sites. Pesticides, TPH-e, and VOCs were the only organic constituents detected. The surface water sample results were screened against AWQCs presented in Table 5-2, where available. Tables 6-2, 6-5, 6-8, 6-10, 6-12, and 6-14 compare organic constituents detected in surface water samples to screening values for each Tidal Area unit.

As noted in Appendix P, detection limits for several pesticides, PCBs, and SVOCs were often above the AWQC, creating a source of uncertainty in the risk assessment.

6.2.2.1 Pesticides in Surface Water

Ten pesticides were detected in five surface water samples collected from the R Area Disposal Site and North Otter Sluice in October 1995 and April 1996, as follows:

	RADSW002 May 1996 North Otter Sluice	RADSW004 October 1995 North Otter Sluice	RADSW008 April 1996 R Area Disposal Site	RADSW010 April 1996 R Area Disposal Site	RADSW011 April 1996 R Area Disposal Site
Pesticide (μg/L)					
4,4'-DDT	ND	0.03	ND	ND	ND
Aldrin	ND	0.01	ND	ND	0.029
alpha-Chlordane	0.042	ND	ND	ND	ND
alpha-BHC	ND	ND	ND	0.067	0.029
beta-BHC	ND	ND	0.027	ND	ND
gamma-BHC	ND	0.01	ND	ND	ND
Dieldrin	ND	0.03	ND	ND	ND
Endrin	ND	0.03	ND	ND	ND
Heptachlor	0.11	0.01	ND	ND	ND
Heptachlor epoxide	ND	ND	0.037	ND	0.013

Note:

ND Not detected

μg/L Micrograms per kilogram

All detections of 4,4'-DDT, heptachlor epoxide, dieldrin, endrin, and heptachlor exceeded screening values. All detections of aldrin and gamma-BHC were below screening values. No screening values are available for alpha-chlordane, alpha-BHC, and beta-BHC. Pesticides were not detected in surface water samples collected from the other sites.

The detection limits for the following nine pesticides exceeded AWQC: 4,4'-DDT, dieldrin, endosulfan I, endosulfan II, endrin, gamma-BHC, heptachlor, heptachlor epoxide, and methoxychlor.

Total DDT, total BHC, and total chlordane concentrations were summed for each analyte group using half the detection limit for nondetect samples. Total DDT concentrations in R Area and North Otter Sluice surface water samples ranged from 0.13 to 0.75 μg/L. Total BHC concentrations in R Area and North Otter Sluice surface water samples ranged from 0.09 to 0.5 μg/L. Total chlordane concentrations in R Area and North Otter sluice surface water samples ranged from 0.05 to 0.25 μg/L. Screening values are not available for total DDTs or total BHCs. All total chlordane concentrations exceeded the screening value (0.004 μg/L); however, these concentrations were based primarily on summing nondetect data.

6.2.2.2 PCBs in Surface Water

PCBs were not detected in surface water samples; however, the detection limits for the following seven PCB isomers exceeded AWQC: Aroclor-1016, Aroclor-1221, Aroclor-1232, Aroclor-1242, Aroclor-1248, Aroclor-1254, and Aroclor-1260. The detection limit for all Aroclors was 0.5 μg/L except for Aroclor-1221, which was 1.0 μg/L.

6.2.2.3 VOCs in Surface Water

Six VOCs were each detected in one surface water sample collected from the Tidal Area sites, as follows: chloromethane (11 μg/L) was detected in a sample collected at location RADSW001 in North Otter Sluice; in the Froid and Taylor Roads Site, 4-methylphenol was detected in sample collected at location FTSSL102 (3.0 μg/L), chrysene was detected in a sample collected at location FTSSL104 (0.6 μg/L), carbon disulfide was detected in a sample collected at location FTSSW001 (20 μg/L), and phenol was detected in one sample collected at location FTSSL102 (0.9 μg/L); and xylene (8.0 μg/L) was detected in a sample collected at location WHSSW006 in the Wood Hogger Site. No screening values are available for VOCs.

6.2.2.4 SVOCs in Surface Water

Bis(2-ethylhexyl)phthalate was the only SVOC detected in surface water samples, in the South Otter Sluice Aquatic unit sampling location OSLSL005 (29.0 μg/L); screening values are not available for bis(2-ethylhexyl)phthalate. SVOCs were not detected in any other surface water samples; however, the detection limit for pentachlorophenol exceeded the AWQC.

Total PAH concentrations were summed from individual PAH detected using one-half the SQL for nondetect results. Total PAH concentrations ranged from 85 to 550 μg/L. All total PAH concentrations exceeded the screening value (15.0 μg/L); however, these concentrations are based almost completely on nondetect data.

6.2.2.5 TPH in Surface Water

Surface water samples from only two sampling locations in the Froid and Taylor Aquatic unit (FTSSW001 and FTSSW002) were analyzed for TPH. At locations FTSSW001, TPH-diesel was detected in samples collected during July 1995, October 1995, and January 1996 at concentrations

ranging from 0.12 to 2.0 milligrams per liter (mg/L). At location FTSSW002, TPH-diesel was detected in samples collected during July 1995 and January 1996 at concentrations of 0.25 and 0.084 mg/L. Screening values are not available for TPH-diesel.

TPH-motor oil was also detected in surface water samples collected at sampling locations FTSSW001 and FTSSW002. TPH-motor oil was detected in all four samples collected from location FTSSW001 at concentrations ranging from 0.16 to 2.3 mg/L, and in the July 1995 and January 1996 samples collected from location FTSSW002 at concentrations of 0.75 and 0.11 mg/L. Screening values are not available for TPH-motor oil.

6.2.2.6 Summary of Organic Constituents in Surface Water

Both pesticides and VOCs were detected infrequently in surface water samples. All detections of 4,4'-DDT, heptachlor epoxide, dieldrin, endrin, and heptachlor exceeded screening values; no screening values are available for VOCs. PCBs were not detected in surface water samples. Because the water solubilities of these chemicals are low, the results were often below detection limits.

TPH-diesel and TPH-motor oil were detected in most samples collected from the Froid and Taylor Aquatic unit. However, no SVOCs were detected in surface water samples.

6.2.3 Summary of Organic COPECs for the Tidal Area Sites

Organic constituents detected in soil, sediment, extractions, and surface water samples were screened using methods described in Section 5.0. Chemicals that exceeded screening values and are considered COPECs are listed below:

Dioxins and Furans (based on soil, sediment and surface water samples)

Pesticides:

- DDTs (DDD, DDE, and DDT) (based on soil or sediment and surface water samples)
- alpha-Chlordane (based on soil or sediment and surface water samples)
- gamma-Chlordane (based on soil or sediment samples)
- Total Chlordanes (based on soil or sediment and surface water samples)
- alpha-BHC (based on soil or sediment and surface water samples)
- beta-BHC (based on surface water samples

- gamma-BHC (based on soil or sediment samples)
- Total BHCs (based on soil or sediment and surface water samples)
- Aldrin (based on soil or sediment samples)
- Dieldrin (based on soil or sediment and surface water samples)
- Endrin (based on surface water samples)
- Heptachlor (based on soil or sediment and surface water samples)
- Heptachlor epoxide (based on soil or sediment and surface water samples)
- Hexachlorobenzene (based on soil or sediment samples)
- Methoxychlor (based on soil or sediment samples)
- Mirex (based on soil or sediment samples)
- trans-Nonachlor (based on soil or sediment samples)

PCBs

- Total PCBs (based on soil or sediment samples)

SVOCs

- 1-Methylnaphthalene (based on soil or sediment samples)
- 2-Methylnaphthalene (based on soil or sediment samples)
- 1-Methylphenanthrene (based on soil or sediment samples)
- 2,4-Dimethylphenol (based on soil or sediment samples)
- 4-Methylphenol (based on soil or sediment and surface water samples)
- 2,6-Dimethylnaphthalene (based on soil or sediment samples)
- Acenaphthene (based on soil or sediment samples)
- Acenaphthylene (based on soil or sediment samples)
- Benzo(a)anthracene (based on soil or sediment samples)
- Benzo(a)pyrene (based on soil or sediment samples)
- Benzo(b)fluoranthene (based on soil or sediment samples)
- Benzo(e)pyrene (based on soil or sediment samples)
- Benzo(g,h,i)perylene (based on soil or sediment samples)
- Benzo(k)fluoranthene (based on soil or sediment samples)

- Benzoic acid (based on soil or sediment samples)
- Bis(2-ethylhexyl)phthalate (based on soil or sediment and surface water samples)
- Butylbenzylphthalate (based on soil or sediment samples)
- Carbazole (based on soil or sediment samples)
- Chrysene (based on soil or sediment samples)
- Dibenz(a,h)anthracene (based on soil or sediment samples)
- Dibenzofuran (based on soil or sediment samples)
- Dibenzothiophene (based on soil or sediment samples)
- Diethylphthalate (based on soil or sediment samples)
- Fluoranthene (based on soil or sediment samples)
- Fluorene (based on soil or sediment samples)
- Indeno(1,2,3-cd)pyrene (based on soil or sediment samples)
- Isophorone (based on soil or sediment samples)
- Naphthalene (based on soil or sediment samples)
- Phenanthrene (based on soil or sediment samples)
- Phenol (based on soil or sediment and surface water samples)
- Pyrene (based on soil or sediment samples)
- Total LMW PAH (based on soil or sediment and surface water samples)
- Total HMW PAH (based on soil or sediment and surface water samples)
- Total PAH (based on soil or sediment and surface water samples)

TPH

- Motor oil (based on soil or sediment and surface water samples)
- Diesel (based on soil or sediment and surface water samples)
- Gasoline (based on soil or sediment and surface water samples)

VOCs

- 2-Butanone (based on soil or sediment samples)
- 4-Methyl-2-pentanone (based on soil or sediment samples)
- Acetone (based on soil or sediment samples)

- Carbon disulfide (based on soil or sediment and surface water samples)
- Chloromethane (based on soil or sediment samples)
- Xylene (based on soil or sediment and surface water samples)

6.3 STATISTICAL EVALUATION OF CHEMICALS OF POTENTIAL ECOLOGICAL CONCERN

This section summarizes the process by which COPECs identified for sediment, soil, and surface water were further evaluated statistically. These evaluations will assist in identifying COECs for the Tidal Area in subsequent sections of this report. Section 6.3.1 discusses the statistical evaluation that was conducted, and Section 6.3.2 discusses the results of the evaluation. Section 6.3.3 discusses the COPECs that were eliminated from further evaluation based on the statistical analysis.

6.3.1 Statistical Evaluation Methods

Exploratory statistics were run on inorganic and organic analytical data for soil, sediment, and surface water using SPSS 7.5. Data from the eight habitat units (Landfill Terrestrial, R Area Terrestrial, R Area Aquatic, Froid and Taylor Terrestrial, Froid and Taylor Aquatic, Wood Hogger Terrestrial, North Otter Sluice Aquatic, and South Otter Sluice Aquatic) were combined into one data set and the maximum, median, and upper bound of the 95th percent UCL were evaluated for each chemical.

For inorganic constituents in soil and sediment, outliers and extreme values were also identified using boxplots. The 25th to 75th percentiles in the boxplots represent 50 percent of the data population. Outliers are values that are more than 1.5 box-lengths from the 75th percentile and extreme values are values more than 3-box lengths from the 75th percentile. The descriptive statistics and results of the outlier analysis are detailed in Appendix Q and summarized in Table 6-23.

Qualitative evaluations were also performed on the data set to assist in evaluating the frequency and magnitude of exceedances of screening values. These evaluations will also assist in identifying COECs in soil, sediment, and surface water for various receptor groups in subsequent sections.

6.3.2 Statistical Evaluation Results

The following subsections discuss the evaluation of soil, sediment, and surface water results for the Tidal Area sites.

6.3.2.1 Inorganic Constituents in Soil and Sediment

The outlier analysis for inorganic constituents in soil and sediment are detailed in Appendix Q. As discussed in Section 6.3.1, an additional statistical screening of the inorganic data for soil and sediment was conducted to identify outliers and extreme values for the data set, which can be viewed as contamination by possible site releases.

For some chemicals, such as aluminum and chromium, there are few data points that fit the definition of an outlier. Aluminum and chromium each had two outliers; the two highest sample concentrations were the outliers. For lead, many samples fit the definition of an outlier, not just the maximum site concentration.

Exceedances of ambient concentrations can also be viewed as contamination by possible site releases. The data evaluation indicates that concentrations of inorganic constituents in soil and sediment did not exceed ambient concentrations frequently, except for lead, nickel, selenium, and zinc as follows:

- Lead had concentrations above ambient values (Tidal Area 99th percent UCL for soil samples, and RWQCB 1998 for sediment samples) at 61 of 225 sampling locations (27 percent). The maximum soil concentration was on the southern edge of the R Area Terrestrial unit towards Froid Road, near Building R-1. This sampling location, RADSBG08, also had elevated concentrations of selenium and zinc.

- Ten sampling locations (4 percent) across the Tidal Area had nickel concentrations above ambient. However, the concentrations only slightly exceeded ambient concentrations and were not indicative of a site release since there was no apparent spatial trend in sampling locations that exceeded the ambient concentrations of nickel. The maximum nickel concentration in soil (242 mg/kg) was detected in the R Area Terrestrial unit at sampling location RADSBH06, and was only twice the ambient concentration. The four highest nickel concentrations in site sediments and soils were determined to be outliers (sampling locations TLSSB002, RADSBA07, RADSBF06, and RADSBH06).

- Eight sampling locations across the Tidal Area had selenium concentrations just above ambient levels: three in the R Area Terrestrial and Aquatic unit, two in the Wood Hogger Terrestrial unit, one in North Otter Sluice Aquatic unit, and two in South Otter Sluice Aquatic unit. The maximum concentration (4.8 mg/kg) was detected at the Wood Hogger Terrestrial unit.

- Eight sampling locations across the Tidal Area had zinc concentrations that exceeded ambient levels: three in the R Area Terrestrial unit, three in the Wood Hogger Terrestrial unit, and two in the Landfill Terrestrial unit. The two highest zinc concentrations in the Tidal Area were detected in soils at the Wood Terrestrial unit, which also contained copper or cadmium in high concentrations. These two soil samples had about 10 times the ambient concentration of zinc.

It should also be noted that in some cases, the ambient concentrations of inorganic constituents exceed the sediment guidance values (ER-L and ER-M). Specifically, Tidal Area ambient (99th percent UCL) values for antimony, arsenic, cadmium, copper, chromium, lead, mercury, nickel and zinc exceed the ER-L values. In addition, ambient (Tidal Area 99th percent UCL and RWQCB San Francisco Bay) concentrations of nickel exceed the ER-M value. As a result, concentrations of these chemicals were found to commonly exceed the sediment guidance values, even though the concentrations were below ambient values.

Lead, mercury, selenium, and zinc were found to exceed the ER-M frequently. Exceedances of the ER-M occurred most often for chemicals with ambient concentrations close to the ER-M. Conversely, concentrations of arsenic and chromium in sediment and soils never exceeded the ER-M, while cadmium and copper infrequently exceeded the ER-M. Wood Hogger Terrestrial unit sampling locations WHSSBI02 and WHSSBE04 had the highest cadmium concentrations, and Wood Hogger Terrestrial unit sampling location WHSSBH03 and Landfill Terrestrial unit sampling location TLSSB007 had the highest copper concentrations.

Mercury was detected at concentrations exceeding the ER-M in isolated sampling locations. Most of the sampling locations with the highest mercury concentrations appear to be along a transect in the southwest corner of the Wood Hogger Site and South Otter Sluice. The maximum concentration of mercury (18.5 mg/kg) was detected at the South Otter Sluice Aquatic unit. Another sampling location identified as having a high mercury concentrations (exceeding the ER-M value) was on the eastern edge of the Wood Hogger Site.

6.3.2.2 Inorganic Constituents in Surface Water

The descriptive statistics for inorganic constituents in surface water are detailed in Appendix N. Inorganic constituents were detected in surface water sampled throughout the Tidal Area. Aluminum, arsenic, cadmium, chromium, copper, lead, mercury, nickel, and zinc were detected in surface water samples at concentrations exceeding screening values. Arsenic exceeded AWQC in surface water from

the Froid and Taylor Roads Site only. Chromium exceeded surface water AWQC at the North Otter Sluice Aquatic unit only. The other inorganic constituents listed appeared to be more widely distributed across the Tidal Area.

6.3.2.3 Organic Constituents in Soil and Sediment

The descriptive statistics for organic constituents in soil and sediment are detailed in Appendix N. Pesticides, PCBs, and SVOCs (specifically PAHs) were frequently detected in samples collected throughout Tidal Area sites. Concentrations of some pesticides, such as DDT and its metabolites, chlordane, and dieldrin, were frequently above the ER-L, but rarely exceeded the ER-M. Total PCBs were never above the ER-M when samples were analyzed using the low detection limit (low level) method, but exceeded ER-Ms by the high detection limit (CLP) method because the sum was derived using one-half the detection limit for nondetects. The actual values for one-half the detection limit are higher with the CLP method than with the low level method.

TPH-motor, TPH-diesel, and TPH-gasoline concentrations were measured, but not compared to screening values. Instead, concentrations of total PAHs, individual PAHs, and other constituents that make up this class of contaminants were compared to screening values for chemicals in soil and sediment, as well as in surface water.

Soil samples from seven locations in the Wood Hogger Site were analyzed for dioxins and furans to delineate the extent of any potential contamination resulting from historical incinerator operations at the site. Individual dioxin congeners or PCDDs and PCDFs were all below detection limits in sediment samples, and only a few dioxin congeners were detected in Wood Hogger soil samples. When the analytical result for an individual dioxin or furan was below the detection limit, a value of one-half the sample detection limit was substituted as its concentration. Nondetected dioxins and furans made up most of the concentration on the basis of TEQs; less than 15 percent of the total TEQs was from detected PCDDs and PCDFs. Total PCDD and PCDF TEQ concentrations in soil at the Wood Hogger Site were approximately the same as or less than in sediments in Otter Sluice (less than 3.0 μg/kg TEQs). Actual detected concentrations of OCDDs, the congeners typically detected at the highest concentrations, were highest in Wood Hogger samples WHSSB009 and WHSSB016.

6.3.2.4 Organic Constituents in Surface Water

The descriptive statistics for organic constituents in surface water are detailed in Appendix N. Most organic chemicals were below detection limits in surface water samples; therefore, further evaluation of the data was not conducted.

6.3.3 COPECs Eliminated from Further Evaluation

Based on the results of the statistical evaluation, chromium, silver, thallium, and vanadium were determined to pose no potential risk to ecological receptors, and thus were not retained as COPECs. The rationale for removing these four metals from the list of COPECs is provided below:

- **Chromium:** The maximum concentration, also identified as an extreme value, was less than the ER-M. Only one hexavalent chromium was detected, the concentration of which was less than both ambient and ER-L; in general, hexavalent chromium is more toxic than trivalent chromium. Concentrations of chromium at all other locations were only slightly elevated above ambient.

- **Silver:** Although one location exceeded the ER-M, silver was not widespread in the Tidal Area. One extreme value and two outliers were identified in the Wood Hogger Terrestrial unit. In the terrestrial environment, silver is not considered to be highly phytotoxic; even high concentrations in soil appear to have little or no effect on plant growth. There is no evidence that silver is biomagnified in terrestrial animals (Adriano 1986).

- **Thallium:** With the exception of one extreme value at sampling location RADSB108 in the R Area Terrestrial unit, concentrations were close to ambient (2.2 mg/kg). The maximum concentration (5.4 mg/kg) was less than three times ambient. The published information on the effects of thallium on terrestrial microorganisms, plants, and animals is limited (ATSDR 1992). No toxicity benchmarks are available for thallium.

- **Vanadium:** With the exception of four outliers in the Wood Hogger Terrestrial unit, concentrations at all locations were close to ambient (96 mg/kg). Additionally, the maximum (163 mg/kg) was less than two times ambient. Published information on the toxicity of vanadium to terrestrial receptors is limited. No toxicity benchmarks are available for vanadium.

Five additional chemicals (aluminum, barium, cobalt, manganese, and nickel) were only identified as COPECs for specific habitat units, not the whole Tidal Area. Aluminum was a COPEC in the South Otter Sluice Aquatic unit and barium, cobalt, manganese, and nickel were COPECs in the R Area Terrestrial unit.

Aluminum was identified as a COPEC in the South Otter Sluice Aquatic unit only. Aluminum was elevated at sampling location WHSSB001 (42,000 mg/kg) in comparison to ambient (27,300 mg/kg). Two outliers and no extreme values were identified for aluminum. Aluminum was close to ambient levels at all other locations.

Barium, cobalt, manganese, and nickel were identified as COPECs in the R Area Terrestrial unit only. For each of these metals, only one elevated concentration, in comparison with ambient values, was observed. Barium was elevated at sampling location RADSBE07 (7,705 mg/kg as compared to the ambient concentration of 530 mg/kg) and cobalt was elevated at sampling location RADSBH06 (108 mg/kg as compared to the ambient concentration of 36 mg/kg). Manganese, with an ambient of 1,500 mg/kg, was elevated at sampling location RADSBI08 (6,300 mg/kg as compared to the ambient concentration of 1,500 mg/kg) and nickel was elevated at sampling location RADSBH06 (242 mg/kg as compared to the ambient concentration of 120 mg/kg).

All other inorganic chemicals (antimony, arsenic, beryllium, cadmium, copper, lead, mercury, molybdenum, selenium, and zinc) were identified as COPECs in all habitat units.

6.4 SUMMARY OF NATURE AND EXTENT OF CONTAMINATION

This section provides a brief summary of the nature and extent of contamination for each habitat unit and across all the Tidal Area sites, with a focus on chemicals and sampling locations of the highest concern.

6.4.1 Landfill Terrestrial Unit

Extreme or outlier values may indicate site releases. Lead and arsenic were elevated in two of eight soil samples. Copper was elevated in one sample. Maximum soil concentrations of nickel, zinc, DDTs, chlordanes, and LMW PAHs exceeded the ER-M.

6.4.2 R Area Terrestrial and Aquatic Unit

Several sampling locations indicated elevated levels of lead and arsenic, according to the outlier analysis. Barium, cobalt, manganese, and nickel were each elevated in only a single sample. Lead exceeded ambient values in many samples, but exceeded the ER-M in just five of 94 soil samples. Of the organic chemicals detected, only DDTs and chlordanes exceeded ER-Ms.

In surface water, lead, mercury, and zinc exceeded AWQCs in at least one sampling quarter. Of the organic chemicals detected in surface water, only DDTs and chlordanes exceeded AWQCs.

6.4.3 Froid and Taylor Aquatic Unit

Maximum soil concentrations of lead, nickel, nickel, zinc, DDTs, chlordanes, and LMW PAHs exceeded the ER-Ms. Of the inorganic chemicals for which the ER-M was exceeded, only lead was identified as an extreme value in the outlier analysis.

In surface water, only total chlordanes and total PAHs exceeded AWQCs for five sampling quarters. For the most part, inorganic chemicals did not exceed AWQCs.

6.4.4 Wood Hogger Terrestrial Unit

Chemicals detected at the Wood Hogger Terrestrial unit may represent site releases, based on the number of chemicals that exceeded the ER-Ms. For inorganic chemicals, ER-Ms were exceeded for cadmium, copper, lead, mercury, nickel, and zinc. Of the organic chemicals detected, 4,4'-DDT, total PCBs, and chlordanes exceeded ER-Ms. ER-Ms were exceeded in both surface and subsurface samples. ER-Ms were exceeded most often in the southern portion of the site. Dioxins were also detected at the site.

6.4.5 North and South Otter Sluice Aquatic Units

Six of 45 sediment samples exceeded the ER-M for mercury (0.71 ppm) in the North and South Otter Sluice Aquatic units. The maximum mercury concentration in sediments was detected in the South Otter Sluice Aquatic unit (18.5 mg/kg) along a gradient near the southwestern boundary of the Wood Hogger Terrestrial unit; an elevated mercury concentration was also detected in one sample in the Wood Hogger Terrestrial unit, indicating a possible site release of mercury. One sample in the North Otter Sluice Aquatic unit exceeded the ER-M for copper. Four of 45 samples exceeded the ER-M for zinc in both the North and South Otter Sluice Aquatic units.

In surface water, total chlordanes and total PAHs exceeded AWQCs for five sampling quarters. Copper was the only inorganic chemical that exceeded AWQCs for five sampling quarters.

6.4.6 All Tidal Area Sites

The following subsections summarize the nature and extent of contamination for soil and sediment, and surface water, across all the Tidal Area sites, with a focus on chemicals and locations of the highest concern.

6.4.6.1 Soil and Sediment

Analytical results for many inorganic chemicals exceeded screening values (ambient concentrations and ER-Ls) in sediment and soil samples. The sampling locations for these soils and sediments were distributed throughout the Tidal Areas rather than being clustered in any particular site. Similarly, pesticides, PCBs, and SVOCs (specifically PAHs) were frequently detected in samples collected throughout Tidal Area sites, but no spatial pattern of contamination was evident.

Based on the evaluation of inorganic and organic data, the areas of concern are near the edges of the sites (such as near railroad tracks, buildings, and roads) in areas of the most anthropogenic impact. In general, elevated inorganic and organic concentrations were found in isolated locations with the exception of the south end of the Wood Hogger Terrestrial unit, where lead, DDTs and other chlorinated pesticides, PCBs, and dioxins were clustered at several locations at concentrations exceeding screening values.

6.4.6.2 Surface Water

Most organic constituents were below detection limits in surface water samples. Conversely, inorganic constituents were detected in surface water sampled throughout the sites. Some of the highest concentrations were found in samples from the central portion of the R Area Disposal Site. However, concentrations of inorganic constituents that exceed AWQCs should be taken into context with concentrations of natural minerals present in water such as calcium and sodium. When these natural minerals are present at high concentrations, evaporative processes may have taken place in which other inorganic chemicals will be present at elevated concentrations. The data show that elevated concentrations of inorganic chemicals were found in site surface waters in late summer to early fall (July to October) when rainfall is scarce and water levels decrease. Sometimes the maximum concentrations occurred at other times of the year only because data were unavailable during the dry season. For samples analyzed in October 1995, the chemical concentrations were fairly consistently

elevated compared to other times of the year. A decrease in water level can result in increased concentrations of inorganic chemicals because of evaporation and the resulting change in equilibrium of the chemical between sediment and water. The concentration may not change if the chemical is at its water solubility. Chemicals can exist "dissolved" at concentrations above their reported solubility when they bind to dissolved organic matter which increases their apparent solubility.

Because surface water concentrations are affected by water levels, the surface water chemistry data may not correlate with sediment chemistry if samples were not collocated in time. Assuming that the sediment is the major sink or source of inorganic chemicals in surface waters, sediment chemistry is a better indicator of site contamination than surface water.

7.0 THE CONCEPTUAL SITE MODEL

The problem formulation phase of a QEA includes evaluation of current site conditions, characterization of chemical and physical stressors, identification of ecological endpoints to be used to evaluate risk, and development of a conceptual site model. Information on the facility background and setting, including site histories, was presented in Section 2.0. The extent and types of habitats and typical species observed at the Tidal Area, including potential physical stressors, were discussed in Section 3.0. The nature and extent of chemical contamination was presented in Section 6.0.

This section concludes the problem formulation phase with the identification of assessment and measurement endpoints and the development of the conceptual site model. The assessment and measurement endpoints represent hypothesized linkages among source stressors (chemical and physical) and natural resources (representative receptors) potentially at risk. The conceptual site model forms the basis for the ecological effects assessment and the risk characterization and defines the scope and goals of the risk assessment.

A complete conceptual site model integrates information on the sources of contaminants, nature and extent of contamination, fate and transport pathways of chemicals, complete exposure pathways to biological receptors, and assessment and measurement endpoints. The conceptual site model is illustrated on Figures 7-1 through 7-3, and described in the following text. Figure 7-1 identifies the sources of contamination and the transport mechanisms of chemicals that result in complete exposure pathways to biological receptors. Figure 7-2 is a food web identifying representative receptors and assists in evaluating ecological risks through several trophic levels, which may be especially important for chemicals that bioaccumulate. Figure 7-3 depicts transport and exposure pathways considered most important at the Tidal Area sites. Table 7-1 lists all assessment endpoints for the Tidal Area sites along with the rationale for their selection. Table 7-2 presents the methodology used for risk characterization.

7.1 SOURCES OF CONTAMINATION

The Tidal Area Landfill will be remediated by containment through capping. As a result, it is not considered further in this QEA except for its perimeter, where contaminants may have leached into the neighboring wetland of the R Area Disposal Site. The adjacent areas of the R Area Disposal (Site 2) and Froid and Taylor Roads (Site 9) Sites may contain remnants of landfill materials including solid waste (such as old cans), solvents, and munitions. The Wood Hogger (Site 11) contains wood scraps

and possible byproducts of wood combustion, in addition to PCP, a wood preservative. Otter Sluice is not expected to be a primary source of contamination, but constitutes a potential secondary source from transport of wastes from other sites.

7.2 NATURE AND EXTENT OF CONTAMINATION

Detailed discussions of the nature and extent of contamination at the Tidal Area sites, as well as identification of COPECs, are presented in Section 6.0. As discussed in Section 5.0, the screening process for COPECs included comparing chemical concentrations in soil, sediment, and surface water against screening values (such as ambient values, ER-Ls, and AWQC). The screening process for COPECs serves as a preliminary characterization of the nature and extent of contamination. The screening also served to preliminarily identify receptors most at risk, since the screening values were in part based on toxicological endpoints. However, the areas of contamination that pose the greatest risk to each receptor group cannot be fully understood until the risk to various receptors is characterized in more detail. Sections 10.0 through 15.0 contain detailed evaluations of the risks posed to each receptor group, including further evaluation of COPECs to identify COECs for each receptor group.

As discussed in Section 6.0, the evaluation of inorganic and organic data for soil and sediment indicate that the areas of highest concern are near the edges of the sites (such as near railroad tracks, buildings, and roads) in areas of the most anthropogenic impact. In general, elevated inorganic and organic concentrations were found in isolated locations with the exception of the south end of the Wood Hogger Terrestrial unit, where lead, DDTs and other chlorinated pesticides, PCBs, and dioxins were clustered at several locations at concentrations exceeding screening values.

For surface water, most organic chemicals were below detection limits in surface water samples. Conversely, inorganic constituents were detected in surface water samples throughout the sites. Some of the highest concentrations were found in samples from the central portion of the R Area Disposal Site.

7.3 FATE AND TRANSPORT

Potential pathways for contaminant mobilization and transport within the Tidal Area and to Suisun Bay include:

1. Groundwater-surface water interactions, including discharge of contaminants dissolved in groundwater to surface water in the Tidal Area and subtidal discharge of contaminants dissolved in groundwater to Suisun Bay.

2. Surface transport, including advective transport of contaminants in surface water (as a dissolved phase or absorbed to suspended particles or colloids) and wind-driven transport of soil particles.

3. Biotic transfer such as movement of contaminants in tissues of plants or animals at the site.

These transport pathways and processes and the potential for migration of site contaminants are discussed in the following sections and are depicted on Figure 7-3.

7.3.1 Groundwater-Surface Water Interactions

Groundwater contamination was addressed in detail in the groundwater confirmation sampling technical memorandum (TtEMI 1998b), which demonstrated that groundwater in portions of the Tidal Area sites contains arsenic, chromium, iron, nickel, and zinc at concentrations that exceed AWQC. Groundwater in the Tidal Area is not affected by organic contaminants. The metals concentrations in groundwater do not appear to form contaminant plumes emanating from sources in the Tidal Area; instead, metals in groundwater are characterized by isolated areas of elevated concentration both within and upgradient from the Tidal Area. Maximum groundwater concentrations of arsenic, chromium, and zinc were approximately twice the AWQC, and maximum concentrations of iron and nickel were approximately 35 times higher than the AWQC.

There are three principal possibilities for groundwater/surface water interaction in the Tidal Area sites: (1) subtidal discharge of groundwater to Suisun Bay; (2) direct discharge of groundwater to Otter Sluice or ponded areas; and (3) lateral infiltration of surface water into and out of the landfill during seasonal flooding of the R Area Disposal Site. The groundwater technical memorandum (TtEMI 1998b) showed that shallow groundwater flow in the Tidal Area site is directed radially toward depressions in the water table in the center of the R Area Disposal Site and north of the Wood Hogger Site; therefore, subtidal groundwater discharge to Suisun Bay does not appear to be a significant concern.

Subsurface soil throughout the Tidal Area sites is largely composed of Bay Mud, a low permeability silty clay unit. The low permeability of the Bay Mud is expected to inhibit groundwater flow and limit the exchange of groundwater and surface water; therefore, groundwater discharge from the Tidal Area

to Otter Sluice does not appear to be a significant transport mechanism. A tidal influence study conducted as part of the RI indicated a limited amount of groundwater/surface water interaction in a narrow band adjacent to Otter Sluice. Groundwater within about 75 feet of Otter Sluice experiences flow reversals caused by tidal variations in Otter Sluice, and may discharge to Otter Sluice to a limited extent. However, the water level in Otter Sluice is higher than adjacent groundwater elevations throughout most of the tidal cycle, indicating that surface water from Otter Sluice typically recharges groundwater.

Seasonal flooding occurs during the rainy season in the R Area Disposal Site and other locations in the Tidal Area (see Figure 2-2) and brings surface water in close proximity to groundwater. However, hydraulic gradients are directed downward during these periods of flooding because the surface water elevation is always higher than the groundwater elevation. Therefore, groundwater does not discharge vertically to surface water to a significant extent during seasonal flooding.

Seasonal flooding brings surface water into the R Area Disposal Site and into contact with the perimeter of the landfill. The landfill perimeter is covered with a veneer of soil and vegetation, which is likely to be permeable. As a result, surface water is likely to infiltrate laterally into the landfill during the seasonal flooding of the R Area Disposal Site, come in contact with refuse in the landfill, and flow out of the landfill as surface water levels drop in the R Area Disposal Site. Infiltration and exfiltration from the landfill during seasonal flooding at the R Area Disposal Site is the primary groundwater/surface water pathway of concern in the Tidal Area. Installing a landfill cap that covers the surface and sides of the landfill and extends down into the Bay Mud (the proposed remedy recommended in the draft record of decision for the landfill site [TtEMI 1998d]) is expected to effectively eliminate this potential migration pathway.

7.3.2 Surface Transport Pathways

The main mechanism for surface transport of contaminants is advective transport with moving surface water. Contaminants can be transported either as a dissolved phase (for example, salts precipitated on the ground surface dissolving in surface water during flooding) or sorbed to suspended particles that become entrained in the water column by resuspension or scouring during flooding. Surface water from the Tidal Area drains through Otter Sluice because the sites are bounded by elevated roadways and railroad tracks south, east, and north of the Tidal Area. Because the Tidal Area is bounded by elevated surface features, overland runoff of contaminants is not a likely transport pathway. Surface

water floods and drains from the R Area Disposal Site and the perimeter of the Wood Hogger Site during extreme tides during the rainy season (for example, when winter storms coincide with high tides), but exchange of surface water between Otter Sluice and the Tidal Area sites is limited during the dry season.

Wind-borne dispersion of contaminants is another possible transport mechanism in the Tidal Area. The predominant wind direction is from the west, and strong west winds are common during the summer months. Therefore, wind erosion would be expected to transport contaminants primarily east of the site. The erosive potential of the winds is mitigated to a significant degree by site vegetation and the hydric nature of soils in many parts of the site. The R Area Disposal, Tidal Area Landfill, and Froid and Taylor Roads Sites are mostly covered with a thick mat of vegetation, which is expected to hold soils in place and prevent wind erosion. A few locations in the R Area Disposal Site and a large paved area in the Wood Hogger Site are devoid of vegetation, and surface soils in these areas may be subject to wind dispersal.

7.3.3 Biotic Transfer of Contaminants

Contaminants may be transported within or between sites in animal tissues. Contaminants in the bodies of mobile receptors such as fish, migrating birds, flying insects, and far-ranging predators may be carried off site and deposited in other locations as feces or corpses. In addition, contaminant distribution and partitioning are affected by burrowing animals such as amphipods and fish in wetland and aquatic environments.

7.4 COMPLETE EXPOSURE PATHWAYS

Complete exposure pathways between COPECs and many groups of ecological receptors occur at all the Tidal Area sites. The routes of exposure of highest concern at the Tidal Area sites are (1) exposure of plants, invertebrates, and fish to chemicals in soil, sediment, and surface water, and (2) exposure of vertebrates to chemicals ingested directly or indirectly in the diet.

Plants and animals at the Tidal Area may be exposed directly to chemicals in environmental media such as soil, sediment, and surface water. Figure 7-1 shows the complete exposure pathways of chemicals from their source to the receptors at risk. Primary releases to soil, sediment, and surface water can result in direct exposures to potential receptors or secondary exposures after transport and partitioning processes between environmental compartments of air, water, soil, sediment, and biota.

Plants at the site may take up chemicals directly from soil or surface water. The soil environment around the roots of plants is an important factor in the availability of chemicals for uptake. Factors such as pH, soil texture, and organic matter content can strongly influence the exposure of plants. The major exposure route for plants to organic chemicals is from atmospheric deposition, in which contaminants enter aboveground vegetation through stomata or diffusion through plant surfaces.

Plants also translocate chemicals to leaves and stems that are eaten by herbivores. In turn, transport of chemicals up the food chain and biomagnification of some chemicals are of concern for predators (secondary and tertiary consumers) feeding in the Tidal Area. Many species ingest sediment or soil particles directly while feeding (oligochaetes, filter feeders, demersal fish, and shorebirds) in aquatic environments or wetlands. Detritivores, such as insects and earthworms, ingest contaminated soil and detritus in the process of feeding in upland habitats. Larger predators, such as herons, egrets, waterfowl, and raptors, ingest sediment or soil indirectly while capturing prey, preening, or grooming (Beyer and others 1994). Mammals and birds also incidentally ingest soil and sediment in the guts or on the bodies of their prey.

7.5 ASSESSMENT AND MEASUREMENT ENDPOINTS

According to EPA (1998), assessment endpoints are environmental characteristics or values which, if found to be significantly affected, would indicate a need for a response action. Assessment endpoints reflect an attempt to incorporate values into the QEA process and are generally developed from an environmental management perspective.

Measurement endpoints, on the other hand, more closely reflect technical considerations in the risk analysis component of the assessment process (EPA 1992); that is, measurement endpoints are designed as surrogates for assessment endpoints, to provide empirical data as the basis for the risk assessment. Measurement endpoints are quantitative measures of ecological exposure and effects, and include qualitative or quantitative descriptions of habitats, populations, or communities at risk, biological measures of toxicity, and derived estimates of risks (such as food-chain analysis).

For the Tidal Area, assessment endpoints focused on habitats as well as representative receptors, while measurement endpoints focused on analytical tools or techniques used to estimate risk. The following sections describe the assessment and measurement endpoints selected for the Tidal Area sites.

7.5.1 Selection of Assessment Endpoints

Selection of assessment endpoints for the Tidal Area focused on maintaining upland and wetland habitat and reducing the risk to wildlife populations from chemical stressors. Wetland quality in the Tidal Area has been affected by water and vector management such as diking and alteration of flow patterns that are outside the scope of this risk assessment. Instead, the risk assessment focused on the chemical stressors at the sites given the current condition, function, and sustainability of the wetlands. The assessment endpoints at the Tidal Area include the following:

- Protection of populations of upland and wetland plants
- Protection of populations of benthic invertebrates
- Protection of populations of terrestrial invertebrates and soil biota
- Protection of fish communities
- Protection of populations of birds in wetland and upland habitats including piscivorous species and shorebirds
- Protection of populations of raptors
- Protection of populations of carnivorous mammals
- Protection of individual species with threatened or endangered status, specifically the salt marsh harvest mouse and California Black Rail

Some groups were selected as assessment endpoints because they represent the base of the food web that supports the ecological community. Some taxa were selected as representative species because they are rare and valued by society as evidenced by their conservation status, such as the salt marsh harvest mouse and the California Black Rail. Some of the selected representative species also have recreational value for birdwatchers and naturalists across the state and country. Finally, protection of higher trophic level organisms necessitates inclusion of lower level trophic level organisms, such as plants, that provide habitat and food for higher level organisms.

Toxicological concerns also guided the selection of representative receptors and endpoints; the inclusion of metals and metalloids as COPECs requires that exposure to lower trophic level species such as benthic invertebrates be evaluated. Some bioaccumulating chemicals, such as mercury, dioxins, pesticides, and PCBs, are of concern especially to higher level species. Factors considered included the sensitivity of representative receptors to effects of COPECs, the potential fate of chemicals

in terms of biogeochemical processes and bioaccumulation, and dominant exposure routes of ingestion for contaminated prey and media. Assessment endpoints were chosen to address the risk posed through all major exposure pathways considered important at this site.

7.5.2 Measurement Endpoints

Selected measurement endpoints are listed in Table 7-1. Measurement endpoints included analytical measures of exposure such as chemical concentrations in tissue, soil, sediment, and water, and measures of effects such as soil and sediment toxicity tests. The primary measurement endpoints for the Tidal Area included the following:

- Comparison of site-specific concentrations of chemicals in sediment and surface water to screening values, such as ER-Ls and AWQC, thought to be protective of aquatic life
- Characterization of soil and sediment using limited physicochemical measurements
- Comparison of concentrations of chemicals in soils to benchmark values for invertebrates and terrestrial plants
- Biological assessment of soils using Microtox and Cytochrome P450 evaluations
- Toxicity testing of whole sediments using amphipod (direct sediment assessment) and topsmelt (testing at the sediment-water interface)
- Evaluation of quantitative risks to indicator wildlife species (terrestrial vertebrates) through a food-chain analysis using an HQ approach.

An evaluation of soils was considered critical to the analysis of exposure and ecological effects. The field survey data were augmented by analysis of soils to develop a comprehensive risk characterization. Soil analysis is especially useful in discriminating between adverse ecological effects caused by chemical contaminants and those associated with physical disturbance of habitat or other confounding factors characteristic of the soil matrix itself (for example, ambient toxicity associated with the intrinsic geochemistry of the soils). Soil parameters included an analysis of particle size and pH and determination of total organic matter. Much of the information about the soils at the Tidal Area was based on Natural Resource Conservation Service documentation (Welch 1977) for habitats in Contra Costa County similar to the Tidal Area.

Risk to aquatic life was evaluated by comparing site-specific concentrations of contaminants to screening values and other benchmarks designed to be protective of aquatic life, and by conducting limited toxicity testing. Also, for predicting risk, fish and amphipod tissues collected from the Tidal

Areas were examined and body burdens of contaminants were compared to effects reported in the literature.

Risk to plants and soil-dwelling invertebrates, important to the health and functioning of wetland and upland habitats, was evaluated by comparing site contaminant concentrations to screening values (ER-Ls and ER-Ms) and other benchmarks associated with adverse effects based on scientific literature.

Representative vertebrate receptors were considered in the context of foraging guilds (Angus 1991). Several guilds may be exposed to site-related COPECs at the Tidal Area. Risk to terrestrial and aquatic vertebrates was evaluated through food-chain analysis for representative receptors.

7.5.3 Food Web

Trophic linkages occur among habitats at the Tidal Area as mobile animals feed in or use more than one habitat type. These linkages are illustrated on Figure 7-2, a simplified model food web of aquatic and terrestrial species that represent habitats at the Tidal Area. For example, decaying organic matter and wetland plants, such as pickleweed and algae, are consumed by aquatic and terrestrial herbivorous invertebrates, including aquatic organisms such as clams, crustaceans (including bay shrimp and amphipods), insects (for example, water boatmen), and polychaetes (worms). Although terrestrial invertebrates were not assessed in WESCO's 1994 study (with the exception of aquatic larval stages of terrestrial insects such as dragonfly nymphs), herbivorous terrestrial invertebrates at the site include insects and probably soil-dwelling organisms such as earthworms. Wetland and upland plants are also consumed by terrestrial herbivorous and omnivorous birds and mammals such as the Suisun Song Sparrow, Cliff and Barn Swallows, black-tailed hares, California voles, and salt marsh harvest mice. In aquatic habitats, herbivorous and omnivorous fish such as topsmelt and yellowfin gobies, as well as western pond turtles, include some plant material in their diet. Shorebirds (such as Black-necked Stilts and Sanderlings) and waterfowl (such as Mallards and Gadwalls) in the wetlands forage for benthic invertebrates.

The top trophic levels of predators include primarily avian and mammalian species. Raptors observed in the Tidal Area sites, such as Northern Harriers, prey on birds and mammals. Wading birds, such as Great Blue Herons, are top trophic level predators of fish, amphibians, birds, and small mammals. Mammalian predators observed in the Tidal Area include coyotes, gray foxes, river otters, and the non-native red fox. Coyotes and foxes consume birds and mammals, and the river otters eat mainly fish and invertebrates.

The habitats at each site in the Tidal Area are, to some extent, separated by physical barriers. Roads, dikes, ditches, and buildings may be effective barriers for some species to immigration and emigration. The small home range or sedentary habits of some species may restrict their exposure to only portions of a site. For example, a salt marsh harvest mouse has a home range of about 1,000 to 3,000 square meters (Bias 1994). As a result, individual salt marsh harvest mice may spend their entire lives within the R Area Disposal Site, for example.

In contrast, many mobile predators (most birds and larger mammals) are very likely to range among habitats in the Tidal Area sites. For example, loggerhead shrikes were observed both along Otter Sluice bordering the emergent brackish marsh habitat and in the seasonal brackish/salt marsh mosaic habitat; they are likely to range over the entire Tidal Area in search of insect and vertebrate prey (WESCO 1995). Great Blue Herons were observed only in aquatic habitats, but they may also forage in upland habitats for small mammals. Northern Harriers, observed in both aquatic and upland habitats, probably forage over the entire Tidal Area in search of birds and mammals. Studies by Craighead and Craighead (1969) in Michigan reported that harriers traveled up to 8.8 kilometers from their roosting area, and then hunted in an area of 12 to 260 hectares. Northern Harriers have been observed nesting throughout the wetlands of NWS SBD Concord.

Top mammalian terrestrial predators, such as red and gray foxes and coyotes, were observed in both upland and aquatic habitats and most likely range over the entire Tidal Area in search of prey. Although the typical home range of a red fox is 1 to 2 square miles, they often travel great distances; some have moved 126 miles from their birth den (Burt 1964). Sheldon (1992) reported a home range of 30 to 40 hectares for gray foxes in California. The home range of the gray fox in other parts of the United States has been estimated at 0.13 to 7.7 square kilometers (Trapp and Hallberg 1975). Coyotes have a hunting route of about 10 miles, but may move up to 100 miles (Burt 1964). The home range of the river otter in the Bay Area is unknown, but they are expected to travel well beyond a single site. Otters have been observed intermittently in the Litigation Area of NWS SBD Concord (PRC 1996b).

Although the roads and ditches are potential barriers to movement among or access to different habitats for some species, they may serve as travel corridors for other species (WESCO 1995). For example, river otters were observed in a number of aquatic habitats. Otter Sluice connects several habitats, and may be used as a corridor. Norway rats may also use roads and ditches to gain access to various habitats. Roads in the Tidal Area may also be used by canids to travel between habitats (WESCO 1995).

7.5.4 Representative Vertebrate Receptors

Because initial contaminant releases were to soils, exposure pathways related to surface soils were of highest concern. However, contaminants in soils often migrate to wetlands, so sediment and surface water pathways were also of potential concern. In addition, contaminated prey may contribute risk to higher trophic level predators. Food-chain analysis has been increasingly applied as a tool to evaluate risks to representative receptors (Pascoe and others 1994a, 1996). The route by which a chemical enters an organism influences the risk analysis. The risk posed by dermal exposure to a chemical is not necessarily equal to ingestion of the same chemical. Additionally, life history traits affect exposure and susceptibility to contaminants. This section describes some life history traits of representative receptors that are relevant to the exposure and effects analysis of the risk assessment.

For the Tidal Area conceptual food web, the representative vertebrate receptors evaluated by food-chain modeling are as follows:

- Salt marsh harvest mouse (*Reithrodontomys raviventris*)
- Gray fox (*Urocyon cinereoargenteus*)
- Northern Harrier (*Circus cyaneus*)
- River otter (*Lutra canadensis*)
- Black-necked Stilt (*Himantopus mexicanus*)
- California Black Rail (*Laterallus jamaicensis coturniculus*)
- Great Blue Heron *(Ardea herodias)*

Section 15.0 presents the exposure assessment and risk characterization for the representative avian and mammalian receptors.

The western pond turtle was evaluated as a representative receptor for herpetofauna by evaluating risk to chemicals in surface water (see Section 14.0). However, protection of herpetofauna was not specifically identified as an assessment endpoint. Risk to the western pond turtle was not evaluated by food-chain modeling, however, due to inaccurate information on the trophic ecology of many reptiles and amphibians in general, and the lack of site-specific data on habitat utilization, ingestion rates, and feeding preferences in particular.

A brief natural history of each representative receptor follows:

Salt Marsh Harvest Mouse (*Reithrodontomys raviventris*). The salt marsh harvest mouse, a federal and state endangered species, is a small, long-tailed mouse found only in saline emergent wetlands of San Francisco Bay. It may be locally common in its preferred habitat, but its present distribution is highly restricted (Zeiner and others 1990a). Commercial and residential development around San Francisco Bay and other related factors have resulted in widespread loss of pickleweed habitats, causing population declines (Crabtree and Thelander 1994).

This mouse depends on dense cover and is restricted to tidal and diked salt marshes, where its preferred habitat is pickleweed. It inhabits the uppermost zone of tidal marshes and seldom-flooded transitional zones. Given the proper moisture regime, it can live in a variety of salt marsh habitats dominated by pickleweed and associated wetland and transitional plants (Shellhammer 1989). Grasslands adjacent to pickleweed marsh may be used for foraging when new grass growth affords suitable cover in spring and summer (Fisler 1965; Shellhammer 1982). Nonsubmerged, salt-tolerant vegetation for escape during highest tides is essential for protection from predators (Shellhammer and others 1982). If nests are constructed, they are built on the ground of grass and sedge (Zeiner and others 1990a). Litter size averages four to six, and some females may raise two litters each year (Ingles 1965).

Seeds and green vegetation make up the diet of the salt marsh harvest mouse; however, Fisler (1965) found a great deal of seasonal variation in stomach contents. The salt marsh harvest mouse occurs with the closely related western harvest mouse at the upper edges of marshes and in marginal areas, but replaces the western harvest mouse in denser stands of pickleweed (Zeiner and others 1990a). The salt marsh harvest mouse is known to occur at the R Area Disposal Site. Predators include hawks, owls, gulls, weasels, snakes, and other mammals (Whitaker 1980).

Gray Fox (*Urocyon cinereoargenteus*). The gray fox is found at low to middle elevations throughout most of the United States and all but the extreme northeast portion of California (Burt and Grossenheider 1976; Zeiner and others 1990a). It is found in many types of habitats. Trapp and Hallberg (1975) describe its preferred habitat as shrublands and brushy woodland, on hilly, rough, rocky, or broken terrain. Zeiner and others (1990a) report that California habitats include shrublands, valley foothill riparian, montane riparian, and brush stages of many types of woodland. It may be found in association with cultivated areas throughout its range (Sheldon 1992). A year-long resident, the gray fox is primarily nocturnal or crepuscular, but is occasionally active during the day

(Ingles 1965). It has been observed in both the aquatic and upland habitats of the Froid and Taylor Roads, Wood Hogger, and R Area Disposal Sites (WESCO 1995).

Gray foxes live in dens. Although they prefer to den in natural cavities, rock piles, snags, logs, slash piles, hollow trees, and under buildings, they will sometimes dig or enlarge an existing burrow (Zeiner and others 1990a). The gray fox is the only American canid with true tree-climbing ability (Sheldon 1992). Nest materials are usually dry grass, leaves, or shredded bark (Sheldon 1992). Litter size ranges from two to seven (Fritzell and Haroldson 1982); most births occur in April.

Feeding patterns vary considerably with season and locale. The gray fox is generally omnivorous and opportunistic, eating mammals, insects, fruits, birds, carrion, plants, grains, and nuts (Trapp and Hallberg 1975; Sheldon 1992). Adults have few predators, but large hawks, Golden Eagles, Great Horned Owls, domestic dogs, and bobcats may prey on pups (Zeiner and others 1990a). (Golden Eagles are special status species as discussed in Section 3.3 and presented in Table 3-4.)

Northern Harrier (*Circus cyaneus*). The Northern Harrier, a California species of special concern, is a low-flying, medium-sized raptor that inhabits most of California. It is a year-long, diurnal resident of the coast, the Central Valley, and the northeastern corner of California, and is found throughout North America. Its winter range in California is nearly twice the size of its breeding range (Zeiner and others 1990b); many individuals migrate into or through California during the winter. It is known to inhabit the project area in both the aquatic and upland habitats of the R Area Disposal Site, Tidal Area Landfill Site, and Otter Sluice (WESCO 1995).

Northern Harriers in California occur in habitats ranging from annual grassland up to lodgepole pine and alpine meadow, breeding from sea level up to 5,700 feet (Zeiner and others 1990b). They frequent meadows, grasslands, open rangelands, desert sinks, and fresh and saltwater emergent wetlands; they are seldom found in wooded areas (Stokes and Stokes 1996; Palmer 1988). They nest on the ground in shallow, slightly hollowed platforms (Bent 1937; Palmer 1988) that may simply be lined with grasses or, particularly in damp places, built up with sticks, straw, reeds, and weed stems, and lined with finer vegetative parts and moss or feathers (Shuford 1993). Clutch size averages from four to six, and eggs are laid from March through July.

Northern Harriers are opportunistic feeders, but their distribution seems tied closely to the presence of small, diurnal, primarily microtine rodents and, perhaps, to birds to some extent (Shuford 1993). They exploit whatever prey are readily available, which results in great dietary variation among seasons and

localities (Shuford 1993). They eat mammals, birds, snakes, lizards, toads, frogs, fish, crayfish, large insects, and spiders (Shuford 1993), taking the greatest variety of prey items in spring and summer and relying more on voles and carrion in the winter. Northern Harriers are thought to compete with red-tailed and red-shouldered hawks for food (Zeiner and others 1990b). They have no natural predators.

River Otter (*Lutra canadensis*). The river otter is widespread in Canada and the western and southwestern United States. It has been found in estuaries and coastal areas throughout the Sacramento-San Joaquin Delta and in Suisun Bay (Zeiner and others 1990a). River otters inhabit quiet sloughs and areas with high vegetation cover associated with a large water source (Liers 1951). The river otter has been observed in the Otter Sluice.

River otters do not dig their own burrows or breeding dens, but utilize thickets of vegetation or enlarge existing burrows (Zeiner and others 1990a). It is not known if otters are currently breeding in the Tidal Area.

River otters eat primarily fish and also crustaceans, amphibians, reptiles, birds, and insects. Grenfell (1978) reported that crayfish were the most important food for otters in Suisun Marsh, with waterfowl (ducks and rails) as secondary sources.

Black-necked Stilt (*Himantopus mexicanus*). The Black-necked Stilt is a long-legged shorebird and year-long resident of the saline emergent wetlands and seasonally ponded wetlands of the Tidal Area. The Black-necked Stilt commonly breeds in both freshwater and saltwater habitats during winter; they nest on the ground with an average clutch size of four (Ehrlich and others 1988). Their nest sites may be open or partially concealed on dry, water-bounded mounds above the tideline. Stilts forage on insects, primarily brine shrimp and brine flies (Hamilton 1975), crustaceans, mollusks, other aquatic invertebrates, and some small fish, amphibians, and reptiles (Zeiner and others 1990b). Stilts generally glean and probe for prey in mud and shallow water (Ehrlich and others 1988).

California Black Rail (*Laterallus jamaicensis coturniculus*). The California Black Rail is currently a federal species of concern and is listed as threatened by CDFG (1998). Black rails were observed near the North Otter Sluice Aquatic unit (see Section 3.0). Black rails are difficult to spot, so are detected using vocalizations. Due to their secretive nature, little is known of their life history or behavior. The foraging habitat is presumed to be on or near substrate at the edges of stands of emergent vegetation. Preferred habitat for the black rail was described by Grinnell and Miller (1944) as chiefly tidal salt

marshes, associated characteristically with heavy growths of pickleweed (*Salicornia*), but the rail also inhabits brackish and freshwater marshes. A later study by Manolis (1978) confirmed this description, finding 95 percent of black rails in marshes dominated by either *Salicornia virginica* or bulrush (*Scirpus* spp.). Black rails need high (damp ground and shallow water) marshes with little annual or daily fluctuations in water levels.

The black rail feeds on isopods, insects, and other arthropods from the surface of mud and vegetation (Zeiner and others 1990b).

Great Blue Heron *(Ardea herodias).* The Great Blue Heron feeds in shallow or open waters in the Tidal Area. The diet of the Great Blue Heron is diverse; however, it typically consists of about 75 percent fish (Cogswell and Christman 1977), with the remainder made up of rodents, amphibians, reptiles, insects, crustaceans, and small birds (Zeiner and others 1990b).

The Great Blue Heron is found in shallow estuaries and saline and freshwater marshes across North America from Alaska to Mexico, with both migratory and resident populations in North America. According to Bayer (1978) as cited in Butler (1992), the size of defended foraging territories of Great Blue Herons in Oregon ranged from 0.6 hectares in a freshwater marsh to 8.4 hectares in an estuary. According to EPA (1993), the distance from the heronry to the nearest feeding area varied from 0 to 34 kilometers. Males assist females in nest-building. Females typically produce four eggs (Terres 1980).

Adult Great Blue Herons seem to have no natural predators because very few would attack such a large bird (Bent 1926). Great damage, however, is done to their eggs and nestlings by crown, ravens, all raptors, probably gulls, and raccoons. Populations in the wild have been declining this century, most likely due to loss of habitat (English 1978).

Western Pond Turtle (*Clemmys marmorata*). Western pond turtles are typically associated with permanent ponds, lakes, streams, irrigation ditches, or permanent pools along intermittent streams. The western pond turtle is an omnivore, feeding on aquatic plant material, a variety of aquatic invertebrates, fishes, frogs, and even carrion. Individuals frequent areas with adequate basking sites, such as partially submerged logs, rocks, mats of floating vegetation, or open mud banks. Two distinct habitats have been described for the deposition of eggs: nests constructed in sandy banks along large, slow moving streams; and along foothill streams, where females may climb hillsides and travel considerable distances to find a suitable nest site. Western pond turtles are mostly diurnal, although crepuscular and nocturnal activity have been observed. Pond turtles are active all year in the warmer

parts of their range and hibernate in areas with colder climates. Clutch sizes range from 3 to 11 eggs, which are laid from March to August. Sexual maturity is reached at about 8 years (Zeiner and others 1988).

7.5.5 Use of Assessment and Measurement Endpoints in Evaluating Risk

The tissue residue data and bioassays used as measurement endpoints are presented in Section 8.0. Bioavailability of site contaminants in soil and sediment is an important issue to be considered in the risk assessment. Section 9.0 discusses bioavailability of contaminants, determined by evaluating tissue residue data and measured physicochemical properties of soil and sediment in the Tidal Area in conjunction with bulk or leachate chemistry of soils and sediments. The risk to various receptor groups was assessed using a weight-of-evidence approach. An evaluation of bulk chemistry of site soil, sediment, and organisms (pickleweed, fish, clams, and rodents) was used as the first line of evidence in assessing risk to various receptor groups.

Concentrations of contaminants in soil were compared to benchmarks for plants (see Section 10.0) and soil biota and invertebrates (see Section 11.0). The risk to fish (see Section 12.0) and herpetofauna (see Section 14.0) was presumed based on levels of chemicals that exceed AWQC. For aquatic invertebrates, concentrations of contaminants in sediments were compared to ER-Ls and ER-Ms to evaluate the relative magnitude of potential risk (see Section 13.0). For birds and mammals (see Section 15.0), food-chain modeling was used to estimate exposure, and doses were compared to TRVs as the primary method for assessing risk. Tissue residue data of all receptor groups were also compared to regional background data as an indication of contamination.

8.0 BIOASSAY AND TISSUE RESIDUE RESULTS

This section summarizes the results of four bioassays and tissue residue analyses conducted for the QEA at the Tidal Area sites. The results of the bioassays and tissue residue analyses will be used in subsequent sections in a weight-of-evidence approach to evaluate risks to specific receptor groups. Sections 8.1 and 8.2 present the results of soil testing by Microtox and Cytochrome P450 conducted for the draft QEA. The results of the whole sediment amphipod bioassay conducted in 1998 are presented in Section 8.3; the results of the SWI test using topsmelt embryos conducted in 1998 are presented in Section 8.4. The results of the tissue residue analysis of plants and animals collected at the site are discussed in Section 8.5; tissue types analyzed included rodent, pickleweed, amphipod, clam, and fish.

8.1 MICROTOX TEST

Microtox relies on measurements of bioluminescence to evaluate a sample's toxicity (EPA 1989; Linder and others 1992). The test, whether aqueous or solid phase, uses freeze-dried cultures of the marine bacterium *Vibrio fisheri*. This bacterium is bioluminescent and produces light; the reaction is the oxidation of a substrate, luciferin, to oxyluciferin that releases energy as light (photons). The reaction is catalyzed by the enzyme luciferase, and is energetically driven by adenosine triphosphate (ATP). Certain chemicals interfere with this reaction by altering cellular respiration (energetic metabolism), affecting the availability of ATP.

The results of solid-phase testing with Microtox generally do not correlate with results obtained using whole organisms such as amphipods (Montgomery and others 1994) because amphipods may be affected by many mechanisms other than cellular respiration. For chemicals that affect cellular respiration, Microtox may be more sensitive than whole organism bioassays, and Microtox tests have better reproducibility than whole organism bioassays (Montgomery and others 1994).

8.1.1 Methods

Forty-nine surface soil samples (0 to 0.5 feet bgs) and one duplicate were collected and subjected to solid-phase and organic-extraction Microtox tests by a commercial laboratory (Inchscape Testing Services, Inc.). Sampling locations are shown on Exhibit 3. In the test, luminescent bacteria were exposed to soils to measure the inhibitory or stimulatory effects of soil constituents on culture metabolism. Changes in the intensity of light output from the bacteria were measured, and biological effects estimated from screening tests (using 100 percent sample matrix without dilution) or

concentration-response curves that yield EC50s (concentration of sample associated with a 50 percent reduction in light intensity) from plotted data. Unlike the aqueous-phase Microtox test that directly tests the liquid sample, the solid-phase test requires a pretesting extraction step. During extraction, a micro-eluate is prepared from a soil sample (about 0.3 gram), then incubated at 15 °C. Following incubation, the soil-diluent slurry is filtered, and the filtrate is subsequently analyzed using the Microtox analyzer. Solid-phase Microtox was developed to directly test solid materials such as soils, sediments, dredge materials, and sludges. Although solid-phase Microtox does not directly test soil particle-organism interactions, the direct incubation step allows for indirect evaluation of soil contamination, particularly adsorbed materials that are relatively bioavailable owing to their solubility (Ross and others 1997).

8.1.2 Results

Results of the Microtox analyses are included in Table 8-1. Tables 8-10 through 8-12 present summary matrices for correlations between the Microtox results, Cytochrome P450 results, and concentrations of selected COECs. All summary statistics were reduced from full data sets using StatMost (DataMost Corporation 1995) and GeoEAS (EPA 1988) (see Appendix R). In addition to the summary statistics and correlation analyses, tests for normality and variance homogeneity were completed. Qualitative comparisons of these reduced data sets suggested that soil samples collected for the biological and ecological effects assessment could be considered a representative subset of the data collected for the RI.

Although reference conditions cannot be directly evaluated from the current data set, the samples collected throughout the Tidal Area sites displayed similar biological activity (mean EC50 for organic-extracts of 0.8 to 1.1 percent; mean EC50 for solid phase of 0.51 to 1.1 percent). Some soil samples presented elevated but not statistically significant biological activities compared to other soils collected throughout the Tidal Area. That is, Neuman-Keul's Test (parametric procedure) and Tukey's Test (nonparametric procedure) indicated no significant differences ($p > 0.05$) for Microtox results from various Tidal Area sites. Additionally, exploratory data analysis using Spearman Rank and Pearson correlation analysis demonstrated no consistently significant correlations in effects associated with organic constituents in soil (see Tables 8-11 and 8-12). The results of the correlation analysis, however, indicated that variables throughout the biological and chemical data sets were not independent.

Microtox inhibition was similar in soils collected from the R Area Disposal Site to the Froid and Taylor Roads and Wood Hogger Sites. Statistically significant correlations ($p < 0.05$) were identified between the WET-acid concentrations of copper and lead and solid-phase Microtox. Organic extraction Microtox correlated with WET-acid, but not with bulk or WET-DI concentrations of lead. WET-DI concentrations of arsenic and copper correlated with solid-phase Microtox, and total metal concentrations of cadmium and nickel correlated with organic-extraction Microtox. Overall, Microtox did not indicate any spatial variability across the Tidal Area sites (that is, Microtox activities were similar for samples collected from all three sites).

8.2 CYTOCHROME P450 TEST

An evaluation of the ability of soil extracts to induce mixed-function oxidase (MFO) systems may be important in assessing soil contamination, especially for evaluating ecological risks associated with long-term, relatively low-level exposures. A gene of the P450 MFO system, CYP1A1, codes for enzymes that can either detoxify (and facilitate excretion) or bioactivate chemicals (making them more toxic). In addition, P450 activation is a biomarker for exposure to chemicals.

The Cytochrome P450 test system used on Tidal Area soil samples has been evaluated in peer-reviewed literature (Anderson and others 1995; Anderson 1995). The test method is standardized through ASTM (1997). In brief, the test uses human hepatoma cells containing the human P450 CYP1A1 gene that has a firefly luciferase gene (reporter gene) fused to it. Luciferase is an enzyme involved in a bioluminescent reaction that produces light. When the P450 is induced, the CYP1A1 locus in this cell line produces luciferase and light is given off. The amount of light is proportional to the amount of the P450 induction.

Both the Microtox and P450 assays use bioluminescence to measure their effects, but the mechanisms are different. Whereas the Microtox tests for effects on cellular respiration, P450 tests for enzyme induction (in this case, the luciferase). For P450 induction, a chemical binds to the aryl hydrocarbon receptor (AhR) in the hepatoma cell, which triggers the transcription of the gene that in turn produces the luciferase. Chemicals that bind to the AhR receptor cause the enzyme induction. As the name implies, these chemicals tend to be aromatic hydrocarbons such as PAHs, PCBs, and dioxins. Hence, testing with P450 indicates that these types of chemicals are active in soil or sediment. Organic compounds that bind to the Ah-receptor and induce CYP1A1 have generally been regarded as toxic or carcinogenic. These types of chemicals also tend to bioaccumulate.

The test is more useful than a simple measure of total concentrations of aromatic hydrocarbons in the soil because some of these chemicals induce P450 enzymes more than others. (They vary in potency.) In fact, some chemicals may inhibit induction. These chemicals may compete for the same (Ah) receptor or downregulate the CYP1A. The overall effect on P450 induction by a mixture of PAHs, PCBs, dioxins, and the like could be difficult to predict based on their concentrations. Therefore, by conducting the P450 assay, an overall effect is tested that could not be predicted by the chemistry data. As a result, it would not be unexpected to find a lack of correlation between total concentrations of aromatic hydrocarbons and the results of the P450 test. Instead, the relative amount of P450 induction may be related to toxicity of the sample.

8.2.1 Methods

Cytochrome P450 evaluations using a reporter gene system (RGS) were completed on soil samples collected from the R Area Disposal, Froid and Taylor Roads, and Wood Hogger Sites. Forty-nine surface soil samples (0 to 0.5 feet bgs) and one duplicate were collected and analyzed for Cytochrome P450. Sampling locations are shown on Exhibit 3.

In performing the test, methylene chloride extracts of environmental samples were added to individual wells of tissue culture plates. Each culture plate contains approximately 1 million 101L cells, which are exposed from 6 to 18 hours (generally the latter) to sample extracts. Volumes of solvent tested have ranged from 2 to 20 microliters (μL), which produces a low background induction when applied to 2 milliliters (mL) of cell culture medium. After exposure, the cells are rinsed, then lysed. Luminescence associated with activation of the luciferase gene is subsequently measured in the exposure wells using a 96-well plate luminometer. Alternatively, the cells are removed from each well, placed into microcentrifuge tubes, and centrifuged. Following centrifugation, luciferase activity and total protein are analyzed on supernatant (the pellet is discarded).

Whether luciferase activity is measured directly in the culture well or on post-centrifugation supernatant, luminescence in relative light units (RLU) of cell extract from each well is recorded for each sample. With each batch of samples, luminescence is also measured in cells exposed to a solvent control (for example, methylene chloride) and reference inducers (for example, 3-methyl cholanthrene, TCDD [tetrachlorodibenzodioxin], or benzo[a]pyrene). For measuring luciferase activities associated with site samples, mean RLUs of the control wells are set equal to unity and sampling activities are converted to fold induction by dividing mean sample RLUs by mean RLUs of solvent controls.

The biochemical response, or fold induction, measured in this assay represents the induction associated with all compounds present in the extract that bind to the Ah-receptor in the same manner as dioxin. Final results may be expressed as fold induction or, by use of the reference toxicant, results can be expressed as equivalents of TCDD or benzo(a)pyrene (for example). For best comparisons among samples, the initial dry weight of the extracted sample, the final volume of the solvent containing the extracted material (2 mL), and the amount applied to the cells (2 to 20 μL) are all recorded. Induction may then be expressed as nanograms of dioxin (or other reference inducer) equivalents per gram dry weight or per liter.

8.2.2 Results

Results of the Cytochrome P450 analyses are included in Table 8-1. Tables 8-10 through 8-12 present summary matrices for correlations between the Microtox results, Cytochrome P450 results, and concentrations of inorganic COPECs and selected essential nutrients and minerals (calcium, potassium, and sodium). All summary statistics were reduced from full data sets using StatMost (DataMost Corporation 1995) and GeoEAS (EPA 1988b) (see Appendix R). In addition to the summary statistics and correlation analyses, tests for normality and variance homogeneity were completed. Qualitative comparisons of these reduced data sets suggested that soil samples collected for the biological and ecological effects assessment could be considered a representative subset of the data collected for the RI.

The results from the Cytochrome P450 analysis for the Tidal Area sites indicated that biological activities in soils across the sites were variable, much more so than was suggested by Microtox. For example, as summarized in Table 8-1, soil samples from the R Area Disposal and Froid and Taylor Roads Sites yielded maximum values of 154 (mean = 41) and 93 (mean = 39) for fold induction (a measure of biochemical response), respectively, while soil samples from the Wood Hogger Site yielded a maximum of 169 (mean = 71). Statistically, the Cytochrome P450 activity measured in extracts of soil collected at the Wood Hogger Site were significantly increased compared to RGS results measured at the R Area Disposal and Froid and Taylor Roads Sites (Neuman-Keul's Test and Tukey's Test, P = 0.05). These results suggest that organic extracts prepared from soils collected at the Wood Hogger Site had higher concentrations of coplanar or other organic chemicals that induce P450 than do soils at the R Area Disposal or Froid and Taylor Roads Sites. Coplanar (having to do with the orientation and structure of the molecule) aromatic compounds are thought to have high P450 potency because they readily bind with the Ah receptor.

Tables 8-11 and 8-12 summarize selected correlations (Pearson's and Spearman's correlations) between Cytochrome P450 and concentrations of inorganic COPECs and selected essential nutrients and minerals (calcium, potassium, and sodium). Many of these correlations are characterized by probabilities between 0.05 and 0.10. Correlations with Cytochrome P450 activity for organic constituents were insignificant, frequently with probabilities greater than 0.5. For example, Cytochrome P450 was not significantly correlated with any one of the following classes of chemicals: PCBs, DDTs, or PAHs at any Tidal Area site. As indicated before, this result is not unexpected. A correlation may have been anticipated if one of these chemical classes were dominant *and* if the profile of individual chemicals of a class were similar across the site. For example for PAHs, if benzo(a)pyrene was dominant in causing P450 induction and was always present with other PAHs, the P450 results may have correlated with the concentration of total PAHs as a whole (the results would actually be correlating with benzo(a)pyrene).

In conclusion, the P450 results indicate soil samples, especially in the Wood Hogger Site, contain chemicals that induce P450, and these chemicals have been associated with toxic effects. The results of this test can be used in the weight-of-evidence approach to identify soil samples of toxicological concern.

8.3 AMPHIPOD TEST

Amphipod toxicity tests were performed on whole sediment from Otter Sluice in 1998, using *Eohaustorius estuarius*. Amphipods are crustaceans of the order Amphipoda and are commonly referred to as beach fleas, sand-hoppers, and scuds (MacGinitie and MacGinitie 1968). Sediment toxicity tests using amphipods are commonly included in estimates of potential risk from contaminated sediment (Ingersoll 1995; ASTM 1992; EPA 1994a; EPA and USACE 1991) because they are sensitive to changes in the environment and are some of the first species to be affected. *E. estuarius* was chosen because it tolerates sediment grain sizes and salinities within the ranges found at the Tidal Area and is sensitive to contaminants (MacDonald and others 1992). Although this species is not common at the site, other amphipods are abundant there.

E. estuarius, the test organism for this investigation, is a free-burrowing, mobile, gammaridean amphipod that inhabits interstitial sediment (Kohn and others 1994). *E. estuarius* is directly exposed to chemical contaminants because it does not form tubes in the sediment like some other amphipods. Although it is generally described as a detritivore and directly ingests the sediment (Meador and

others 1997), some related species have also been referred to as sand-lickers (Eltringham 1971). *E. estuarius* is routinely collected from sandy sediment off the coasts of Washington and Oregon, where the habitat has been described as sand, fine sand, or 94 percent sand (Boese and others 1997; Gunther and others 1997; Meador and others 1997).

8.3.1 Methods

Replicate acute 10-day toxicity tests were used to assess the toxicity of the whole sediment collected from seven locations in Otter Sluice (see Exhibit 4). Biological endpoints measured include adult survival and reburial. Exposure chambers were prepared using designated sediment composite samples collected from each location; a set of five laboratory replicates was completed for each sample location. Homogenized sediment from each composite sample was placed in a 1-liter glass container to a depth of 2 centimeters, and 900 mL of filtered seawater was added. Constant temperature and constant illumination were maintained throughout the test period (static test). A daily record was kept of water quality parameters in the test chambers (dissolved oxygen, salinity, temperature, pH and, in some chambers, ammonia).

At least 20 test animals were introduced to each exposure chamber to initiate the bioassay. Standard toxicant tests were included as part of the testing process. The initial number of amphipods that burrowed into the sediment within an hour after being placed in the treatment tanks was recorded. The number of emerging amphipods was recorded daily. After 10 days of exposure, live amphipods were carefully removed by sieving the sediment and collecting the amphipods in clean sea water. The number that reburied themselves in the control sediment after 1 hour was recorded. The complete bioassay series was repeated if more than 10 percent of the control animals died or showed evidence of sublethal effects.

8.3.2 Results

Results from the amphipod bioassay are provided in Table 8-2. For the seven locations tested, the mean survival ranged from 92 to 100 percent and mean reburial ranged from 92 to 100 percent; therefore, the results did not indicate toxicity. In fact, percent survival was higher at these locations than is indicated in literature values for percent survival in tests of fine-grained San Francisco Bay sediments from reference sites. For example, Gunther and others (1997) and Swartz and others (1994) found survival rates of 70 to 85 percent in fine grained (less than 50 percent sands) sediments, while survival in sandy sediments (greater than 90 percent sands) was greater than 90 percent. Grain size in

sediment collected from Otter Sluice is small; percent sands in sediments collected for the amphipod bioassays ranged from 0 to 1.1 percent.

8.4 TOPSMELT TEST

As part of the characterization of risk to fishes in Otter Sluice, an SWI bioassay using the topsmelt (*Atherinops affinis*) embryo was conducted in 1998. The test measures biological effects on embryos exposed to conditions at the interface between the sediment and overlying water. The endpoint of hatchability is measured after approximately 12 days in this test. Pacific Eco-Risk Laboratory (PERL) in Martinez, California, conducted this test under subcontract to TtEMI. Intact sediment cores from seven locations in Otter Sluice were tested.

Sediment cores were collected in June 1998 for this test; however, the first run of the test was rejected due to the low survival of embryos in control sediments. PERL repeated tests on the control sediments to evaluate the problem and recommended some modifications to the test protocol to improve test quality and to minimize the confounding effects of factors such as iron precipitation and low dissolved oxygen content. A conference call was held on September 17, 1998, with the regulatory and trustee agencies to discuss these issues and select a course of action. During this call, modifications to the protocol were accepted by all parties, and PERL agreed to recollect intact cores at the Tidal Area to repeat the test. The agencies also agreed that using the chemistry data from the original sampling event was satisfactory if the second set of cores was collected from the same locations. The second round of sediment cores for the bioassay was collected on September 23, 1998.

Field and laboratory methods (including the revised protocol) and test results are summarized in Sections 8.4.1 and 8.4.2.

8.4.1 Methods

The SWI toxicity test with topsmelt embryos followed a method similar to that used for echinoderm larvae (*Stronglyocentrotus purpuratus*) (Anderson and others 1996). This test evaluates the influence of conditions at the SWI on hatching success, and determines whether this influence is statistically different than occurs in embryos exposed to control sediments.

Exposure chambers consisted of a polycarbonate tube (3.75 inches interior diameter) capped at the bottom. This tube contained undisturbed sediment cores approximately 2 inches deep. This sediment

was covered with 500 mL of filtered sea water from Bodega Bay Marine Laboratory (diluted to 20 ppt salinity) immediately before the start of the test. The embryo exposure tubes were placed on the surface of the sample so the screens were located 1 centimeter above the sediment surface. The embryo exposure tubes consisted of a 1.5 × 6 inch tube (inside diameter of 2.75 inches) with a 220 micrometer (μm) polyethylene screen fastened 1 centimeter above the bottom of the tube. Four laboratory replicates were performed for each sample location, and involved adding at least 10 freshly fertilized embryos to each tube.

Embryos for this test were shipped from Aquatic Biosystems Laboratory in Fort Collins, Colorado, and information on these embryos was documented, including the age and condition of the embryos upon receipt and at the beginning of the test. Eggs and sperm used to produce the embryos for the test were from the same stock.

Water quality parameters, including sulfide and total ammonia concentrations, were measured at least three times (beginning, middle, and end) during the test. Dissolved oxygen, pH, and salinity were measured daily. The photoperiod was 14 hours light:10 hours dark and the temperature was maintained at 20 ± 1 °C. A slow stream of air was delivered near the embryos to provide an adequate oxygen supply when dissolved oxygen concentrations dropped below 60 percent. The bioassay was terminated after 12 days.

Clean sediment controls were run with the test using fine-grained sediment from Yaquima Bay. A reference toxicity test was performed using a series of concentrations of copper chloride and a water-only control. To evaluate the condition of the organisms used in the test, the median effective concentration (EC_{50}) results of the reference toxicity test were compared to previous tests run by the laboratory.

Modifications to the SWI Protocol: Based on a conference call held on September 17, 1998, with the Navy and representatives from the regulatory and trustee agencies, the following steps were recommended to reduce the effect of confounding factors on test results:

- Visually inspect sediment cores for signs of iron precipitation.
- Measure in situ pH of overlying water at each location.
- Hold cores in the dark at 4 °C at least 24 hours before starting the test.
- Set up cores in test chambers.

- Set up two sets of clean sediment controls (Sediment Control #1 and #2), and one set of water only controls.
- Replace overlying water with Bodega Bay water, adjusted to a salinity of 20 ppt.
- Check pH in each replicate every 12 hours for up to 72 hours. If the pH measures less than 7.5, adjust it upward to between 7.5 and 8.5.
- When the pH stabilizes in all replicates over two measurements (24 hours), add embryos and begin the test.
- During the test, measure pH and dissolved oxygen daily
- If pH falls below 7.5, adjust it upward to between 7.5 and 8.5. Stir. If any single replicate requires pH adjustment and stirring, stir all replicates at all locations, including Control #1.
- If dissolved oxygen falls below 60 percent saturation in any one replicate, bubble all replicates from all locations, including Control #1. Bubble at 100 bubbles per minute midway down the water column.
- Leave Control #2 alone (no stirring) except for aeration if dissolved oxygen falls below 60 percent.

8.4.2 Results

Results obtained from PERL in December 1998 are provided in Table 8-3. The test was completed successfully, with control hatchability of 80 percent for the pH-adjusted control (Control #1) and 85 percent for the unadjusted control (Control #2); these two controls were not significantly different from each other. Reference toxicant results were consistent with previous trials. Water quality parameters were maintained within acceptable limits; pH was adjusted once at the beginning of the test, as it dropped to 7.40 in two site samples, and test replicates were aerated gently after the dissolved oxygen content dropped below 60 percent in some samples. Percent hatchability was compared to the pH-adjusted control using the Homoscedastic t-Test.

Mean percent hatchability ranged from 2.5 to 75 percent in the seven samples. The test results indicated toxicity to topsmelt embryos at the sediment-water interface in five samples (OSLSL001, OSLSL002, OSLSL003, OSLSL004, and OSLSL007), and little toxicity in two samples (OSLSL005 and OSLSL006) compared to the pH-adjusted control. Bioassay results, laboratory procedures, and water quality parameters were validated. A PV qualifier (presumed valid) was assigned to only one sample (OSLSL003) with a comment code of k, indicating that the ammonia concentration exceeded guidelines at the end of the test. The final measurement of ammonia was 9.56 on day 12, whereas the

limit for ammonia is 8.8 mg/L. However, the ammonia was lower on days 2 and 8. A qualifier of PV means that data usability may be limited. Ammonia may have been a factor contributing to the low mean (2.5 percent) hatchability of the topsmelt in sample OSLSL003.

No other samples were qualified. The EC_{25} and EC_{50} of the copper reference toxicant test were within specified guidelines, and the controls met the acceptability requirement of greater than or equal to 80 percent hatching success. The control sediments met the acceptability criteria for greater than or equal to 80 percent hatching success and all water quality parameters met the acceptability criteria. No R qualifiers were assigned.

8.4.3 Confounding Factors

The test was conducted to assess the potential effects of chemicals on fish species that may spawn in Otter Sluice. The seven sample locations were distributed from near the mouth of Otter Sluice (North Otter Sluice) to the Wood Hogger (South Otter Sluice), exposing the embryos to a range of chemical concentrations. However, the percent hatching results do not adhere to general expectations based on chemical concentrations in the sediment. The results of the SWI bioassay suggest that confounding factors may have affected the hatchability of fish embryos. Potential confounding factors such as salinity, holding time, ammonia, and grain size were evaluated in comparison to other SWI topsmelt bioassays conducted recently in the San Francisco Bay area.

The SWI toxicity test using topsmelt embryos was part of three other Navy investigations: (1) NWS SBD Concord Litigation Area Year 4 Monitoring, (2) Alameda Point RI, and (3) Naval Fuel Depot (NFD) Point Molate RI. The results of each of these sets of tests are widely divergent across projects. SWI toxicity test results from all of these investigations were compiled with the results from the Tidal Area investigation. The compiled set of topsmelt results was correlated with potential confounding factors in the sediment (salinity, percent clay) and test water quality conditions (salinity, dissolved oxygen, ammonia). The results of the correlation analysis are shown in Table 8-4. Mean hatchability was significantly correlated with grain size of the sediment (percent clay) ($r=-0.596$, $p<.001$, no data from Alameda Point were available for grain size at the time this report was prepared). Grain size in Outer Sluice is small, with percent clays ranging from 95.4 to 99.8 percent in sediments tested with the topsmelt. No strong correlations were noted between hatchability and test water quality conditions. Therefore, the results of this topsmelt test may be confounded by sediment grain size.

The SWI topsmelt test is relatively new. SWI tests may present an alternative to tests that use pore water centrifuged from the sediment, which would eliminate confounding factors such as elevated ammonia that result from the centrifugation process. However, current SWI protocols may also be subject to confounding factors. In fact, PERL has expressed concern that the anomalous SWI topsmelt results indicate that this test is not suitable for use in risk assessment at this time (PERL 1999). Toxicity tests using fish eggs are relatively unproved, so the results of the test should be used cautiously in a weight-of-evidence evaluation.

8.5 TISSUE RESIDUE RESULTS

Concentrations of contaminants in tissue collected in the field provide a measure of bioaccumulation of chemicals at the site. Tissue residues in prey items were also used to characterize risk to birds and mammals from ingestion of contaminated prey through food-chain modeling (see Section 15.0). In addition, an attempt was made to use the tissue residue results for characterizing risk to the organism itself because limited information was available from the literature. Currently, no action levels are available to identify tissue concentrations with effects levels.

Locations where tissue was collected for residue analysis are shown on Exhibit 4. Rodents were collected from the R Area and Wood Hogger Terrestrial units and concentrations of chemicals in their tissues used to evaluate risk to rodents and risk to receptors that prey on rodents, including the Northern Harrier and the gray fox. Fish were collected from Froid and Taylor Terrestrial unit and Otter Sluice to evaluate risk to fish (see Section 12.0) and to receptors preying on them, including the Great Blue Heron and the river otter (see Section 15.0). Clams were collected from Otter Sluice and were evaluated for risk to benthic invertebrates (see Section 13.0) and to receptors that eat them, including the California Black Rail and the river otter (see Section 15.0). Amphipods were collected from the Froid and Taylor Roads Aquatic unit to evaluate risk to aquatic invertebrates and to receptors that eat them, including the Black-necked Stilt (see Section 15.0).

8.5.1 Rodent Tissue Results

During the small-mammal trapping used to document the presence of salt marsh harvest mice, rodents were collected and their tissues analyzed for residues. The rationale for the selection of rodent trap locations is described in Section 4.3.3.3. Based on 1995 soil sample data, traps were located as close to soil hot spots as possible while considering the quality of salt marsh harvest mouse habitat at these locations. Trap locations and rodent capture results are illustrated on Exhibit 2.

Each sample consisted of a composite of several individuals in order to collect an adequate volume of rodent tissue for analysis. Rodent capture data, including the composition of composite tissue samples and target soil samples closest to rodent capture locations are listed in Table 4-6. All three of the rodent tissue composite samples from the R Area Disposal Site were composed of house mice. At the Wood Hogger Site, composite sample WHC1 was composed of six house mice and two deer mice, composite sample WHC2 was composed of four house mice and three deer mice, and WHC3 was composed of two house mice.

The tissue residue data for rodents collected from the R Area and Wood Hogger Terrestrial units are presented in Tables 8-5B and 8-7B, respectively. Rodent tissue samples were analyzed for inorganic chemicals, PCBs, and pesticides, but not for semivolatile compounds such as PAHs. The rodent tissue samples collected from the Wood Hogger Site were also analyzed for dioxins. The rodent tissue data are interpreted in Section 9.0 as they apply to bioavailability of site contaminants. The rodent tissue results are also used in the evaluation of risk to vertebrate receptors in Section 15.0.

8.5.2 Pickleweed Tissue Results

Pickleweed tissue samples were collected to evaluate bioaccumulation in wetland plants and to use in food-chain modeling for salt marsh harvest mice. The rationale for selection of pickleweed sampling locations is described in Section 4.3.3.1. Pickleweed was collected from three locations in the R Area Disposal Site and one location in the Wood Hogger Site, where pickleweed provided suitable habitat for salt marsh harvest mice and soil data indicated the highest concentrations of inorganic chemicals. Pickleweed tissue samples were analyzed only for metals.

The tissue residue data for pickleweed collected from the R Area and Wood Hogger Terrestrial units are presented in Table 8-5A and 8-7A. The pickleweed tissue data are interpreted in Section 9.0 as they apply to bioavailability of site contaminants (see Section 9.0). The pickleweed tissue data are also interpreted further in Section 10.0 as part of the evaluation of risks to plants, and in the evaluation of risks to vertebrate receptors in Section 15.0.

8.5.3 Amphipod Tissue Results

Amphipods were the dominant invertebrate present at the Froid and Taylor Roads Site during field surveys in 1998. Amphipods were collected with dipnets. The tissue residue data for amphipods collected from the Froid and Taylor Roads Site are presented in Table 8-6A. Tissues were analyzed

for inorganic chemicals, PCBs, and pesticides. Tissues were not, however, analyzed for SVOCs such as PAHs and phthalates.

The amphipod tissue data are interpreted in Section 9.0 as they apply to bioavailability of site contaminants. The amphipod tissue results are also interpreted further in Section 13.0 as part of the evaluation of risk to aquatic invertebrates, and in Section 15.0 as part of the evaluation of risk to vertebrate receptors.

8.5.4 Clam Tissue Results

As described in Section 4.3.3.2, native clams (*Macoma balthica*) were collected using dipnets from seven locations in Otter Sluice (see Exhibit 4). These tissue samples were analyzed for metals, PCBs, and pesticides. The two clam tissue samples from locations OSLLSL006 and OSLSL007 in South Otter Sluice were also analyzed for dioxins.

The tissue residue concentrations in clams collected from the North Otter Sluice are presented in Table 8-8A, and for the South Otter Sluice in Table 8-9A. The clam tissue data are interpreted in Section 9.0 as they apply to bioavailability of site contaminants. The clam tissue results are also interpreted further in Section 13.0 as part of the evaluation of risk to aquatic invertebrates, and in Section 15.0 as part of the evaluation of risk to vertebrate receptors.

8.5.5 Fish Tissue Results

Fish were collected using baited minnow traps in the same locations where clams and amphipods were collected (see Exhibit 4). Fish collected during the June 1998 sampling effort consisted of sculpin (Family Cottidae), stickleback (*Gasterosteus aculeatus*), and mosquito fish (*Gambusia affinis*). An attempt was made to collect adequate tissue volume of the same species for each composite sample; however, mixed species composites were collected at some locations. Species composition of each sample is presented in Table 4-5.

The tissue residue data for fish collected from the Froid and Taylor Aquatic unit are presented in Table 8-6B, from North Otter Sluice are presented in Table 8-8B, and from South Otter Sluice in Table 8-9B. The fish tissue data are interpreted in Section 9.0 as they apply to bioavailability of site contaminants. The fish tissue results are also interpreted further in Section 12.0 as part of the

evaluation of risk to fish receptors at the Tidal Area, and in Section 15.0 as part of the evaluation of risk to vertebrate receptors.

9.0 BIOAVAILABILITY

This section introduces the physicochemical factors that affect bioavailability of chemicals to representative receptors. An understanding of bioavailability is useful in predicting toxicity to receptors because organisms can only uptake and bioaccumulate bioavailable forms of a chemical. In dynamic environments, such as wetland sediments and upland soils, contaminants partition among the particulate and soluble phases, form complexes that alter their bioavailability, and undergo biogeochemical transformations into forms that may differ in their toxicity to ecological receptors. Therefore, for many chemicals, the total concentration in soil or sediment may represent a worst-case scenario and not necessarily the bioavailable fraction to which the receptors are actually exposed (Tessier and Campbell 1987; Knezovich 1994; Newman and Jagoe 1994; Pascoe and others 1994c; Linder and others 1994). In some cases, the most bioavailable form of a chemical is not always the most toxic.

Bioavailability at the Tidal Area sites was evaluated using several lines of evidence, including evaluating soil and sediment results for relevant physicochemical parameters. Physicochemical factors that can affect the bioavailability of chemicals in soil, sediment, and water include pH, oxidation-reduction potential, TOC, salinity, hardness, temperature, grain size. Other indirect measures of bioavailability were also evaluated, including (1) correlating bulk chemistry data with the results of chemical extractions of sediment or soil (such as WET-DI and WET-acid extractions); (2) conducting toxicity tests (bioassays); and (3) analyzing tissue residues in receptors collected at the site.

Section 9.1 discusses parameters that affect bioaccumulation (such as TOC and pH) in relation to site-specific conditions at the Tidal Area. Sections 9.2 and 9.3 evaluate the results of site-specific WET extractions and AVS/SEM analyses. Tissue samples were also collected and bioassays conducted to assist in evaluating bioavailability at the Tidal Area. The results of the tissue analyses are discussed in Section 9.4, and the results of the bioassays are discussed in Section 9.5.

9.1 PARAMETERS AFFECTING BIOAVAILABILITY

The environment is composed of separate but interconnected compartments such as soil, sediment, water, air, and biota. Chemicals exist in a variety of forms, and partition into particulate and dissolved phases. When a chemical is released into the environment, it becomes distributed among these compartments and phases according to both the properties of the chemical and its environment (Connell 1990).

Organisms may be exposed to surface water, soil, sediment, or pore water dermally or by ingestion of contaminated food or particles. A variety of processes control the form of contaminants and their availability for uptake by biota. In general, some transfer mechanism must be in operation to move the contaminants in bulk sediment or soil into an organism across a biological membrane (such as skin, lungs or gills, and gut), which often occurs in the solution phase. The dietary route of exposure is unique because catabolic processes in the gut can make contaminants more bioavailable. For other uptake routes, partitioning between particulate and solution phases is more important in determining bioavailability. Generally, the freely dissolved fraction is the most bioavailable. Factors that reduce the freely dissolved phases generally translate into a reduction in bioavailability (Benson and others 1994; Suffet and others 1994).

Metals may exist as freely dissolved ions or as complexes with inorganic or organic ligands in soluble phases. Not all soluble metal complexes are available; in general, free metal ions are the most bioavailable. Inorganic ligands include fluorides, chlorides, sulfates, hydroxides, and carbonates under oxic conditions, and sulfides under anoxic conditions. Metal speciation in the presence of ligands affects bioavailability and toxicity (Newman and Jagoe 1994). Although many metals are hydrophilic, cadmium and mercury are often in lipid-soluble complexes that can cross biological membranes.

Organic contaminants are also strongly affected by processes controlling sorption. Many organics compounds, such as PCBs, PAHs, and organochlorine pesticides, sorb to suspended solids and sediments and can persist in these phases for long periods (Knezovich and others 1987). HMW PAHs and PCBs partition to biota, dissolved organic matter, and sediments (Suffet and others 1994).

Given these processes, several physicochemical parameters were evaluated to assess bioavailability at the Tidal Area. These specific parameters include TOC, grain size, pH, oxidation-reduction potential, hardness, salinity, and temperature, and are discussed in the following subsections. A discussion of biologically-mediated transformation as it relates to the Tidal Area is also presented below.

9.1.1 Total Organic Carbon and Grain Size

TOC is organic matter consisting primarily of humic and fulvic acids resulting from the breakdown of plant and animal material. Organic matter may coat sediment or soil particles, or may be dissolved in surface waters or sediment pore water (in the interstitial space between sediment particles). TOC is a measure of all organic matter both in soluble and particulate phases. In general, smaller particles are higher in TOC because they have a higher surface area per unit mass. TOC can both sorb organic

chemicals and complex metals. Chemicals are not appreciably bioavailable while they are sorbed to organic matter, mostly because they may be in a form that is too large to pass through biological membranes. Therefore, a high TOC is generally associated with a decrease in bioavailability. However, there is not always a clear relationship between TOC and bioavailability because other environmental factors also play a strong role, and not all types of organic matter equally sorb or complex chemicals.

In a sediment environment, the freely dissolved concentration of a chemical is a better measure of bioavailability than TOC itself because other factors influence the proportion that is bound to the TOC, such as pH and salinity. When chemicals bind to dissolved organic matter, their solubility increases. Raising the solubility will result in a net increase in bioavailability if the net concentration of freely dissolved chemical increases. The partitioning of a chemical between particulate and dissolved phases determines its bioavailability. Physical disturbances or changes in the chemistry of the system will change the partitioning of the chemical and influence its bioavailability.

Overall, soils at the Tidal Area sites were characteristically rich in organic carbon (see Table 9-1). TOC concentrations in soils at the Wood Hogger Site showed the widest range of all sites (265 to 271,000 mg/kg). TOC values were less than 1,600 mg/kg at only four sampling locations and above 100,000 mg/kg at only six. These observations are consistent with Joice muck soils, which tend to have high TOC values (up to 45 percent) in the wetlands adjacent to Suisun Bay.

Grain size is an important variable, as smaller particles carry greater organic carbon fractions and therefore carry a higher contaminant load per unit mass than larger particles. Particle size is also an important factor in the bioavailability by oral ingestion. Smaller particles, with a larger surface-to-volume-ratio, are more highly subject to the solubilizing action of gastric fluid (O'Flaherty 1998).

Physical characteristics of the Tidal Area soils are presented in Table 9-1. Grain size distributions were measured at 132 locations throughout the Tidal Area sites. The soils in the Tidal Area sites primarily consist of silty clays, although sandy zones were detected at a few sampling locations (for example RADSBB06, RADSBJ02, and WHSSBM08). Clay- and silt-sized particles typically make up 70 to 90 percent of each soil sample, although soils contain greater proportions of sand in the Wood Hogger Site and selected locations in the R Area Disposal Site. In addition, the soils are rich in organic material; average TOC concentrations for the samples was 65,000 mg/kg, or 6.5 percent. Soil pH was typically neutral to slightly basic (6.5 to 8.5), although moderately acidic conditions (pH 4.5

to 6.5) were observed in several locations. The high proportion of silt- and clay-sized particles and the high TOC levels in the soils offer abundant sites for contaminant adsorption.

9.1.2 pH (Hydrogen Ion Concentration)

Soil pH is a measure of its hydrogen ion concentration (or more accurately, its activity) and thus its acidity or alkalinity. Soil pH influences or regulates many chemical and biological processes occurring in soil, including the availability of nutrients and other metals.

For metals, the free ionic, or hydrated, form is more toxic than the undissociated form; thus, metals are generally more toxic in acidic than in alkaline environments. Metals may become more bioavailable as pH decreases (Mayer and others 1994). Just as organic content of soils can influence its chemistry, soil pH influences chemical speciation and movement in soils. For example, studies using soil-dwelling invertebrates indicate that soil pH is a prime factor for predicting the uptake and accumulation of many heavy metals (Ma 1982; Van Gestel and Van Dis 1988). Low pH leads to increased desorption of metal cations as a result of competition with hydrogen ions. Low soil pH, therefore, tends to increase the toxicity of many heavy metals to soil dwelling invertebrates. Soil pH also affects the availability of many plant nutrients. For example, one of the major functions of phosphorus is to promote root growth, but low pH (that is, acidic soils) tie up phosphorus and make it unavailable for root growth. The net effect can be a loss of root mass, which can be related to the ability of the plants to take up water and nutrients (Linder and others 1996a, 1996b).

Table 9-1 summarizes soil pH data for samples collected at Tidal Area sites. The pH values for most of the soil samples from the Tidal Area sites were between 6.5 and 8.5. At the R Area Disposal Site, however, eight soil samples had a pH value below 5.5 (one at 3.3). These soil values, however, are consistent with the Joice muck soils occurring in the Tidal Area. Reconnaissance surveys indicated that the soils at the R Area Disposal Site, although disturbed by past landfill activities and other management practices, were more likely to reflect pre-Navy conditions for soils, since the Froid and Taylor Roads and Wood Hogger Sites have been subject to ongoing Navy activities. The relatively neutral pH of soils throughout most of the Tidal Area indicates that inorganic chemicals in soils are not fully bioavailable. The effect of pH on the bioavailability and toxicity of inorganic chemicals specific to various receptors is discussed in Sections 10.0 through 15.0.

9.1.3 Oxidation-Reduction Potential (Redox Potential or Eh)

Oxidation-reduction potential (Eh, or redox potential) is a measure of the tendency of a system to act as an oxidizing (electron acceptor) or a reducing (electron donor) agent. Sulfur, iron, manganese, and nitrogen in wetlands are the most important elements involved in redox processes in submerged sediments. Iron and manganese oxides are an important sink for metals in oxic conditions due to the rapid adsorption of metals to negatively charged sites on the surface. Hydrous iron and manganese oxides that form rapidly when reduced sediments are oxidized may scavenge soluble metalloids or metals, such as arsenic, copper, and zinc, from the water column by coprecipitation (USACE 1989). In aerobic or oxic conditions, hydrous iron oxides tend to decrease the bioavailability of sediment-bound arsenic, copper, lead, and zinc (Luoma and Bryan 1978; Tessier and Campbell 1987). Iron oxides and manganese oxides are reduced under anoxic conditions and become more soluble in water; formerly associated metal ions may then become more bioavailable (Mayer and others 1994). Under anoxic conditions, S^{2-} plays an important role in speciation and availability as metals form sulfide complexes with relatively low solubility. This interaction reduces metal concentrations in pore water (interstitial waters) and likely reduces bioavailability (DiToro and others 1990). The precipitation of sulfides in anoxic conditions can be an important factor limiting mobility of copper, mercury, cadmium, lead, and zinc (Hong and others 1994).

Metals such as cobalt precipitate in the presence of oxygen and dissolve in anoxic conditions; other metals, such as cadmium, zinc, copper, and nickel, are more soluble in the presence of oxygen and precipitate as sulfides in anoxic conditions. Copper partitions to organic materials in some sediments and to iron or manganese oxides in others, based on the relative abundances of these components (Luoma 1986). The fate of particle-bound contaminants is central to wetlands because the food webs are generally based on detritus; partitioning of metals at the oxidized sediment-water interface is a critical component in estimating contaminant bioavailability (Luoma and Davis 1983).

Biotic and abiotic processes responsible for the transformation of some organic contaminants may also vary with redox potential; the reductive halogenation of DDT to DDD versus the oxidative halogenation of DDT to DDE is one example (Mayer and others 1994).

Redox potential was not directly measured at the Tidal Area sites; however, the fine Bay Mud exists under mostly reduced conditions except for a relatively thin layer on top. Most contaminants in the Tidal Area were found at higher concentrations in the samples collected in the upper 0.5 feet of the

cores. It is assumed that this upper horizon of sediments and wetland soils is subject to periodic oxidizing conditions due to tidal inundation and movement of animals such as fish, otters, muskrat, turtles, and wading birds. Other biotic processes such as bioturbation by infauna may increase the mobility of sulfide-bound metals by creating more oxic conditions (Greene and Chandler 1994).

Changes in redox potential of sediments can release metals to the solute phase as a result of associated changes in pH. Insoluble sulfides of many metals, formed under reduced conditions, are rapidly oxidized when conditions become aerobic, releasing soluble metal ions. Oxidation of iron and manganese produces hydrogen ions, while sulfide oxidation produces sulfate; these processes result in an increase in acidity. Generally, free metal ions tend to be present in greater abundance and are more available at low pH and under oxidizing conditions (USACE 1989). A change to more oxic conditions, such as occurs in sediment disturbance or bioturbation, may increase the mobility of cadmium, copper, lead, mercury, and zinc. Elements such as selenium and arsenic, however, are generally more soluble under alkaline conditions (Hong and others 1994).

Changes in the redox potential of sediments may also alter the nature of the organic matter (particulate or dissolved) in terms of its ability to bind organic chemicals. Aeration of organic matter has been shown to change the sorption of hydrophobic organic chemicals to organic matter (Schweitzer 1998; Hunchak-Kariouk and others 1997). For sediments, a change in bioavailability upon aeration and disturbance of anoxic sediments may result. In general, the disturbance of sediments results in increased mobilization and overall bioavailability of both inorganic and organic chemicals.

9.1.4 Hardness

Hardness refers to the concentration of multivalent cations, particularly calcium and magnesium, in water. The presence of divalent cations (Ca^{++} and Mg^{++}) in the water column can cause particulate, colloidal, or soluble organic matter to flocculate and settle from the water column; trace metals may coprecipitate with the flocculated material (USACE 1989). In general, most metals are less toxic in harder water (Mayer and others 1994); a similar relationship for organic contaminants has not been shown. In general, calcium and magnesium cations do not affect the speciation of cationic toxicants but may compete for the same ligands as binding sites. Hardness may also affect the speciation of anionic toxicants (Erikson and others 1994).

A variety of studies have indicated decreased toxicity to aquatic organisms with increased hardness for cadmium, cobalt, copper, and zinc; similar studies have shown lower mercury and zinc residues in fish

exposed to waters of increasing hardness (Mayer and others 1994). High calcium levels have been shown to decrease cadmium bioaccumulation in freshwater and marine crustaceans (Hawker 1990). In other studies, where hard water was defined as 150 micrograms per gram ($\mu g/g$) (total Ca^{2+} and Mg^{2+}), uptake of cadmium in snails and fish was demonstrated to be lower in hard water than in soft water (0 $\mu g/g$ total Ca^{2+} and Mg^{2+}; Hawker 1990). Since hardness often correlates with pH and alkalinity, effects of each component are difficult to distinguish. Other studies have shown negligible effects of hardness on metal toxicity (Erikson and others 1994).

The transition from freshwater to seawater results in a wide variability in hardness. The salt composition of fresh water is determined by local geologic factors and is dominated by calcium; saltwater is more uniform in its composition and is dominated by sodium. In estuarine or brackish conditions, such as at much of the Tidal Area, the pH and hardness may vary spatially and temporally and are generally lower than values for marine environments (Knezovich 1994).

Hardness of water at the Tidal Area was not directly measured, but measurements at the nearby NWS SBD Concord Litigation Area (PRC 1996b) indicate that surface water at the Tidal Area can be assumed to be relatively hard, with reduced bioavailability of metals. Some of the AWQCs used to screen surface water contaminant concentrations in the Tidal Area are hardness-dependent and thus account for effects of hardness on bioavailability and toxicity.

9.1.5 Salinity

In general, marine and freshwater taxa are similar in sensitivity to most inorganic and organic contaminants, and bioavailability of chemicals may be similar in both environments (Knezovich 1994). One exception is cadmium, which is generally more toxic to freshwater organisms, perhaps due to differences in speciation of cadmium, which exists in the ionic form in fresh water and as a complexed form ($CdCl_2$) in sea water. Bivalves have been shown to increase bioaccumulation of cadmium as salinity decreases (Hawker 1990). Changes in bioavailability may occur in estuarine habitats such as the Tidal Area, where the freshwater/saltwater transition fluctuates spatially and temporally.

Fresh water appears to have a higher capacity to maintain many metals in soluble or suspended particulate form (Hawker 1990). Metals sorbed to particulates or dissolved ligands in fresh water may be subject to a desorption process as salinity increases. Soluble anions in sea water, such as Cl^-, SO_4^{2-}, and HCO_3-, form soluble complexes with metals, while a competitive exchange of cations (sodium, potassium, calcium, and magnesium) on the sorptive substrates may increase the desorption process

(Knezovich 1994). Metals released during this desorption process are likely readsorbed onto particulate matter, but short-term changes in bioavailability at steep salinity gradients may occur. Some studies have indicated that toxicity of some metals such as copper and cadmium is inversely related to salinity; these effects may be linked to or confounded by effects on the ability of organisms to osmoregulate (Knezovich 1994).

The main effect of salinity on availability of organic compounds involves solubility: neutral organic compounds are less soluble in sea water and more readily enter the particulate phase. However, the octanol-water partition coefficients (K_{ow}) are generally higher for organic compounds in sea water, indicating that the potential for bioaccumulation is greater. Thus, overall, salinity seems to have little net effect on the bioavailability of many organic compounds (Knezovich 1994).

Salinity varies seasonally and annually at the Tidal Area and is strongly influenced by precipitation patterns and water management practices. While salinity measured in Suisun Bay is generally between 2 and 10 ppt (CDFG 1987), salinity in the tidal wetland and ponded areas of the Tidal Area is much higher. Salinity values of 8 to 18 ppt in the Wood Hogger Site, 8 to 29 ppt in the R Area Disposal Site, and 20 to 53 ppt in the evaporating ponds at the Froid and Taylor Roads Site have been measured (WESCO 1995). High salinities during late summer and early fall may contribute to increased toxicity at these sites. In screening the surface water data from these sites, the lower of the freshwater or saltwater AWQC were used to account for differences in bioavailability and toxicity due to salinity. This approach was based on guidance from the San Francisco Bay Basin Plan (RWQCB 1986).

9.1.6 Temperature

Metabolic rates for ectothermic cold-blooded animals generally rise with increasing temperature, resulting in increased diffusion or uptake of contaminants across gill or cell membranes (Hawker 1990; Mayer and others 1994). The toxicity of copper and zinc to fish increases slightly with temperature (Smith and Heath 1979 as cited in Mayer and others 1994). The toxicity of many pesticides to daphnids has been shown to increase with increasing temperature during acute exposure (Mayer and others 1994). However, the effect of DDT and DDD on fish was negatively correlated with temperature (Macek and others 1969 as cited in Mayer and others 1994). Many PAHs are more soluble in warmer water (McElroy and others 1989); the effect on their toxicity was not reported.

Water temperatures for Suisun Bay range from 8 to 22 degrees Celsius throughout the year (California Division of Water Resources and U.S. Bureau of Reclamation 1994); most of the water in Otter Sluice

and the tidal wetlands flushes twice daily with tide, although the area is considered tidally muted by dikes and tidal gates. The temperature in the shallow water in the ponded wetlands is expected to significantly increase during warm spring and summer days, possibly affecting toxicity.

9.1.7 Biologically Mediated Transformation

Many organometallic compounds are formed as a result of biologically mediated processes. Lead and mercury can be bio-alkylated by microorganisms, for example. Organic forms of arsenic can be formed by phytoplankton and passed along the food chain (Hawker 1990). The availability and toxicity of several metals and metalloids, such as arsenic, selenium, and mercury, increase as a result of biomethylation, making them more lipid-soluble (Mayer and others 1994). In general, an increase in the number of organic substitutions on a metallic compound tends to make the compound more hydrophobic and therefore more likely to bioaccumulate (Hawker 1990). PAHs and other organic compounds may be transformed or degraded by bacteria, fungi, and algae; lower-weight PAHs are generally degraded more rapidly than are higher weight PAHs (Cerniglia and Heitkamp 1989).

9.2 WASTE EXTRACTION TESTS

WET extraction chemistry data were collected to aid in estimating bioavailability of site contaminants, particularly metals. The soluble fraction of the chemical usually represents the chemical concentration that is most bioavailable; WET-DI and WET-acid extractions are approximations of the soluble fractions. The WET-acid test consists of a dilute HCl acid extraction of the soil. The WET-DI consists of a deionized water extraction of the soil. WET-acid extractions usually remove significantly more bound metals than do WET-DI extractions (see Section 4.2.1).

The WET-DI is an aqueous extraction representing the immediate soluble component of sediment-bound contaminants. This aqueous extraction technique assumes that only the water-soluble portion of the total metals is available; in reality, acidic conditions in plant root rhizospheres or animal guts may allow a different fraction of the total metals to become available. The WET-DI extraction can be compared to the acute exposure of an organism to metals in sediments because deionized water will remove a smaller proportion of the metal concentration from the sediment particles than will acid extraction. Weakly bound contaminants are expected to enter the soluble phase during the extraction. In general, the metals most easily extracted tend to be the most bioavailable.

The bioavailability of metals under acidic conditions in plant root rhizospheres or animal guts may be more closely approximated by either the bulk chemistry (total concentration) or the WET-acid chemistry results. The bulk chemistry analysis consists of a rigorous acid extraction step before the sample is analyzed for metals by atomic absorption.

The dilute HCl (WET-acid) leaches out more tightly bound inorganic contaminants and may more closely represent the fraction expected to enter the solute phase over longer periods of time or in acidic environments. Dilute HCl allows a partial fractionation of metals in soils or sediments, releasing both inorganic- and organic-associated metals, while leaving the silicate matrix relatively intact (Luoma and Bryan 1981; Weimin and others 1992). Dilute HCl extractions remove the exchangeable metals sorbed on carbonate, organic, and sulfidic phases, as well as oxides and hydroxides of manganese and iron (Agemian and Chau 1976). Tessier and others (1984) have shown correlations between acid extractions of easily extracted metals and tissue levels in molluscs, indicating that the bioavailability of metals is inversely related to metal binding strength. Dilute HCl extraction can be used to estimate chronic metal exposure because it removes a greater concentration of the metal from the sediment particle surface.

Results of the WET extractions and bulk chemistry were presented in Section 6.0. Correlations were also calculated among WET-DI, WET-acid, and bulk chemistry data for inorganic chemicals; Appendix R presents the results of the statistical summary. The Pearson correlation coefficient quantifies the relationship between variables and assumes that the distributions are normally distributed. The Spearman rank correlation coefficient based on ranks is used for data sets that are not normally distributed. Statistical significance of correlation coefficients was established by hypothesis testing.

Aluminum, arsenic, cadmium, chromium, lead, nickel, vanadium, and zinc showed statistically significant correlations between bulk chemistry and WET-acid extraction concentrations. Cobalt, copper, and mercury were not correlated. Copper, lead, and mercury bulk chemistry concentrations correlated significantly with WET-DI concentrations, while aluminum, arsenic cadmium, nickel, vanadium and zinc did not show a significant correlation.

The amount of metal absorbed from ingested media depends on the organism, the form of the metal in the soil, and the soil's physical characteristics (Hamel and others 1998). Hamel and others (1998) measured the bioaccessability of metals in soils in synthetic gastric fluid compared to rigorous acid extraction techniques often employed to predict bioavailability. In general, Hamel and others (1998)

found that the bioaccessability (measured as the mass metal recovered from gastric juice extraction divided by the mass of metal obtained by toxicity leaching protocol using concentrated HCl with a low liquid:solid ratio) of chromium (2 to 8 percent) and nickel (11 to 40 percent) were low. Bioaccessabilities were higher for arsenic, cadmium, and lead—closer to 50 percent (Hamel and others 1998). This gastric extraction experiment may approximate the potential bioavailability of metals from ingestion better than other techniques such as WET-acid because the strength of the acid and the liquid:solid ratio better approximates physiological conditions (digestive properties).

The potential extractability of a metal from a soil does not equate with the amount that is actually taken up or the amount that is eliminated by the organism. For example, gut absorption of lead is affected by the levels of other metals in the gut (Sheppard and others 1995) and by the amount of food in the gut or liquid:solid ratio (Hamel and others 1998). The extraction techniques are merely indicators of the relative mobility and bioavailability of metals in soils.

9.3 RATIO OF SIMULTANEOUSLY EXTRACTABLE METALS TO ACID VOLATILE SULFIDES IN SEDIMENTS

AVS is an important solid binding phase in reduced sediments for some divalent metals of toxicological interest (cadmium, copper, nickel, lead, and zinc) (Ankley and others 1996). AVS exists in natural sediments primarily as iron sulfide complexes. A number of cationic metals (such as zinc, copper, nickel, and cadmium) will displace iron from the monosulfide and thereby may be rendered biologically unavailable (Ankley and others 1994). Generally, if the molar concentration of AVS is greater than the molar concentration of these cationic metals, they will be bound and biologically unavailable. Conversely, the ratio of the molar concentration of these SEM to AVS can be used to predict whether these metals are potentially bioavailable.

SEM/AVS data are useful for identifying trends in potential bioavailability of metals. A ratio (SEM/AVS) greater than 1.0 indicates that the binding potential of the AVS has been exceeded, so that some metals will be bioavailable. The greater the ratio, the more bioavailable some metals will be, and presumably the more toxic the sediment. For example, Long and others (1998) found that of 52 sediment samples tested, 28 percent were toxic to amphipods when the SEM/AVS was greater than 1.0, but that 50 percent of the samples were toxic if the SEM/AVS was greater than 5.

The SEM and AVS data represent a snapshot of the conditions that existed at the time the samples were collected, and conditions in the field are expected to vary over time. Also, SEM/AVS sometimes

correlates with toxicity but not at other times, presumably because AVS is only one factor that controls bioavailability (Long and others 1998). Therefore, the SEM/AVS data are evaluated as one line of evidence in predicting potential bioavailability and toxicity for sediments.

Sediments collected from Otter Sluice in 1998 were evaluated for AVS and SEM. The data are presented in Tables 9-2 and 9-3. Table 9-2 presents the measured concentrations of AVS and extracted metals in the sediments and their converted molar concentrations. Table 9-3 shows the SEM/AVS ratios. The SEM/AVS ratios were all well below 1.0, indicating that the AVS metals in Otter Sluice are not expected to be bioavailable.

Table 9-3 also shows the contribution of each metal to the total SEM when the AVS is exceeded. By subtracting each metal from the AVS beginning with the least soluble metal (copper) and continuing to the most soluble, the metals that are expected to be bioavailable can be identified. A negative number indicates that the AVS concentration has been exceeded, and metals may be bioavailable. None of the number were negative.

9.4 TISSUE RESIDUES AS INDICATORS OF BIOAVAILABILITY

The tissue residue results were presented in Section 8.0 and summarized in Tables 8-5A through 8-9B. Tissue residue results as an indicator of bioavailability are discussed below by tissue type. Tissue residues are positive indicators of bioavailability because a chemical must be bioavailable in order to be taken up by a receptor. However, the degree to which a chemical bioaccumulates, and the resultant tissue concentration measured in the laboratory, is also a function of the metabolic processes of the organism. Thus, significant linear correlations between soil and tissue concentrations of a chemical are not expected.

9.4.1 Pickleweed Tissue Residues

Pickleweed tissues were collected from the R Area Disposal and Wood Hogger Sites. The pickleweed tissue residue data are presented in Tables 8-5A and 8-7A.

Inorganic chemicals that serve as nutrients for plant development and growth are taken up both passively and actively by plants. Sometimes, metals that mimic nutrients are taken up incidentally. Both nutrient (such as barium, boron, calcium, copper, iron, manganese, molybdenum, phosphorous and zinc) and non-nutrient metals (such as lead and mercury) can be toxic to plants, depending on the

exposure concentration. Of the essential nutrients, only copper, manganese, and zinc exceeded ER-Ls and were considered potential problems for plants.

Arsenic and mercury were not detected in pickleweed samples from the R Area or Wood Hogger Terrestrial units. Lead was detected in pickleweed samples from the Wood Hogger, but not from the R Area Terrestrial unit. Bioavailability of these metals to plants in the R Area and Wood Hogger Terrestrial units appears limited, perhaps due to site conditions or because the plants do not readily take up these contaminants. Aluminum, copper, and zinc were detected in pickleweed samples from both sites. Pickleweed tissues were not analyzed for organic chemicals.

The implications of chemicals found in pickleweed in terms of effects on plants are discussed in Section 10.0. Pickleweed tissue residue data were also used in the food-chain modeling to assess risk to higher vertebrate receptors (see Section 15.0).

9.4.2 Rodent Tissue Residues

Rodent tissues were collected from the R Area Disposal and Wood Hogger Sites. The rodent tissue residue data are presented in Tables 8-5B and 8-7B. Ingestion of soil incidentally with food and during grooming are assumed to be major pathways of exposure of rodents to site chemicals. Most inorganic chemicals detected in soils were also detected in rodent tissues, indicating that inorganic chemicals in soil are somewhat bioavailable. The exception is arsenic, which was not detected in rodent tissues from either site.

In general, the bioavailability of inorganic chemicals in soils is lower than the more soluble forms used in laboratory toxicity studies. Toxicological studies often use highly bioavailable forms of a chemical compared to the forms found in the environment. For example, lead from mine-contaminated soils fed to rodents was only 10 to 20 percent as bioavailable as a soluble lead salt, lead acetate, added to soil (O'Flaherty 1998). Similarly, oral arsenic is 10 to 30 percent as bioavailable to monkeys from soil and dust than from a soluble salt (Freeman and others 1995, as cited in O'Flaherty 1998). The importance of oral bioavailability is discussed further in the context of the food-chain modeling and risk characterization in Section 15.0.

Organic chemicals detected in rodent tissues from the R Area Disposal and Wood Hogger Sites include DDTs, PCBs, BHCs, and methoxychlor. Rodent tissues collected from the Wood Hogger Site also contained detected concentrations of aldrin, endosulfan, endrin, mirex, and dioxins.

9.4.3 Fish, Clam, and Amphipod Tissue Residues

The sediments in aquatic environments are the major sink and source of contaminants for aquatic organisms. Benthic organisms are in direct contact with sediments. Fish are mainly exposed from the water phase, but the chemicals partition between sediment (and other particles such as algae) and water. Bioaccumulation of contaminants in invertebrates and fish may be an important source of trophic transfer to higher level receptors.

Four species of fish, including gobies, sculpin, stickleback, and mosquito fish, were collected from the Froid and Taylor Aquatic and North and South Otter Sluice Aquatic units, as described in Section 4.3.3 and summarized in Tables 8-6B, 8-8B, and 8-9B. Clams were collected only from the North and South Otter Sluice Aquatic units. Clam tissue residue data are presented in Tables 8-8A and 8-9A. Amphipods were collected only from the Froid and Taylor Aquatic unit. Amphipod tissues are presented in Table 8-6A.

Most inorganic chemicals detected in sediments were also detected in fish, clam, and amphipod tissues. An exception is antimony, which was not detected in clams or amphipods and was detected in only one of five composite fish samples. Cadmium, which exceeded the ER-L in sediments from the Froid and Taylor Aquatic unit, was not detected in amphipod tissues. Several chlorinated pesticides, PCBs, and dioxins were also detected in tissues of clams, fish, or amphipods. Tissue residues of fish and clams were compared to regional fish and bivalve tissue levels (as discussed further in Sections 12.0 and 13.0). Tissue residue data are also evaluated in Section 15.0 as part of food-chain modeling for evaluating risk to piscivorous birds and mammals.

Zinc residues (164 mg/kg) in clam tissues from North Otter Sluice were an order of magnitude less than clams and other bivalves in the San Francisco Bay/Delta region (with 127 to 1,578 mg/kg), according to data from the San Francisco Estuary Institute (SFEI) (1997). Mercury did not appreciably bioaccumulate in invertebrates from the Tidal Area. The tissue residue in clams from the North Otter Sluice Aquatic unit was 0.04 mg/kg mercury, and bivalve tissues from the greater San Francisco Bay/Delta region range from 0.1 to 0.57 mg/kg mercury. The clams from the North Otter Sluice Aquatic unit had slightly higher concentrations of all metals in their tissues than did clams from the South Otter Sluice Aquatic unit.

9.5 BIOASSAYS RESULTS AS INDICATORS OF BIOAVAILABILITY

The Microtox results were presented in Section 8.1. Based on statistical analyses (see Appendix R), arsenic and copper concentrations from the WET-DI extraction correlated with Microtox results. Since the WET-DI represents the most soluble and potentially bioavailable fraction of inorganic constituents, arsenic and copper are probably important chemicals based on the response by the Microtox test. Lead concentrations in the WET-acid extraction correlated with Microtox organic extraction results, but not with Microtox solid-phase results; WET-DI concentrations of lead did not correlate with any Microtox results.

Amphipod bioassay results were presented in Section 8.0. All amphipods exposed to sediments from the North and South Otter Sluice Aquatic units exhibited better than 90 percent survival and reburial. These results indicate that the exposure level to chemicals in these sediments was not great enough to cause adverse effects in amphipods under laboratory conditions. The exposure level is partly based on the bioavailability of these contaminants. Since some chemical concentrations exceeded ER-Ms, including mercury, nickel, and zinc, some toxicity may have been anticipated. As a result, it appears that the levels of chemicals actually available in sediments from Otter Sluice are lower than their total concentrations. A correlation analysis (between amphipod results and concentrations of chemicals in site sediments) was not completed due to the small sample size.

Sediment samples from Otter Sluice were tested using the topsmelt SWI test, as discussed in Section 8.0. The results of the topsmelt bioassay suggest that confounding factors may have affected the hatchability of fish embryos. For example, ammonia may have contributed to the observed toxicity in at least one sample. A correlation analysis (between topsmelt results and concentrations of chemicals in site sediments) was not completed due to the small sample size, but the sediments with the lowest topsmelt hatchability were not the ones with the highest concentrations in the sediments. This indicates that some of the chemicals in the sediments may have not been bioavailable during the topsmelt bioassay.

10.0 RISK TO PLANTS

Protection of populations of upland and wetland plants was identified in Section 7.0 as an assessment endpoint for the Tidal Area. For upland and wetland plants, exposure of the plants via soil and surface water provided rationale for selection of this assessment endpoint. Potential food-chain transfer to terrestrial herbivores for upland plants, and to the salt marsh harvest mouse and other special status species for wetland plants, also supported selection of this assessment endpoint.

Ecological surveys and literature reviews identified plants occurring or potentially occurring at the Tidal Area (see Section 3.2). The only special status plant that may have been observed in the Tidal Area is the marsh gumplant (*Grindelia stricta* var. *angustifolia*), a member of the sunflower family (see Section 3.3). Although special status plants were generally not observed at the Tidal Area, they may occur in the Tidal Area based on the habitat.

Pickleweed tissue was selected as a measurement endpoint for wetland plants because it is essential for the habitat and dietary requirements of the endangered salt marsh harvest mouse and is abundant and widespread throughout the Tidal Area wetlands. Chemical levels protective of pickleweed were assumed to be sufficiently protective of other plants, particularly wetland plants.

For the evaluation of risks to plants presented in this section, plants were considered to be primarily exposed to site chemicals through soil and sediment only. Soil and sediments down to 3 feet in depth were considered in the analysis. Risk to plants from COPECs was evaluated in a weight-of-evidence approach using available tools, including:

- Identification of COPECs based on ambient concentrations and ER-Ls
- Evaluation of bulk chemistry, especially as related to plant nutrient requirements and bioavailability
- Evaluation of tissue concentrations of inorganic chemicals in pickleweed tissue collected from the site as a measure of bioavailability
- Observations of vegetation, flora, and soil conditions at the Tidal Area
- A comparison of soil chemistry data to terrestrial plant benchmarks including CDFG preliminary remediation goals (PRG)

COECs for plants were subsequently identified based on the results of this assessment.

Section 10.1 presents the COPECs that were identified for plants based on the screening methods outlined in Section 5.2.1. Section 10.2 discusses the exposure assessment, and Section 10.3 the effects assessment and determination of COECs for plants. Section 10.4 summarizes the exposure and effects assessment to characterize the risk to plants at the Tidal Area.

10.1 CHEMICALS OF POTENTIAL ECOLOGICAL CONCERN FOR PLANTS

As described in Section 5.0, an inorganic COPEC for plants was identified if chemical concentrations (1) exceeded ambient concentrations (Tidal Area and San Francisco Bay ambient values, as available) and (2) exceeded ER-Ls or if no ER-Ls were available. Organic COPECs were identified if chemical concentrations exceeded ER-Ls or if no ER-Ls were available. Based on further statistical evaluations of the data in Section 6.3, chromium, silver, thallium, and vanadium were eliminated from further evaluation as COPECs.

ER-Ls were used as a screening value in the absence of promulgated criteria for plants, but since ER-Ls are based on toxicity to fish and aquatic invertebrates, concentrations that exceed the ER-L do not necessarily indicate a risk to plants. Soil benchmarks for plants, described in Section 10.3, were available for a limited number of chemicals. As a result, ER-Ls were used for initial screening of COPECs, and soil benchmarks were used along with other information from the literature to evaluate the specific effects of chemicals in soil on plants.

Specific Tidal Area habitat units for which the risk to plants was evaluated include the Landfill Terrestrial unit, R Area Terrestrial unit, R Area Terrestrial and Aquatic unit, Froid and Taylor Terrestrial unit, Froid and Taylor Aquatic unit (which is designated an aquatic unit since it has standing water most of the year, but which could support plants), and Wood Hogger Terrestrial unit. Tables 10-1 through 10-6 identify COPECs for each of these habitat units, and indicate the highest screening value that was exceeded. The North and South Otter Sluice Aquatic units were not evaluated since they are aquatic environments that do not support upland or wetland plants. Although ER-M exceedances are noted on Tables 10-1 through 10-6, the ER-M is provided for reference purposes only since ER-Ls were used to identify COPECs.

Chemicals for which no screening values exist include pesticides, SVOCs, VOCs, explosives, diesel, gasoline, and motor oil. Total PAHs sometimes exceeded screening values when the concentration was composed of all nondetects and one-half the sample detection limit was substituted for the concentration

of each nondetected chemical. PAHs were not considered COPECs if all individual PAHs were below detection limits of the low detection limit analytical method.

10.2 EXPOSURE ASSESSMENT FOR PLANTS

The complete exposure pathways for plants are depicted on Figure 7-1. The major exposure route of inorganic chemicals to plants is through root uptake from soil or water and translocation of contaminants into the plant. Root uptake is both an exposure pathway for COPECs and an uptake route for nutrients.

Plants at the site may take up chemicals directly from the soil or surface water and suffer direct or indirect effects of exposure. The soil environment around the roots of plants is an important factor in the availability of chemicals for uptake. Factors such as pH, soil texture, and organic matter content can strongly influence exposure of plants by altering the bioavailability of the chemicals (see Section 9.0).

Atmospheric deposition is a greater source of organic contaminants to aboveground plant material than is uptake from soil or water through roots, especially for organic chemicals of low water solubility (Ockenden and others 1998; McLachlan and others 1995). Hydrophobic organic chemicals such as PAHs and PCBs are not readily taken up by roots or appreciably translocated within the plant xylem (Will and Suter 1995). Hydrophobic organic chemicals from atmospheric sources may be sorbed to leaf surfaces and subsequently absorbed into the waxy cuticle or enter through stomata and be translocated via the phloem. Atmospheric sources can include volatilization of site contaminants from soil, water, and sediments. The extent of uptake and accumulation of hydrophobic organic chemicals in plants depends on the physicochemical properties of the chemical and the nature (such as lipophilicity) of the contaminant storage compartment in the plant (Komp and McLachlan 1997).

Physicochemical properties of inorganic chemicals and the soil determine the exposure of metals to plants. Iron and manganese oxides and organic matter are the major sinks for metals in oxic soils and sediments, and sulfide minerals are a sink for metals under anoxic conditions (Simpson and others 1998; Jenne and Luoma 1977). Upland soils tend to be more oxidized than are soils in wetlands. Wetland soils and sediments have higher levels of organic matter, resulting in microbial depletion of oxygen. Ionic strength and pH control metal solubility. Metals have lower solubility at higher ionic strength, so exposure to metals may be greater in fresh water than in saline or brackish water. Dissolved metals, either freely dissolved or bound to dissolved organic matter, can be taken up by roots

and translocated in the xylem of the plant. The pH of the environment also determines the availability of metals to plants by controlling speciation, precipitation reactions, and sorption-desorption properties of organic matter.

Once in the plant, metals can be sequestered in the roots in vacuoles or cell walls or translocated to aboveground parts (Will and Suter 1995). The locations and forms of metals in plants depend on plant species, growth stage, physiological state, and the presence of other metals (Will and Suter 1995).

10.2.1 Chemical Exposure Based on Tissue Residue Data

The exposure assessment of site chemicals to plants is based mostly on pickleweed tissue residue data. Pickleweed is the plant of most concern in the Tidal Area due to its abundance and importance for protection of the endangered salt marsh harvest mouse. Concentrations of metals in pickleweed tissues collected in the R Area Disposal and Wood Hogger Sites are presented in Tables 8-5A and 8-7A. In the R Area Disposal Site, pickleweed tissue samples were collected at locations where the concentrations of lead and zinc were high. However, for some chemicals such as mercury, the location of the highest mercury concentrations was not collocated with the pickleweed tissue samples.

Based on an evaluation of soil to tissue concentrations, the bioavailability of lead appears to be low. Lead was detected in only one of four pickleweed tissue samples. The tissue concentration of lead in pickleweed from the Wood Hogger Site was 0.14 mg/kg, while the soil concentration was 39 mg/kg. Lead was not detected in pickleweed tissue samples collected from the R Area Disposal Site, although lead in soil at collocated sample locations was high (275 mg/kg, 127 mg/kg, and 285 mg/kg at sample locations RADSB007, RADSB017, and RADSBI06, respectively). The tissue residue data are discussed further in Section 10.3.3 in the context of potential toxicological effects.

Exposure to organic chemicals was of potential concern mostly in the Wood Hogger Site. At the Wood Hogger Site, the highest concentrations of organic chemicals are located in an area of high human disturbance, where soils are combined with gravel and the area consists of disturbed upland and wetland habitat. This area represents a fairly low quality habitat.

10.2.2 Additional Factors Affecting Exposure

Several soil factors commonly limit revegetation on disturbed or remediated soils containing high concentrations of metals (Linder and others 1996a, 1996b; Munshower 1994). The interaction of these

factors with metals in soils frequently contributes to relatively poor vegetation growth. In general, factors that recur as prominent causes of poor vegetation stands are often independent of contaminants; these factors include soil pH, salinity, sodicity (elevated sodium concentrations), cation exchange capacity (CEC), organic matter, soil texture and structure, and bulk density and porosity.

A casual inspection of soils at the Tidal Area suggests that, in general, data on soils of Contra Costa County represent current conditions at the Tidal Area. As part of the weight-of-evidence approach focused on soils, empirically derived critical values for soil physicochemical parameters are summarized in Table 10-7. In an environmental management context, these values should be viewed with particular attention to ambient conditions that might confound the interpretation of adverse effects associated with COPECs.

Vegetation at the Tidal Area sites appears low in diversity relative to undisturbed tidal wetlands. As part of WESCO's site characterization (1995), stressed vegetation was evaluated throughout the Tidal Area sites. According to WESCO's report, vegetation stress in the Tidal Area sites related to environmental causes was noted primarily in dead or largely dead patches of pickleweed. Previous studies in similar wetlands at the NWS SBD Concord Litigation Area found several large stands of pickleweed with high percentages of dead stems (O'Neil 1988). Evidence at these sites suggested that bioaccumulation of metals was impairing pickleweed growth and health and promoting an expansion of the parasitic vine, dodder. Other potential causes for pickleweed stress include frequency of flooding, competition from other plants, and parasitism (O'Neil 1988). Stunted growth, chlorosis, necrosis, and other pathological changes in plants may be the result of one or several factors including environmental stress (such as suboptimal, or large variations in, levels of salt, water, light, and temperature), poor nutrient availability, physical disturbances, or chemical toxicity. It is unknown whether chemical concentrations in soil, sediment, and surface water were associated with pickleweed stress at this site.

Frequency and duration of flooding can be a primary cause for major diebacks of pickleweed and other middle and high marsh plants. Pickleweed is well adapted to a cycle of frequent tidal submergence and emergence associated with marsh areas above the mean high water line (Josselyn 1983). It also grows well in the drier, nontidal conditions in diked salt marshes because of its tolerance for high salinities. However, pickleweed is not well adapted to long periods of submergence, and will not survive tidal regimes where the daily period of submergence exceeds emergence (Hinde 1954). Long periods of submergence can cause pickleweed die-offs by several mechanisms. First, pickleweed is a poor light absorber and requires relatively high light intensity for photosynthesis. Light reduction under

submerged conditions can greatly reduce its photosynthetic capabilities (Josselyn 1983). Second, pickleweed may leach nutrients and organic compounds during submergence (Mahall and Park 1976). The combination of photosynthetic inhibition and nutrient losses will limit or stop pickleweed growth. Third, pickleweed can be shaded out by dense layers of wrack and periphyton algal mats. Wracks consists of plant matter (primarily dead pondweed in the Tidal Area sites) and other marsh debris concentrated by tidal action or winds in particular locations in the marsh. Periphyton algal mats consist of dense associations of macrophytic algae that tend to grow in areas where standing water occurs. The algal mats and wrack materials may float or be pushed by winds into certain regions of some diked marshes, where they effectively blanket the pickleweed. This blanket appears to inhibit light penetration to the pickleweed. When water levels drop, the dead and dying algal mats and wrack materials cause further stress by draping over the pickleweed growth. Pickleweed death caused by deposition of wrack is a normal occurrence in tidal marshes (Josselyn 1983), and dieback from periphyton blanketing has been observed in diked salt marshes in south San Francisco Bay (WESCO 1993).

Six locations at the Tidal Area contained single or multiple large patches of dead pickleweed, varying in size from less than 2,000 square feet to several acres. The probable cause of pickleweed death noted in the WESCO field surveys was inundation or salinity buildups for five of the six locations (see Section 3.4.5).

No evidence of flooding or periphyton/wrack draping was found during the 1994 survey. Rather, a distinct boundary between the dead or dying pickleweed zone and adjacent healthy stands of pickleweed existed.

Evidence did not indicate that dead pickleweed was attributable to inundation near the intersection of Froid and Taylor Roads. Instead, stressed vegetation occurred in an approximately 3,000 square-foot zone of dead or dying pickleweed roughly in the center of the Froid and Taylor Roads Site. Here, dense patches of dead or dying pickleweed were interspersed with zones of barren ground or very sparse dead pickleweed. Soils had an unnatural blackened or "stained" appearance very different from the gray to darkened soil matrix colors typical of Bay Muds. Scrap wood and debris are found throughout the zone, suggesting that some sort of surface debris disposal may have occurred there.

Physical structures affecting the Tidal Area sites (specifically, the roads and dikes in and around the R Area Disposal, Froid and Taylor Roads, and Wood Hogger Sites) have clearly had a negative effect on the wetlands.

10.3 EFFECTS ASSESSMENT FOR PLANTS

The effects assessment for plants in the Tidal Area was based on evaluation of benchmark values, additional factors contributing to effects, and potential toxicological effects of COPECs on plants, as discussed in the following subsections.

10.3.1 Comparisons with Benchmark Values

COPECs were compared to existing literature values associated with potential adverse effects on plants. Maximum site-specific concentrations were compared to benchmark values. The benchmarks presented in Tables 10-8 through 10-11 include terrestrial plant, soil and litter, and invertebrate benchmarks for the Landfill Terrestrial Unit, R Area Terrestrial Unit, Froid and Taylor Terrestrial Unit, and Wood Hogger Terrestrial Unit, respectively. Only the plant benchmarks are relevant to the discussion in this section. Plant benchmarks included CDFG PRGs provided in a memorandum to DTSC from Susan Ellis of CDFG (1997). Where PRGs were not available, benchmarks developed by Oak Ridge National Laboratory (ORNL) cited in Will and Suter (1995a) were used. The CDFG PRGs were based on literature reviews conducted by USFWS of effects of chemicals in soil on plants and other organisms for a number of inorganic chemicals. ORNL also developed benchmarks after conducting a comprehensive literature review for several inorganic chemicals and a few organic chemicals. The plant benchmarks represent the lowest observed effect level (LOEL) for phytotoxicity, which is a threshold for significant effects on growth and production. The ORNL benchmark was derived from the 10th percentile of LOELs provided in the literature or, for chemicals where LOELs were unavailable, an LC50 was used with an uncertainty factor of 5 applied (Will and Suter 1995).

Maximum site-specific soil concentrations of Tidal Area COPECs frequently exceeded benchmarks for plants (see Tables 10-8 through 10-11); however, field observations could not unequivocally support a cause-effect relationship between soil concentrations of COPECs and the condition of vegetation.

COPECs that do not exceed benchmarks for plants at ambient concentrations, but exceed benchmarks at site concentrations, are:

- Landfill Terrestrial Unit: cadmium
- R Area Terrestrial Unit: antimony, lead, and selenium
- Froid and Taylor Terrestrial Unit: lead
- Wood Hogger Terrestrial Unit: antimony, cadmium, lead, and selenium

The available plant benchmarks for organic chemicals (PCBs, PAHs [acenaphthene and biphenyl], chlorobenzene, phenol, pentachlorophenol, di-n-butylphthalate, and diethylphthalate) were not exceeded in soils at any site. There were no benchmarks for pesticides.

10.3.2 Additional Factors Contributing to Effects: Plant Nutrients and Trace Elements

The effects of contaminants may be confounded by features of the soil matrix itself (Linder and others 1994a; Marschner 1986; Munshower 1994). Plants require a variety of inorganic macro- and micronutrients for healthy growth. An under- or over-supply of nutrients can strongly affect plant vigor independent of site contamination. Many inorganic constituents on the priority pollutant list, such as copper and zinc, are required as trace elements by plants, but are toxic at high levels. Limited data were collected to characterize soil nutrient potential in the wetlands of the Tidal Area sites. A brief summary of the existing information on plant nutrients is included as part of this assessment of risk for plants at the Tidal Area sites. This summary of the role of nutrients and trace metals, whether associated with contaminants or naturally occurring chemicals, is critical to the risk assessment and future risk management decisions at the Tidal Area.

10.3.2.1 Plant Macronutrients

Nitrogen deficiency is characterized by small, pale plants and retarded growth; the most common plant-available form of the element is the nitrate ion (NO_3^-). Nitrogen is generally stored in the soil as organic matter, mostly in the upper soil horizons. Quite often, disturbed soils are nitrogen limited because the upper soil horizon has been altered. Soils at the Tidal Area sites are disturbed (for example, trenched or filled) and may be nitrogen deficient; therefore, existing vegetation signatures must be evaluated in that context. Stored topsoil used as fill generally loses nitrogen that is converted from the organic form to the more soluble nitrate or ammonium ions. The stored topsoil, even when returned to the disturbed landscape, may be depleted of nitrogen and altered in physical structure. Chemical and biological processes that can affect the normal cycling of nitrogen in the system may be disrupted.

Phosphorus in soils is generally available to plants as the phosphate ion (PO_4^{2-}), which is critical to early seedling germination and growth. Generally, if the organic matter in soil is sufficient, a continual supply of phosphorus is available to plants as organic matter decomposes. The relatively high TOC concentrations at the Tidal Area sites suggest that phosphorus is not a limiting factor to plants and is not an important confounding factor in evaluating of vegetation signatures and site-specific COPECs. However, some site soils had low TOC content, indicating potential nutrient deficiency.

Potassium is critical to the normal physiological function of plants; its significance to long-term sustainability varies with plant age. Potassium concentrations in Tidal Area soils are variable, but plant-potassium interactions are generally not limited in disturbed soils unless phytotoxicity associated with residual materials is apparent.

As a macronutrient, calcium is primarily associated with physiological functions of plant cells and with the plant cell wall. In western soils, total calcium concentrations range from less than 0.1 percent to 5 percent. Even in disturbed soils, calcium is not likely to occur in deficient or excess concentrations, especially with soil pH ranging between 6.5 and 8.0, as occurs at most of the Tidal Area sites. Similarly, magnesium is critical to normal plant functions, including photosynthesis; generally, magnesium concentrations are adequate for plants even in disturbed soils. Soil pH values in the Tidal Area sites did not suggest confounding interactions with either of these divalent cations.

Sulfur is critical to normal plant functions, since it is a constituent of proteins and enzymes required in normal plant processes. A major portion of soil sulfur is in organic matter; sulfur in soil organic matter is released slowly as a result of decomposition. Total soil sulfur content was not measured at the Tidal Area sites. Carbon disulfide content, which is a function of the environmental redox potential, was measured. However, on the basis of existing information about the soils as well as general information on the relationships between sulfur and organic content, no confounding effects related to sulfur requirements were anticipated at the Tidal Area sites.

10.3.2.2 Trace Elements and Micronutrients

Plant micronutrients, including barium, boron, copper, iron, manganese, molybdenum, and zinc, are required in trace amounts for growth and normal function. Concentrations of trace elements are highly variable in soils, whether or not they have been disturbed by human activities. The role of these elements in normal plant function varies from one species to another, making it difficult to generalize levels that are associated with normal function versus levels that cause adverse effects. However,

potential deficiency levels or toxic concentrations of these elements are summarized in Table 10-12, to assist in understanding the role of plant-soil interactions in promoting long-term sustainability of soils at the Tidal Area sites.

10.3.3 Potential Toxicological Effects of COPECs on Plants

In general, the soil analysis suggests that the physicochemical properties of soils should not significantly limit vegetation growth and sustainability. However, diminished vegetative cover or vigor was apparent in each of the Tidal Area sites apparently due to physical disturbances in many areas. Chemical toxicity to plants, however, was not evaluated directly. As a result, potential effects of chemicals on plants can only be surmised based on the benchmark comparisons and on other information from the literature in conjunction with pickleweed tissue residue data.

10.3.2.1 Potential Effects of Inorganic COPECs on Plants

Because pickleweed was collected from sample locations with the highest concentrations of inorganic chemicals and the pickleweed appeared to be healthy, inorganic chemicals are not expected to have a an adverse impact on vegetation of the site. Nevertheless, each COPEC was examined for potential effects on plants. It is understood that there are species differences in sensitivity to chemical contaminants. The weight of evidence also takes into consideration the diversity of flora found at the site and other indicators of wetland health and function.

Antimony

Little is known about the phytotoxicity of antimony. The benchmark was based on a study of 5 parts per million (ppm) antimony added to soil, which caused unspecified toxic effects on plants (Kabata-Pendias and Pendias 1984, as cited in Will and Suter 1995). Due to the limited information available, antimony cannot easily be evaluated. The maximum site concentration of antimony found in soils from the R Area Disposal and Wood Hogger Sites slightly exceeded the benchmark. Also, antimony was not detected in pickleweed tissues from the Tidal Area. As a result, antimony is not considered a COEC.

Arsenic

The Tidal Area 99th percent UCL ambient concentration of arsenic exceeded the CDFG PRG. The maximum concentration of arsenic was at the Landfill Perimeter Terrestrial unit, and was about twice the ambient value. Arsenic was below detection limits (0.24 mg/kg) in all four composite pickleweed

samples collected from the R Area and Wood Hogger Terrestrial units. Since arsenic was not bioavailable, arsenic is not considered a COEC.

Cadmium

Cadmium exceeded benchmarks and ambient levels in samples collected at the Landfill Terrestrial, Froid and Taylor Aquatic, and Wood Hogger Terrestrial units. At the Wood Hogger Site, the maximum soil concentration was about 10 times the CDFG PRG. However, cadmium was not detected in pickleweed collected from the Wood Hogger (detection limit of 0.02 mg/kg). If the cadmium was in an available form, it would readily be taken up by plants. Therefore, cadmium is not considered a COEC. Zinc, which cadmium mimics, can mitigate the effects of cadmium (Wallace and others 1977, as cited in Will and Suter 1995); since zinc was detected at 8 mg/kg in the pickleweed collected at Wood Hogger, it may be reducing the effects of cadmium.

Copper

Copper is a micronutrient essential for plant growth, but can be toxic in high concentrations. Copper toxicity is mostly directed at the roots of plants, where it interferes with enzyme functioning (Mukherji and Das Gupta 1972, as cited in Will and Suter 1995). The Tidal Area ambient concentration of copper is twice the CDFG benchmark, but less than the ORNL benchmark for copper toxicity in plants. The maximum copper concentrations in soils from the Landfill Terrestrial, R Area Terrestrial, Froid and Taylor Aquatic, and Wood Hogger Terrestrial units exceeded benchmarks and ambient levels. However, the 95th percent UCL for copper in soils at the Landfill Terrestrial, R Area Terrestrial, Froid and Taylor Aquatic, and Wood Hogger Terrestrial units was less than the ambient concentration (Tidal Area 99th percent UCL).

The pickleweed tissue concentration in samples from the Wood Hogger Site was 0.54 mg/kg and 0.36 to 1.0 mg/kg in the R Area Disposal Site, on a wet weight basis. One of the R Area Disposal Site pickleweed sample locations had a soil copper concentration of 272 mg/kg, whereas the other two sample locations showed 62.2 and 74 mg/kg. The pickleweed tissue data did not appear to correlate with soil concentrations, indicating that the plants are regulating copper uptake even at high copper concentrations in soil. The minimum plant tissue concentrations required for growth vary somewhat for different species, but a general requirement is 10 mg/kg on a wet weight basis (Florida Agricultural Information Retrieval System [FAIRS] 1999). The plants in the Tidal Area are therefore subject to

copper nutrient deficiency. The bioavailability of copper at the site appears low; therefore, copper is not considered a COEC for plants.

Lead

Lead exceeded CDFG PRGs in samples at the Wood Hogger and R Area Terrestrial units at the maximum soil concentrations found in those samples. However, the calculated 95th percent UCL for lead from these sites and the ambient concentration (Tidal Area 99th percent UCL) did not exceed the PRG for lead, but did exceed the ORNL benchmark. Lead was detected at trace levels (0.14 mg/kg) in pickleweed from the Wood Hogger Site, and not detected in pickleweed from the R Area Disposal Site. Soil at the Wood Hogger Site where pickleweed was collected had less than ambient levels of lead (39 mg/kg). However, soils in the R Area where pickleweed was collected had high lead concentrations (106 to 285 mg/kg), indicating that bioavailability of lead to plants may vary with soil conditions, but was low for all pickleweed samples collected.

The pickleweed tissue data indicate low bioavailability. Since soil concentrations did not appear to correlate with tissue residue data, it is difficult to predict whether any soil conditions in the Tidal Area exist that would make lead more bioavailable than was observed from the limited pickleweed sample size. The phytotoxicity of lead is relatively low compared with other trace elements. In high concentrations of soluble forms, however, lead may elicit effects by disturbing electron transfer and affecting mitochondrial respiration and photosynthesis (Miles and others 1972, as cited in Will and Suter 1995). Site conditions indicate that lead is not in highly soluble forms. As a result, lead is not considered a COEC for plants.

Mercury

Maximum soil concentrations in all terrestrial units exceeded the CDFG PRG for mercury. However, the Tidal Area ambient concentration of mercury also exceeded the CDFG PRG. Mercury was below detection limits in pickleweed tissues collected from the R Area Disposal and Wood Hogger Sites, indicating low bioavailability. However, maximum mercury concentrations were not at the sample locations where pickleweed was collected. The pickleweed collected from the Wood Hogger Site (sample location WHSSB021) was nearby, but not at, the sample location (WHSSB024) with the highest mercury concentration. Mercury and its compounds are taken up and translocated to only a limited extent in plants (Will and Suter 1995), therefore is not expected to bioaccumulate in pickleweed

even at the maximum site concentration in the Wood Hogger. Therefore, mercury is not considered a COEC.

Nickel

Nickel is an essential nutrient for plants, but at high concentrations can be toxic. Ambient and all unit maximum concentrations exceed the CDFG plant PRG for nickel. Nickel was detected in one of four pickleweed tissue samples.

Nickel can affect absorption of cobalt and other nutrient metals. Cobalt was detected in two of four pickleweed samples. Nickel toxicity is exhibited by chlorosis and foliar necrosis (Khalid and Tinsley 1980, as cited in Will and Suter 1995). More subtle effects include reduction in plant weight, seed germination, and root growth (Will and Suter 1995). There appear to be differences in species sensitivity and other factors that determine thresholds for nickel toxicity since some studies indicate a clear reduction in plant growth at soil concentrations where no effects were seen in other studies. The pH of the soil is one factor known to affect nickel availability and toxicity: 100 ppm soil concentration had no effect on seedling shoot weight at pH 7.5, but caused a 64 percent reduction at pH 5.8 (Wallace and others 1977, as cited in Will and Suter 1995). This finding suggests that the CDFG PRG of 20 ppm may be conservative. The 95th percent UCL (75 mg/kg) for nickel in soil for the R Area Terrestrial unit is less than the Tidal Area and San Francisco Bay ambient concentrations (120 and 112 mg/kg) indicating that nickel contamination is not widespread in the R Area Terrestrial unit. Furthermore, since nickel bioavailability appears to be low, nickel is not considered a COEC for plants.

Selenium

Selenium levels are high in the San Francisco Bay region compared with national levels. The confidence level for the ORNL benchmark for selenium of 0.7 mg/kg is low because it is based on few studies (Will and Suter 1995). The 95th percent UCL for selenium concentrations in soil samples collected from the Wood Hogger Terrestrial unit is 0.64 mg/kg, which is below the CDFG PRG of 1.0 mg/kg and the ORNL benchmark. Furthermore, it was not detected in pickleweed tissues collected from the R Area and Wood Hogger Terrestrial units. Therefore, selenium is not considered a COEC for plants.

Zinc

Zinc is an essential element for plant growth. However, high levels have been associated with decreased plant growth. Ambient levels of zinc in the Tidal Area exceed the CDFG and ORNL benchmarks for zinc. However, zinc bioavailability is lowest at pH 5.5 to 7.0, which is typical for Tidal Area soils (Juma 1998). The optimum nutrient status of zinc for most plants is about 100 mg/kg wet weight (FAIRS 1999). Critical values on a dry weight basis have been reported to be about 10 to 20 mg/kg (FAIRS 1999; Federation of America Scientists 1999). Tissue residue of zinc for pickleweed tissue collected in the Wood Hogger Site was 8 mg/kg, and in the R Area Disposal Site, the mean concentration was 2.7 mg/kg (wet weight basis). Therefore, pickleweed in the R Area Disposal Site appears to be deficient in zinc. The bioaccumulation factor (BAF) for zinc in pickleweed from the Wood Hogger Site was 0.10, and ranged from 0.01 to 0.02 for pickleweed in the R Area Disposal Site. As a result, zinc bioavailability is particularly low in the R Area Disposal Site. Zinc is not considered a COEC for plants.

10.3.2.2 Potential Effects of Organic COPECs on Plants

Pickleweed tissues were not analyzed for organic chemicals because concentrations in tissues were not expected to be high. Uptake of organic chemicals from soils through roots and translocation to aboveground vegetation is limited compared to uptake through leaves from atmospheric sources. Atmospheric sources include atmospheric deposition of chemicals from sources off site, or from volatilization of organic chemicals in site soils. Based on the discussion in the previous subsection, inorganic chemicals were not considered COECs for plants.

The few organic chemicals for which benchmarks were available were not found at high concentrations in soils and sediments in the Tidal Area. None of these available benchmarks for organic chemicals were exceeded (see Tables 10-8 through 10-11). Concentrations of pesticides found in soils in the Tidal Area were also much lower than are generally used for crop applications. As a result, organic chemicals are not expected to pose a threat to plants, and were therefore not considered COECs.

10.3.2.3 Other Inorganic COPECs

Insufficient information exists to evaluate the effects of barium, beryllium, cobalt, manganese, and molybdenum on plants. However, these inorganic constituents were either not detected or detected at low concentrations (as compared to concentrations in site soils) in tissue samples of pickleweed or

rodents from the terrestrial habitats or in clam or amphipods in aquatic habitats, indicating low site bioavailability.

10.4 RISK CHARACTERIZATION FOR PLANTS

The soils at the Tidal Area sites are all disturbed by human use. In many instances, the physical alteration of habitat (for example, through drainage and soil compaction) is likely the prime source of adverse effects on vegetation, especially in areas such as the Wood Hogger Site.

On the basis of current information, soil tilth at the Tidal Area sites also appears relatively disturbed. The micronutrient status of the soils is of concern with respect to bioavailability. Copper, zinc, and other micronutrient levels were low in pickleweed tissues compared to reported minimum concentrations adequate for plant growth; however, the nutritional needs for pickleweed may differ from typical agricultural crops.

Based on the analysis of exposure and effects, no COECs were identified for plants. The pickleweed tissue residue data indicate little risk to plants from inorganic chemicals, even in areas with elevated concentrations of inorganic chemicals in soils.

Exposure to organic chemicals was of concern mostly in the Wood Hogger Site, in an area of high human disturbance that represents fairly low quality habitat. Organic chemicals were not measured in pickleweed tissues, but the organic concentrations in soil did not exceed soil benchmarks for plants. Organic chemicals are therefore not expected to pose a risk to plants at concentrations found in site soils.

11.0 RISK TO SOIL BIOTA AND TERRESTRIAL INVERTEBRATES

Protection of soil biota and populations of terrestrial invertebrates was selected in Section 7.0 as an assessment endpoint because these organisms are important prey items for birds and mammals and play an important role in nutrient cycling in wetland and upland systems. Soil biota are particularly at risk to contaminants, since they are in direct contact with the soil.

Ecological surveys conducted at the Tidal Area did not specifically target soil biota and terrestrial invertebrates. However, no special status invertebrates are considered to potentially occur at the Tidal Area.

The measurement endpoints for soil biota and terrestrial invertebrates focused on conducting surrogate measurements directly on soils, rather than collecting tissue samples or conducting direct biological tests. Specifically Microtox and Cytochrome P450 assays, as well as WET analyses, were conducted on soils to assist in assessing risk to soil biota and terrestrial invertebrates.

For this assessment, soil biota and terrestrial invertebrates were considered to be primarily exposed to site chemicals through soil only. Surface soils to 3 feet bgs were considered in the analysis. Risk to soil biota and terrestrial invertebrates was evaluated in a weight-of-evidence approach using available tools, including:

- Identification of COPECs based on ambient concentrations and ER-Ls
- A comparison of soil chemistry data to CDFG PRGs and benchmarks for soil- and litter-dwelling invertebrates. This comparison involved only COPECs for which sufficient information is available.
- A limited physicochemical analysis of soils (pH, TOC, and particle size).
- A biological effects assessment using Microtox and Cytochrome P450 measurements together with bulk chemistry and chemical extraction analyses (WET results).

COECs for these organisms were subsequently identified based on the results of this assessment.

Section 10.1 presents the COPECs that were identified for soil biota and terrestrial invertebrates based on the screening methods outlined in Section 5.2.1. Section 10.2 discusses the exposure assessment, and Section 10.3 the effects assessment and determination of COECs for these organisms. Section 10.4 summarizes the exposure and effects assessment to characterize the risk to soil biota and terrestrial invertebrates at the Tidal Area.

11.1 CHEMICALS OF POTENTIAL ECOLOGICAL CONCERN FOR SOIL BIOTA AND TERRESTRIAL INVERTEBRATES

As described in Section 5.0, an inorganic COPEC for invertebrates was identified if chemical concentrations (1) exceeded ambient concentrations (Tidal Area and San Francisco Bay ambient values, as available) and (2) exceeded ER-Ls or if no ER-Ls were available. Organic COPECs were identified if chemical concentrations exceeded ER-Ls or if no ER-Ls were available. Based on further statistical evaluations of the data in Section 6.3, chromium, silver, thallium, and vanadium were eliminated from further evaluation as COPECs.

ER-Ls were used as a screening value in the absence of promulgated criteria for soil biota and terrestrial invertebrates, but since ER-Ls are based on toxicity to fish and aquatic invertebrates, concentrations that exceed the ER-L do not necessarily indicate a risk to soil biota and terrestrial invertebrates. As a result, ER-Ls were used for initial screening of COPECs, and soil benchmarks were used along with other information from the literature to evaluate the specific effects of chemicals in soil on soil biota and terrestrial invertebrates.

Specific Tidal Area habitat units for which the risk to soil biota and terrestrial invertebrates was evaluated include the Landfill Terrestrial unit, R Area Terrestrial unit, Froid and Taylor Terrestrial unit, and Wood Hogger Terrestrial unit. Tables 10-1, 10-2, 10-4, and 10-6 identify COPECs for each of these habitat units, and indicate the highest screening value that was exceeded. The remaining habitat units were not evaluated since they are aquatic environments. Although ER-M exceedances are noted on Tables 10-1, 10-2, 10-4, and 10-6, the ER-M is provided for reference purposes only since ER-Ls were used to identify COPECs.

Chemicals for which no screening values exist include pesticides, SVOCs, VOCs, explosives, diesel, gasoline, and motor oil. Total PAHs sometimes exceeded screening values when the concentration was composed of all nondetects and one-half the sample detection limit was substituted for the concentration of each nondetected chemical. PAHs were not considered COPECs if all individual PAHs were below detection limits of the low detection limit analytical method.

11.2 EXPOSURE ASSESSMENT FOR SOIL BIOTA AND TERRESTRIAL INVERTEBRATES

The complete exposure pathways for soil biota and terrestrial invertebrates (primarily detritivores) are depicted on Figure 7-1. Complete exposure pathways include dermal contact with soil or surface water and dietary exposure to soil, detritus, or prey. Plant material (live or decaying) as a food source is not considered directly in this assessment, but is indirectly considered by evaluating chemical levels in soils.

Biological factors that affect exposure include feeding mode, selectivity in diet, position in the food chain, foraging depth, organism size, assimilation efficiency, bioavailability, and detoxifying mechanisms (Connell 1990; Fisher 1995). Variability in exposure results from the mobility of organisms; some invertebrates are relatively immobile during larval phases, while others remain highly mobile throughout their lifespan.

The following subsections discuss the soil parameters affecting exposure to soil biota and terrestrial invertebrates, and the WET results in terms of potential exposure to these organisms.

11.2.1 Soil Parameters Affecting Exposure

Limited physical characterization of Tidal Area soils was completed in conjunction with the RI activities. The physicochemical characteristics of soil determine its productivity and ambient biological activity, both of which may confound evaluation of soil toxicity. Preliminary evaluations at the Tidal Area sites focused on the physical, biological, and chemical effects of contaminants on soil, as well as the trophic transfer of contaminants from soil to higher-level receptors. Contaminants primarily change soil chemical properties, but they may also indirectly influence biological and physical soil properties. The events leading to chemical release at any site, however, may also be associated with physical disturbances to soil that potentially mask, or allow for misinterpretation of, chemical effects associated with soil.

The bioavailability of contaminants in soil, which is discussed in Section 9.0, is also important in determining the exposure to soil biota and terrestrial invertebrates. Factors such as pH, particle size, and organic matter content can influence the bioavailability of chemicals. The physicochemical characteristics of Tidal Area soils is summarized in Table 9-1. Overall, most of the soils at the Tidal Area sites were organic-rich and generally ranged between slightly acidic to neutral in pH. Some

R Area Disposal Site soils were acidic (pH values less than 6), which is expected of soils of the Joice-Reyes association, especially in marsh wetlands around San Francisco Bay. On the basis of limited soil characterization, few confounding factors beyond physical disturbance of soils were apparent for the Tidal Area. However, the heterogeneity of certain physicochemical features of the soils, especially TOC and pH, clearly suggests that the bioavailability of chemicals in soil varies across sites. This observation of interacting factors is supported by the results of WET-DI and WET-acid extractions (see Section 11.2.2).

Texture refers to the proportion of particles of different size classes (gravel, sand, silt, and clay) that make up a sample. Knowledge of texture is important for assessing water relations, erodibility, and retention of cations, anions, and toxicants. The surface area of the particles in a unit mass of sediment increases as sediment particle size decreases (USACE 1989). As surface area increases, the number of charged binding sites increases, resulting in more sites for adsorption. Particle size is thus an important variable, as smaller particles carry greater contaminant loads and organic carbon fractions.

Physical characteristics of the Tidal Area soils are presented in Table 9-1. Grain size distributions were measured at 132 locations throughout the Tidal Area sites. The soils in the Tidal Area sites primarily consist of silty clays, although sandy zones were detected at a few sampling locations (for example RADSBB06, RADSBJ02, and WHSSBM08). Clay- and silt-sized particles typically make up 70 to 90 percent of each soil sample, although soils contain greater proportions of sand in the Wood Hogger Site and selected locations in the R Area Disposal Site. In addition, the soils are rich in organic material; average TOC concentrations for the samples was 65,000 mg/kg, or 6.5 percent. Soil pH was typically neutral to slightly basic (6.5 to 8.5), although moderately acidic conditions (pH 4.5 to 6.5) were observed in several locations. The high proportion of silt- and clay-sized particles and the high TOC levels in the soils offer abundant sites for contaminant adsorption.

11.2.2 Waste Extraction Tests

WET-acid and WET-DI results are included in Table 6-22 (see Appendix R). Although the availability of soil constituents cannot be assessed solely through any chemical extraction, the results of the WET analyses indicate that concentrations of inorganic COPECs in bulk soils and in chemical extracts differ in some instances by an order of magnitude. WET concentrations of COPECs were sufficiently high to warrant their consideration as a source of risk to terrestrial invertebrates.

Frequently, WET extractions contained metal concentrations at levels that could present risks to soil-dwelling biota as well as to plants via rhizosphere exposure. Although WET analyses were not conducted on all soil samples, the data suggest that inferences developed for the limited number of samples collected for the ERA may be extrapolated to the larger RI data set. Some analytes, such as copper, were more easily desorbed from soils than others. Data are not adequate to address the sources of this variability, but soil physicochemical properties, such as TOC, are critical factors in determining the extraction potential of chemicals in soil.

11.3 EFFECTS ASSESSMENT FOR SOIL BIOTA AND TERRESTRIAL INVERTEBRATES

Adverse biological effects to soil biota and terrestrial invertebrates are the expected result following their exposure to bioavailable COPECs. The effects assessment for plants in the Tidal Area was based on a biological effects assessment using Microtox and Cytochrome P450 measurements, evaluation of benchmark values, and evaluation of potential toxicological effects of COPECs on soil biota and terrestrial invertebrates, as discussed in the following subsections.

11.3.1 Solid-Phase and Organic-Extraction Microtox

In parallel with analysis of chemical concentrations in soil samples at the Tidal Area sites and their limited physicochemical characterization, biological assessments were completed on soil samples using Microtox (see Section 8.1). Although only a limited number of soil samples were subjected to biological testing, those evaluated by Microtox indicated consistent results in all soil samples. For example, solid-phase Microtox presented EC50s ranging between 0.8 to 1.1 percent soil (the Microtox test results are in units of percent soil sample required to reduce light output of microorganisms in Microtox reagent by 50 percent). No apparent differences in Microtox measurements were noted across the Tidal Area sites. Few, if any, risks appear likely to be expressed at any of the Tidal Area sites as evidenced by Microtox results, although uncertainties in the extrapolation of Microtox results to risks for other soil biota must be acknowledged.

11.3.2 Cytochrome P450

In contrast to the Microtox results, Cytochrome P450 results showed statistically significant differences between the Wood Hogger, R Area Disposal, and Froid and Taylor Roads Sites. Correlations between Cytochrome P450 activities were not strongly associated with co-planar organic constituents in Tidal

Area soils (for example, DDTs, PCBs, and PAHs). Cytochrome P450 data coincide with analytical results of known inducers, spatial patterns linking enzyme induction and COPECs at the Wood Hogger Site are apparent. In general, correlations between P450 results and concentrations of specific chemicals were not statistically significant. Nevertheless, increased P450 activation has been associated with sublethal effects on nearly all organisms. This result was not unexpected. The purpose of the test was to test the combined effect of chemicals in the soil for Cytochrome P450 induction. The induction of Cytochrome P450 does not, in itself, indicate toxicity, but indicates that chemicals that have been linked to adverse effects in a variety of organisms are active in the soil (Hodgson and Levi 1994).

11.3.3 Comparisons with Benchmark Values

To assess potential ecological effects associated with soils at the Tidal Area, concentrations of COPECs in soil were compared to CDFG PRGs (CDFG 1997) and ORNL PRGs and soil litter benchmarks (Will and Suter 1995). ORNL benchmarks are receptor-based, whereas the ORNL PRG is the lowest benchmark for all species evaluated. CDFG PRGs are also receptor-based. Most of the benchmarks are derived from studies on earthworms, nematodes, and bacteria that represent high exposure since they are in direct contact with the soil. The maximum site concentrations for all terrestrial units in comparison with the PRGs and benchmarks were presented in Tables 10-8 through 10-11 along with benchmarks for plants.

In general, soil samples from the Tidal Area terrestrial units did not contain inorganic COPECs at concentrations greater than ambient values. However, soil and litter benchmark values for soil- and litter-dwelling terrestrial invertebrates were frequently exceeded by ambient concentrations, suggesting that regional differences in baseline conditions must be addressed if soil toxicity is to be adequately evaluated at the Tidal Area using these benchmark values. For chemicals with benchmarks available, the exceedance of a benchmark is therefore relevant but not sufficient for identifying that chemical as a COEC.

In addition, ambient concentrations (that is, the Tidal Area 99th percent UCL) of all inorganic chemicals exceeded the CDFG PRGs except for lead. The ambient concentration of lead (95 mg/kg) was just below the CDFG PRG value of 100 mg/kg. Therefore, several inorganic COPECs detected at concentrations close to or above their respective ambient concentrations also exceeded the PRGs.

COPECs that exceed either PRGs or ORNL soil benchmarks at site concentrations are follows:

- Landfill Terrestrial Unit: Cadmium (CDFG), copper (CDFG and ORNL), lead (CDFG), mercury (CDFG and ORNL), and zinc (CDFG and ORNL)
- R Area Terrestrial Unit: Copper (CDFG and ORNL), lead (CDFG and ORNL), mercury (CDFG and ORNL), nickel (CDFG and ORNL), and zinc (CDFG and ORNL)
- Froid and Taylor Terrestrial Unit: COPEC concentrations did not exceed CDFG or ORNL criteria
- Wood Hogger Terrestrial Unit: Cadmium (CDFG and ORNL), copper (CDFG and ORNL), lead (CDFG and ORNL), mercury (CDFG and ORNL), and zinc (CDFG and ORNL)

Soil samples from the Wood Hogger Terrestrial unit contained cadmium, copper, and zinc at concentrations greater than Tidal Area ambient values. Consequently, the potential for exposure to terrestrial invertebrates seemed greatest at this unit.

There were few toxicologically-based benchmarks available for organic chemicals. ORNL PRGs were available for chlorobenzene and phenol and were specific to earthworms (that is, the lowest benchmark of all receptors for these chemicals was for the earthworm). Site concentrations of chlorobenzene and phenol did not exceeded the ORNL PRG.

11.3.4 Potential Toxicological Effects of COPECs on Soil Biota and Terrestrial Invertebrates

Although qualitative by design, an evaluation of invertebrate receptors and other soil biota is critical to the QEA process. Evaluation of potential soil toxicity represents one potential measurement endpoint that is relevant to ecological effects assessment.

11.3.4.1 Potential Effects of Inorganic COPECs on Soil Biota and Terrestrial Invertebrates

The inorganic COPECs for each habitat unit were evaluated for potential effects to soil biota and invertebrates based on toxicological information provided in the literature. The primary source of information was Will and Suter (1995), the document that provided the ORNL benchmark values, which were derived from a comprehensive literature review.

Since the benchmarks that were available for inorganic constituents were often greatly exceeded even under ambient conditions, they may be too conservative for the Tidal Area sites. Most toxicological

studies by design dose test organisms with soluble, bioavailable forms of heavy metals (for example, by adding them to soil) in order to maximize the possibility that effects will be achieved. These studies may not represent conditions naturally present in the field. However, this approach is protective.

Cadmium

The ambient concentration of cadmium (1.9 mg/kg) exceeded the CDFG PRG for invertebrates (1.0 mg/kg). Cadmium levels at Tidal Area sites ranged from nondetect to a maximum of 20.8 mg/kg at the Wood Hogger Terrestrial unit. The three highest cadmium concentrations (greater than 6 mg/kg) were located in the Wood Hogger Terrestrial unit; however, these elevated concentrations were located in isolated areas and are not indicative of widespread contamination at the Wood Hogger Site.

Few studies were available to assess risk to soil biota and invertebrates based on soil concentrations of cadmium. Nematode (*Caenorhabditis elegans*) reproduction was reduced by 36 percent when exposed to a solution of 3.6 ppm cadmium chloride. At higher doses of cadmium, earthworm reproduction and growth are affected (Bengtsson and others 1986; Neuhauser and others 1984). Cadmium at 10 mg/kg soil caused a statistically significant reduction in cocoon production (Khalil and other 1996). Soil at 100 mg/kg cadmium significantly reduced sperm counts in earthworms (Cikutovic and others 1993). Several terrestrial invertebrates including earthworms have demonstrated the ability to adapt to increased exposures to cadmium by inducing cadmium-specific binding proteins (Beeby 1991). Based on available information, cadmium is considered a COEC only for the Wood Hogger Site.

Copper

The 95th percent UCL for copper in soils at the Wood Hogger Site is 62 mg/kg, which is below the Tidal Area ambient soil concentration of copper (81 mg/kg). As a result, copper contamination is not widespread and incremental risk from site activities is minimal, except at locations with maximum concentrations.

The ambient copper concentration is above the CDFG PRG and ORNL benchmark for soil biota and invertebrates. The benchmark for earthworms is 50 mg/kg and 30 mg/kg for microbes in soil (Will and Suter 1995). The terrestrial isopod (*Porcellio scaber*) produced 53 percent fewer juveniles in a diet spiked with 50 ppm copper (Hopkin and Hames 1994, as cited in Will and Suter 1995). Based on this information, Tidal Area ambient soil concentrations of copper may produce adverse effects on soil biota and terrestrial invertebrates. Further, the potential for occurrence of these adverse effects will be

greatest at the Wood Hogger Terrestrial unit location (WHSSBH03) of the maximum site copper concentration (607 mg/kg). Because the copper contamination is isolated and not widespread, copper is not considered a COEC for the Tidal Area.

Lead

The Tidal Area ambient concentration of lead (95 mg/kg) did not exceed the CDFG PRG (180 mg/kg). The maximum concentrations of lead at all terrestrial units, except for the Froid and Taylor Terrestrial unit, exceeded the CDFG PRG for lead. The highest site concentration of lead (1,160 mg/kg) was in a sample (RADSBG08) collected at the R Area Disposal Site near the road where habitat is disturbed. The 95th percent UCL for the R Area Disposal Site is based on 94 samples analyzed for lead (83 mg/kg) was below the ambient level (95 mg/kg). The 95th percent UCL for the Wood Hogger Site was just above the ambient level (101 mg/kg). As a result, lead contamination is not widespread. However, since several sampling locations greatly exceed the PRG at the Wood Hogger and R Area Disposal Sites, lead is considered a COEC for soil biota and invertebrates at these two sites.

Slugs, wood lice, and springtails have a high tolerance for lead in their diets (Will and Suter 1995). The ambient 99th percent and the 95th percent UCLs are in between the CDFG PRG and ORNL benchmarks for soil biota. Since lead in soils is usually not very bioavailable compared to lead salts prevalently used in toxicity studies (O'Flaherty 1998), lead is not expected to be a problem for soil biota in the Landfill Terrestrial unit, where the maximum soil concentration (156 mg/kg) exceeded the CDFG PRG of 100 mg/kg.

Mercury

The Tidal Area ambient concentration of mercury (0.32 mg/kg) exceeded the CDFG PRG (0.12 mg/kg) and the ORNL benchmark (0.1 mg/kg). The maximum Tidal Area mercury concentration (18.5 mg/kg) was in the Wood Hogger Terrestrial unit. The 95th percent UCL for mercury in the Tidal Area soil samples is 0.86 mg/kg, indicating that mercury in soil samples is not widespread. However, the 95th percent UCL concentration is greater than the CDFG PRG and ORNL benchmark and consequently considered to be potentially toxic to soil biota. The maximum Tidal Area mercury concentration (18.5 mg/kg) was in the Wood Hogger terrestrial unit. Soil concentrations of mercury at other Tidal Area sites were not elevated.

The ORNL benchmark for mercury was based on a study by Abbasi and Soni (1983) that observed decreased earthworm cocoon production at 0.5 ppm mercury chloride (a safety factor was applied to estimate a no observed effect concentration [NOEC] for the benchmark). Mercury in Tidal Area soils is not expected to be as bioavailable as the mercury chloride used in the study; in soils of average TOC and redox potential, mercury is expected to be associated with sulfides or sulfates, which may render them less bioavailable (O'Flaherty 1998). Therefore, mercury is not considered a COEC for the R Area Disposal Site where the maximum concentration is 0.58 mg/kg.

The effects of mercury on carbon mineralization by native soil microflora were manifested at much lower concentrations than were the effects on the nitrogen mineralization and nitrification by microflora (Will and Suter 1995), but the results were variable. An 87 percent reduction in carbon mineralization by microflora occurred in one soil sample at 0.1 ppm, whereas no effect occurred in another soil at 100 ppm (Landa and Fang 1978, as cited in Will and Suter 1995). The magnitude of effects in different soils was not related to pH or organic matter content (Will and Suter 1995).

Based on this evaluation, mercury is considered a COEC for the Wood Hogger Site only.

Nickel

The maximum nickel concentration (242 mg/kg) in soils from the Tidal Area was collected in the R Area Disposal Site. The upper 95th percent UCL (75 mg/kg) in soil for the R Area Terrestrial unit is less than the Tidal Area ambient concentration (120 mg/kg), indicating that nickel contamination is not widespread in the R Area Disposal Site and that incremental risk from site activities is minimal. The Tidal Area ambient concentration of nickel was above the CDFG PRG (50 mg/kg) but below the ORNL benchmark (200 mg/kg) for earthworms. Will and Suter (1995b) place high confidence in the benchmark for nickel because there was a large amount of data.

Nickel at 30 ppm reduced dehydrogenase activity of microflora after a 6-day exposure (Rogers and Li 1985, as cited in Will and Suter 1995). Microbial respiration was reduced in soil treated with 10 ppm nickel sulfate after 42 days (Giashuddin and Cornfield 1979, as cited in Will and Suter 1995). In the same study, nitrogen mineralization was affected at 100 ppm nickel. Most other effects of nickel on microbial processes and on earthworms occur at much higher concentrations. For example, the benchmark for effects in earthworms is 200 ppm nickel, substantially higher than the Tidal Area ambient value of 120 mg/kg. The site maximum (242 mg/kg) indicates risk to earthworms, but is only about twice ambient. As a result, nickel is not considered a COEC.

Zinc

The soil sample with the maximum concentration of zinc (3,010 mg/kg), collected in the Wood Hogger Terrestrial unit, was well above the upper 95th percent UCL for zinc (283 mg/kg) in the Wood Hogger. The soil sample with the highest zinc concentration was collected at the northern end of the Wood Hogger next to Froid Road. The upper 95th percent UCL for zinc in Wood Hogger soil samples was just above the Tidal Area ambient concentration (264 mg/kg). Although high concentrations of zinc were detected in other Tidal Area sites, they represented isolated rather than widespread contamination.

The Tidal Area ambient concentration of zinc (264 mg/kg) exceeded both the CDFG invertebrate PRG (93 mg/kg) and the ORNL benchmark (200 mg/kg) based on earthworms. A lowest observed effect concentration (LOEC) for decreased nitrification by soil microflora is 1,000 mg/kg zinc (Wilson 1977, as cited in Will and Suter 1995). A LOEC for decreased denitrification (by 29 percent) by *Pseudomonas* sp. was 50 mg/kg (Bollag and Barabasc 1979). Many other studies have set NOECs or LOECs at much higher concentrations using microbial endpoints. It therefore appears that there are significant differences in species sensitivities to zinc. The ambient and 95th percent UCL zinc concentrations indicate some level of risk to earthworms and soil biota with uncertainty due to possible differences between the bioavailability of zinc at the site compared to the studies used to derive the benchmarks. Soil concentrations of zinc at or near the maximum Tidal Area detected value of 3,010 mg/kg indicate strong risk potential to soil biota. Zinc is therefore considered a COEC for the Wood Hogger Terrestrial unit.

Other Inorganic COPECs

Insufficient information exists to evaluate the effects of arsenic, barium, beryllium, cobalt, manganese, molybdenum, and selenium on soil biota and terrestrial invertebrates. However, these inorganic constituents were either not detected or detected at low concentrations (as compared to concentrations in site soils) in tissue samples of pickleweed or rodents from the terrestrial habitats or in clam or amphipods in aquatic habitats, indicating low site bioavailability.

11.3.4.2 Potential Effects of Organic COPECs on Soil Biota and Terrestrial Invertebrates

Benchmarks for soil biota and invertebrates were limited for organic chemicals. Benchmarks were available for chlorobenzene and phenol; these benchmarks were not exceeded at site concentrations

(see Tables 10-8 through 10-11). Site concentrations of organic COPECs, including pesticides (DDTs, dieldrin, hexachlor, heptachlor), PAHs, and PCBs, are compared below to literature-reported effects to evaluate potential effects due to these organic COPECs.

Pesticides

Soil biota have some ability to adapt to contaminants in the environment. DDT, once used as an insecticide, has been ubiquitous in the environment for so long that invertebrates have adapted to it after bioaccumulating high levels (Forsyth and others 1983). A literature review by Will and Suter (1995) revealed that very little information was available on effects of these chemicals at low concentrations, such as those found in Tidal Area soils. Bacteria have been shown to adapt to high concentrations of dioxins and chlorinated hydrocarbons; in the laboratory, microbial activity initially decreased, and then recovered in soil (from Times Beach, Missouri) contaminated with high concentrations of dioxins and chlorinated hydrocarbons (Arthur and others 1988).

At site concentrations, dieldrin was below a NOEC for earthworms of 1,500 μg/kg for reproductive effects (Hendricks and others 1995). Chlordane levels in site soils were below a level (6.0 mg/kg in soil) that caused reduced sperm counts in earthworms (Cikutovic and others 1993), except in samples from the Froid and Taylor Terrestrial unit (chlordanes up to 190 mg/kg). Based on available information, pesticides are not considered COECs for soil biota and terrestrial invertebrates except for chlordanes in the Froid and Taylor Terrestrial unit.

PAHs

Wood lice are affected by benzo(a)pyrene, considered perhaps the most toxic PAH, at 100 μg/kg applied to food. Concentrations of total PAHs that are expected to have more limited effects than benzo(a)pyrene are below this level. The maximum site concentration of total PAHs is 99 μg/kg. Based on available information, PAHs are not considered COECs for soil biota and terrestrial invertebrates.

PCBs

An LC50 of 1,200 mg/kg Aroclor 1254 in crickets for a 14-day soil bioassay was reported by Paine and others (1993). The concentrations are more than an order of magnitude lower with the congener-specific analysis than with the CLP method. Tidal Area concentrations (0.004 to 0.074 mg/kg) are

below this LC50. Maximum PCB concentrations in all Tidal Area sites, by the low detection limit method, were always below the ER-M, but some ER-Ls were exceeded for PCBs. Total PCBs based on summing with one-half the detection limit for nondetects may grossly overestimate the actual PCB concentration in site soils. Based on available information, PCBs are not considered COECs for soil biota and terrestrial invertebrates.

11.4 RISK CHARACTERIZATION FOR SOIL BIOTA AND TERRESTRIAL INVERTEBRATES

The risk characterization for soil biota was based on observational data from the site, comparison of chemical concentrations in soil to benchmarks available from CDFG and ORNL, supplemental toxicological data from peer-reviewed literature, and Microtox and P450 assessments.

Direct evaluations of soil biota at the Tidal Area sites were based on a limited number of biological tests and a cursory soil analysis; however, these measurements added substantially to the characterization of current conditions at the site. For example, heterotrophic processes such as nutrient cycling cannot occur without microorganisms to carry out the majority of the critical functions required by soils. Although abiotic factors influence the presence and activity of an organism, an understanding of the biological factors along with the physical constraints contributes to the weight of evidence necessary to evaluate of ecological risks associated with past chemical releases. Organisms are the filter through which all nutrients pass, and even a preliminary assessment of their ability to cycle nutrients is critical to the QEA process (Dindal 1990).

Results from Microtox and Cytochrome P450 tests suggested a range of biological activities in soils collected at the Tidal Area sites. Microtox presented a relatively low level of biological activity across the Tidal Area sites; in contrast, Cytochrome P450 presented increased activities in soils collected from the Wood Hogger Site, suggesting that inducing chemicals such as coplanar organic constituents are active at levels that may cause effects to soil biota.

Ambient levels of inorganic chemicals may pose a risk to soil biota and invertebrates. Alternatively, the environment may select for species that are tolerant of local conditions. Additionally, organisms may adapt to some degree to concentrations of chemicals present in the environment. An effort was made to present the potential risks to soil biota in the context of ambient conditions based on information from the literature. The literature studies are generally based on nominal soil

concentrations (for example, those added to the soil by the experimenter) that may not reflect the same level of bioavailability as for contaminants found in the natural soil.

Based on the risk characterization, COECs that were identified for the Wood Hogger Terrestrial unit included cadmium, lead, mercury, and zinc. Lead was also identified as a COEC for the R Area Terrestrial unit and chlordane was identified as a COEC for the Froid and Taylor Terrestrial unit. Identification of these COECs was based on a few limited exceedances of the ER-Ms; review of the chemical distributions did not reflect widespread contamination nor indicate a potential source for these exceedances.

12.0 RISK TO FISH

The protection of the fish community in Otter Sluice was identified in Section 7.0 as an assessment endpoint for the Tidal Area because fish serve as important prey items for birds and mammals, such as the Great Blue Heron and the river otter. Fish are also particularly at risk to COPECs, since they are in direct contact with surface water and sediment.

Ecological surveys and literature reviews identified fish occurring or potentially occurring at the Tidal Area (see Section 3.2). Fish diversity and abundance varied across the Tidal Area sites, both spatially and seasonally. No special status fish species were observed during the surveys at the Tidal Area, but fish occurring seasonally in Suisun Bay could potentially be found in Otter Sluice. These special status species may include Sacramento splittail (*Pogonichtys macrolepidotus*), winter-run chinook salmon (*Oncorhynchus tshawytscha*), delta smelt (*Hypomesus transpacificus*), and longfin smelt (*Spirinchus thaleichthys*), as described in Section 3.3.

Fish tissue was selected as a measurement endpoint for assessing risk to fish. The tissue residue data were also used in food-chain modeling to represent prey for birds and mammals (see Section 15.0). In addition, sediments were collected from Otter Sluice and tested in the laboratory for toxicity to fish using a SWI bioassay to provide another line-of-evidence for assessing risk to fish.

For this assessment, fish were considered to be primarily exposed to site chemicals through surface water only. Risk to fish from site chemicals was evaluated in a weight-of-evidence approach using available tools, including:

- Identification of COPECs based on AWQC
- Qualitative observations of fish in Otter Sluice
- Comparison of fish tissue residues with literature-reported effects and with regional fish tissue residues (Regional Monitoring Program [RMP] data)

COECs for fish were subsequently identified based on the results of this assessment.

Section 12.1 presents the COPECS that were identified for fish based on the screening of surface water against AWQCs. Section 12.2 discusses the exposure assessment, and Section 12.3 discusses the effects assessment and determination of COECs for fish. Section 12.4 summarizes the exposure and effects assessments to characterize the risk to fish at the tidal area.

12.1 CHEMICALS OF POTENTIAL ECOLOGICAL CONCERN FOR FISH

Because fish were considered to be primarily exposed to site chemicals through surface water only, site chemicals were screened against AWQCs to determine COPECs for fish. AWQCs were used as the screening value for fish since they are intended to be protective of most aquatic biota, and concentrations that exceed AWQCs indicate a potential for adverse effects. Chemicals for which AWQC values were not available were also considered COPECs.

Specific Tidal Area habitat units for which the risk to fish was evaluated include the Froid and Taylor Aquatic unit (which is designated an aquatic unit since it has standing water most of the year), North Otter Sluice Aquatic unit, and South Otter Sluice Aquatic unit. There is limited surface water in the R Area Terrestrial and Aquatic unit, so it is not considered ecologically relevant for fish; however, this unit is included in this section for completeness since it is designated as an aquatic unit.

Table 12-1 identifies COPECs for each of these habitat units based on the AWQC screening value. Based on the lack of available literature to evaluate toxicity to fish, inorganic chemicals for which no AWQCs exist were not considered COECs. Chemicals for which AWQC values were not available include antimony, barium, cobalt, manganese, molybdenum, thallium, vanadium, pesticides, SVOCs, VOCs, diesel, and motor oil.

12.2 EXPOSURE ASSESSMENT FOR FISH

The exposure pathways for fish are depicted on Figure 7-1. As shown on Figure 7-1, fish may be exposed to site chemicals in surface water and sediment through direct contact and ingestion, as well as through ingestion of chemicals in prey.

Biological factors such as lipid content, metabolic rate, diet selectivity, behavior, and feeding mode may also affect the uptake and accumulation of these chemicals. For example, the gills and body surfaces of fish are permeable to some types of dissolved chemicals (Fisher 1995). The water-to-gill transfer of hydrophobic chemicals is also of critical importance for fish (Connell 1990). Therefore, uptake through gills and oral membranes are additional routes of exposure for fish that must be considered.

Chemical Exposure Based on Tissue Residue Data

Although specific routes of exposure were not measured, tissue residues in fish were evaluated as a direct measure of chronic exposure, bioavailability, and bioaccumulation of chemicals. The body burden of a resident fish reflects the net accumulation of a chemical, incorporating, but not revealing, the dynamics of uptake and depuration of the chemical. As such, body burdens cannot be directly compared against dose-related toxicity measures reported in the literature. However, body burdens can be used to evaluate qualitatively whether site-specific chemicals are bioaccumulating in fish to a greater degree than at a reference location. Therefore, fish body burdens rather than water concentrations can better reflect total exposure over long periods of time.

Fish were collected in June 1998 and included sculpin (Family Cottidae), stickleback (*Gasterosteus aculeatus*), and mosquitofish (*Gambusio affinis*). Species composition of each sample is presented in Table 4-5. The tissue residue data for fish collected from the Froid and Taylor Aquatic unit are presented in Table 8-6B, from North Otter Sluice Aquatic unit in Table 8-8B, and from South Otter Sluice Aquatic unit in Table 8-9B.

Tissue residue results were compared to data from the RMP (SFEI 1997) that included fish from the San Francisco Bay/Delta region (see Table 12-2). The RMP data that were used for these comparisons were selected from sites in the bay with a preference for sites closest to NWS SBD Concord with similar habitat, namely Suisun Bay, Grizzly Bay, and Pacheco Creek. When data from these sites were unavailable, other reference sites were evaluated. Comparisons of site-specific data with reference sites is important because, as described in EPA (1997), "...samples from a reference area can support site-specific decisions regarding uptake, body burden, and accumulation of chemicals."

In addition, the tissue residue results were compared to literature-reported effects. For example, some metals serve as nutrients for fish, and their concentrations in tissues may not be directly related to concentrations in water or sediment. These issues are discussed below in the effects assessment.

Table 12-2 summarizes data for tissue residues from fish collected in the Otter Sluice and Froid and Taylor Aquatic units compared to RMP and other fish data. For chemicals reported, tissue concentrations of fish collected from the Otter Sluice and Froid and Taylor Aquatic units were not elevated as compared to RMP and other data.

12.3 EFFECTS ASSESSMENT FOR FISH

The effects assessment for fish in the Tidal Area was based on evaluation of the site-specific SWI bioassays and potential toxicological effects of COPECs on fish, as discussed in the following subsections.

12.3.1 Sediment-Water Interface Bioassay

An SWI bioassay using topsmelt (*Atherinops affinis*) embryos was conducted at seven locations in Otter Sluice to assess risk to fish from chemicals in sediments. The test measures biological effects on embryos exposed to conditions at the interface between the sediment and overlying water. Results are summarized in Table 8-3. The two SWI topsmelt tests performed on samples adjacent to the southwest corner of Otter Sluice had the highest hatching success, and were not significantly different than the test controls. These data indicate that chemicals in those sediment samples were not toxic to topsmelt embryos under test conditions. The apparent toxicity of the North Otter Sluice Aquatic unit sediments based on the topsmelt bioassays is more likely due to confounding factors such as ammonia and the percent fines in sediment (small silt or clay particles can coat fish eggs preventing them from hatching), rather than from chemical chemicals, according to the laboratory that conducted the topsmelt test. Additional discussion of the confounding factors associated with this test is presented in Section 8.4.3.

12.3.2 Potential Toxicological Effects of COPECs on Fish

Potential effects of chemicals on fish is evaluated based on comparisons to AWQCs, direct toxicity tests using the SWI bioassay, and on other information from the literature in conjunction with fish tissue residue data. AWQCs are generally derived from laboratory studies of direct lethal or sublethal effects, but do not specifically address bioaccumulation, and are therefore not appropriate for evaluating chemicals that bioaccumulate (such as PCBs, DDTs, dioxins, and mercury). AWQCs are appropriate measures of potential direct toxicity to fish exposed to surface water via direct contact and uptake pathways, and can also be used to assess potential effects on fish.

Of the inorganic COPECs identified for fish (see Table 12-1), aluminum, arsenic, cadmium, chromium, copper, lead, mercury, nickel, silver, zinc, DDT, dieldrin, endrin, heptachlor, heptachlor epoxide and chlordanes exceeded AWQCs in at least one sample. Since AWQCs are appropriate measures of potential direct toxicity to fishes, COPECs that did not exceed AWQC were not considered COECs and are not evaluated further.

12.3.2.1 Potential Effects of Inorganic COPECs on Fish

This section further evaluates COPECs requiring further evaluation in terms of (1) spatial and temporal degree of exceedance, (2) presence of a site-specific source, and (3) corroborating evidence of bioavailability and toxicity.

Aluminum and Nickel

Neither aluminum nor nickel was elevated above ambient concentrations in soil or sediment at the site, suggesting that the levels measured in surface water are a natural result of soil properties in the area. Aluminum and nickel are not considered COECs since no site source for them exists.

Arsenic and Chromium

Arsenic and chromium exceeded AWQCs only during the October 1995 sampling period, which followed an extended drought. Samples collected in subsequent years were below AWQCs. Metals in surface water can become concentrated during droughts, and at the end of the annual dry season. The seasonal pattern of drydown during which chemicals may become concentrated in surface water during extended drought periods may result in occasional toxic levels of metals in remnant pools of water. However, fish typically leave such intermittent pools for deeper, cooler, less saline water during dry periods, regardless of the presence of anthropogenic chemicals, so actual exposure of fish to maximum concentrations is not expected. Because surface water is tidally connected to Suisun Bay, chemicals may enter the aquatic habitats from off site and become resident as the aquatic habitats shrink in the late summer. Because arsenic and chromium in the surrounding soil and sediment do not pose a risk to representative receptors, these chemicals in surface water are considered to represent regional conditions, and therefore arsenic and chromium are not considered COECs.

Cadmium

Cadmium concentrations in surface water samples exceeded AWQCs only in one R Area Terrestrial and Aquatic unit sample. Cadmium was not detected in fish tissues collected at the Tidal Area; therefore, it is not considered a COEC.

Copper

Copper and zinc were the most potentially toxic chemicals detected in surface water at the site. Exceedances of AWQCs for copper occurred in every aquatic habitat sampled, and ranged up to an order of magnitude above the chronic AWQC. However, copper in surface water were less than EC50s for fertilization, embryo development, and mortality (96 hour) for topsmelt (Anderson and others 1991).

Concentrations of copper exceeding chronic AWQC may cause increased mortality to early life stages of fish (Suter and Tsao 1996). The gill is the primary organ for concentrating copper in aquatic organisms. Copper concentrations can significantly affect the hatchability of fish eggs and reduce the growth of fry (EPA 1976).

Results of a 7-day growth and survival toxicity test of copper chloride to larval topsmelt (*Atherinops affinis* [Ayres]) revealed that sensitivity to copper increases at lower salinities (Anderson and others 1991). The LC_{50} values for copper ranged from 205 mg/L at 34 ppt to 44 mg/L at 10 ppt. Copper uptake was not affected by changes in salinity, suggesting that increased sensitivity to copper was due partly to the increased physiological challenge of osmoregulation.

Copper toxicity was also found to increase with increasing pH (Chapman and McGrady 1977). The acute toxicity of copper to cutthroat trout (*Salmo clarki*) was inversely correlated with water hardness and alkalinity (Thurston and others 1979). At a given alkalinity, hardness determined the LC_{50} while, at a given hardness, alkalinity determined the LC_{50}.

Lethal effects of copper on the freshwater fish (*Puntius arulius*) were evaluated by using static bioassay tests. The 24-hour LC_{50} value was 2.7 mg/L copper, the 48-hour LC_{50} was 2.25 mg/L, the 72-hour LC_{50} was 2.1 mg/L, and the 96-hour LC_{50} was 1.9 mg/L (Shivaraj and Patil 1988).

The concentrations of copper in water that caused significant effects on larvae were similar for brook trout, rainbow trout, lake trout, brown trout, northern pike, white sucker and smallmouth bass, ranging from 31.7 to 43.5 mg/L copper, except for the northern pike which proved considerably more resistant (104.1 mg/L copper) (McKim and others 1978). Another study of age-specific toxicity of copper was conducted using larval topsmelt (*Atherinops affinis*) (McNulty and others 1994). The early-age cohorts (0, 3, and 5 days) were less sensitive to copper chloride than larval fish 7 days or older. The median lethal concentrations (LC_{50}) ranged from 365 mg/L for the newly-hatched to 137 mg/L for 20-day old

larvae. The NOECs were 180 mg/L for larvae up to 3 days old and 100 mg/L for all other age cohorts. The investigators found a significant negative correlation between LC_{50} values and gill and cutaneous surface area. This may indicate that the increase in sensitivity with larval age is related to increase in copper uptake, either through respiratory or cutaneous paths.

Because sensitivities of fish to copper vary by species and developmental stage, and concentrations exceed the threshold for some demonstrated effects, copper is considered a COEC for fish.

Lead

Lead at the Tidal Area sites exceeded the AWQC only infrequently. Although water-borne lead can cause a variety of adverse affects to fish, particularly to early life stages, fish are able to clear lead from their blood rapidly when lead levels in water decrease. Clearance half-time for fish is between 3 and 4 weeks (DeMayo 1981).

The maximum concentration of lead occurred in North Otter Sluice during October 1995. The concentration of lead in October 1995 (up to 57.3 μg/L) was an order of magnitude higher than the concentration in the previous July, but then decreased to 2.1 μg/L in January 1996. Concentrations of lead in North Otter Sluice sediments never exceeded the ER-M. Based on the available information, lead is not considered a COEC for fish.

Mercury

Mercury exceeded AWQCs occasionally, but was generally below the detection limit. However, detection limits for mercury sometimes exceeded the chronic AWQC, so some uncertainty is associated with actual surface water concentrations. Because mercury is known to bioaccumulate in fish, a secondary line of evidence was evaluated. Body burdens of mercury in fish collected from the Froid and Taylor Aquatic and North and South Otter Sluice Aquatic units were less than 0.1 mg/kg (dry weight basis), which was below a body burden 0.66 to 5.6 mg/kg (wet weight basis) that constitutes a threshold for toxic effects in fish (Suter and others 1999). In addition, mercury in fish from the Tidal Area was within the range of reported regional values for fish collected in the San Francisco Bay/Delta RMP data (SFEI 1997) (see Table 12-2). Based on this information, mercury is not considered a COEC for fish in the Tidal Area.

Silver

Silver was only detected in one Froid and Taylor Aquatic unit sample slightly above AWQCs and was not detected in fish tissue. Therefore, silver is not considered a COEC for fish.

Zinc

Zinc and copper were the most potentially toxic chemicals detected in surface water at the site. Zinc levels in 25 percent of the surface water samples exceeded chronic AWQCs in the Tidal Area, with a maximum HQ of 7.4. No clear spatial or temporal trends in concentration were apparent.

Limited episodic exposure to zinc in surface water may pose a risk to fish. Changes in ventilatory behaviour, such as coughs and gill purges, were observed in bluegill fish as a result of sublethal exposure to zinc (Diamond and others 1990). Acute toxicity of zinc chloride (96-hour LC_{50} of 75 ppm) to catfish (*Heteropneustes fossilis*) led to cyclical increase and decrease in mucous cell density in the air sac (a modified gill structure). The increase in mucous cell density might be due to a stimulatory synthetic effect of the zinc. This results in heavy mucus precipitation and clogging of respiratory sites, leading to asphyxiation and death of the exposed fish (Hemalatha and Banerjee 1993).

Sublethal exposure of catfish (*Heteropeneustes fossilis*) to zinc chloride (67.5 mg/L $ZnCl_2$) produced a general decrease in haemoglobin content, returning to normal values after 40 to 50 days. Leucocytosis, thrombocytosis, and a decrease in coagulation time were also evidenced by exposed fish (Shandilya and Banerjee 1989).

In the experimental assessment of acute zinc toxicity to the developmental stages of the cyprinid (*Cirrhinus mrigala*), eggs were found to be more resistant to zinc than were higher stages. Increased incubation period and change in fish behaviour (for example, fast opercular beat, loss of balance, and wriggling movement) were noted during the experiment. Median lethal values for eggs, fry, and fingerlings were 10 mg/L zinc (24-hour), 7.0 mg/L zinc (96-hour), and 0.35 mg/L zinc (96-hour) (Sharma and Sharma 1995).

Acclimation of juvenile steelhead (*Salmo gairdneri gairdneri*) and rainbow trout (*Salmo gairdneri*) to sublethal waterborne concentrations of zinc resulted in increased tolerance. Development of tolerance was dependent on the time and concentrations of metals used during acclimation (Anadu 1983). Judy and Davis (1979) reported that the addition of calcium nitrate in solution inhibits the toxicity of Zn^{+2} to

fathead minnows. However, the exact physiological interaction between zinc and calcium was not investigated. Based on the available information, zinc is considered a COEC for fish.

12.3.2.2 Potential Effects of Organic COPECs on Fish

DDT, dieldrin, endrin, and heptachlor in surface water exceeded AWQCs only in the North Otter Sluice Aquatic unit, the area of greatest tidal exchange with Suisun Bay. Water in this reach of Otter Sluice has a very short residence time on the site. Fish tissues from the North Otter Sluice Aquatic unit did not contain elevated levels of DDT, dieldrin, endrin aldehyde (a product of endrin metabolism), or heptachlor compared to data reported in the RMP. Therefore, neither DDTs, dieldrin, endrin, nor heptachlor were considered as COECs for fish.

Heptachlor epoxide, a breakdown product of heptachlor, exceeded AWQCs only in the R Area Terrestrial and Aquatic unit. Low levels of heptachlor may affect carbohydrate metabolism, osmoregulation, and hemostatic mechanisms in fish (Srivastava and Mishra 1987). However, the aquatic portion of the R Area Disposal Site provides very limited fish habitat and is not considered ecologically relevant. Neither heptachlor nor heptachlor epoxide was detected in fish tissues from other aquatic sites; therefore, heptachlor epoxide is not considered a COEC for fish.

Total concentrations of chlordanes, PCBs, and PAHs exceeded AWQCs only when nondetect results were included as one-half the SQL. When actual detected concentrations were summed, none of these chemical classes exceeded their respective AWQC. As a result, these chemicals were not considered as COECs.

Dioxins were measured in fish from the South Otter Sluice Aquatic unit to determine whether dioxins in soil at the Wood Hogger Site were contributing to elevated levels in fish tissue. Fish from Otter Sluice had concentrations of dioxins, based on TEQs, less than that of white croaker collected from San Pablo Bay, and approximately equal to that of halibut collected from San Francisco Bay (see Table 12-2). Detected concentrations of dioxins in fish from the South Otter Sluice Aquatic unit were 5 to 11 picograms per gram (pg/g) adult tissues. Eggs from fish in Otter Sluice could contain slightly higher concentrations, but are not expected to approach the threshold for the most sensitive species reported, lake trout (*Salvelinus namaycush*). Mortality in newly hatched lake trout occurs at 40 pg/g egg (Spitsbergen and others 1991). Based on the available information, dioxin is not considered a COEC for fish.

12.4 RISK CHARACTERIZATION FOR FISH

An assessment of exposure and effects must consider potential exposure pathways for fish and the likely ecological effects resulting from exposures to individual or multiple stressors.

COECs were based on a weight-of-evidence approach integrating (1) the frequency and magnitude with which site-specific chemical concentrations exceed screening values, (2) the evidence of bioavailability of chemicals to representative receptors, and (3) the site-specific body burdens of representative receptor relative to reference locations. Based on the risk characterization, only copper and zinc were identified as COECs for fish.

The Froid and Taylor Aquatic unit supports fish species typical of ephemeral surface waters such as mosquitofish and stickleback. Fish abundance varies dramatically by season. Fish may enter the surface water at the Froid and Taylor Roads Site on a high incoming tide or storm surge during periods of general flooding, such as was observed during the winter of 1998. Once in the isolated pools of the Froid and Taylor Aquatic unit, they are not likely to return to Suisun Bay.

At the Froid and Taylor Aquatic unit, high levels of metals coincide with increases in concentrations of minerals such as calcium, resulting from evaporation. The impact on fish from this concentration of minerals as well as potential chemicals depends on whether the exposures occur during sensitive life stages. Most stickleback in warm water typically complete their life cycle in a single year, maturing in the spring, reproducing throughout the summer, and then entering a period of senescence as summer wanes. The highest concentrations of chemicals occur in early fall, at the end of the dry season, long after most stickleback have finished breeding. Mosquitofish are also short-lived, and extremely tolerant of poor water quality. They brood their young internally, where they are somewhat protected from environmental conditions. This species, native to the southeastern United States, was introduced into California as a mosquito control agent, as the adults feed on larval mosquitoes in quiet, backwater areas. An individual female, which can store sperm for many months, could repopulate the aquatic habitat of Froid and Taylor Roads in a matter of weeks (TtEMI 1998e). Observations of rapid population explosions of these two species in the small pools at the Froid and Taylor Aquatic unit indicate the strong reproductive success of the individuals present. This is considered a qualitative yet significant line of evidence indicating that site chemicals are not adversely affecting fishes at this site. Because of the isolated, ephemeral nature of the site, population level effects beyond the Froid and Taylor Aquatic unit are not of concern.

Otter Sluice provides the most permanent aquatic habitat in the Tidal Area, and supports an abundance of fish year-round. However, as a linear, manmade channel, it lacks the diversity of microhabitats that characterizes more natural tidal sloughs in the Suisun Bay area. Nevertheless, Otter Sluice appears to support reproducing populations of several species of native fishes, such as stickleback and prickly sculpin. Highly dynamic surface water exchange with Suisun Bay brings nutrients, plankton, and the chemical mixture characteristic of the bay during that limited window of time twice each day. Otter Sluice is not considered a source of chemicals with adverse effects on fish, nor are fish living in Otter Sluice a source of chemicals relative to other fishes in Suisun Bay and its environs.

13.0 RISK TO AQUATIC INVERTEBRATES

Protection of populations of aquatic (benthic) invertebrates was identified in Section 7.0 as an assessment endpoint because benthic invertebrates are an important part of the aquatic environment and serve as important prey items for birds and mammals. Benthic invertebrates are particularly at risk to contaminants, since they are in direct contact with the sediment.

Ecological surveys identified aquatic invertebrates occurring or potentially occurring at the Tidal Area, including various aquatic insects, polychaetes, and crustaceans (see Section 3.2). No special status invertebrates were observed during the surveys, nor were any considered to potentially occur at the Tidal Area.

Clam and amphipod tissues were selected as measurement endpoints to aid in assessing risk to invertebrates. The tissue residue data were also used in food-chain modeling to represent prey for birds and mammals (see Section 15.0). In addition, sediments were collected from Otter Sluice and tested in the laboratory for toxicity to amphipods to provide another line-of-evidence for assessing risk to aquatic invertebrates.

For the evaluation of risks to aquatic invertebrates presented in this section, benthic invertebrates were considered to be primarily exposed to site chemicals through sediment, since sediment contains greater concentrations of chemicals than surface water and benthic invertebrates come in direct contact with sediments. Risk to aquatic invertebrates from COPECs was evaluated in a weight-of-evidence approach using available tools, including:

- Identification of COPECs based on ambient concentrations and ER-Ls
- Comparison of site-specific concentrations of chemicals in sediment to screening values (ER-Ls and ER-Ms) and AWQC thought to be protective of aquatic life
- Observations of aquatic invertebrates and habitat conditions in Tidal Area sites
- A biological effects assessment using an amphipod whole sediment assay (where available)
- Evaluation of amphipod and clam tissue residues, comparisons of clam tissue data with literature-reported effects, and comparisons with regional bivalve tissue residues (RMP data [SFEI 1997])

COECs for aquatic invertebrates were subsequently identified based on the results of this assessment.

Section 13.1 presents the COPECs that were identified for aquatic invertebrates based on the screening methods outlined in Section 5.2.1. Section 13.2 discusses the exposure assessment, and Section 13.3 the effects assessment and determination of COECs for aquatic invertebrates. Section 13.4 summarizes risks to aquatic invertebrates. Section 13.4 summarizes the exposure and effects assessment to characterize the risk to aquatic invertebrates at the Tidal Area.

13.1 CHEMICALS OF POTENTIAL ECOLOGICAL CONCERN FOR AQUATIC INVERTEBRATES

As described in Section 5.0, an inorganic COPEC for invertebrates was identified if chemical concentrations (1) exceeded ambient concentrations (Tidal Area and San Francisco Bay ambient values, as available) and (2) exceeded ER-Ls. Organic COPECs were identified if chemical concentrations exceeded ER-Ls. Based on further statistical evaluations of the data in Section 6.3, chromium, silver, thallium, and vanadium were eliminated from further evaluation as COPECs.

ER-Ls are based on toxicity to fish and aquatic invertebrates, and therefore concentrations that exceed the ER-L indicate potential risks to benthic invertebrates. When ER-Ls were unavailable, information from the literature was used to qualitatively assess risk.

Specific Tidal Area habitat units for which the risk to aquatic invertebrates was evaluated include the R Area Terrestrial and Aquatic unit, Froid and Taylor Aquatic unit, the North Otter Sluice Aquatic unit, and the South Otter Sluice Aquatic unit; the other habitat units were not evaluated since they do not support benthic invertebrates. Tables 13-1 to 13-4 identify COPECs for each of these habitat units, and indicate the highest screening value that was exceeded. Although ER-M exceedances are noted on Tables 13-1 to 13-4, the ER-M is provided for reference purposes only since ER-Ls were used to identify COPECs.

Chemicals for which no screening values exist include pesticides, SVOCs, VOCs, and motor oil.

13.2 EXPOSURE ASSESSMENT FOR AQUATIC INVERTEBRATES

Figure 7-1 shows the complete exposure pathways for aquatic invertebrates. Aquatic invertebrates may be exposed to chemicals in the diet and through direct ingestion of sediment or water, or from dermal and gill absorption of chemicals in sediment pore water or surface water.

Biological factors such as lipid content, metabolic rate, diet selectivity, behavior, and feeding mode may affect the uptake and accumulation of chemicals. Some metals serve as nutrients, and their concentrations in tissues may not be directly related to concentrations in water or sediment.

The exposure assessment focused on clams and amphipods as representative aquatic invertebrates. Sediment exposure was assumed to be the exposure pathway of greatest concern for aquatic invertebrates. Sediment chemistry was evaluated by comparing concentrations detected to ER-Ls and ER-Ms, not only to assist in identifying COPECs, but also for the assessment of potential effects. ER-Ls and ER-Ms are particularly important for evaluating potential risk to sensitive early life stages of aquatic organisms, and for assessing risk from acute or subchronic exposures. However, the most direct measure of chronic exposure is by evaluating tissue residue data. Tissue data were collected for clams and amphipods, two representative invertebrates in the Tidal Area. The tissue residues in clams were compared to regional bivalve tissue data available from RMP and provided by SFEI (1997), and from other literature sources. Regional background amphipod tissue data were not available. Reports of tissue residues associated with effects are limited, but were used when available.

Body burdens can compared with regional data from other invertebrates to identify elevated concentrations that indicate significant exposure by the organisms. Invertebrates collected from the Tidal Areas included amphipods and clams (*Macoma balthica)*. Regional data were available from the RMP, supplied by SFEI (1997), for bivalves including clams (*Corbicula fluminea*), oysters (*Crassostrea gigas*), and mussels (*Mytilus californianus*). No regional data area available for amphipods.

Table 13-5 shows the tissue concentrations of chemicals in clams collected from the Tidal Area. Amphipod tissue chemical concentrations are presented in Table 8-6A. The tissue concentrations of contaminants in clams from the Tidal Area were at the low end of the range for reported regional bivalve concentrations with the exceptions of lead, mercury, and zinc. These comparisons demonstrate that, in general, invertebrates in the Tidal Area are not bioaccumulating high concentrations of inorganic or organic constituents compared to regional conditions.

In some cases, chemicals that were not identified as COPECs were still evaluated for risk to invertebrates if they were detected in tissues, because low concentrations in sediments and water can result in bioaccumulation for some kinds of chemicals.

13.3 EFFECTS ASSESSMENT FOR AQUATIC INVERTEBRATES

The effects assessment for aquatic invertebrates in the Tidal Area was based on an amphipod whole sediment bioassay, as well as an evaluation of ER-Ls and ER-Ms and tissue residue data, as discussed in the following subsections.

13.3.1 Amphipod Bioassay - Whole Sediment Test

A 10-day amphipod (*Eohaustorius estuarius*) bioassay of whole sediments collected from North and South Otter Sluice was conducted in 1998 (see Section 8.0). The endpoints evaluated were amphipod survival and reburial. All sediments tested had between 92 and 97 percent survival and reburial of amphipods. Some samples were statistically significantly different from control sediments that had 100 percent survival and reburial; however, this level of survival and reburial was well within the San Francisco Bay reference envelope approach of greater than 66 percent survival (RWQCB 1998). Based on the bioassay results, sediments did not demonstrate toxicity to amphipods.

13.3.2 Potential Toxicological Effects of COPECs on Aquatic Invertebrates

Some toxic effects on aquatic invertebrates are expected if sediment chemical concentrations exceeding ER-Ls and ER-Ms. However, since ER-Ls and ER-Ms were derived from studies of several aquatic organisms, there could be a wide range in species sensitivity to each chemical. For example, in amphipod bioassays O'Connor and others (1998) found that of 239 sediment samples containing at least one concentration above an ER-M, only 38 percent were toxic in an amphipod bioassay. On the other hand, of 481 samples that did not exceed an ER-L, only 5 percent were toxic in an amphipod bioassay (O'Connor and others 1998).

Potential chemical impacts to aquatic invertebrates were assessed by integrating the bulk sediment chemistry data and information from the literature as well as evaluating ER-Ls and ER-Ms. Each chemical was evaluated individually, as discussed below.

Aluminum

Information on aluminum toxicity in aquatic invertebrates was limited. According to the ER-Ls and AWQC, aluminum levels in the Tidal Area may pose a risk to sensitive aquatic invertebrates. Aluminum was evaluated as a COPEC for in the South Otter Sluice Aquatic unit because the maximum site concentration exceeded the ambient level. However, the maximum aluminum concentration in

sediment was just 1.56 times the Tidal Area 99th percent UCL ambient value. Therefore, site activities are not believed to have been the source of aluminum in the Tidal Area and aluminum is not considered a COEC for aquatic invertebrates.

Arsenic

Maximum arsenic levels in sediment samples exceeded the Tidal Area ambient value and the ER-L but not the ER-M. The bioavailability of arsenic is not associated with AVS binding. Therefore, tissue data are the best indicator of arsenic bioavailability to aquatic organisms. Arsenic concentrations in clams from the Tidal Area were lower than RMP bivalve data (see Table 13-5). Therefore, arsenic is not considered a COEC for aquatic invertebrates.

Cadmium

Maximum cadmium concentrations in sediment samples exceeded ER-Ls at the Froid and Taylor Aquatic unit and at South Otter Sluice. Cadmium levels in Tidal Area clams are within the range of the RMP data (see Table 13-5). Cadmium is not considered a COEC for aquatic invertebrates.

Copper

The maximum copper concentration in sediments from North Otter Sluice (272 mg/kg) slightly exceeded the ER-M (270 mg/kg). Ambient levels of copper exceed the ER-L. Therefore, sensitive species would be at risk naturally or would have adapted. According to the SEM/AVS data, copper is not likely to be appreciably bioavailable in site sediments, as confirmed by tissue residue data. Levels in Tidal Area clams were not elevated compared to regional bivalve data (see Table 13-5). Copper is not considered a COEC for aquatic invertebrates.

Lead

Lead concentrations in clam tissues were slightly elevated compared to RMP data (see Table 13-5). However, sediments from Otter Sluice did not exceed the ER-M. The San Francisco Bay ambient (43.2 mg/kg) sediment concentration of lead is close to the ER-L (46.7 mg/kg) and the Tidal Area ambient value (95.0 mg/kg) exceeds the ER-L; therefore, lead often exceeds the ER-L in site sediments. Lead exceeded the ER-M in only one sample location at the Froid and Taylor Aquatic unit; therefore, lead was not considered a COEC for aquatic invertebrates.

Mercury

The SEM/AVS data indicated that mercury may be of concern with respect to bioavailability in North Otter Sluice Aquatic unit sediments. However, concentrations in tissues of aquatic invertebrates in the Tidal Area were comparable to regional values (see Table 13-5). Sediment concentrations at a few sample locations in North Otter Sluice Aquatic unit exceed the ER-M, but are not greatly elevated. A few sample locations had elevated mercury concentrations in sediments of the South Otter Sluice Aquatic unit and the adjacent Wood Hogger Terrestrial unit that would indicate possible site releases, but mercury was not found to bioaccumulate in fish or clams. Therefore, mercury was not considered a COEC for aquatic invertebrates.

Nickel

According to Thompson and others (1997), nickel was identified as a potential contributor to toxicity to invertebrates in sediments from the greater San Francisco Bay/Delta Region. Regional and Tidal Area nickel concentrations are high (Thompson and others 1997). Tissue residues in clams from the Tidal Area were similar to the RMP data (see Table 13-1). Tidal Area nickel concentrations and their associated effects on aquatic invertebrates do not appear to be attributable to site releases, and nickel is not considered a COEC for aquatic invertebrates.

Selenium

Selenium was a COPEC only for the Froid and Taylor Aquatic unit. The maximum concentration (1.5 mg/kg) slightly exceeded the ER-M (1.4 mg/kg). Selenium was not a concern in terms of the magnitude and frequency of results that exceeded screening values (see Section 6.0); therefore, selenium was not considered a COEC for aquatic invertebrates.

Zinc

Zinc can bioaccumulate to high levels in aquatic invertebrates since it is taken as a nutrient (Beyer and others 1996). Zinc is usually stored in a nontoxic form in bivalves (Beyer and others 1996). The tissue levels of zinc in clams from Otter Sluice were much lower than regional bivalve data (see Table 13-5). Therefore, while the SEM/AVS data indicate that zinc is likely to be bioavailable in sediments from the North Otter Sluice Aquatic unit and zinc levels sometimes exceed ER-Ms, the tissue data indicate otherwise. The tissue residues in clams from the North Otter Sluice Aquatic unit were, however,

slightly higher than in the South Otter Sluice Aquatic unit. The concentrations that exceed ER-Ms indicate that zinc could be toxic to sensitive species of invertebrates or to sensitive individuals. Zinc levels were elevated at many sample locations. The outlier analysis indicates that many sediment samples can be considered outliers. There is no spatial trend in the sediment concentrations of zinc, and site sources of zinc have not been identified. Since zinc levels were high in bivalves from Suisun Bay (SFEI 1997), water and sediments coming in from the bay may be contributing to the zinc at the site. Therefore, zinc was not considered a COEC for aquatic invertebrates.

Organic Chemicals

The organic chemicals detected in aquatic invertebrates from the Tidal Area include DDTs, chlordanes, dieldrin, PCBs, hexachlorobenzene, methoxychlor, trans-nonachlor, and dioxins (PCDDs and PCDFs). All are persistent organic chemicals that are ubiquitous in the environment. The concentrations of these chemicals are not elevated in sediments (see Table 6-4, 6-7, 6-11, and 6-13) compared to regional background concentrations (RWQCB 1998), and they are not elevated in clam tissues compared to RMP bivalve data (see Table 13-5). The exception is chlordanes in the Froid and Taylor Aquatic unit.

Chlordanes in sediments from the Froid and Taylor Aquatic unit are elevated compared to San Francisco Bay sediments (RWQCB 1998). However, the amphipods collected from the Froid and Taylor Aquatic unit did not contain elevated tissue concentrations of chlordane (0.2 μg/kg wet weight) compared to clams from Otter Sluice and, since they are different species, caution must be exercised in making the comparison. The San Francisco Bay ambient concentration of chlordanes exceeds the ER-L, and the Froid and Taylor Aquatic unit sediments exceed the ER-L in six of 11 samples. Since the result for only one of 11 sediment samples exceeded the ER-M, the high concentration appears to be isolated.

Dioxins were detected in clams from South Otter Sluice. Dioxins act by a mechanism associated with the AhR. While invertebrates have this receptor, dioxins and other chemicals that act by an AhR-mediated mechanism (such as PCBs and PAHs) are not as toxic to invertebrates as they are to vertebrates (Safe 1990). In general, mammals are more affected by these chemicals, followed by fish, and then invertebrates (Safe 1990). The AhR in higher organisms (vertebrates) has a more extensive (perhaps endogenous) role. Alternative mechanisms (other than AhR-related) of toxicity may affect invertebrates, but invertebrates still do not appear as susceptible to dioxins as are vertebrates. The concern involving PCBs, PAHs, and dioxins in the Tidal Area should therefore be focused more on

birds, mammals, and fish rather than on invertebrates. Based on the available information, organic chemicals were not considered COECs for aquatic invertebrates.

13.4 RISK CHARACTERIZATION FOR AQUATIC INVERTEBRATES

North and South Otter Sluice provide the best overall habitat quality for aquatic invertebrates in the Tidal Area. North Otter Sluice provides invertebrates as prey for the California Black Rail, a special status species. Protection of individual black rails was identified as an assessment endpoint (see Section 7.0). Aquatic invertebrates in North and South Otter Sluice in general support an abundance and diversity of waterfowl, shorebirds, and mammals. The artificial ponds and ditches in the R Area Terrestrial and Aquatic and the Froid and Taylor Aquatic units support smaller, less diverse invertebrate populations than Otter Sluice, providing fewer feeding opportunities for wildlife. Clams, for example, were found in Otter Sluice, but not in the Froid and Taylor Aquatic or R Area Terrestrial and Aquatic units. Amphipods were not found during 1995 in the Froid and Taylor Aquatic unit, but were collected there in 1998.

Water quality can be impaired during the dry season (late summer and early fall), as demonstrated by decreased dissolved oxygen levels (WESCO 1995). Seasonal fluctuations in salinity and other water quality parameters could affect sensitive species. The flapgates at the mouth of Otter Sluice may limit natural tidal flow, affecting water quality and habitat conditions.

Isolated sample locations pose a concern to aquatic invertebrates from elevated concentrations of inorganic chemicals: mercury in South Otter Sluice Aquatic unit and zinc in all site units. ER-Ms of lead and zinc were each exceeded in one of 11 sediment samples of Froid and Taylor Aquatic unit. However, tissue residues in invertebrates from these sites were not elevated compared to RMP data (SFEI 1997). The amphipod bioassay also showed no effects.

According to Thompson and others (1997), sediments from the greater San Francisco Bay/Delta region contain levels of DDTs, dieldrin, and chlordanes and other chlorinated pesticides that often exceed ER-Ls. These are ubiquitous, persistent chemicals. The levels of these chemicals were not significantly elevated in sediments compared to RWQCB (1998) San Francisco Bay ambient levels except at one sample location in the Froid and Taylor Aquatic unit. The tissue residues of invertebrates from these sites were not elevated compared to RMP bivalve data (SFEI 1997).

Otter Sluice in particular supports a diversity of waterfowl, and North Otter Sluice supports the special status California Black Rail that feeds on invertebrates. The habitats in the R Area and Froid and Taylor Aquatic units do not support the diversity and abundance of aquatic invertebrates found in Otter Sluice. Based on the weight-of-evidence, no COECs were identified for aquatic invertebrates.

14.0 RISK TO REPTILES AND AMPHIBIANS

The protection of herpetofauna (reptiles and amphibians) was not specifically identified in Section 7.0 as an assessment endpoint for the Tidal Area. However, a qualitative assessment of risk to reptiles and amphibians was conducted to assist in evaluating overall risk to ecological receptors at the Tidal Area.

Ecological surveys conducted at the Tidal Area did not specifically target reptiles and amphibians. However, during other ecological surveys conducted at the Tidal Area (see Section 3.2), western pond turtles (*Clemmys marmorata*) were observed at several sites (for example, the Wood Hogger Site, R Area Disposal Site, and Otter Sluice). Both subspecies of the western pond turtle, *Clemmys marmorata marmorata* and *Clemmys marmorata pallida*, are special status species (see Section 3.3). No special status species of amphibians were observed. The presence or absence of special status or other species can only be inferred based on habitat suitability and general records on the distribution and habitat requirements of selected species from the literature.

Because the western pond turtle is a special status species, it was selected as a representative receptor for evaluating risk to herpetofauna. Reptiles and amphibians are an especially intractable group of animals to evaluate in an ecological risk assessment, so it is not surprising that they have seldom been included in assessments conducted at other sites. For example, the construction of plausible exposure scenarios and the calculation of dose estimates for various species of reptiles and amphibians is complicated by life-history considerations. Reptiles and amphibians exhibit basic life-cycle differences that can affect not only the range of contaminants they are exposed to, but the timing and route of exposure as well. For species having development stages that pass through or temporarily reside in aquatic, semi-aquatic (transitions zones), and terrestrial environments, the question of estimating exposure can be complicated, especially if each life stage and exposure route is characterized by widely differing sensitivity to contaminant effects.

For this assessment, reptiles and amphibians were considered to be primarily exposed to site chemicals through surface water only. Risk to amphibians and reptiles from site chemicals was evaluated in a weight-of-evidence approach using available tools, including.

- Identification of COPECs based on AWQC
- Qualitative observations of herpetofauna
- Literature review

COECs for reptiles and amphibians were subsequently identified based on the results of this assessment.

Section 14.1 identifies the COPECs for reptiles and amphibians that were identified based on the screening of surface water. Section 14.2 discusses the exposure assessment, and Section 14.3 discusses potential effects to reptiles and amphibians. Section 14.4 summarizes the information into a risk characterization for reptiles and amphibians at the Tidal Area sites.

14.1 CHEMICALS OF POTENTIAL ECOLOGICAL CONCERN FOR REPTILES AND AMPHIBIANS

Because reptiles and amphibians were considered to be primarily exposed to site chemicals through surface water only, site chemicals were screened against AWQCs to determine COPECs for reptiles and amphibians. AWQCs were used as the screening value for reptiles and amphibians since they are intended to be protective of most aquatic biota, and concentrations that exceed AWQCs indicate a potential for adverse effects. Chemicals for which AWQC values were not available were also considered COPECs. These chemicals include pesticides, SVOCs, VOCs, diesel, and motor oil.

Specific Tidal Area habitat units for which the risk to reptiles and amphibians was evaluated include the Landfill Terrestrial unit, R Area Terrestrial and Aquatic unit, Froid and Taylor Aquatic unit (which is designated an aquatic unit since it has standing water most of the year), Wood Hogger Terrestrial unit, North Otter Sluice Aquatic unit, and South Otter Sluice Aquatic unit. Table 14-1 identifies COPECs for each of these habitat units based on the AWQC screening value. The remaining habitat units were not evaluated since they are terrestrial environments that do not support reptiles or amphibians.

Chemicals for which AWQC values were not available include pesticides, SVOCs, VOCs, diesel, and motor oil.

14.2 EXPOSURE ASSESSMENT FOR REPTILES AND AMPHIBIANS

The complete exposure pathways for herpetofauna are depicted on Figure 7-1. Because the various life stages of reptiles and amphibians can inhabit aquatic, semi-aquatic, and terrestrial environments, a comprehensive analysis would ideally include all contaminated media and both the potential pathways and routes of exposure, as follows:

- **Surface Water:** Ingestion during drinking and feeding and dermal contact
- **Sediments:** Dermal contact and incidental ingestion
- **Soils:** Dermal contact and incidental ingestion
- **Air:** Respiration and dermal absorption of volatile contaminants from soils
- **Food Chain:** Ingestion of contaminated prey

In general, early life stages of reptiles and amphibians are more vulnerable to most inorganic and organic contaminants that have been studied. In the case of eggs, exposure can be either direct, from surface-water sources or soil pore water, or indirect from maternal transfer.

14.3 EFFECTS ASSESSMENT FOR REPTILES AND AMPHIBIANS

The effects assessment for reptiles and amphibians in the Tidal Area was based on a review of toxicological effects of chemical concentrations in the current literature, as discussed in the following subsections.

14.3.1 Literature Review

A literature review was conducted to assess the current state of knowledge with respect to contaminant effects on reptiles and amphibians. A key source of information used in this analysis was a recent review chapter on the ecotoxicology of metals by Grillitsch and Linder (in press). Although the body of literature on the general topic of environmental contamination and impacts to reptiles and amphibians is growing, relatively little work has been done in this area as compared to better-studied species of mammals, birds, fish, benthic invertebrates, and plankton. However, even though this body of work is limited, sufficient information was available to generate a list of potential measurement endpoints for reptiles and amphibians that could be used in support of QEAs.

- **Population and Physiological Endpoints:**
  - Mortality/survival
  - Growth/development
  - Fertilization/hatching success/fecundity
  - Specific developmental abnormalities
  - Tissue burdens of contaminants
  - Osmoregulatory processes

- Immunosuppresion
- Cellular biomarkers (such as histopathological abnormalities, membrane potential, and DNA damage)
- Metallothionein induction
- Direct measurements of energy reserves (such as lipids, glycogen, and protein content)

- **Behavioral Endpoints:**
  - Righting behavior (turtles)
  - Mate recognition
  - Predator avoidance/fright response
  - Learning acquisition
  - Hyperactivity
  - Visual and auditory deficits

Unfortunately, given the sparse and scattered nature of the published data on this topic (for example, few studies used the same species, exposure scenarios, or toxicity endpoints), it was not possible to derive a set of useful screening benchmarks for reptiles and amphibians. By far the largest number of studies (at least for reptiles) provided synoptic information relating tissue burdens or blood-levels of contaminants to environmental concentrations, with little or no description of measured or hypothesized effects. Moreover, laboratory toxicity tests with amphibians typically focus on acute or short-term chronic exposures with mortality as the primary endpoint, whereas longer-term exposures aimed at detecting subtle effects that impair population sustainability (such as reproductive and some behavioral endpoints) might be more useful for evaluating impacts that would result from exposure scenarios under actual field conditions.

Given the discussed limitations for conducting a comprehensive pathway analysis and exposure assessment for reptiles and amphibians, it was decided to consider only the surface water exposure route in this assessment. Although this approach ignores several important pathways, a more sophisticated analysis could not be justified based on: (1) insufficient information on the trophic ecology (for example, ingestion rates and types of prey and other ingested food items, including incidental ingestion of sediments and soil) of species of interest and estimates of contaminant levels in their diets, (2) the lack of appropriate toxicological screening benchmarks for sediments and soils, (3) limited data on utilization of the sites by reptiles and amphibians (for example, the general importance of these two groups compared to other ecological receptors), and (4) the assumption that risk to reptiles and amphibians will not be greater than would be calculated in more detailed analyses

conducted for higher-level receptors (in other words, any response actions to protect other species are assumed to be protective of reptiles and amphibians).

Risk to the western pond turtle, and to reptiles and amphibians in general, at the Tidal Area sites was evaluated by comparing surface-water contaminant concentrations to a set of screening benchmarks derived from AWQC (EPA 1998), proposed water quality criteria for California (EPA 1997), and water quality criteria specified in the Bay Basin Plan (1986) for San Pablo Bay.

The primary COPECs identified at sites where there is the potential for exposure of site chemicals to reptiles and amphibians include cadmium, copper, chromium, lead, mercury, nickel, silver, and zinc. Maximum concentrations measured for several metals exceeded the benchmark values by one to two orders of magnitude, as shown in the table below.

MAXIMUM METAL CONCENTRATIONS (μg/L) IN SURFACE WATER FOUND AT INDIVIDUAL TIDAL AREA SITES COMPARED TO BENCHMARK SCREENING VALUES

Metal	Screening Value	Landfill Terrestrial	R Area Terrestrial and Aquatic	Froid and Taylor Aquatic	Wood Hogger Terrestrial	North Otter Sluice Aquatic	South Otter Sluice Aquatic
Aluminum	87	**1,370**	**5,570**	**1,610**	**748**	**37,700**	**2,100**
Arsenic	36	--	--	**275**	--	--	--
Cadmium	1.1	1.8	**8.3**	--	2.5	--	--
Copper	3.2	**14.5**	**32.0**	**13.4**	**13.7**	**82.0**	7.8
Chromium[a]	11	--	--	--	--	**102**	--
Lead	3.1	--	**41.5**	4.0	3.7	**57.3**	--
Mercury	.025	--	**0.35**	**0.17**	**0.20**	**0.66**	**0.24**
Nickel	8.2	**28.6**	**211.0**	**44.7**	--	**118.0**	--
Silver	.22	--	--	0.30	--	--	--
Zinc	58	--	**265.0**	95.2	**329.0**	**346.0**	**430.0**

Notes: **Concentrations more than three times the benchmark values are shown in bold.**

a Comparison is for benchmark value of Chromium VI

14.3.2 Potential Toxicological Effects of COPECs on Reptiles and Amphibians

Detailed information on the toxicity potential and mechanism of toxicity for reptiles and amphibians has not been well studied for many groups of inorganic and organic contaminants, although there is a growing list of common and persistent environmental contaminants that are known or believed to be toxic to reptiles and amphibians. Of the metals that are known to have high toxicity potential, the best

studied are aluminum, arsenic, cadmium, chromium, copper, lead, mercury, and zinc. Organic compounds that have received the most attention include PCBs and organochlorine pesticides (primarily DDT and its metabolites).

Much of the ecotoxicological work on reptiles has focused on economically important species, such as the American alligator, and on several common and widespread species of turtles. Turtles in particular have been studied as potential biomonitors of pollution because they are relatively long-lived, widely distributed geographically, and found in a variety of habitats (Meyers-Schone and Walton 1994). Metals are generally found in the highest concentrations in liver and kidney tissue, with the exception of lead, which is found at higher levels in bone and, for turtles, in the carapace as well. Determining the nature and magnitude of effects and the overall ecological importance of environmental pollutants is difficult, however, as many studies have reported finding high body burdens of contaminants in reptiles, and these elevated levels have not been accompanied by signs of impairment or underlying pathologies.

The toxicology of most metals and organic contaminants has generally been studied in more detail and is better described for amphibians than for reptiles mostly because frogs, toads, and salamanders are more amenable to laboratory toxicity testing. They are relatively easy to rear, offer a range of sensitive endpoints, and have shorter generation times. As with reptiles, most of the toxicological literature on amphibians focuses on metals, PCBs, and pesticides.

Aluminum

Aluminum toxicity has been well documented in studies of the impact of acidification on aquatic systems. The toxicity of aluminum to amphibians is known to be influenced by a number of complex physicochemical and biological factors such as pH, hardness, dissolved organic carbon (DOC), and both the developmental stage and species of amphibian examined. Aluminum speciation also affects toxicity, with free Al^{3+} and the hydroxy complexes the most toxic. The primary cause of aluminum mortality in amphibian embryos has been termed the "curling effect." This effect is produced when the vitelline membrane that surrounds the embryo fails to expand, causing the elongated embryos to become tightly constricted. The curling effect is believed to be primarily mechanical in nature, as embryos will survive and develop normally if the membrane is removed. Exposure to aluminum has also been associated with the appearance of fluid-filled blebs on dermal surfaces, suggesting epithelial irritation and the disruption of osmoregulation (Freda 1991).

Cadmium

Cadmium is one of the best-studied metals in reptiles, where it has been found to concentrate in liver, kidney, muscle, and brain tissue (Grillitsch and Linder [in press]). In amphibians, cadmium exposure has been linked to retarded growth, developmental malformations (such as incurvated axis, underdevelopment or abnormal development of fins and eyes, and microencephaly), the formation of dermal blisters, reduction in pigmentation, and cellular injury to the alimentary canal of frogs (Ghosh and Chakrabarti 1992). Perez-Coll and others (1986) reported that cadmium produced skeletal malformations, delayed development, reduced body size, and behavioral disorders in toad (*Bufo arenarum*) embryos. Growth retardation may affect the size and sustainability of amphibian populations, as the amount of time that individuals spend at a smaller size increases their vulnerability to predation.

Copper

Horne and Dunson (1995) examined acute effects of aluminum, copper, iron, lead, and zinc on frogs (*Rana sylvatica*) and salamanders (*Ambystoma jeffersonianum*), and found that copper was the most toxic and fast acting of the metals studied.

Lead

Lead exposure has been widely linked to reproductive failure and developmental abnormalities in amphibians. Strickler-Shaw and Taylor (1990) relate lead exposure to a range of neurological defects in green frog (*Rana clamitans*) tadpoles, including decreased acquisition and retention of discriminate avoidance learning.

Mercury

Mercury is another commonly studied metal, and has been the focus of intense interest in studies of American alligator (*Alligator mississipiensis*) populations from the Florida everglades (Heaton-Jones and others 1997). The potential for biomagnification of methylmercury in aquatic species has also been suggested (Meyers-Schone and Walton 1994). For amphibians, mercury has been associated with impaired fertilization, ova maturation, and postembryonic development, and is known to interfere with normal neurochemical events linked to central nervous system integration, as well neuroendocrine regulation (Punzo 1993).

Pesticides and PCBs

In reptiles, organochlorine pesticides and PCBs have an affinity for tissues with high fat content, and tend to concentrate in the liver and kidney more than in other soft tissues.

Other COPECs

Insufficient information was available to assess the toxicological effects of the other COPECs on reptiles and amphibians.

14.4 RISK CHARACTERIZATION FOR REPTILES AND AMPHIBIANS

The literature review revealed several limitations in evaluating risk to reptiles and amphibians, including:

- Allometric scaling models and models for extrapolating between effects (for example, toxicity endpoints) and across species (or higher order extrapolations) have not been developed
- There is a general lack of ecotoxicological, dose-response, and pharmacokinetic data for many classes of contaminants and for most species of reptiles and amphibians
- Differences in test species, exposure duration, general test methodology, and toxicity endpoints have generally confounded the development of TRVs
- The development and application of food-chain models is hampered by uncertain knowledge of the trophic ecology of many reptiles and amphibians in general, and the lack of site-specific data on habitat utilization and feeding preferences
- Toxicity testing under controlled laboratory conditions cannot be conducted for many species of reptiles, given their relatively long gestation times and slow reproductive rates

All of the metal COPECs are known to be toxic to sensitive life stages of reptiles and amphibians when present in sufficient concentrations, and warrant special attention. However, assessment of the general level of risk that is posed by metals at the Tidal Area sites is problematic, given that:

- Analytical chemistry results report only total levels of metals, and concentrations of the bioavailable fractions of metals are unknown
- Complex antagonistic and synergistic interactions between metals and environmental and biological matrices determine toxicity potential, and place additional constraints on the estimation of risk from data sets that only report total concentrations for a limited number of chemical variables

- From a review of the literature, is was concluded that there is high uncertainty with respect to the specification of threshold levels for individual metals, their mechanism of action, and the nature of the effects that would result from exposure to concentrations present at the Tidal Area sites

- Exposure potential cannot be adequately assessed, as there is limited site information on populations size, distribution, trophic ecology, and life-history characteristics of the reptile and amphibian species that may inhabit these sites

Given the paucity of data for deriving screening benchmark values and the limitations imposed by only examining surface water pathways, it is tempting to make comparisons with acute and chronic toxicity endpoints available from a limited number of laboratory studies of reptiles and amphibians and TRVs developed for other species of wildlife and fish. This approach is likely to yield little useful information, however, given the high variability in toxic response that is known to exist within even closely related species, and the uncertainty that would be introduced in extrapolating between effects endpoints and to a poorly studied group of organisms, such as reptiles and amphibians.

Conclusions regarding the overall level of risk to reptiles and amphibians at the Tidal Area sites, therefore, are tentative at best. Potentially toxic concentrations of metals have been identified at several sites used by reptiles and amphibians, so risk of ecological effects should not be dismissed. Given the importance of other ecological components within the Tidal Area sites, and the limitations discussed in this section regarding the treatment of reptiles and amphibians in QEAs, a more comprehensive analysis of reptiles and amphibians cannot be justified. Any response actions taken at the Tidal Area sites should be based on more complete estimates of risk that have been obtained for higher-level organisms, and it is assumed that actions based on these criteria will generally be protective of reptiles and amphibians.

15.0 RISK TO BIRDS AND MAMMALS

The evaluation of risk to birds and mammals focused on selected assessment endpoints identified in Section 7.5 and used an approach that evaluated exposure through the ingestion pathway. Risk to representative birds and mammals at the Tidal Area sites was evaluated quantitatively based on an HQ approach. In the HQ approach, site-specific daily doses determined by food-chain modeling were compared to TRVs, where the HQ is equal to ingested dose divided by TRV. The derivation of TRVs and the use of food-chain analysis in the HQ approach was described in detail in a technical memorandum (EFA WEST 1998) and was described briefly in Section 5.2.2. Food-chain analysis was conducted for each COPEC and receptor pair for which a TRV was available. For COPECs that did not have a TRV, a more qualitative assessment of risk was performed based on available information in the scientific literature. COECs were subsequently determined by the screening process described in Section 5.2.2.

The primary line of evidence for assessing risk to birds and mammals was the HQ approach (using food-chain modeling). In addition, for the endangered salt marsh harvest mouse, tissue residue data of house mice collected from the Tidal Area were evaluated as a surrogate for evaluating potential bioaccumulation of contaminants. The food-chain modeled dose relies on certain assumptions, such as 100 percent bioavailability in order to be conservative and protective. The tissue residue data are a more accurate reflection of the exposure of site contaminants to the representative receptors.

Ingestion of contaminated material is the most important exposure pathway for vertebrate receptors at the Tidal Area sites; therefore, potential risks to receptors were evaluated only for the ingestion pathway. Inhalation and dermal exposure routes were not addressed quantitatively because they are considered less important and there is a lack of data concerning exposure and absorption rates. For many chemicals, but especially those that tend to bioaccumulate in terrestrial animals, ingestion is generally assumed to be the primary route of exposure (Pascoe and others 1996; Pastorok and others 1996). Uncertainty associated with not considering inhalation and dermal routes of exposure is addressed in the uncertainty analysis in Section 16.0.

The evaluation of exposure via ingestion was limited to ingestion of chemical-affected environmental media (soil and sediment) and chemical-affected food sources (prey). Ingestion of surface water was

not considered because chemical concentrations in surface water indicate that the contribution would be negligible to the total dose.

Information from the literature was used to support the effect assessment and risk characterization. In cases for which TRVs were unavailable, a dose was calculated for the chemical, and the dose was compared to the limited information available on a qualitative basis (that is, no HQs were calculated if no TRV was available). The use of limited information increases the uncertainty in predicting potential effects. Section 16.0 further discusses uncertainty.

The representative receptors selected for food-chain modeling for each habitat unit are presented in the following table. Selection of these species was based on the assessment endpoints identified in Tables 7-1 and 7-2, the food web summarized on Figure 7-2, and discussions with the regulatory and trustee agencies. Representative mammalian receptors are the river otter, gray fox, and salt marsh harvest mouse. The representative avian receptors are the Great Blue Heron, Northern Harrier, Black-necked Stilt, and California Black Rail.

REPRESENTATIVE RECEPTORS USED IN FOOD-CHAIN MODELS

Otter Sluice (North and South) Aquatic Unit	Landfill Perimeter Terrestrial Unit	R Area Terrestrial Unit	R Area Terrestrial and Aquatic Unit	Froid and Taylor Terrestrial Unit	Froid and Taylor Aquatic Unit	Wood Hogger Terrestrial Unit
River Otter Great Blue Heron California Black Rail	Salt Marsh Harvest Mouse Northern Harrier Gray Fox	Salt Marsh Harvest Mouse Northern Harrier Gray Fox	Salt Marsh Harvest Mouse Northern Harrier Gray Fox Black-necked Stilt Great Blue Heron	Salt Marsh Harvest Mouse Northern Harrier Gray Fox	Black-necked Stilt Great Blue Heron	Salt Marsh Harvest Mouse Northern Harrier Gray Fox

Section 15.1 summarizes the COPECs that were evaluated for birds and mammals. Section 15.2 discusses the exposure assessment, including site-specific doses calculated using food-chain models. Section 15.3 summarizes the TRVs used and potential effects of COPECs. Section 15.4 presents the risk characterization, including the HQs calculated for each receptor, and discusses back calculations

that were conducted to evaluate concentrations in soil or sediment that would be required to produce little or no risk. Section 15.4 also summarizes the results of the evaluation of risk to birds and mammals, including COECs that were identified and the spatial extent of areas posing a risk.

15.1 CHEMICALS OF POTENTIAL ECOLOGICAL CONCERN FOR BIRDS AND MAMMALS

Inorganic COPECs evaluated for birds and mammals as those exceeding ambient values and whose statistical evaluation indicated they were elevated (see Section 5.2.2 and Figure 5-2). All organic chemicals detected were evaluated for risk to birds and mammals. TRVs were available for most inorganic chemicals, PCBs, dioxins, DDTs, benzo(a)pyrene (mammals only and used for assessing risk of total PAHs), and some chlorinated pesticides. For chemicals with no TRVs available, a qualitative assessment of risk was made.

COPECs for which no TRVs were available include acetone, aluminum, antimony, beryllium, BHCs, 2-butanone, butylbenzylphthalate, chloromethane, dieldrin, hexachlorobenzene, mirex, phenol, and trans-nonachlor. Most toxicological studies on chemicals are conducted on rats and mice, so chemicals for which TRVs were unavailable were only evaluated for risk to the salt marsh harvest mouse (as the most relevant species to evaluate).

15.2 EXPOSURE ASSESSMENT: FOOD-CHAIN ANALYSIS

Food-chain modeling integrates ecological information, such as life history and feeding behavior of receptors, and spatial variation in chemical concentrations in prey and soil into the risk assessment process. Food-chain modeling is an accepted method for estimating site-specific doses of chemicals to birds and mammals via trophic transfer (Linder and others 1993; Pascoe and others 1994). The use of food-chain analysis and TRVs in the HQ approach is described in detail in a technical memorandum prepared by EFA WEST (1998). The quantification of ecological risks is associated with several uncertainties, including the limitations of closed-system modeling. Uncertainty is discussed in Section 16.0.

15.2.1 Dose Model

Estimates of exposures for higher trophic level organisms were based on daily dose estimates modeled from measurements of chemical concentrations in soil or sediment and food sources (Pascoe and others

1994, 1996; Pastorok and others 1996). A food-chain model was used to calculate high and low daily dose estimates for each receptor in order to provide a range of site-specific doses for evaluation. In addition, a "typical" dose using average life history parameters was also calculated if there was an apparent risk based on the high dose estimate. Typical doses were not calculated for the salt marsh harvest mouse or California Black Rail because their special status warrants protection of individuals; therefore, the high dose model is more appropriate.

Site-specific doses were calculated as the sum of the daily dietary exposure estimates for ingestion of food items and incidentally ingested soil and sediment. The following equation was adapted for each receptor:

$$Dose_{total} = \frac{([IR_{prey} \times C_{prey}] + [IR_{soil} \times C_{soil}]) \times SUF}{BW}$$

where:

$Dose_{total}$	=	Estimated dose from ingestion (mg/kg body weight per day)
IR_{prey}	=	Ingestion rate of prey (kilograms per day [kg/day])
C_{prey}	=	Concentration of chemical in prey (mg/kg)
IR_{soil}	=	Ingestion rate of soil (kg/day)
C_{soil}	=	Concentration of chemical in soil (mg/kg)
SUF	=	Site use factor (unitless), which is a ratio of site-specific area to receptor's foraging range (unitless)
BW	=	Body weight (kg) of receptor

Every effort was made to tailor assumptions to conditions at the Tidal Area to reduce uncertainty. Nevertheless, sources of uncertainty may result from inappropriate assumptions concerning bioavailability, diet proportions of receptors, food-chain transfer, and other biological and physical factors and processes influencing exposure and toxicity at the site. For these reasons, low and high estimates of dose were calculated to span the range of reasonable doses. Both of these estimates used reasonably conservative values from appropriate literature based on habitat, taxa, exposure route, and other relevant ecological factors. The typical dose was calculated to provide another level of refinement in assessing risk to receptors when risk was indicated using the conservative (high) dose estimate and not using the low dose estimate. The typical dose is based on average life history

parameters of body weight and ingestion rate and was calculated using the maximum tissue residue and soil concentrations.

High dose estimates incorporated these parameters:

- Used the *lowest* adult body weight found in the literature
- Used the *highest* ingestion rate or the *highest* adult body weight found in the literature to calculate the ingestion rate using the appropriate equation from Nagy (1987)
- Used a *higher* estimate of site use factor (SUF) based on literature evaluation

Low dose estimates incorporated these parameters:

- Used the *highest* adult body weight found in the literature
- Used the *lowest* ingestion rate or the *lowest* adult body weight found in the literature to calculate the ingestion rate using the appropriate equation from Nagy (1987)
- Used a *lower* estimate of SUF based on literature values

Typical dose estimates incorporated these parameters:

- Used the *average* adult body weight found in the literature of calculated from the available high and low body weights
- Used the *average* ingestion rate or the *average* adult body weight found in the literature to calculate the ingestion rate using the appropriate equation from Nagy (1987)
- Used a *higher* estimate of SUF based on literature evaluation

In addition, ambient doses were calculated for some chemicals based on ambient sediment concentrations (RWQCB 1998) or soil concentrations (99th percent UCL for the Tidal Area) to provide a relative comparison of levels of risk from activities at the Tidal Area compared to regional ambient conditions. Calculations of ambient doses were based on incidental ingestion of ambient sediment only because ambient concentrations in prey were not available. Therefore, prey tissue contribution to the dose was assumed to be zero in the ambient dose. Ambient doses were then used to calculate ambient HQs. Ambient HQs greater than 1.0 indicate that ambient conditions pose a potential risk to the receptor. It is more meaningful to compare site HQs with ambient HQs, rather than with ambient soil concentrations, because HQs are measures of risk. For example, when the site HQ is the same or less

than the ambient HQ, there is no incremental risk from site activities. Likewise, when the site HQ exceeds the ambient HQ, there is incremental risk from site activities.

15.2.2 Exposure Parameters in the Dose Model

Exposure models for birds and mammals are based on the assumption that exposure to chemicals is primarily through ingestion of prey and through incidental ingestion of sediment and soil during grooming, feeding, or burrowing activities (Beyer and other 1994). Other possible routes of exposure, such as surface water ingestion, dermal contact, and inhalation, were not evaluated in these models. The exposure models estimate the mass of a chemical ingested daily by a receptor per kilogram of body weight (daily chemical dosage). Estimates of exposure are based generally on knowledge of the spatial and temporal distribution of both chemicals and receptors and on specific natural and life history characteristics that influence exposure to chemicals. Site-specific data on chemical concentrations in soil and prey are used in conjunction with available literature values for other parameters to estimate daily dose. The selection of chemical concentrations in soil and prey used in the models is discussed in Section 15.2.2.1.

The exposure expressed in terms of a daily dose, as described above, includes parameters specific to individual receptors. The parameters in the daily dose equation, previously described, that are specific to individual receptors include receptor body weight, prey ingestion rate, prey composition, rate of incidentally ingested sediment or soil, and SUF. The values and rationale for their selection are presented in the following sections for each individual receptor.

15.2.2.1 Concentrations of Chemicals in Prey and Sediment or Soil

Area doses were calculated for each habitat unit (see Exhibit 1) by modeling the estimated daily dose with the maximum concentration of each chemical in both tissue and sediment or soil from that spatial unit. In addition, to further refine the risk assessment, doses were calculated using the 95th percent UCL for sediment and soil when risk was indicated using the maximum concentration. For most receptors, the 95th percent UCL provides a more realistic exposure concentration for the model than does the maximum concentration.

For risk to birds and mammals, surface soil or sediment to a 3-foot depth was considered in the analysis. Risk was evaluated for all inorganic COPECs for birds and mammals even if concentrations

in prey were below detection limits because incidental sediment ingestion can be a significant contributor to the total dose. When prey tissue concentrations were below the detection limit, a value of one-half the detection limit was used in the model to calculate the daily dose estimate.

For PCBs, the CLP PCB method is an Aroclor analysis, while the low detection limit PCB method is a congener-specific analysis. Because the high and low TRVs for PCBs were based on total PCBs rather than on individual PCB isomers, the daily dose estimates were based on total PCBs. The concentration of total PCBs was calculated by summing each of the PCB isomers for each soil and sediment sample. For those results reported as not detected, one-half the detection limit was used to calculate total PCB concentrations. The maximum total PCB concentration of all of the soil and sediment samples for a given site was then calculated for both the regular level (Aroclor analysis) and low level (congener-specific analysis) results for each site. The higher of the two was selected as the maximum exposure point concentration in environmental media at that site.

For DDTs, the CLP pesticide method included concentrations for 4,4'-DDD, 4-4'-DDE, and 4,4'-DDT, while the low detection limit pesticide method results included concentrations for 2,4'-DDD, 4,4'-DDD, 2,4'-DDE, 4,4'-DDE, 2,4-DDT, and 4,4'-DDT. The low avian TRV and both mammalian TRVs were based on total DDTs. High TRVs for birds were derived for both DDT and DDE isomers separately. For total DDTs (mammal TRVs and low TRV for birds), the concentration used in the dose model was based on summing the isomers of DDD, DDE, and DDT for each soil and sediment sample. For those results reported as not detected, one-half the detection limit was used to calculate total DDT concentrations. The maximum total DDT concentration of all soil and sediment samples for a given site was then calculated for both the regular level and low level results for each site. The higher total DDT concentration of the two was used as the maximum exposure point concentration in the dose calculation.

High and low TRVs were derived for 2,3,7,8-TCDD — the most toxic dioxin based on the Great Lakes Water Quality Initiative (EPA 1995; see Appendix S). Dioxins are a whole class of chemicals including several PCDDs and several PCDFs. Individual PCDDs and PCDFs share a common mechanism of toxicity, but the potencies for each are different. The potency of each congener is expressed relative to TCDD (the most toxic congener) as a TEF. Therefore, the TEF for TCDD itself is 1.0, and all other PCDDs and PCDFs have TEFs less than 1.0. TEFs for ecological receptors were available from the WHO (1996). The concentration of each PCDD and PCDF in a sediment, soil, or

tissue sample was multiplied by its TEF to be converted to a TEQ, and all TEQs in a sample were summed according to the WHO guidance document (1996). The WHO guidance document (1996) lists different sets of TEFs for mammals, birds, and fish, although some TEFs are the same for different species. Generally, higher taxonomic levels of vertebrates are more sensitive to dioxins than lower vertebrates. The TEFs used were based on the receptor (for example, for piscivorous birds, the TEQs in the fish prey were tabulated using TEFs for birds). Since the TEQs represent a concentration relative to TCDD, the TEQ concentration can be used in the dose models and compared directly to the TRVs for TCDD.

The maximum total PAH concentration of soil and sediment samples for a given site was calculated for both the CLP and the low detection limit SVOA concentration data available. PAHs that were not detected using CLP methods contributed significantly to total PAH concentrations when one-half the detection limit was used in summing the totals; this approach was considered unreasonably conservative. Therefore, total PAH concentrations data based on the low detection limit method data were used in the food-chain model (including using one-half the detection limit for nondetects), and the CLP data were not used. The daily doses of total PAHs were compared to the TRV for benzo(a)pyrene, considered the most toxic of the PAHs because TRVs are not available for PAHs as a class. Most of the individual PAHs have potencies much less than benzo(a)pyrene (ASTDR 1999). Because of the conservative nature of using the TRV for benzo(a)pyrene, using total PAHs from the low detection limit method of analysis provides an analysis considered adequately conservative.

15.2.2.2 Dose Parameters for the Salt Marsh Harvest Mouse

The salt marsh harvest mouse (*Reithrodontomys raviventris*) is an endangered species that has been recorded in the R Area and the western portion of the Wood Hogger (Ibis 1999 in Appendix O). Exposure to food and incidentally ingested soil are likely to be the major routes of exposure to chemicals for the salt marsh harvest mouse. The following parameters were used in estimating site-specific doses for the salt marsh harvest mouse:

- **Ingestion Rate$_{prey}$:** The high and low prey ingestion rates of 0.0035 and 0.0026 kg/day were calculated using high and low body weights from salt marsh harvest mice caught at NWS SBD Concord (Harvey and Associates 1996) in an equation for dry weight food intake for herbivorous mammals (Nagy 1987).

- **Prey Composition:** According to Zeiner and others (1990a), salt marsh harvest mice eat 100 percent vegetation, including seeds and plants. The diet composition for the salt marsh harvest mouse was assumed to be 100 percent pickleweed, and site-collected pickleweed tissue residue concentrations were used in the model. Incidental soil ingestion was also considered in the estimated daily dose, which follows.

- **Ingestion Rate$_{soil}$:** The salt marsh harvest mouse ingestion rate for soil was assumed to be similar to that of a meadow vole. The estimated soil ingestion rate for meadow voles studied by Beyer and others (1994) was 2.4 percent of the total prey ingestion rate. In the same study, the soil ingestion rate for white-footed mice was estimated at 2 percent. The higher rate of 2.4 percent of the prey ingestion rate was used to calculate the soil ingestion rates for the salt marsh harvest mouse; the low and high soil ingestion rates were, therefore, 0.000062 and 0.000084 kg/day, respectively.

- **Site Use Factor:** The SUF accounts for the size of the area of concern (contaminated area) in comparison to the home range of the receptor. If the investigation area is greater than the feeding range of the species, it is likely that the animal spends 100 percent of its feeding time in the site and would be assigned a SUF of 1.0. According to Golley and others (1975), the home range of harvest mice ranges from 0.16 to 0.26 hectares. For each investigation area, the high, low, and typical dose estimates were based on a SUF of 1.0 for the mouse.

- **Body Weight:** Realistic high and low body weights of 0.016 and 0.009 kilogram were obtained from salt marsh harvest mice trapping data from the Litigation Area at NWS SBD Concord (Harvey and Associates 1996); these values are actual weights of small and large adult salt marsh harvest mice.

15.2.2.3 Dose Estimates for the Gray Fox

Gray foxes (*Urocyon cinereoargenteus*) have been observed in the Tidal Area Landfill. They feed primarily on small mammals, but are also known to eat insects, birds, and vegetative matter. Exposure to food and incidentally ingested soil are likely to be the major routes of exposure to chemicals. The following parameters were used to estimate site-specific doses for the fox:

- **Ingestion Rate$_{prey}$:** The high, low, and average prey ingestion rates of 0.342, 0.167, 3.84 mg/kg were calculated using body weights from Storm and others (1976), as cited in EPA (1993) in an equation for dry weight daily intake for all eutherian mammals (Nagy 1987). High, low, and average body weights, as described below, were used to calculate the respective prey ingestion rates.

- **Prey Composition:** Gray foxes are opportunistic feeders, feeding primarily on small mammals but they also eat insects, fruits, acorns, birds, and eggs (Hockman and Chapman 1983; EPA 1993). In a study in western Maryland, gray foxes were found to have a higher proportion of plants (especially corn, persimmons, and wild grapes) in their diet than did red foxes (Hockman and Chapman 1983). These types of plants are not readily available in

the Tidal Area, and tissue data for birds and insects were not available, so the fox doses were calculated assuming a diet of 100 percent rodents and used the tissue residue concentrations from rodents collected in the R Area Disposal and Wood Hogger Sites.

- **Ingestion Rate$_{soil}$:** The incidental ingestion rate of soil by the gray fox was assumed to be similar to that of red foxes. Beyer and others (1994) estimated the soil ingestion rate for the red fox at 2.8 percent. This soil ingestion rate was multiplied by the ingestion rate for prey to obtain the low, high, and average soil ingestion rates of 0.0047, 0.00958, and 0.00582 kg/day, respectively.

- **Site Use Factor:** The SUF accounts for the size of the area of concern (contaminated area) in comparison to the feeding range of the receptor. If the investigation area is greater than the feeding range of the species, the animal likely spends 100 percent of its time in the site and would be assigned a SUF of 1.0. According to Ables (1969), as cited in EPA (1993), the mean home range of adult red foxes in Wisconsin was 717 hectares. An average home range of 1,990 hectares was found in western Maine forests and bogs (EPA 1993). The entire Tidal Area is approximately 2,752 hectares. A high and low SUF of 1 and 0.75, respectively, were used for the R Area Disposal Site. High and low SUFs of 0.75 and 0.5 were used for the Wood Hogger Area, which covers less than 100 hectares, and for the eight sampling locations along the perimeter of the Tidal Area Landfill.

- **Body Weight:** The high, low, and average body weights of 7.04, 2.95, and 3.84 kilograms were based on data on male and female adult red foxes from Storm and others (1976), as cited in EPA (1993).

15.2.2.4 Dose Estimates for the Northern Harrier

The Northern Harrier (*Circus cyaneus*) is a CDFG species of special concern but is not threatened or endangered. The Northern Harrier is a low-flying raptor that has been observed foraging in wetlands of the Tidal Area. Exposure to food and exposure to incidentally ingested soil are likely to be the major routes of exposure to chemicals. The following parameters were used in the food-chain model:

- **Ingestion Rate$_{prey}$:** The ingestion rate of prey for the Northern Harrier was calculated using body weight data from Storm and others (1976) in an equation from Nagy (1987) for all birds. The low, high, and average prey ingestion rates on a dry weight basis of 0.0264, 0.0415, and 0.0341 kg/day, respectively, were used in calculating low, high, and typical daily dose estimates.

- **Prey Composition:** Northern Harriers feed mostly on voles and other small mammals, birds, frogs, reptiles, and crustaceans (Brown and Amadon 1968). For this assessment, rodents were assumed to be the only food source for the Northern Harrier. According to Temeles (1989), harriers at a study site near Davis, California, attacked rodents almost exclusively (93 percent of 531 capture attempts). MacWhirter and Bildstein (1996) claim that the harrier preys on small- and medium-sized rodents and birds (chiefly passerines and small waterbirds), reptiles, and frogs in the summer and captures *Microtus* voles almost

exclusively in the winter. A study looking at pellet content in the northern part of the harrier range in winter found a diet of 84 to 93 percent of *Microtus* voles, 1 to 4 percent deer mouse (*Peromyscus musculus*) and house mouse (*Mus musculus*), 1 to 3 percent shrews, less than 5 percent rabbits, and 1 to 9 percent passerine birds (meadowlarks [*Sturnella* spp.], Northern Cardinal [*Cardinalis cardinalis*], and Song Sparrow [*Melospiza melodia*]) (Bildstein 1987). A small amount of insects, including beetles, grasshoppers, crickets, and locusts is taken during the breeding season, usually by recently fledged young (MacWhirter and Bildstein 1996). For the food-chain model, a diet of 100 percent rodents was assumed; the model used mouse tissue residue data collected from the sites.

- **Ingestion Rate$_{soil}$:** Harrier food consumption habits were assumed to be similar to those of bald eagles. The soil ingestion rate for the bald eagle (Pascoe and others 1996) was estimated at 0.70 percent of the prey ingestion rate. The low, high, and average soil ingestion rates of 0.000185, 0.000291, and 0.000239 kg/day were used in calculating low, high, typical daily dose estimates, respectively.

- **Site Use Factor:** The size of a Northern Harrier home range in the breeding season is 170 to 1,500 hectares, and the median home range from eight studies is 260 hectares (Smith and Murphy 1973; MacWhirter and Bildstein 1996). The Tidal Area is approximately 2,752 hectares; as a result, a SUF of 1 was used for this analysis.

- **Body Weight:** The Northern Harrier is strongly sexually dimorphic in color, pattern, and size; females are about 50 percent heavier and 12.5 percent larger than males (Palmer 1988; MacWhirter and Bildstein 1996). For spring migrant birds in Wisconsin, the mean body mass for an adult male was 370 grams (range 297 to 469 grams, n equals 29), while an adult female was 546 grams (range 466 to 752 grams, n equals 52). During breeding season, adult males average 336 grams (range 308 to 387 grams, n equals 57), and adult females average 513 grams (435 to 654 grams, n equals 24) (Bildstein 1988, as cited in MacWhirter and Bildstein 1996). To calculate exposure factors for the harrier, high, average, and low body weights of 0.595, 0.44, and 0.298 kilograms, respectively, were used (Hammerstrom and others 1985).

15.2.2.5 Dose Estimates for the Great Blue Heron

The Great Blue Heron (*Ardea herodias*) has been observed feeding in shallow or open waters in the Tidal Area. The Great Blue Heron is found in shallow estuaries and saline and freshwater marshes. The diet of the Great Blue Heron is diverse; however, its diet typically consists of about 75 percent fish (Cogswell and Christman 1977), while the remaining 25 percent consists of rodents, amphibians, reptiles, insects, crustaceans, and small birds (Zeiner and others 1990b). Exposure to food and incidentally ingested soil are likely to be the major routes of exposure to chemicals. The following parameters were used in the model:

- **Ingestion Rate$_{prey}$:** The ingestion rate for prey was calculated using body weights (Butler 1992) in an equation for dry weight daily food intake for all birds (Nagy 1987). The high, low, and average body weights of the Great Blue Heron yielded the high, low, and typical ingestion rates of 0.094, 0.105, and 0.0995 kg/day.

- **Prey Composition:** Palmer (1962) states that the diet of herons is composed of fish, small rodents (such as pocket gophers and field mice), frogs, lizards, and insects (such as grasshoppers). According to Zeiner and others (1988), the Great Blue Heron's diet is 75 percent fish, with small rodents, amphibians, insects, crustaceans, snakes, lizards, and birds also taken. For this assessment, fish were assumed to be the only food source for the heron based on prey availability in Otter Sluice; fish tissue concentrations from fish collected in Otter Sluice were used in the model.

- **Ingestion Rate$_{sediment}$:** Great Blue Heron aquatic food consumption habits were assumed to be similar to those of Mallards. The estimated sediment ingestion rate for the Mallards studied by Beyer and others (1994) was 3.3 percent. This proportion of sediment was multiplied by the ingestion rate to yield high, low, and typical sediment ingestion rates of 0.0031, 0.00345, and 0.00328 kg/day, respectively.

- **Site Use Factor:** The SUF was determined by dividing the estimated home range by the habitat area in the area of concern. According to Butler (1992), the size of defended foraging territories of Great Blue Herons in Oregon ranged from 0.6 hectares in a freshwater marsh to 8.4 hectares in an estuary. The Tidal Area is approximately 2,752 hectares; however, it is not used as a breeding area, and herons do not reside there year-round. A SUF of 0.75 was assumed for the low dose estimate, and 1.0 was assumed for the high and typical dose estimates.

- **Body Weight:** High (2.48 kilograms) and low (2.09 kilograms) body weights for Great Blue Herons were taken from data on male and female adults during nesting, postnesting, and winter from British Columbia and Oregon populations (Butler 1992). An average body weight of 2.295 kilograms was calculated for the typical dose.

15.2.2.6 Dose Estimates for the Black-Necked Stilt

The Black-necked Stilt (*Himantopus mexicanus*) is a year-long resident of the saline emergent wetlands and seasonally ponded wetlands of the Tidal Area. Stilts forage on insects, crustaceans, mollusks, other aquatic invertebrates, and some small fish (Zeiner and others 1990b). Exposure to food and incidentally ingested soil are likely to be the major routes of exposure to chemicals for the Black-necked Stilt. The following parameters were used in the model:

- **Ingestion Rate$_{prey}$:** Little information was available in the literature regarding food ingestion rates for Black-necked Stilts. Based on low, high, and typical body weights (0.124, 0.208, and 0.166 kilogram, respectively [Dunning 1993]) a low, high, and typical prey ingestion rate was calculated using the Nagy (1987) allometric equation for all birds;

this method resulted in low, high, and typical ingestion rates of 0.015, 0.021, and 0.018 kg/day, respectively.

- **Prey Composition:** Black-necked Stilts eat primarily brine shrimp and brine flies (Hamilton 1975). For this assessment, amphipods were assumed to be the only food source to the Black-necked Stilt based on occurrence of prey and availability of tissue data from the site.

- **Ingestion Rate$_{sediment}$:** Black-necked Stilts forage by pecking for invertebrates in the sediment or snatching flying insects in mid-flight. Sediment is ingested incidentally as a part of the peck method. A sediment ingestion rate of 17 percent of the prey ingestion rate was based on data of the Stilt Sandpiper (*Micropalama himantopus*) from Beyer and others (1994) because they have similar feeding habits and data were not available specifically for the Black-necked Stilt. The high, low, and typical sediment ingestion rates were 0.00357, 0.00255, and 0.0031 kg/day, respectively.

- **Site Use Factor:** Little information is available in the literature regarding the home range of the Black-necked Stilt. Black-necked Stilts have been observed foraging extensively in small areas of the site, such as the Froid and Taylor Aquatic areas. The high, low, and typical dose estimates for the Black-necked Stilt were based on a SUF of 1.0.

- **Body Weight:** Black-necked Stilts are sexually dimorphic; male stilts weigh approximately 1.1 times more than females. Males weigh about 177 grams, and females weigh about 160.31 grams, with an average body weight of 166 grams (Hamilton 1975). Little information was available in the literature regarding the range of Black-necked Stilt body weights; as a result, 25 percent of the average body weight of 166 grams was used to calculate a low and high body weight of 124 grams and 208 grams, respectively.

15.2.2.7 Dose Estimates for the California Black Rail

The California Black Rail (*Laterallus jamaicensis coturniculus*) is a state-listed threatened species present near Otter Sluice (Harvey and Associates 1998) (see Appendix O). The California Black Rail feeds on isopods and insects and other arthropods from the surface mud and vegetation (Zeiner and others 1990b). Exposure to food and incidentally ingested sediment are likely to be the major routes of exposure to chemicals. Only high and low doses were calculated for the rail because it has conservative status. The following parameters were used in the model:

- **Ingestion Rate$_{prey}$:** The ingestion rate for prey was calculated using body weights from Flores (1991) in an equation for dry weight daily food intake for all birds (Nagy 1987). The low and high body weights were used to calculate the range for high and low ingestion rates of 0.00463 and 0.00783 kg/day, respectively.

- **Prey Composition:** According to Ehrlich and others (1988), the California Black Rail diet is composed mostly of insects, some crustaceans, and seeds of aquatic vegetation. According to Eddleman and others (1994), California Black Rails are probably opportunistic foragers. Individuals collected in San Diego Bay, California, in 1912 had eaten exclusively the isopod crustacean *Alloniscus mirabilis* (Eddleman and others 1994). The composition of the diet of the California Black Rail used in the doses was assumed to be 100 percent clams based on the available tissue data and occurrence of prey in Otter Sluice in conjunction with information from the literature. Since clams are considered to bioaccumulate chemicals more than most other invertebrates, this diet assumption is adequately protective.

- **Ingestion Rate$_{sediment}$:** California Black Rail's food consumption habits are poorly known. The foraging habitat is presumed to be on or near substrate at edges of stands of emergent vegetation, both above and below high tide line (Eddleman and others 1994). According to Eddleman and others (1994), "the bill shape suggests generalized feeding methods such as gleaning or pecking at individual items." The California Black Rail's rate of incidental sediment ingestion was assumed to be similar to that of a sandpiper. The average sediment ingestion rate for the four species of sandpipers studied by Beyer and others (1994) was 18 percent of the prey ingestion rate. The low and high sediment ingestion rates were 0.00083 and 0.00141 kg/day.

- **Site Use Factor:** According to Eddleman and others (1994), home ranges of California Black Rails in Arizona ranged from 0.1 to 1.8 hectares. An SUF of 1 was assumed for both high and low dose estimates because individual rails likely forage almost exclusively in parts of the Tidal Area.

- **Body Weight:** High and low body weights for California Black Rails were taken from data on male and female adults during nesting, postnesting, and winter in Mittry Lake, Arizona (Eddleman and others 1994). For the model, the low body weight was 0.0205 kilogram, and the high body weight was 0.046 kilogram.

15.2.2.8 Dose Estimates for the River Otter

The river otter (*Lutra canadensis*) has been observed in Otter Sluice. It is a mobile predator of fish, crayfish, bivalves, and other prey in the Suisun Bay area. Exposure to food and exposure to incidentally ingested soil are likely to be the major routes of exposure to chemicals for the river otter. The following parameters were used in the model:

- **Ingestion Rate$_{prey}$:** For the otter, the high and low ingestion rates of prey of 0.465 and 0.247 kg/day were based on Nagy (1987) using an equation for dry weight daily food intake for all mammals and using body weights from EPA (1993). The typical prey ingestion rate of 0.356 kg/day was calculated as the average of the high and low prey ingestion rates.

- **Prey Composition:** The composition of prey in the river otter's diet includes a variety of fish, marine invertebrates, snails, insects, and birds (EPA 1993). For the food-chain model, the composition of prey was based on the occurrence of prey in the investigation area and the available tissue residue of fish and clams. The diet for the otter was assumed to be 50 percent fish and 50 percent clams.

- **Ingestion Rate$_{sediment}$:** Incidental sediment ingestion was also considered in the diet. River otter incidental sediment ingestion rates are assumed to be similar to those of mink. The sediment ingestion rate was 1 percent of the prey ingestion rate and yielding the high, low, and typical sediment ingestion rates of 0.00465, 0.00247, and 0.00356 kg/day.

- **Site Use Factor:** The SUF accounts for the size of the area of concern (contaminated area) in comparison to the feeding range of the receptor. If the investigation area is greater than the home range of the species, the animal likely spends 100 percent of its time in the site and would be assigned a SUF of 1.0. River otters have very large home ranges; the home range of otters in a coastal marsh in Texas ranged from 184 to 461 hectares (EPA 1993). A SUF of 0.5 was used for the high dose and typical dose estimates, while 0.25 was used for the low dose estimate.

- **Body Weight:** High, average, and low body weights of 10.42, 8.18, and 4.74 kilograms for the river otter were based on male and female adults from populations of river otters in Alabama and Georgia (EPA 1993).

15.3 EFFECTS ASSESSMENT: TOXICITY REFERENCE VALUES AND HAZARD QUOTIENT INTERPRETATION

Site-specific daily dose estimates were compared to high and low TRVs to estimate the potential adverse biological effects on each receptor. Based on this comparison, the risk to each assessment endpoint was characterized; this comparison was performed in a manner consistent with EPA's HQ methodology (EPA 1986), as follows:

$$HQ = \frac{Dose}{TRV} = \frac{(mg/kg/day)}{(mg/kg/day)}$$

where:

HQ = Hazard quotient (unitless)

Dose = Chemical-specific, receptor-specific, site-specific daily dose estimate (mg/kg/day)

TRV = Chemical-specific, receptor-specific toxicity reference value (mg/kg/day)

15.3.1 Toxicity Reference Values

The TRVs were derived from a working group consisting of the Navy, the Navy's contractor, and the Region IX BTAG, which included representatives of EPA, USFWS, NOAA, DTSC, RWQCB, and CDFG. The methods used for deriving the TRVs are described in the Navy CLEAN technical memorandum, "Development of Toxicity Reference Values for Conducting Ecological Risk Assessments at Naval Facilities in California" (EFA WEST 1998). Each TRV represents a critical exposure level from a toxicological study and is supported by a dataset of toxicological exposures and effects. A low TRV is a conservative value consistent with a chronic no effect level. A high TRV represents a mid-range of lowest observed adverse effect level (LOAEL) for a given chemical, where the endpoint of toxicity was ecologically relevant. TRVs were derived separately for birds and mammals using available toxicological literature.

The TRVs for TCDD are not in the technical memorandum by EFA WEST (1998) but are provided in Appendix S along with the basis for their selection. The TRVs for TCDD were derived from the EPA Great Lakes Water Quality Initiative for the protection of wildlife (EPA 1995). EPA provided a thorough review of the literature on birds and mammals to arrive at a TRV that was adopted as the low TRV for birds and mammals. The same body of data along with more recent papers were evaluated for the high TRVs for mammals and birds. All PCDDs and PCDFs were evaluated in the food-chain model in terms of TEQs based on their relative toxicity to TCDD and were compared to the TRV for TCDD (as described in Section 15.2.1).

TRVs were not available for PAHs as a class but were available for benzo(a)pyrene (considered the most toxic PAH) and naphthalene (a ubiquitous PAH) for mammals only. Only a qualitative analysis of the effects of PAHs on birds could be provided because insufficient information was available to derive a TRV (EFA WEST 1998). PAHs were evaluated as a class, rather than as individual PAHs; the modeled daily dose of total PAHs was compared to the TRV for benzo(a)pyrene as a conservative first step. The TRV for naphthalene was not used in this assessment. The use of benzo(a)pyrene to evaluate risk to all PAHs is a conservative approach, so the low detection limit method of PAH analysis was used to calculate the total PAH concentration. The higher detection limit method (CLP) greatly overestimates total PAHs (when summing with one-half the SQL for nondetects) because many individual PAHs were below detection limits.

General TRVs derived for mammals and birds must be converted to each site-specific receptor of concern. This extrapolation of data based on body scaling is called allometric conversion. The underlying assumption of allometric conversions is that physiological functions, such as metabolic rates, are a function of body size (Opresko and others 1993). Allometric conversions assume that smaller animals have higher metabolic rates and are typically able to detoxify or eliminate ingested chemicals more quickly than larger animals (Opresko and others 1993; Sample and others 1996). The allometric conversion equations by Sample and others (1998) were used to extrapolate doses according to methods described by Opresko and others (1993) and Sample and others (1996). The following allometric conversion equations were used for this food-chain analysis:

<u>For mammals</u> $TRV_{receptor} = TRV_{test\ organism}\ (\text{Body Weight}_{test\ organism} / \text{Body Weight}_{receptor})^{1/4}$

<u>For birds</u> $TRV_{receptor} = TRV_{test\ organism}\ (\text{Body Weight}_{test\ organism} / \text{Body Weight}_{receptor})^{1}$

TRVs for each chemical, allometrically converted for each of the representative receptors, are in a TRV technical memorandum (EFA WEST 1998).

15.3.2 Hazard Quotient Approach

Risk to representative receptors, including the river otter, salt marsh harvest mouse, gray fox, Great Blue Heron, California Black Rail, Black-necked Stilt, and Northern Harrier, was characterized by calculating a HQ using an area dose for each habitat unit and a literature-derived TRV (HQ is equal to dose divided by TRV). A low dose estimate was divided by a high TRV, and a high dose estimate was divided by a low TRV, resulting in two HQs for each chemical-receptor pair that span the range of possible risks identified by this method (EFA WEST 1998). As explained in EPA regulatory guidance (EPA 1989), the HQ approach indicates that receptors may be at risk if the HQ exceeds 1.0. Due to differences in the degree of conservatism in selection of TRVs for various chemicals and receptors, the resulting HQ values should not be compared between chemicals or receptors; instead they should be considered individually.

The use of low and high doses to calculate HQs ensures that the assessment of risk to vertebrates accounts for the influence of ecological variability. Age, sex, and seasonal fluctuations in morphology and behavior are sources of variability addressed in food-chain modeling by using a range of exposure factor parameters to estimate doses. This approach yields HQs that bracket a range of risk based on conservative assumptions and acknowledges the ecological variability reported in the literature.

The worst-case scenario is represented by the case in which the HQ_1 calculated using the lower dose and the high TRV (HQ_1 equal to low dose divided by high TRV) is greater than 1.0. In the worst-case scenario, the receptor is at significant and immediate risk from that chemical if all the assumptions of the model are correct. The high TRV represents the low to mid-range of doses that caused observable effects in laboratory animals.

The best-case scenario, represented by the situation in which the HQ_2 is calculated using the high dose and the low TRV (HQ_2 equal to high dose/low TRV) is less than or equal to 1.0, indicates no risk from exposure of that receptor to that chemical. High doses were conservatively estimated (assuming small adult size, high ingestion rates, and exposure to maximum contamination levels) and are likely to overestimate the risk, especially for individual animals that range throughout the site. Low TRVs represent a concentration at which no adverse effects were observed in laboratory animals.

When the HQ_2 is greater than 1.0, risk is not necessarily indicated since the dose is only above a no effects level; the risk analysis is then further refined by comparing the high dose to the high TRV, defined as an HQ_3 (HQ_3 equal to high dose/low TRV). An HQ_3 greater than 1.0 indicates that the conservative dose estimate exceeds the low to mid-range of doses that caused observable effects in laboratory animals. This indicates probable risk to the receptor.

The HQ_2 and HQ_3 compare the high dose to the low and high TRV, respectively. However, the high and low doses may not reflect the average individual in the population. As a result, when the HQ_2 or HQ_3 is greater than 1.0, calculation of a dose is recommended for a receptor that has average exposure parameters such as body weight and ingestion rate. In such cases, an HQ_4 (typical dose/low TRV) and HQ_5 (typical dose/high TRV) can be calculated to assess more definitively risk to the typical individual within the population. Thus the HQ_4 and HQ_5 better define the "gray area" when the high dose indicates potential or probable risk based on conservative assumptions, but the risk to the typical receptor is not known. These typical doses were not calculated for threatened and endangered species because they were not considered sufficiently protective.

The interpretation of each HQ is summarized in the following table below and on Figure 5-4.

SUMMARY OF HAZARD QUOTIENT INTERPRETATION

HQ = Dose/TRV	Low TRV	High TRV
Low Dose	Not applicable	$HQ_1 > 1$ indicates significant and immediate risk
High Dose	$HQ_2 < 1$ indicates little or no risk	$HQ_3 > 1$ indicates probable risk
Typical Dose	$HQ_4 < 1$ indicates little or no risk to typical receptor $HQ_4 > 1$ indicates potential risk to typical receptor	$HQ_5 > 1$ indicates significant and immediate risk to typical receptor HQs < 1 indicates probable risk

Notes:

HQ Hazard quotient
TRV Toxicity reference value

15.3.3 Chemicals Evaluated Qualitatively

HQs could not be calculated if there was no TRV. In cases in which TRVs were unavailable, a dose was calculated for each chemical, and the dose was compared to literature-reported doses associated with effect and/or no-effect levels for any endpoints that were tested. The salt marsh harvest mouse is an endangered species and most toxicological information was based on rodents. The salt marsh harvest mouse was selected for evaluating those chemicals about which limited information was available. Tissue residue data of house mice from the Tidal Area were used as a surrogate for the salt marsh harvest mouse and were evaluated for bioaccumulation of these other chemicals. Studies on chemical effects on rodents were more readily available than for other organisms such as birds, and they are more relevant to the salt marsh harvest mouse than other representative receptors. The primary literature source was from ATSDR profiles of each chemical. Best professional judgment was used in interpreting the literature data when information on a chemical was limited. Uncertainty associated with this approach is discussed in Section 16.0.

15.4 RISK CHARACTERIZATION

The results of the food-chain modeling and HQ approach to evaluating risk to birds and mammals in the Tidal Area are presented in this section along with a qualitative interpretation of exposure to the chemicals for which TRVs were not available. The complete dose calculations are provided in Appendix T. Summaries of the results are presented as embedded tables throughout this section.

Food-chain modeling was done on every chemical that was considered a COPEC requiring further evaluation (see Section 6.0 for COPEC identification) for each site unit. TRVs were available for both birds and mammals for the following chemicals: arsenic, cadmium, cobalt, copper, lead, manganese, mercury, nickel, selenium, zinc, aldrin, PCBs, DDT, and DDE. For mammals only, TRVs were also available for lindane, heptachlor, methoxychlor, and PAHs. COPECs for which no TRVs were available included aluminum, antimony, barium, beryllium, molybdenum, mirex, trans-nonachlor, hexachlorobenzene, heptachlor epoxide, BHCs, phenol, 2-butanone, dieldrin, and chloromethane.

All HQ_1s (low dose/high TRV) and HQ_5s (typical dose/high TRV) were less than 1.0, indicating that there is no immediate or significant risk to any individual or typical receptor from the chemicals in any of the Tidal Area sites. In addition, no HQ_3s (high dose/high TRV) were greater than 1.0, indicating that no conservative high dose exceeds the effect level selected for the high TRV; therefore, risk is not probable under the assumption. For some chemical-receptor pairs, HQ_2 (high dose/low TRV) and HQ_4 (typical dose/low TRV) exceeded 1, indicating potential risk; these results are discussed below. The interpretation of these overall results in a risk-management context discussed in Section 16.0 using a weight-of-evidence approach.

15.4.1 Potential Risks to Representative Receptors from Chemical Exposures in the Landfill Terrestrial Unit

The Landfill Terrestrial unit is the perimeter of the landfill in the vicinity of the R Area Disposal Site (see Section 1.0). Eight sample locations were selected on the perimeter of the landfill in order to evaluate the risk that contaminants bordering the landfill may migrate into the R Area Disposal Site. All organic chemicals detected in the Landfill Terrestrial unit and all inorganic COPECs requiring further evaluation (see Section 6.0) were evaluated by food-chain modeling. Tables 6-1 and 6-2 show the values that exceeded screening values. COPECs for which no TRVs were available included aluminum, antimony, beryllium, mirex, trans-nonachlor, hexachlorobenzene, heptachlor epoxide, BHCs, phenol, 2-butanone, dieldrin, and chloromethane.

Point doses were calculated for each of the eight sample locations in the Landfill Terrestrial unit for representative receptors, specifically the salt marsh harvest mouse, gray fox, and Northern Harrier. The point doses were calculated using the concentrations of chemicals in soil at each sample location coupled with the maximum prey tissue concentrations of chemicals from prey collected in the R Area Terrestrial unit. Prey tissue included rodent and pickleweed were collected in the R Area Disposal Site

but not at the eight Landfill Terrestrial unit sample locations. The daily dose estimates of each chemical at each soil sample location were compared to low and high TRVs. These data are presented in their entirety in Appendix T, and only those indicating risk (HQ greater than 1.0) are presented in the following table. The only HQs that exceeded 1.0 at the Landfill Terrestrial unit were HQ_2s and HQ_4s for copper, lead, nickel, and zinc. A discussion of the results for each representative receptor follows the table, which presents the HQ results for risk to receptors in the Landfill Terrestrial unit.

RISK TO RECEPTORS IN THE LANDFILL TERRESTRIAL UNIT

Analyte[a]	Sample Location[b]	Potential Risk? ($HQ_2 > 1$)[c]	HQ_2 Tidal Area Ambient[d]	Potential Risk To Typical Receptor? ($HQ_4 > 1$)[e]	HQ_4 Tidal Area Ambient[f]
Salt Marsh Harvest Mouse					
Lead	TLSSB007	503.48	185.44	N/A[g]	N/A
Nickel	TLSSB002	4.46	2.43	N/A	N/A
Northern Harrier					
Lead	TLSSB007	106.48	23.19	44.18	12.82
Gray Fox					
Copper	TLSSB007	1.09	< 1.0	< 1.0	< 1.0
Lead	TLSSB007	691.84	330.54	396.29	189.41
Nickel	TLSSB002	5.89	4.36	3.37	2.50
Zinc	TLSSB002	1.99	< 1.0	1.14	< 1.0
Zinc	TLSSB005	1.60	< 1.0	< 1.0	< 1.0

Notes:

HQ Hazard quotient

TRV Toxicity reference value

a All HQ_1s (low dose/high TRV), HQ_3s (high dose/high TRV), and HQ_5s (typical dose/high TRV) were below 1.0, indicating no significant or immediate risk. Only HQ_2 and HQ_4 greater than 1.0 are presented.

b Point doses were calculated, rather than an area dose; the highest point dose is shown.

c HQ_2 is equal to high dose/low TRV.

d Ambient dose is (sediment only)/low TRV.

e HQ_4 is equal to typical dose/low TRV.

f Ambient refers to the 99th percent UCL Tidal Area ambient value.

g N/A, not applicable, signifies that HQ_4 was not evaluated for special status species.

15.4.1.1 Risk to the Salt Marsh Harvest Mouse at the Landfill Terrestrial Unit

Risk to the salt marsh harvest mouse, which resides in the R Area Disposal Site, from possible migration of chemicals from the Landfill Terrestrial unit was evaluated. All HQ_1, HQ_3, and HQ_5 values were less than 1.0. A potential risk (HQ_2 greater than 1.0) was posed to the salt marsh harvest mouse from exposure to lead and nickel at concentrations found in the Landfill Terrestrial unit. There was little or no risk from exposure to organic chemicals in the Landfill Terrestrial unit (HQ_2 less than 1.0). As an endangered, federally protected species, the risk to the typical salt marsh harvest mouse was not determined because it is not considered to be protective. A discussion of the risk to the salt marsh harvest mouse from each chemical follows.

Lead

A potential risk (HQ_2 greater than 1.0) was posed to the salt marsh harvest mouse from lead according to the model. Only one location (TLSSB007) of eight surface soil samples in the Landfill Terrestrial unit had a concentration of lead greater than the ambient concentration. The concentration of this sample was 1.6 times the 99th percent UCL ambient concentration for the Tidal Area and therefore not significantly elevated. Most (96 percent) of the modeled dose of lead was from incidental ingestion of soil, rather than from ingestion of prey because prey tissue concentrations were low. The model assumes a bioavailability of 100 percent of the ingested dose of lead from soil, which is a conservative approach. The TRV for lead was based on a laboratory study that used lead acetate. Lead in soil is expected to be 10 to 20 percent as bioavailable as lead acetate (O'Flaherty 1998). As a result, the model is conservative and indicates a potential risk even at ambient concentrations.

Lead accumulates primarily in bone tissues; the accumulation of lead can affect bone formation and growth, but also affects hemesynthesis and blood pressure, causes neurological and reproductive effects, and has effects on liver cells that may lead to hepatic carcinomas. The high daily dose estimate (1.51 mg/kg/day) of ingested lead to the salt marsh harvest mouse using the maximum soil concentration of lead (location TLSSB007) exceeded the low TRV for lead, which was based on a NOEL for reproductive effects in white rats (Krasovskii and others 1979) and exceeded a dose that was associated with a low-effect level for reproductive endpoints in the same study. It did not exceed the high TRV that was associated with a mid-level effect in the same study. The high daily dose estimate was well below effect levels in mice for the reproductive endpoints of number of litters, number of

pups per litter, number of live pups per litter, and decrease in body weight (Morrissey and others 1989; Rasile 1995). Lead at the Landfill Perimeter Terrestrial unit is not considered a significant risk.

Nickel

Nickel was generally only just above ambient at the Landfill Perimeter unit. Only one of eight sample locations (sample location TLSSB002) had a nickel concentration high enough to indicate risk above ambient concentrations; the HQ_2 for this location exceeded 1.0. Most (83 percent) of the modeled dose of nickel was from incidental ingestion of soil. The model assumed that nickel in soil was 100 percent bioavailable. If bioavailability were to be taken into account, there probably would be little or no risk to the salt marsh harvest mouse at any sample location. The high daily dose estimate of nickel was 4.5 times the low TRV, which was based on a no-effect-level equivalent for reproductive effects. Since the study upon which the TRV was based used nickel chloride dissolved in water, the source of nickel was much more bioavailable than sources of nickel expected in soil. Given that the model used in the HQ_2 is conservative and that nickel is not significantly elevated, nickel is not of high concern for the mouse.

Other COPECs (with no TRVs)

COPECs for which no TRVs were available included aluminum, antimony, beryllium, mirex, trans-nonachlor, hexachlorobenzene, BHCs, phenol, 2-butanone, dieldrin, and chloromethane. The modeled daily dose estimates to the salt marsh harvest mouse of the following COPECs were far below chronic oral doses known to cause effects in laboratory rodents according to ATSDR toxicological profiles for 2-butanone, hexachlorobenzene, mirex, and dieldrin. Insufficient information was available for trans-nonachlor, BHCs, and chloromethane.

The maximum concentration of aluminum (27,400 mg/kg in one sample) was only slightly above the Tidal Area ambient (99th percent UCL) concentration (27,300 mg/kg). The modeled dose of aluminum to the salt marsh harvest mouse is 261 mg/kg/day. While a TRV has not been derived for aluminum, some data are available on aluminum toxicity. An oral dose of greater than 100 mg/kg/day could cause reproductive and neurological effects in rodents fed aluminum (Sparling and Lowe 1996). According to the ATSDR profile for aluminum (1995a), the lowest chronic oral dose of aluminum associated with effects was 14 mg/kg/day, which caused decreased fetal weight in rats. Laboratory studies, however, use soluble forms of aluminum that do not necessarily represent the same

bioavailability of aluminum in soil, so the food-chain modeled dose is expected to be very conservative. Most of the aluminum in the soil is not expected to be soluble or readily extractable upon ingestion (see Section 9.0). The oral dose from the maximum soil concentration of aluminum in the Landfill Terrestrial unit was only 1.2 times the ambient dose, indicating that site activities did not contribute significantly to the apparent risk.

The concentration of antimony in two samples (2.5 mg/kg at TLSSB006 and 3.1 mg/kg at TLSSB007) was slightly above the Tidal Area ambient (99th percent UCL) concentration (2.2 mg/kg); both locations were also slightly above the ER-L (2.0 mg/kg) but were below the ER-M (25 mg/kg). The high daily dose estimate of antimony at the sample location with the highest soil concentration was 0.033 mg/kg/day. This is below an acute dose equivalent (100 mg/kg/day) of antimony that caused heart damage in a rat (ATSDR 1995b). There were few studies available on antimony, however, and none with chronic doses.

The major toxicological effects of beryllium occur when the compound is inhaled from the air and beryllium is then deposited in the lungs of mammals (Amdur 1991). Exposure assessments were not done for inhalation routes, so the risk posed to the salt marsh harvest mouse from inhalation of beryllium in site soils is not known. The concentration of beryllium in two samples (0.51 mg/kg at TLSSB003 and 0.56 mg/kg at TLSSB004) was above the Tidal Area ambient (99th percent UCL) concentration (0.18 mg/kg). ER-Ls and ER-Ms were not available for beryllium.

Organic chemicals for which there were no TRVs were detected in trace amounts in soils of the Landfill Terrestrial unit. Based on the modeled doses, they would not be expected to pose a risk to the salt marsh harvest mouse. The modeled high daily dose of phenol (0.18 mg/kg/day) to the salt marsh harvest mouse was significantly below a reported reproductive effect in rats from a subchronic exposure (about 260 mg/kg/day dose equivalent) of phenol (ATSDR 1989). There were no soil screening values for phenol.

15.4.1.2 Risk to the Northern Harrier at the Landfill Terrestrial Unit

Food-chain models indicated a potential risk (HQ_2 and HQ_4 greater than 1.0) to the Northern Harrier from exposure to lead in the Landfill Terrestrial unit. There was little or no risk from exposure to organic chemicals or other metals (HQ_2 less than 1.0). Lead was above the Tidal Area ambient value (99th percent UCL) in only one of eight samples (sample location TLSSB007) in the Landfill

Terrestrial unit. Although a potential risk is posed to the harrier from lead in the Landfill Terrestrial unit, a potential risk is also posed to the harrier from Tidal Area ambient concentrations of lead because the ambient HQ_2 equals 23 and the HQ_4 equals 13. The low TRV for lead is a very conservative benchmark. The high modeled daily dose is equivalent to a low-effect level for decreased egg production in Japanese quail (Edens and others 1976), but lower than an equivalent dose that caused decreased egg production in chickens (Edens and Garlich 1983). The difference between studies could be due either to the nature under which the study was conducted or differences in species' sensitivity to lead (beyond metabolic differences which are taken into account with the allometric scaling). In the study with chickens, the chickens were allowed to depurate some of the lead before egg production, indicating that the dose at time of egg production may have been lower than suggested by the oral dose. The maximum modeled dose of lead was below an effect level of decreased hemoglobin levels and adrenal and testes weight (Morgan and others 1975). Low concentrations of lead have been associated with neurological and neuromuscular effects, effects on the immune system, and effects on kidneys (ATSDR 1995d). Lead accumulates in bone tissues and at high concentrations may affect bone formation and strength. While there is a potential risk of reproductive effects in the harrier from exposure to lead from the Landfill Terrestrial unit, ambient concentrations of lead also pose a potential risk to the harrier for reproductive effects. Lead is not significantly elevated at this site and is not considered a significant risk.

15.4.1.3 Risk to the Gray Fox at the Landfill Perimeter Terrestrial Unit

Food-chain models indicate there was no immediate or significant risk (HQ_1 and HQ_5 were less than 1.0) or probable risk (HQ_3 were less than 1.0) to the gray fox. Copper, lead, nickel, and zinc had HQ_2s greater than 1.0. The HQ_4 for copper was less than 1.0. A discussion of the risk to the fox from each chemical follows.

Copper

For the Landfill Terrestrial unit, the modeled results indicated a potential (HQ_2 greater than 1.0) risk from copper to the fox using the conservative high dose, but little or no risk (HQ_4 less than 1.0) to the typical gray fox. Copper was above ambient in three of eight surface soil samples bordering the landfill, but risk was indicated for only one soil sample. About 75 percent of the modeled dose of copper was from incidental ingestion of soil. The bioavailability of copper in soil was assumed to be

100 percent, which is conservative. The HQ_2 for copper was just above 1.0 at 1.09, and the model is conservative, so copper is not expected to be of concern to the gray fox.

Lead

The modeled results indicated potential risk to the fox in the Landfill Terrestrial unit when both conservative (HQ_2 greater than 1.0) and average (HQ_4 greater than 1.0) life history parameters were used in the daily dose model. However, lead also poses a potential risk to receptors at ambient concentrations because the ambient HQs were above 1.0 (ambient HQ_2 equals 331 and ambient HQ_4 equals 189). About 80 percent of the modeled dose of lead was from incidental ingestion of soil, with an assumption of bioavailability of 100 percent. The TRV for lead was based on a laboratory study that used lead acetate. Lead in soil is expected to be 10 to 20 percent as bioavailable as lead acetate (O'Flaherty 1998). The model is therefore conservative but would indicate a potential risk even if bioavailability were considered to be only 10 percent of the total lead present. Lead was elevated above ambient in one of eight samples indicating that an incremental risk posed by site activities. The lead concentration in this sample (156 mg/kg), however, was within the range of lead concentrations found in soil in the R Area Disposal Site, indicating that animals in this site are not at elevated risk from lead from the perimeter of the landfill.

The maximum modeled dose to the fox from lead at the Landfill Terrestrial unit is associated with possible reproductive effects in an equivalent dose in rodents in a study by Krasovskii and others (1979). The allometric conversion of the TRV from a rodent-equivalent dose to a fox-equivalent dose takes into account metabolic differences between species, but additional reasons may account for differential species sensitivity to a chemical (further discussed in the uncertainty analysis in Section 16.0). As a result, it is useful to evaluate the modeled dose of the fox with studies of other species of animals. The high modeled dose of lead to the fox was below an equivalent NOEL for endpoints of plasma levels, hematopoietic effects, and bone growth in beagle dogs fed lead acetate for 13 weeks (Delaquerriere-Richardson and others 1982). The high daily dose estimate was also below a NOEL for decreased body weight in dogs and below a NOEL for neurological effects in rabbits.

Nickel

Nickel poses a potential risk to the fox in the Landfill Terrestrial unit when either a high or typical dose was evaluated (HQ_2 equals 5.89 and HQ_4 equals 3.37). However, ambient concentrations of nickel also

pose a potential risk because the ambient HQ_2 equals 4.36 and HQ_4 equals 2.5. Nickel was above the ambient value in only one of eight soil samples collected from the perimeter of the landfill site. The risk from the maximum soil concentration of nickel did not add much incremental risk above the ambient value. The nickel concentration in this sample (131 mg/kg) is within the range of nickel concentrations found in soil sampled in the R Area Disposal Site. This suggests that an incremental risk would not be posed to animals in the R Area Disposal Site from nickel in the Landfill Terrestrial unit.

The TRV for nickel was based on a study using nickel chloride, a highly bioavailable form of nickel. Therefore, the estimate of risk was conservative. The high daily dose estimate of nickel was below an equivalent dose that caused reproductive effects in rats in a study by Smith and others (1993). The TRV was derived by applying an uncertainty factor to create a no-effect-level equivalent from the dose that caused the reproductive effects in rats. Therefore, the modeled dose of nickel to the fox was above this extrapolated no-effect-level and below the effect-level for reproductive effects in rats.

Zinc

A potential risk to the typical fox (HQ_4 greater than 1.0) was indicated from one sample location only. HQ_2s for zinc were slightly greater than 1.0 at two of eight sample locations in the Landfill Terrestrial unit, indicating a potential risk to the gray fox. The HQ_2s and HQ_4s for these sample locations were not much greater than 1.0 (see the risk to receptors table shown previously). The low TRV was a no-effect-level equivalent derived by applying an uncertainty factor of 10 to an effect level of cellular changes in the pancreas and adrenal cortex of rats (Gasaway and Buss 1972). The modeled dose of zinc to the fox was greater than this no-effect-level equivalent, but lower than the level that produced effects. The zinc HQ_2 was based on conservative assumptions and only slightly exceeded the low TRV, so zinc is not considered to be of high concern.

15.4.1.4 Summary of Risk to Birds and Mammals in the Landfill Terrestrial Unit

There was no immediate or significant risk (HQ_1 less than 1.0 and HQ_5 less than 1.0), or probable risk (HQ_3 less than 1.0), to the salt marsh harvest mouse, gray fox, or Northern Harrier from any chemical in soil bordering the landfill site. There was an indication of potential risk (HQ_2 greater than 1.0) to the salt marsh harvest mouse from nickel and lead. Also, there was a potential risk (HQ_4 greater

than 1.0) to the typical Northern Harrier from lead and to the typical gray fox from lead, nickel, and zinc.

The soil concentrations of copper, lead, nickel, and zinc in the Landfill Terrestrial unit were within the range of concentrations detected in the R Area Disposal Site indicating that migration of contaminants from the Landfill Terrestrial unit into the adjacent R Area Disposal Site would not pose additional risk to receptors in the R Area Disposal Site (a description of risk to R Area Disposal Site receptors follows).

Only one of eight soil samples bordering the landfill had a concentration of lead greater than ambient (greater than 95 mg/kg). Nickel was above ambient in only one of eight soil samples collected on the perimeter of the landfill site. Two of eight soil samples on the border of the landfill site had zinc concentrations above ambient, and three of eight soil samples had soil concentrations of copper above ambient. These concentrations were not high and significant risks to these receptors is not indicated.

Organic chemicals were detected in low concentrations that were not expected to pose risk (all HQs less than 1) at the Landfill Terrestrial unit.

15.4.2 Potential Risks to Representative Receptors from Chemical Exposures in the R Area Terrestrial Unit

In the R Area Terrestrial unit, COPECs for which TRVs were available included arsenic, cobalt, copper, lead, manganese, mercury, nickel, selenium, zinc, DDT, DDE, lindane and heptachlor (mammals only), and PAHs (mammals only). COPECs for which no TRVs were available included aluminum, antimony, barium, beryllium, mirex, trans-nonachlor, hexachlorobenzene, heptachlor epoxide, BHCs, phenol, 2-butanone, dieldrin, and chloromethane.

Representative receptors for the R Area Terrestrial unit were the salt marsh harvest mouse, gray fox, and Northern Harrier. Area doses were calculated using the maximum soil and prey concentrations in the R Area Disposal Site. Site-specific prey tissue included rodent and pickleweed. The daily dose estimates of each chemical at each soil sample location were compared to low and high TRVs. These data are presented in their entirety in Appendix T; those indicating risk (HQ greater than 1.0), are presented in the following table.

No immediate or significant risk was posed to any receptor (HQ_1, HQ_3, and HQ_5 less than 1.0). A potential risk (HQ_2 greater than 1.0) was posed to the salt marsh harvest mouse from lead, manganese, and nickel. Also, a potential risk (HQ_2 and HQ_4 greater than 1.0) to the gray fox was indicated from lead, manganese, nickel, selenium, and zinc and to the harrier from exposure to lead. A discussion of the risk to each representative receptor follows.

RISK TO RECEPTORS IN R AREA TERRESTRIAL UNIT

Analyte[a]	Sample Location[b]	Potential Risk? ($HQ_2 > 1$)[c]	HQ_2 Tidal Area Ambient[d]	Potential Risk To Typical Receptor? ($HQ_4 > 1$)[e]	HQ_4 Tidal Area Ambient[f]
Salt Marsh Harvest Mouse					
Lead	RADSBG08	3627.04	295.56	N/A	N/A
Manganese	RADSBI08	3.53	3.53	N/A	N/A
Nickel	RADSBH06	8.04	3.88	N/A	N/A
Gray Fox					
Lead	RADSBG08	5580.24	440.73	3197.36	252.54
Manganese	RADSBI08	4.91	1.15	< 1.0	< 1.0
Nickel	RADSBH06	13.24	5.82	7.58	3.33
Selenium	RADSBG08	3.35	< 1.0	1.92	< 1.0
Zinc	RADSB017	2.38	< 1.0	1.37	< 1.0
Northern Harrier					
Lead	RADSBG08	433.29	30.92	239.52	17.09

Notes:

HQ Hazard quotient

TRV Toxicity reference value

a All HQ_1s (low dose/high TRV), HQ_3s (high dose/high TRV), and HQ_5s (typical dose/high TRV) were below 1.0, indicating no significant or immediate risk. Only HQ_2 and HQ_4 greater than 1.0 are presented.

b Point doses were calculated rather than an area dose; the highest point dose is shown.

c HQ_2 is equal to high dose/low TRV.

d Ambient dose is (sediment only)/low TRV.

e HQ_4 is equal to typical dose/low TRV.

f Ambient refers to the 99th percent UCL Tidal Area ambient value.

g N/A, not applicable, signifies that HQ_4 was not evaluated for special status species.

15.4.2.1 Risk to the Salt Marsh Harvest Mouse at the R Area Terrestrial Unit

Results from the food-chain model indicated a potential risk (HQ_2 greater than 1.0) to the salt marsh harvest mouse from exposure to lead, manganese, and nickel. Little or no risk was posed from exposure to organic chemicals in the R Area Disposal Site (HQ_2 less than 1.0). As an endangered, federally protected species, the risk to the typical receptor was not determined because it is not considered to be adequately protective. A discussion of the risk to the salt marsh harvest mouse from each chemical follows.

Lead

The HQ_2 for lead (3,627) based on the maximum concentration in soil (1,160 mg/kg) for the salt marsh harvest mouse was very high, even compared to the ambient HQ_2 (296). When the 95th percent UCL was used in the dose estimate instead of the maximum soil concentration, the HQ_2 was lower (277) than the ambient HQ_2, indicating that the risk is not widespread but is limited to locations with maximum concentrations. Lead was above the ambient value in 18 of 94 surface soil samples, but the 95th percent UCL (83 mg/kg) was below the Tidal Area ambient concentration of lead (95 mg/kg). Soil samples significantly elevated above ambient concentrations can be considered to contribute incremental risk to receptors from site activities. Based on a comparison of the ambient HQ_2 and the HQ_2 using the 95th percent UCL of lead, most locations do not show incremental risk above ambient conditions. The maximum soil concentration (1,160 mg/kg) of lead in the R Area Terrestrial unit was located on the south end near Froid Road.

The contribution of lead in the dose to the salt marsh harvest mouse from prey tissue (pickleweed) was negligible. The modeled dose of lead comes almost exclusively from incidental soil ingestion when the mice ingest soil while feeding or grooming. The risk may be overstated since the model assumes 100 percent bioavailability and the TRV was based on a study using lead acetate, a highly bioavailable form of lead. However, even if bioavailability were taken into account, a potential risk would be posed to the salt marsh harvest mouse. The modeled dose using either the maximum soil concentration or 95th percent UCL is equivalent to a dose which is associated with increased prostate weight and possible reproductive effects (Hilderbrand and others 1973, Krasovskii and others 1979). The dose, however, is below NOELs of other studies with reproductive and behavioral endpoints. The low TRV for lead was selected from the study with the lowest no-effect level, in order to be conservative. The

high modeled dose is therefore above a no-effect level, but below the mid-range of effects for ecologically relevant endpoints.

Tissue residues of lead in house mice collected from the R Area Disposal Site were not high (see Table 8-5b), ranging from 0.25 to 1.2 mg/kg; the lower range of background concentrations of lead in rodents from uncontaminated sites is 1 mg/kg or lower (Beyer 1996). Lead toxicity, including reproductive effects in mammals, is not noted below a tissue level of 5 mg/kg of dry weight in liver or 10 mg/kg in kidneys (Beyer 1996). While body burdens may differ slightly between the house mouse and salt marsh harvest mouse, the tissue residue data are probably the best indicator of the bioavailability of lead in the ecosystem and best piece of evidence in predicting exposure to the salt marsh harvest mouse. Based on the evidence of low body burdens of lead in house mice collected in the R Area Disposal Site, little or no risk would be posed to the salt marsh harvest mouse from lead at this site.

Manganese

A potential risk (HQ_2 equal to 3.53) is posed to the salt marsh harvest mouse from exposure to manganese in the R Area Terrestrial unit when the maximum soil concentration is used in the dose model. The manganese concentration was elevated (6,300 mg/kg) in one soil sample (sample location RADSBI08); that concentration is 4.2 times the 99th percent UCL Tidal Area ambient value.

Nickel

A potential risk (HQ_2 equal to 8.04) was posed to the salt marsh harvest mouse from exposure to nickel in the R Area Terrestrial unit. Four of 94 soil samples in the R Area Disposal Site had nickel concentrations above the 99th percent UCL Tidal Area ambient value. Only one sample location was identified as an outlier and may be indicative of an isolated release.

Only about 3 percent of the modeled dose was from pickleweed with 97 percent coming from incidental soil ingestion. When using the 95th percent UCL, instead of the maximum soil concentration, a risk is still posed to the salt marsh harvest mouse (HQ_2 equal to 2.64); however, this risk is lower than the risk predicted from ambient conditions (ambient HQ_2 of 3.88). As a result, even ambient levels of nickel pose a potential risk to the salt marsh harvest mouse under the assumptions of the model. If bioavailability were taken into account, little or no actual risk may be posed to the salt marsh harvest

mouse. The bioavailability of nickel in soil is expected to be low when compared to other metals on the basis of a study by Hamel and others (1998) who measured bioaccessibility of metals in soil by extracting soil with synthetic gastric juices. House mice collected from the R Area Terrestrial unit did not bioaccumulate nickel to the level of other metals (of metals detected in tissues, nickel concentrations were the lowest) (see Table 8-5B). The potential effects of these concentrations of nickel, in terms of potential effects, are unknown because insufficient information is available on nickel effect based on body burdens.

Other COPECs (with no TRVs)

The concentrations of the organic COPECs with no TRVs, specifically mirex, trans-nonachlor, hexachlorobenzene, heptachlor epoxide, BHCs, phenol, 2-butanone, dieldrin, and chloromethane, are very low. Based on the modeled doses, they would not be expected to pose a risk to the salt marsh harvest mouse. Of these, only BHCs were detected in tissues of house mice collected from the R Area.

Inorganic chemicals for which TRVs were unavailable included aluminum, antimony, barium, and beryllium. The modeled dose of aluminum to the salt marsh harvest mouse is 320 mg/kg/day. Sparling and Lowe (1996) associate this dose with possible reproductive effects (for example, greater than 100 mg/kg/day) if the assumptions of the model are correct; however, the model's assumption of 100 percent aluminum bioavailability is probably greatly overestimated. Table 8-5B shows aluminum concentrations of 17 to 46 mg/kg in tissues of house mice collected from the R Area Terrestrial unit. Sparling and Lowe (1996) reported laboratory rats had background levels of aluminum of 8.6 mg/kg in their kidneys and 702 mg/kg in femurs as compared to treated rats fed 2,835 mg/kg/day for 30 days that had 9 mg/kg aluminum in their kidneys and 1,349 mg/kg in femurs. Whole body burden data of background concentrations were not available but should be between the concentrations for kidneys and femurs (for example, 8.6 to 702 mg/kg). According to these data, the house mice from the R Area Terrestrial unit do not appear to have elevated body burdens of aluminum. Furthermore, the maximum soil concentration of aluminum in the R Area Terrestrial unit is only 1.2 times the Tidal Area ambient soil concentration (site and ambient HQs were not calculated because there is no TRV for aluminum).

Antimony, barium, and beryllium concentrations in soil of the R Area Terrestrial unit sometimes exceeded ambient concentrations; however, not enough is known about the toxicology of antimony to make an assessment. Antimony was not detected in house mice collected from the R Area Terrestrial

unit. The major toxicological effects of beryllium occur when the compound is inhaled from the air and beryllium is then deposited in the lungs of mammals (Amdur 1991). Exposure assessments were not done for inhalation routes, so the risk posed to the salt marsh harvest mouse from inhalation of beryllium in site soils is not known. The maximum soil concentration of beryllium (0.57 mg/kg) was not sufficiently elevated above the 99th percent UCL Tidal Area ambient value (0.18 mg/kg) to be a concern.

Barium was detected at 2 to 4 mg/kg in house mice collected in the R Area. Effects associated with these concentrations are not known. Barium is naturally present in animal tissue and may be an essential element in trace amounts. Rats exposed to barium concentrations in their diet showed toxic responses. In both acute and chronic oral exposure scenarios increased blood pressure was observed in exposed rat populations (ATSDR 1990). In other acute exposure studies gastrointestinal effects and respiratory weakness were observed in the exposed populations (ATSDR 1990). Ovary weight and ovary/brain weight ratios both decreased as a result of acute oral exposure to barium in rat populations (ATSDR 1990). Published data concerning developmental, reproductive, or carcinogenic effects of barium on mammalian species are very limited (ATSDR 1990). Barium was elevated (7,705 mg/kg) in one sample location (RADSBE07) in the R Area Terrestrial unit. Only one of 94 samples exceeded the 99th percent UCL Tidal Area ambient value (530 mg/kg).

15.4.2.2 Risk to the Gray Fox at the R Area Terrestrial Unit

The table showing risk to receptors (shown previously) summarizes the HQs for the gray fox from chemicals in the R Area Terrestrial unit. HQ_1, HQ_3, and HQ_5 values were less than 1.0, indicating no significant risk. Lead, manganese, nickel, selenium, and zinc had HQ_2 or HQ_4 values greater than 1.0. A discussion of the risk to the fox from each chemical follows.

Lead

A potential risk was posed to the fox when both conservative (HQ_2 greater than 1.0) and average (HQ_4 greater than 1.0) life history parameters were used in the daily dose model. The area HQ_2 of 5,580 and HQ_4 of 3,197 for lead for the gray fox were very high, even compared to the ambient HQ_2 of 441 and ambient HQ_4 of 253. When the 95th percent UCL was used in the dose estimate instead of the maximum soil concentration, the HQ_2 and HQ_4 are much lower (585 and 335 respectively). The area doses were high because there is one outlier of lead with a high concentration (1,160 mg/kg). This

sample location is at the edge of the site not far from railroad tracks and Froid Road. Lead levels at other sample locations in the R Area Terrestrial unit were not significantly elevated.

About 80 percent of the modeled dose of lead was from incidental ingestion of soil that assumed a bioavailability of 100 percent, which is a conservative approach. The TRV for lead was based on a laboratory study that used lead acetate. Lead in soil is expected to be 10 to 20 percent as bioavailable as lead acetate (O'Flaherty 1998). As a result, the model is conservative but would indicate a potential risk even if bioavailability were considered to be only 10 percent of the total lead present.

The maximum modeled dose to the fox from lead at the R Area Terrestrial unit is associated with possible reproductive effects in an equivalent dose in rodents in a study by Krasovskii and others (1979). The allometric conversion of the TRV from a rodent-equivalent dose to a fox-equivalent dose takes into account metabolic differences between species, but additional reasons may account for differential species sensitivity to a chemical (see the uncertainty analysis presented in Section 16.0). As a result, it is useful to evaluate the modeled dose with studies of other animals. The high modeled dose of lead to the fox was below an equivalent NOEL for endpoints of plasma levels, hematopoietic effects, and bone growth in beagle dogs fed lead acetate for 13 weeks (Delaquerriere-Richardson and others 1982). The high daily dose estimate was also below a NOEL for decreased body weight in dogs and below a NOEL for neurological effects in rabbits.

Manganese

A potential risk (HQ_2 equal to 4.9) was indicated for the gray fox from exposure to manganese in the R Area Terrestrial unit when the maximum soil concentration is used in the dose model. At only one of 94 sample locations, the manganese sample concentration was elevated. The maximum soil concentration of manganese (6,300 mg/kg) poses little or no risk to the typical gray fox (HQ_4 less than 1.0); therefore, manganese is not of high concern for risk to the fox.

Nickel

Nickel posed a potential risk to the fox when a high or typical dose was evaluated (HQ_2 equal to 13 and HQ_4 equal to 7.5) for the R Area Terrestrial unit. When using the 95th percent UCL instead of the maximum soil concentration, the HQ_2 and HQ_4 (HQ_2 equal to 5.1 and HQ_4 equal to 2.9) are lower than

the ambient HQ_2 and HQ_4 (5.8 and 3.3, respectively). The risk from the maximum soil concentration of nickel did not add much incremental risk above ambient; therefore, nickel is not a concern.

Selenium

Selenium posed a potential risk to the fox in the R Area Terrestrial unit when either a high or typical dose was evaluated (HQ_2 and HQ_4 greater than 1.0) using conservative assumptions. The conservative HQ_2 (3.3) and HQ_4 (1.9) are not much greater than 1, so these values do not indicate high concern for R Area Terrestrial unit selenium levels. The modeled dose is below a dose that caused hepatic lesions in rodents, but above an extrapolated no-effect level (for hepatic lesions) (Harr and others 1966).

Zinc

The HQ_2 and HQ_4 for zinc in the R Area Terrestrial unit slightly exceeded 1.0 (HQ_2 equals 2.91 and HQ_4 equals 1.67). Both prey tissue and soil contributed to the modeled dose. The maximum soil concentration of zinc was 3.6 times the Tidal Area ambient level. Only five of 94 soil samples exceeded the Tidal Area ambient concentration of zinc, indicating that zinc contamination is not widespread in the R Area Terrestrial unit. Zinc bioaccumulates in mice, so an increase of zinc in the soil contributes significantly to the oral dose of the fox. The 95th percent UCL for zinc (140 mg/kg) was below the Tidal Area ambient concentration of zinc (264 mg/kg). Although the 95th percent UCL was lower than the ambient concentration of zinc, the HQ_2 based on the 95th percent UCL (1.9 mg/kg) instead of the maximum concentration exceeds the ambient HQ_2 (0.3 mg/kg), in large part because the ambient HQ_2 assumes that there is no zinc in prey.

The maximum modeled dose of zinc to the gray fox was greater than a no-effect-level equivalent, but lower than the level that produced cellular changes in the pancreas and adrenal cortex of rats (Gasaway and Buss 1972); therefore, zinc is not of concern for the gray fox.

15.4.2.3 Risk to the Northern Harrier in the R Area Terrestrial Unit

No immediate or significant threat (HQ_1, HQ_3, and HQ_5 less than 1.0) was indicated for the harrier from any chemical in the R Area Terrestrial unit. A potential risk was posed to the harrier only from lead when either a high or typical dose was evaluated (HQ_2 and HQ_4 greater than 1.0). That potential risk, however, also exists for ambient levels of lead (HQ_2 and HQ_4 greater than 1.0). The high modeled daily dose is equivalent to a low-effect level for decreased egg production in Japanese quail

(Edens and others 1976), but lower than an equivalent dose that caused decreased egg production in chickens (Edens and Garlich 1983). The difference between studies could be either due to the nature of the conditions under which the study was conducted or differences in species sensitivity to lead. In the study with chickens, the chickens were allowed to depurate some of the lead before egg production, indicating that the dose at time of egg production may have been lower than suggested by the oral dose.

While a potential risk of reproductive effects was indicated for the harrier from exposure to lead in the R Area Terrestrial unit, ambient levels of lead also pose a potential risk to the harrier for reproductive effects. Lead in prey contributes significantly to the dose, so the HQ_2 and HQ_4 using the 95th percent UCL (which includes prey in the dose) are greater than the ambient HQ_2 and HQ_4 (which does not include prey in the dose), even though the ambient soil concentration (95 mg/kg) is higher than the 95th percent UCL (83 mg/kg).

The maximum modeled dose of lead was below an effect level of decreased hemoglobin levels and adrenal and testes weight (Morgan and others 1975). Low concentrations of lead have been associated with neurological and neuromuscular effects, effects on the immune system, and effects on kidneys. Lead accumulates in bone tissues and may affect bone formation and strength.

15.4.2.4 Summary of Risk to Birds and Mammals in the R Area Terrestrial Unit

No significant or immediate risk (HQ_1, HQ_3, and HQ_5 less than 1.0) was posed for the salt marsh harvest mouse, Northern Harrier, or gray fox at the R Area Terrestrial unit. A potential risk (HQ_2 greater than 1.0), however, was indicated for the salt marsh harvest mouse from lead, manganese, and nickel; to the Northern Harrier (HQ_4) from lead; and to the gray fox (HQ_4) from lead, manganese, nickel, selenium, and zinc.

HQ_2s were not high for the chemicals evaluated, except for lead. The daily dose estimate for lead should probably be reduced by 80 percent to account for differences in bioavailability between lead in the soil and lead acetate, the highly bioavailable form of lead used in the study upon which the TRV was based. If the bioavailability is taken into account, a possible risk still remains to the salt marsh harvest mouse, Northern Harrier, and gray fox from lead when the maximum soil concentration is used to calculate the area dose. The maximum soil concentration of lead (1,160 mg/kg) was an order of magnitude greater than the Tidal Area ambient concentration, but the 99th percent UCL for lead was below the ambient value; incremental risk is implied for all sample locations at which the point HQ

exceeds the ambient HQ. A spatial analysis of the risk to birds and mammals is presented in Section 15.6.

Nickel did not pose a risk to the harrier but did pose a potential risk to the salt marsh harvest mouse and gray fox. The HQ_2s were 8.04 and 13.24 for the salt marsh harvest mouse and fox, respectively. The HQs were based on the maximum soil and prey tissue concentrations. Bioavailability was assumed to be 100 percent in the model. The model's assumptions, however, were conservative, so the risk may be less than indicated. Nickel concentrations in site soil are not considered to be from site releases (see Section 6.3) because they are not significantly elevated above ambient at most locations.

15.4.3 Potential Risks to Representative Receptors from Chemical Exposures in the R Area Terrestrial and Aquatic Unit

The R Area Terrestrial and Aquatic unit is located on the southeastern end of the R Area (see Exhibit 3). This portion of the R Area Disposal Site is wetland habitat that may be submerged under water nearly year-round in a wet year. Three sample locations were selected in the R Area Terrestrial and Aquatic unit in order to evaluate the risk of contaminants to shorebirds and wading birds such as the Black-necked Stilt and Great Blue Heron.

COPECs for which TRVs were available were arsenic, cadmium, copper, lead, mercury, nickel, zinc, aldrin, DDT, DDE, heptachlor, chlordanes (mammals only), PCBs, and PAHs (mammals only). COPECs for which no TRVs were available were mirex, trans-nonachlor, hexachlorobenzene, BHCs, and dieldrin.

Point doses were calculated for each of the three sample locations in the R Area Terrestrial and Aquatic unit. The point doses were calculated using the concentrations of chemicals in sediment at each sample location, coupled with the maximum prey tissue concentrations of chemicals from prey collected across the R Area Disposal Site. The daily dose estimates of each chemical at each soil sample location were compared to low and high TRVs. These calculations are presented in their entirety in T.

Little or no risk was indicated for the Great Blue Heron and Black-necked Stilt in the R Area Terrestrial and Aquatic unit; all HQs were less than 1.0.

As discussed in detail in Section 15.4.2, no immediate or significant risk was posed to any receptor (HQ_1, HQ_3, and HQ_5 less than 1.0) for the R Area Terrestrial unit. A potential risk (HQ_2 greater

than 1.0) was posed to the salt marsh harvest mouse from lead, manganese, and nickel. Also, a potential risk (HQ_2 and HQ_4 greater than 1.0) to the gray fox was indicated from lead, manganese, nickel, selenium, and zinc and to the harrier from exposure to lead.

15.4.4 Potential Risks to Representative Receptors from Chemical Exposures in the Froid and Taylor Terrestrial Unit

The Froid and Taylor Terrestrial unit was evaluated for risk to terrestrial receptors, including the salt marsh harvest mouse, gray fox, and Northern Harrier from chemicals that were present above ambient concentrations. One sample location was available for the small upland Froid and Taylor Terrestrial unit, and all organic chemicals detected in it were designated as COPECs (see Table 6-6). There were no inorganic COPECs.

Doses were calculated for each chemical at the single sample location in the Froid and Taylor Terrestrial unit. The doses were calculated using the concentrations of chemicals in the soil coupled with the maximum prey tissue concentrations of chemicals from prey collected in the R Area Terrestrial unit, since tissue was not available for this site. For the salt marsh harvest mouse, the entire dose of organic chemicals was from incidental soil ingestion because organic chemicals were not analyzed in pickleweed. The daily dose estimates of each chemical at each soil sample location were compared to low and high TRVs. These data are presented in their entirety in Appendix T. No risk (all HQs less than 1.0) was indicated for the salt marsh harvest mouse, gray fox, or Northern Harrier in the Froid and Taylor Terrestrial unit.

15.4.5 Potential Risks to Representative Receptors from Chemical Exposures in the Froid and Taylor Aquatic Unit

The Froid and Taylor Aquatic unit contains some areas that may be submerged under water nearly year-round in a wet year, so the Froid and Taylor Aquatic unit was analyzed for risk to representative aquatic receptors, including the Great Blue Heron and the Black-necked Stilt. Stilts and herons have been observed feeding in the shallow waters at this site. Chemistry data from 11 sample locations were available for the Froid and Taylor Aquatic unit, as well as tissue data for fish and amphipods.

Point doses were calculated for each of the 11 sample locations in the Froid and Taylor Aquatic unit. The point doses were calculated using the concentrations of chemicals in sediment at each sample location coupled with the maximum prey tissue concentrations of chemicals from prey collected in the

Froid and Taylor Area. Prey tissue included fish and amphipods. The daily dose estimates of each chemical at each soil sample location were compared to low and high TRVs. These calculations are presented in their entirety in Appendix T, and those indicating risk (HQ greater than 1.0) are presented in the following table. No significant or immediate risk (HQ_1, HQ_3, and HQ_5 less than 1.0) was shown for the Great Blue Heron or Black-necked Stilt in the Froid and Taylor Aquatic unit. Potential risk (HQ_2 and HQ_4 greater than 1.0) was shown for lead for these receptors and a description follows.

RISK TO RECEPTORS IN FROID AND TAYLOR AQUATIC UNIT

Analyte[a]	Sample Location[b]	Potential Risk? ($HQ_2 > 1$)[c]	HQ_2 Tidal Area Ambient[d]	Potential Risk To Typical Receptor? ($HQ_4 > 1$)[e]	HQ_4 Tidal Area Ambient[f]
Great Blue Heron					
Lead	FTSSB002	1,765.04	146.17	1,462.64	121.12
Black-Necked Stilt					
Lead	FTSSB002	2,133.63	175.17	1,366.11	112.16

Notes:

HQ Hazard quotient
TRV Toxicity reference value
UCL Upper confidence limit
a All HQ_1s (low dose/high TRV), HQ_3s (high dose/high TRV), and HQ_5s (typical dose/high TRV) were below 1.0, indicating no significant or immediate risk. Only HQ_2 and HQ_4 greater than 1.0 are presented.
b Point doses were calculated rather than an area dose; the highest point dose is shown.
c HQ_2 is equal to high dose/low TRV.
d Ambient dose is (sediment only)/low TRV.
e HQ_4 is equal to typical dose/low TRV.
f Ambient refers to the 99th percent UCL Tidal Area ambient value.
g N/A, not applicable, signifies that HQ_4 was not evaluated for special status species.

15.4.5.1 Potential Risk to the Great Blue Heron in the Froid and Taylor Aquatic Unit

Lead was the only chemical that poses a potential risk to the Great Blue Heron in the Froid and Taylor Aquatic unit when either a high or typical dose was evaluated (HQ_2 equal to 1,765 and HQ_4 equal to 1,462). Ambient levels of lead also pose a potential risk to the Great Blue Heron (ambient HQ_2 equal to 146 and ambient HQ_4 equal to 121). Five of 11 soil and sediment samples exceeded the ambient value, and the maximum concentration was 515 mg/kg (about 5 times the Tidal Area 99th percent UCL ambient value and 10 times the RWQCB San Francisco Bay ambient value). Lead in prey only accounts for 1.3 percent of the modeled dose; the remainder is from sediment ingestion under the

assumption that the lead is 100 percent bioavailable in the sediment. The concentrations in the fish (0.22 mg/kg) were comparable to those of fish from Suisun Bay (see Section 12.2). This indicates that the lead in the sediment is not very bioavailable. Lead may present a small incremental risk at this site if model assumptions are true.

15.4.5.2 Potential Risk to the Black-Necked Stilt in the Froid and Taylor Aquatic Unit

No significant and immediate risk (HQ_1 and HQ_5 less than 1.0) or probable risk (HQ_3 less than 1.0) was indicated for the Black-necked Stilt in the Froid and Taylor Aquatic unit. A potential risk does exist for the stilt from lead in the Froid and Taylor Aquatic unit because the HQ_2 of 2,133 and HQ_4 of 1,366 were than HQs based on ambient concentrations of lead (ambient HQ_2 equal to 175 and HQ_4 equal to 112). About 4 percent of the modeled dose was from prey (amphipods), and 96 percent was from incidental sediment ingestion. The stilt eats much more prey than (incidentally ingested) sediment, yet the bulk of the dose is from sediment due to the model assumption that 100 percent of the lead in sediment is bioavailable. The tissue residue data indicate low bioavailability in lead (BAF equals 0.03).

15.4.5.3 Summary of Risk to Representative Receptors from Chemical Exposures in the Froid and Taylor Aquatic Unit

No immediate or significant risk (HQ_1, HQ_3, and HQ_5 less than 1.0) was indicated for the Great Blue Heron or Black-necked Stilt from any chemical in the Tidal Area. Potential risk (HQ_2 and HQ_4 greater than 1.0) was indicated for the Great Blue Heron and Black-necked Stilt from lead in the Froid and Taylor Aquatic unit. Lead concentrations were somewhat elevated; the 95th percent UCL (420 mg/kg) was about two times the Tidal Area ambient value. Tissue residues of fish collected from the site did not have elevated concentrations of lead when compared to regional RMP fish data (SFEI 1997). Bioavailability of the lead therefore appears to be low.

15.4.6 Potential Risks to Representative Receptors from Chemical Exposures in the Wood Hogger Terrestrial Unit

The Wood Hogger Terrestrial unit (see Exhibit 3) included 83 chemistry sample locations. All inorganic COPECs requiring further evaluation were evaluated for risk to birds and mammals, and all organic chemicals detected were evaluated for risk to birds and mammals. TRVs were available for most inorganics, PCBs, dioxins, DDTs, benzo(a)pyrene (mammals only; used for assessing risk of total PAHs), and some chlorinated pesticides.

For chemicals with no TRVs available, a qualitative assessment of risk was made. Most toxicological studies on chemicals are conducted on rats and mice, so chemicals for which TRVs were unavailable were only evaluated for risk to the salt marsh harvest mouse. COPECs for the Wood Hogger Terrestrial unit for which no TRVs were available included antimony, arsenic, dieldrin, heptachlor epoxide, hexachlorobenzene, and trans-nonachlor.

Area doses were calculated for the Wood Hogger Terrestrial unit using the maximum concentrations of chemicals in soil, coupled with the maximum prey tissue concentrations of chemicals from prey collected in the Wood Hogger Terrestrial unit. Prey tissue included rodent and pickleweed. The daily dose estimates for each chemical were compared to low and high TRVs; these calculations are presented in their entirety in Appendix T. Only those HQs greater than 1.0, indicating risk, are presented in the following table.

No significant or immediate risk was indicated for any chemical receptor pair (all HQ_1, HQ_3, and HQ_5 less than 1.0). The only HQs that exceeded 1.0 at the Wood Hogger Terrestrial unit were HQ_2s and HQ_4s for cadmium, copper, lead, mercury, selenium, zinc, and PCDDs and PCDFs. A discussion of the results for each representative receptor follows the summary table.

RISK TO RECEPTORS IN WOOD HOGGER TERRESTRIAL UNIT

Analyte[a]	Sample Location[b]	Potential Risk? ($HQ_2 > 1$)[c]	HQ_2 Tidal Area Ambient[d]	Potential Risk To Typical Receptor? ($HQ_4 > 1$)[e]	HQ_4 Tidal Area Ambient[f]
Salt Marsh Harvest Mouse					
Cadmium	WHSSBI02	2.52	< 1.0	N/A	N/A
Copper	WHSSBH03	1.72	< 1.0	N/A	N/A
Lead	WHSSBF03	1878.59	295.56	N/A	N/A
Selenium	WHSSBC02	1.14	< 1.0	N/A	N/A
Zinc	WHSSBI02	2.65	< 1.0	N/A	N/A
PCDD/Fs	WHSSB016	5.74	No ambient	N/A	N/A
Gray Fox					
Cadmium	WHSSBI02	2.750	< 1.0	1.576	< 1.0
Copper	WHSSBH03	2.125	< 1.0	1.217	< 1.0
Lead	WHSSBF03	2162.67	330.54	1498.35	189.4
Mercury	WHSSB024	1.046	< 1.0	< 1.0	< 1.0

RISK TO RECEPTORS IN WOOD HOGGER TERRESTRIAL UNIT (Continued)

Analyte[a]	Sample Location[b]	Potential Risk? ($HQ_2 > 1$)[c]	HQ_2 Tidal Area Ambient[d]	Potential Risk To Typical Receptor? ($HQ_4 > 1$)[e]	HQ_4 Tidal Area Ambient[f]
Gray Fox (Continued)					
Selenium	WHSSBC02	2.384	< 1.0	1.365	< 1.0
Zinc	WHSSBI02	4.211	< 1.0	2.412	< 1.0
PCDD/Fs	WHSSB016	6.84	No ambient	3.91	No ambient
Northern Harrier					
Lead	WHSSBF03	168.97	23.19	93.40	12.82

Notes:

HQ Hazard quotient
PCDD Polychlorinated dibenzodioxin
PCDF Polychlorinated dibenzofuran
TRV Toxicity reference value
UCL Upper confidence limit

a All HQ_1s (low dose/high TRV), HQ_3s (high dose/high TRV), and HQ_5s (typical dose/high TRV) were below 1.0, indicating no significant or immediate risk. Only HQ_2 and HQ_4 greater than 1.0 are presented.
b Point doses were calculated rather than an area dose; the highest point dose is shown.
c HQ_2 is equal to high dose/low TRV.
d Ambient dose is (sediment only)/low TRV.
e HQ_4 is equal to typical dose/low TRV.
f Ambient refers to the 99th percent UCL Tidal Area ambient value.
g N/A, not applicable, signifies that HQ_4 was not evaluated for special status species.

15.4.6.1 Risk to the Salt Marsh Harvest Mouse in the Wood Hogger Terrestrial Unit

No immediate or significant risk (HQ_1, HQ_3, and HQ_5 less than 1.0) was indicated from any chemical for which there is a TRV for the salt marsh harvest mouse in the Wood Hogger Terrestrial unit. A potential risk (HQ_2 greater than 1.0) was posed to the salt marsh harvest mouse from exposure to cadmium, copper, lead, selenium, and zinc, and dioxins (PCDDs and PCDFs). As an endangered, federally protected species, the risk to the typical salt marsh harvest mouse was not determined because it is not considered to be adequately protective. A discussion of the risk to the salt marsh harvest mouse from each chemical follows.

Cadmium

Cadmium posed a potential risk (HQ_2 greater than 1.0), but not a probable risk (HQ_3 less than 1.0), to the salt marsh harvest mouse in the Wood Hogger Terrestrial unit. The HQ_2 for cadmium, based on the maximum soil concentration (20.8 mg/kg), was 2.52, only slightly above 1.0. The Tidal Area ambient cadmium concentration was 1.9 mg/kg. Four sample locations in the Wood Hogger Terrestrial unit were determined to be outliers, indicating potential anthropogenic sources adding incremental risk. Most of the modeled dose to the salt marsh harvest mouse was from soil ingestion; cadmium was not detected in pickleweed and may not be readily bioavailable.

Copper

A potential risk (HQ_2 greater than 1.0) was indicated for the salt marsh harvest mouse from copper in the Wood Hogger Terrestrial unit; however, the HQ_2 was only slightly above 1.0 (HQ_2 equal to 1.72) using the maximum copper concentration (607 mg/kg). This sample location (WHSSBH03) was the only soil that exceeded the ER-L; there were three other outliers out of 63 samples. Most of the modeled dose to the salt marsh harvest mouse was from incidental ingestion of soil, with the conservative assumption of 100 percent bioavailability. Copper is not of high concern for the salt marsh harvest mouse.

Lead

A potential risk (HQ_2 equal to 1,878 for maximum concentration) was indicated for the salt marsh harvest mouse from lead in the Wood Hogger Terrestrial unit, according to the assumptions of the food-chain model. Ambient concentrations of lead, however, also posed a potential risk to the salt marsh harvest mouse because the HQ_2 for Tidal Area ambient concentrations of lead is 296.

Most of the modeled dose was from incidental soil ingestion; lead was detected in pickleweed at 0.14 mg/kg compared to 728 mg/kg in the soil. The TRV for lead was based on a study using lead acetate, a highly bioavailable form of lead. Lead in contaminated soil and dust has been estimated at being 10 to 20 percent as bioavailable as lead acetate (O'Flaherty 1998); therefore, model assumptions are conservative.

House mice collected from the Wood Hogger Terrestrial unit had tissue residues of lead of 0.45 to 0.66 mg/kg, which is low; the lower range of background concentrations of lead in rodents from

uncontaminated sites is 1.0 μg/g (that is, 1.0 mg/kg) or lower (Beyer 1996). As a result, the modeled dose of lead to the salt marsh harvest mouse should be presumed to be conservative because lead does not appear to be very bioavailable at the site. In addition, the calculated risk is based on sample results from a few sample locations with elevated soil concentrations of lead. Three sample locations out of 63 had lead levels of concern: WHSSB014 (598 mg/kg), WHSSBE04 (593 mg/kg), and WHSSBE08 (320 mg/kg). The 95th percent UCL is 101 mg/kg, which is just above the Tidal Area ambient value (95 mg/kg). The HQ_2 based on the 95th percent UCL (332.37) was slightly greater than the ambient HQ_2 (295.56).

Selenium

The potential risk to the salt marsh harvest mouse from selenium in the Wood Hogger Terrestrial unit is not a major concern because the conservative HQ_2 was only slightly greater than 1.0 (HQ_2 equal to 1.14). The sample location with the maximum soil concentration of selenium (418 mg/kg) was an outlier (WHSSBC02), and may be attributable to an isolated release.

Zinc

A potential risk to the salt marsh harvest mouse was indicated from zinc in the Wood Hogger Terrestrial unit, but the conservative HQ_2 of 2.65 is only slightly higher than 1.0. About 90 percent of the modeled dose of zinc was from incidental soil ingestion. The food-chain model assumes that the bioavailability of zinc from all dietary sources, including from soil, is 100 percent, which is conservative. Zinc, therefore, is not expected to be a problem even at the maximum soil concentration in the Wood Hogger (3,010 mg/kg). The 95th percent UCL was 283 mg/kg, and the Tidal Area ambient value was 264 mg/kg, further indicating that, overall, zinc should not pose a concern to the salt marsh harvest mouse at this site.

Dioxins (PCDDs and PCDFs)

The dioxin analysis was focused on the southwestern corner of the Wood Hogger unit where no pickleweed is found and a suitable habitat does not exist for the salt marsh harvest mouse. Nonetheless, the risk to the salt marsh harvest mouse was evaluated based on the risk from incidental soil ingestion only.

A potential risk to the salt marsh harvest mouse was indicated from dioxins in the Wood Hogger Terrestrial unit (conservative HQ_2 equals 5.74). The HQ_2, however, was not much above 1.0. Daily dose estimates and HQs of PCDDs and PCDFs were based on TEQs. The TEQs were summed for all PCDDs and PCDFs, including those not detected. For nondetected PCDDs and PCDFs, a value of one-half the sample quantitation limit was substituted as its concentration. This approach introduces uncertainty into the assessment (see uncertainty analysis discussed in Section 16.0). If only detected PCDDs and PCDFs were evaluated, no risk would be indicated for the salt marsh harvest mouse from dioxins. The HQ_2 is a sensitive measure of possible risk because the estimate of dose is compared to a conservative effects level (low TRV). The TRV for dioxin was based on a NOEC for a three-generational study of fertility in rats; when one generation was evaluated, the NOEC was 10 times that of the three-generational study. As a result, a potential risk is indicated only when the most conservative assumptions are used.

15.4.6.2 Risk to the Gray Fox in the Wood Hogger Terrestrial Unit

A potential risk (HQ_2 and HQ_4 greater than 1.0) was indicated for the gray fox from cadmium, copper, lead, mercury, selenium, zinc, and PCDDs and PCDFs in the Wood Hogger Terrestrial unit. The risk to receptor table summarizes the risk to the gray fox from chemicals in the Wood Hogger Terrestrial unit. A discussion of the risk to the fox from each chemical follows.

Cadmium

A potential risk for the gray fox was indicated from cadmium in the Wood Hogger Terrestrial unit, but the HQ_2 and HQ_4 were not much above 1.0 (HQ_2 equal to 2.75 and HQ_4 equal to 1.58). Most of the modeled dose of cadmium was from incidental ingestion of soil because prey concentrations were low. When the 95th percent UCL is used instead of the maximum soil concentration, little or no risk would be indicated (HQ_2 and HQ_4 less than 1.0).

Copper

In the Wood Hogger Terrestrial unit, a potential risk was indicated for the fox based on conservative models; HQ_2 and HQ_4 were 2.12 and 1.22, respectively. The HQ_2 is the most sensitive measure of possible risk because the most conservative estimate of dose is compared to a conservative effects level. Most of the modeled dose of copper to the fox was from incidental ingestion of soil indicating that

incremental risk is directly related to the soil concentration. When the 95th percent UCL is used, instead of the maximum soil concentration, little or no risk is indicated (HQ_2 and HQ_4 less than 1.0).

Lead

The HQ_2 and HQ_4 for lead were high (2,615 and 1,498, respectively), indicating a potential risk to the gray fox in the Wood Hogger Terrestrial unit. Lead concentrations were elevated in some sample locations (see the previous discussion of the salt marsh harvest mouse).

The TRV for lead was based on a study using a rodent as the test species. The high modeled dose of lead to the fox was below an equivalent NOEL for endpoints of plasma levels, hematopoietic effects, and bone growth in beagle dogs fed lead acetate for 13 weeks (Delaquerriere-Richardson and others 1982). The high daily dose estimate was also below a NOEL for decreased body weight in dogs and below a NOEL for neurological effects in rabbits.

Mercury

The conservative HQs (HQ_2 and HQ_4) for mercury indicate a potential risk for the gray fox; however, the risk is not great since HQ_2 and HQ_4 were not much above 1.0 (1.05 and 1.5, respectively). Most of the modeled dose of mercury to the fox was from incidental ingestion of soil. The TRV for mercury is based on methylmercury, a highly bioavailable and toxic form of mercury that is not expected to be the major form of mercury in soils of average organic matter content and where the redox potential is not expected to be very low (O'Flaherty 1998). Mercury in upland soils tends to be in an inorganic form. As a result, the actual risk is much less than the modeled risk and is not considered to be of concern.

Selenium

A potential risk for the gray fox was indicated from selenium at the Wood Hogger Terrestrial unit (HQ_2 equals 2.4 and HQ_4 equals 1.4); however, HQs were only slightly above 1.0. Most of the modeled dose of selenium was from selenium in prey tissues. Selenium appears to have a higher bioaccumulation factor than other metals at the site; the maximum prey tissue concentration of selenium was 10 percent of the maximum soil concentration. However, since only one of 63 soil samples indicated incremental risk, selenium is not of concern.

Zinc

A potential risk to the gray fox was indicated from zinc at the Wood Hogger Terrestrial unit because the HQ_2 and HQ_4 for zinc were 4.2 and 2.4, respectively; however, the HQs were not much greater than 1.0. Zinc in both prey tissues and soil contributed to the daily dose estimate. The maximum soil concentration of zinc was approximately 11 times the Tidal Area ambient level. As a result, an increased incremental risk is posed from zinc associated with this site.

PCDDs and PCDFs

Using conservative assumptions, potential risk (HQ_2 equal to 6.84 and HQ_4 equal to 3.91) was indicated for the gray fox from PCDDs and PCDFs at the Wood Hogger Terrestrial unit. Daily dose estimates and HQs of PCDDs and PCDFs were based on toxic equivalents. The majority of the risk based on TEQs was from PCDDs and PCDFs that were below detection limits, so there is great uncertainty in this analysis. Only through inclusion of nondetected chemicals is risk indicated. The TRV for dioxin was based on a NOEC for a three-generational study of fertility in rats. The modeled dose was based on total TEQs summed with one-half the SQL for each nondetected PCDD and PCDF. When one generation was evaluated, the NOEC was 10 times that of the three-generational study. Therefore, the modeled dose is above a NOEC, but below a dose that was associated with reproductive effects. Since conservative assumptions were employed, significant risk is not indicated.

15.4.6.3 Risk to the Northern Harrier in the Wood Hogger Terrestrial Unit

No immediate or significant threat (HQ_1 and HQ_5 less than 1.0), or probable risk (HQ_3 less than 1.0), was indicated for the harrier from any chemical in the Wood Hogger Terrestrial unit. As shown in the previous table, a potential risk was indicated for the harrier from lead when either a high or typical dose was evaluated (HQ_2 equals 169 and HQ_4 equals 93); however, that potential risk also was posed for ambient concentrations of lead (ambient HQ_2 and HQ_4 greater than 1.0). About 85 percent of the modeled dose was from ingestion of soil, while the remaining 15 percent was from ingestion of prey. The high modeled daily dose is equivalent to a low-effect level for decreased egg production in Japanese quail (Edens and others 1976), but below an effect level of decreased hemoglobin levels and adrenal and testes weight (Morgan and others 1975). Low levels of lead have been associated with neurological and neuromuscular effects, effects on the immune system, and effects on kidneys. Lead accumulates in bone tissues and may affect bone formation and strength.

While a potential risk of reproductive effects was indicated for the harrier from exposure to lead in the Wood Hogger Terrestrial unit, ambient concentrations of lead also pose a potential risk to the harrier for reproductive effects. The 95th percent UCL of lead (101 mg/kg) in soil in the Wood Hogger Terrestrial unit was close to the ambient value, indicating that contamination is not widespread. A spatial analysis of risk is presented in Section 15.6. and shown on Exhibit 18.

15.4.6.4 Summary of Risk to Representative Receptors from Chemical Exposures in the Wood Hogger Terrestrial Unit

There is no immediate or significant risk (HQ_1, HQ_3, and HQ_5 less than 1.0) to the salt marsh harvest mouse, gray fox, or Northern Harrier from any chemical in the Wood Hogger Terrestrial unit. Potential risk (HQ_2 greater than 1.0) was indicated for the salt marsh harvest mouse from cadmium, copper, lead, selenium, zinc, and PCDDs and PCDFs in the Wood Hogger Terrestrial unit. Also, a potential risk (HQ_2 and HQ_4 greater than 1.0) was posed to the gray fox from cadmium, copper, lead, mercury, selenium, zinc, and PCDDs and PCDFs and to the Northern Harrier from lead.

The HQs for the fox, harrier, and salt marsh harvest mouse were not high, except for the HQ_2 and HQ_4 for lead. The TRV for lead and the food-chain model assumptions are conservative. However, lead contributes incremental risk to the receptors from at least three sample locations, which were elevated according to the outlier analysis (see Section 6.0). The 95th percent UCL of lead (101 mg/kg) in soil in the Wood Hogger Terrestrial unit was close to the ambient value, indicating that contamination is not widespread. A spatial analysis of risk is further presented in Section 15.6 and shown in Exhibit 18.

15.4.7 Potential Risks to Representative Receptors from Chemical Exposures in the North Otter Sluice Aquatic Unit

The North Otter Sluice Aquatic unit includes the slough along the western and southwestern perimeter of the R Area. Nineteen locations were sampled in the unit to evaluate the risk of contaminants. All inorganic COPECs requiring further evaluation and all detected organic concentrations were evaluated for risk to birds and mammals. In the North Otter Sluice Aquatic unit, COPECs for which TRVs were available included arsenic, copper, lead, mercury, nickel, selenium, zinc, DDT, DDE, chlordanes (mammals only), and PAHs (mammals only). COPECs for which TRVs were not available included aluminum, antimony, beryllium, molybdenum, mirex, trans-nonachlor, hexachlorobenzene, BHCs, methylphenol, and dieldrin. For chemicals with no TRVs available, a qualitative assessment of risk was made.

Representative receptors for the North Otter Sluice Aquatic Area included the river otter, Great Blue Heron, and California Black Rail. Point doses were calculated for each of the sample locations in the North Otter Sluice Aquatic unit; the calculations were based on the sediment concentrations and maximum tissue concentrations. HQs generated using the doses and the low and high TRVs are presented in their entirety in Appendix T, and HQs indicating risk (HQ greater than 1.0) are presented in the following table. The food-chain modeling indicated no significant and immediate risk (HQ_1 and HQ_5 less than 1.0) or probable risk (HQ_3 less than 1.0) from chemicals in the North Otter Sluice Aquatic unit. A potential risk (HQ_2 or HQ_4 greater than 1.0) was indicated for lead, nickel, and selenium. A discussion of the results for each representative receptor follows the table, which presents the HQ results for the North Otter Sluice Aquatic unit.

RISK TO RECEPTORS IN THE NORTH OTTER SLUICE AQUATIC UNIT

Analyte[a]	Sample Location[b]	Potential Risk? ($HQ_2 > 1$)[c]	HQ_2 Tidal Area Ambient[d]	Potential Risk To Typical Receptor? ($HQ_4 > 1$)[e]	HQ_4 Tidal Area Ambient[f]
River Otter					
Lead	RADSBA02	178.63	35.32	79.21	15.66
Nickel	RADSBA07	1.66	< 1.0	No	< 1.0
Selenium	OSLS001	1.38	< 1.0	No	< 1.0
Great Blue Heron					
Lead	RADSBA02	622.97	146.17	516.23	121.12
California Black Rail					
Lead	RADSBA02	342.22	79.63	N/A[g]	N/A[g]

Notes:

HQ Hazard quotient

TRV Toxicity reference value

UCL Upper confidence limit

a All HQ_1s (low dose/high TRV), HQ_3s (high dose/high TRV), and HQ_5s (typical dose/high TRV) were below 1.0, indicating no significant or immediate risk. Only HQ_2 and HQ_4 greater than 1.0 are presented.

b Point doses were calculated rather than an area dose; the highest point dose is shown.

c HQ_2 is equal to high dose/low TRV.

d Ambient dose is (sediment only)/low TRV.

e HQ_4 is equal to typical dose/low TRV.

f Ambient refers to the 99th percent UCL Tidal Area ambient value.

g N/A, not applicable, signifies that HQ_4 was not evaluated for special status species.

15.4.7.1 Risk to the River Otter in the North Otter Sluice Aquatic Unit

The food-chain model for the river otter used a prey composition of half clams and half fish. No chemical had an HQ_1, HQ_3, or HQ_5 less than 1.0; three chemicals had an HQ_2 or HQ_4 greater than 1.0. A discussion of the risk to the river otter from lead, nickel, and selenium follows.

Lead

No immediate and significant risk (HQ_1 and HQ_5 less than 1.0) or probable risk (HQ_3 less than 1.0) to the river otter exists from lead in the North Otter Sluice Aquatic unit. Potential risk (HQ_2 and HQ_4 greater than 1.0) was indicated for the river otter from lead in the North Otter Sluice Aquatic unit. The HQ_2 and HQ_4 for the unit (178.6 and 79.2, respectively) are much greater than 1.0; however, even ambient levels of lead indicated potential risk to the river otter because the ambient HQ_2 was 35 and the ambient HQ_4 was 16.

The maximum sediment concentration was 99.5 mg/kg, just above the 99th percent UCL Tidal Area ambient value (95 mg/kg). The 95th percent UCL sediment concentrations of lead (60.9) was above the San Francisco Bay ambient value (RWQCB 1998). The actual risk to the otter may be more accurately described with the 95th percent UCL instead of maximum sediment concentration, but the maximum was also evaluated to be conservative. The HQs using the 95th percent UCL sediment concentrations and the maximum tissue concentrations were an HQ_2 of 101.3 and an HQ_4 of 45.0 for the North Otter Sluice Aquatic unit, still above the ambient HQ_2 and HQ_4.

The food-chain model uses a conservative assumption that all sources of lead were 100 percent bioavailable. However, prey tissue concentrations of lead were low in clam and below the detection limit in fish tissue. This indicates that the lead in this ecosystem was not very bioavailable, as was indicated by SEM/AVS data (see Section 9.0). Most (about 80 percent) of the modeled dose of lead to the river otter was from incidental sediment ingestion under the assumption of 100 percent bioavailability. The TRV for lead was based on a laboratory study that used lead acetate, a highly bioavailable form of lead, so if the source of lead in the sediment is much less bioavailable than lead acetate, the HQs would be conservative.

Lead accumulates primarily in bone tissues; this lead accumulation can affect bone formation and growth but also affects hemesynthesis and blood pressure, causes neurotological and reproductive

effects, and causes histopathological changes in kidney and liver cells (Casarett and Doull 1991). The high daily dose estimate of ingested lead to the river otter using the maximum sediment and prey concentrations in North Otter Sluice Aquatic unit was 0.107 mg/kg/day. The dose exceeded the low TRV for lead, which was based on a NOEL for reproductive effects in white rats (Krasovskii and others 1979), and exceeded a dose (allometrically converted to 0.004 mg/kg/day for the river otter) that was associated with an effect level for reproductive endpoints in the same study. Selection of TRVs was based on quality of the study and endpoints, which are considered the most ecologically relevant. The allometric conversion of the TRV from a rodent-equivalent dose to an otter-equivalent dose takes into account metabolic differences between species, but additional reasons may explain differences between species sensitivity to a chemical. Therefore, it is useful to evaluate the modeled dose with studies of other animals. The high modeled dose for the river otter was below an equivalent NOEL for endpoints of plasma levels, hematopoietic effects, and bone growth in beagle dogs fed lead acetate for 13 weeks (Delaquerriere-Richardson and others 1982). The modeled doses were also below a NOEL for reproductive effects in mice where the endpoint was measured as pup weight at birth (Draski and others 1989). In addition, lead in North Otter Sluice sediments did not exceed the ER-M (based on 19 samples), so the actual risk appears to be low.

Nickel

No immediate and significant risk (HQ_1 and HQ_5 less than 1.0) or probable risk (HQ_3 less than 1.0) was indicated from nickel for the river otter at the North Otter Sluice Aquatic unit. A potential risk (HQ_2 greater than 1.0) was posed to the river otter from nickel at the North Otter Sluice Aquatic unit. The HQ_2 was not high (1.66) and ambient concentrations of nickel yielded an HQ_2 of 0.99 for the river otter. The HQ_4 for nickel at the North Otter Sluice Aquatic unit was less than 1.0, indicating little or no risk is posed to the typical river otter, where the typical dose is calculated using average life history parameters of body weight and ingestion rates and a conservative SUF. The TRV for nickel was determined by applying an uncertainty factor of 10 to a low-effect level found for reproductive effects in rats using nickel chloride. Therefore, while the area high dose estimates for the otter in the North Otter Sluice Aquatic unit exceeded this NOEL, the doses were not associated with a known effect level. In addition, forms of nickel in sediment and soil are not expected to be as bioavailable or as readily absorbed from the gastrointestinal tract as nickel chloride. As a result, sources of nickel in the North Otter Sluice Aquatic unit are not expected to pose a risk to the river otter.

Selenium

Selenium may pose a potential risk (HQ_2 greater than 1.0) to the otter at the North Otter Sluice Aquatic unit according to the food-chain model assumptions. The HQ_2 for selenium in the North Otter Sluice Aquatic unit was 1.38, only slightly above 1.0; however, little or no risk (HQ_4 less than 1.0) was posed to the typical river otter based on a model incorporating average life history parameters. Most of the modeled dose of selenium to the river otter was from selenium in prey (fish and clams) from the North Otter Sluice Aquatic unit. The ambient HQ_2 calculated with an assumption of no selenium in prey, was much lower than the area HQ_2 for the North Otter Sluice Aquatic unit. Also, using the 95th percent UCL, the calculated selenium concentration in sediment, instead of the measured maximum sediment concentration, did not result in a lower calculated HQ because the prey accounts for most of the modeled dose. The low TRV for selenium was based on a no-effect level for hepatic lesions in rats. A no-effect level for the reproductive endpoint of reduced fetal body weight or skeletal development in mice was 10 times higher than the low TRV. The HQ_2 barely exceeded 1.0 with an assumption of 100 percent bioavailability, so selenium is not expected to pose a threat to river otters in the North Otter Sluice Aquatic unit.

15.4.7.2 Risk to the Great Blue Heron in the North Otter Sluice Aquatic Unit

No immediate or significant risk (HQ_1, HQ_3, and HQ_5 less than 1.0) was indicated to the heron from exposure to chemicals present in the North Otter Sluice Aquatic unit. There was an indication of a potential risk (HQ_2 and HQ_4 greater than 1.0) to the heron from exposure to lead only in the North Otter Sluice Aquatic unit. The HQs for lead are presented in the risk to receptor table (shown previously); they show that the HQ_2 and HQ_4 for the heron were high (623 and 516, respectively). The HQs for ambient concentrations of lead were also high in the North Otter Sluice Aquatic unit (ambient HQ_2 equals 146 and ambient HQ_4 equals 121). Most of the modeled dose of lead was from incidental sediment ingestion rather than from prey. The TRV for lead was based on a study using lead acetate, a highly bioavailable form of lead, whereas forms of lead in sediment and soil are typically 10 to 20 percent less bioavailable than lead acetate (O'Flaherty 1998). The low TRV for lead was based on an endpoint of decreased egg production in Japanese quail. The high TRV was associated with decreased egg production in chickens. The high and typical modeled doses of lead to the heron did not exceed the high TRV.

Lead can also affect the central nervous system, gastrointestinal and neuromuscular effects. Lead also targets the kidneys, possibly causing renal effects at high doses. In birds, lead has been shown to decrease levels of ALAD, involved in hemesynthesis, at doses lower than the low TRV and therefore lower than the modeled dose to the heron in the North Otter Sluice Aquatic unit. Decreased ALAD levels may result in anemia. This endpoint, however, was not selected for the low TRV because it was not considered as ecologically relevant as reproductive effects.

15.4.7.3 Risk to the California Black Rail in the North Otter Sluice Aquatic Unit

The food-chain model parameters used for the California Black Rail were described above in Section 15.2 and in Appendix T. The California Black Rail is a special status species; therefore, the HQ_4 and HQ_5 were not evaluated because they are not adequately protective of individuals.

According to the model assumptions, a potential risk was indicated for the California Black Rail (HQ_2 equal to 342) from lead only at the North Otter Sluice Aquatic unit. Most of the modeled dose was from incidental sediment ingestion; prey tissues did not contribute significantly to the dose (about 1 to 2 percent). Ambient levels of lead also indicate potential risk because the ambient HQ_2 was 79.63. The modeled doses of lead from the North Otter Sluice Aquatic unit exceeded the NOEL (allometrically converted equivalent) for reproductive effects in the Japanese quail. Effects on growth, survival, and reproduction are unlikely at these doses; however, other sublethal systemic effects of lead toxicity, such as hematopoietic effects, may be possible in the California Black Rail at the North Otter Sluice Aquatic unit based on conservative assumptions of 100 percent bioavailability.

15.4.7.4 Summary of Risk to Representative Receptors from Chemical Exposures in the North Otter Sluice Aquatic Unit

No immediate or significant risk (HQ_1, HQ_3, and HQ_5 less than 1.0) was indicated for the river otter, Great Blue Heron, or California Black Rail from any chemical in the Tidal Area. Lead was the only chemical to pose a risk to the typical river otter (HQ_4 greater than 1.0). The HQs for the river otter, Great Blue Heron, and California Black Rail were not high, except for the HQs for lead; the TRV for lead and the food-chain model assumptions are conservative.

COPECs for which TRVs were unavailable included aluminum, antimony, beryllium, molybdenum, mirex, trans-nonachlor, hexachlorobenzene, BHCs, methylphenol, and dieldrin. The concentrations of

these chemicals were very low or below detection in clam or fish tissues (prey of North Otter Sluice Aquatic unit receptors) and are not expected to pose a risk.

15.4.8 Potential Risks to Representative Receptors from Chemical Exposures in the South Otter Sluice Aquatic Unit

The South Otter Sluice Aquatic unit includes the slough along the west and south perimeter of the Wood Hogger. Twenty-six locations were sampled in the unit to evaluate the risk of contaminants. All inorganic COPECs requiring further evaluation and all detected organic chemicals were evaluated for risk to birds and mammals. In the South Otter Sluice Aquatic unit, COPECs for which TRVs were available include arsenic, copper, lead, mercury, nickel, selenium, zinc, DDE, DDT, lindane, chlordanes (mammals only), and PAHs (mammals only). COPECs for which no TRVs were available include aluminum, antimony, barium, beryllium, molybdenum, mirex, trans-nonachlor, hexachlorobenzene, BHCs, and methylphenol. For chemicals with no TRVs available, a qualitative assessment of risk was made.

Representative receptors for the South Otter Sluice Aquatic unit included the river otter, Great Blue Heron, and California Black Rail. Point doses were calculated for each of the sample locations in the South Otter Sluice Aquatic unit; the calculations were based on the sediment concentration and maximum tissue concentration. HQs generated using the doses and the low and high TRVs are presented in their entirety in Appendix T, and HQs indicating risk (HQ greater than 1.0), are presented in the following table. The food-chain models indicated no significant and immediate risk (HQ_1 and HQ_5 less than 1.0) or probable risk (HQ_3 less than 1.0) from chemicals in the South Otter Sluice Aquatic unit. A potential risk (HQ_2 or HQ_4 greater than 1.0) was indicated for lead, nickel, selenium, and PCDDs and PCDFs in the South Otter Sluice Aquatic unit. A discussion of the results for each representative receptor follows the table, which presents the HQ results for the South Otter Sluice Aquatic unit.

RISK TO RECEPTORS IN THE SOUTH OTTER SLUICE AQUATIC UNIT

Analyte[a]	Sample Location[b]	Potential Risk? ($HQ_2 > 1$)[c]	HQ_2 Tidal Area Ambient[d]	Potential Risk To Typical Receptor? ($HQ_4 > 1$)[e]	HQ_4 Tidal Area Ambient[f]
River Otter					
Lead	WHSSB002	93.60	35.32	41.51	15.66
Nickel	WHSSB001	1.36	< 1.0	No	< 1.0
Selenium	WHSSB001	1.39	< 1.0	No	< 1.0
PCDDs and PCDFs	OSLS008	2.4	No ambient	1.1	No ambient
Great Blue Heron					
Lead	WHSSB002	343.83	146.17	284.92	127.07
Mercury	WHSSB022	2.19	< 1.0	1.81	< 1.0
PCDD/Fs	OSLS008	6.35	N/A[g]	5.26	No ambient
California Black Rail					
Lead	WHSSB002	185.75	79.63	N/A[g]	N/A[g]
Mercury	WHSSB022	1.04	< 1.0	N/A[g]	N/A[g]
PCDDs and PCDFs	OSLS008	3.61	no ambient	N/A[g]	N/A[g]

Notes:

HQ Hazard quotient
PCDD Polychlorinated dibenzodioxin
PCDF Polychlorinated dibenzofuran
TRV Toxicity reference value
UCL Upper confidence limit

a All HQ_1s (low dose/high TRV), HQ_3s (high dose/high TRV), and HQ_5s (typical dose/high TRV) were below 1.0, indicating no significant or immediate risk. Only HQ_2 and HQ_4 greater than 1.0 are presented.
b Point doses were calculated rather than an area dose; the highest point dose is shown.
c HQ_2 is equal to high dose/low TRV.
d Ambient dose is (sediment only)/low TRV.
e HQ_4 is equal to typical dose/low TRV.
f Ambient refers to the 99th percent UCL Tidal Area ambient value.
g N/A, not applicable, signifies that HQ_4 was not evaluated for special status species.

15.4.8.1 Risk to the River Otter in the South Otter Sluice Aquatic Unit

The food-chain model for the river otter used a prey composition of half clams and half fish. A discussion of the risk to the river otter from the chemicals that had an HQ_2 or HQ_4 greater than 1.0 follows.

Lead

No immediate and significant risk (HQ_1 and HQ_5 less than 1.0) or probable risk (HQ_3 less than 1.0) to the river otter was indicated from lead in the South Otter Sluice Aquatic unit. Potential risk (HQ_2 and HQ_4 greater than 1.0) to the river otter was indicated from lead. The HQ_2 and HQ_4 for the unit (93.6 and 41.5, respectively) are much greater than 1.0; however, even ambient concentrations of lead indicated potential risk to the river otter because the ambient HQ_2 is 35 and the ambient HQ_4 is 16.

The 95th percent UCL sediment concentration of lead (61 mg/kg) for the South Otter Sluice Aquatic unit was just above ambient (43 mg/kg) for San Francisco Bay (RWQCB 1998). The actual risk to the otter may be more accurately described with the 95th percent UCL instead of maximum sediment concentration, but the maximum was evaluated also to be conservative. The HQs using the 95th percent UCL sediment concentrations and the maximum tissue concentrations were HQ_2 of 62 and HQ_4 of 27.5 for the South Otter Sluice Aquatic unit, still above the ambient HQ_2 and HQ_4. The maximum sediment concentration was 99.5 mg/kg. Lead concentrations in the South Otter Sluice Aquatic unit are low compared to the rest of the Tidal Area.

The food-chain model uses a conservative assumption that all sources of lead were 100 percent bioavailable. However, prey tissue concentrations of lead were low in clam and below the detection limit in fish tissue. This indicates that the lead in this ecosystem was not very bioavailable. Most (about 80 percent) of the modeled dose of lead to the otter was from incidental sediment ingestion under the assumption of 100 percent bioavailability. The TRV for lead was based on a laboratory study that used lead acetate, a highly bioavailable form of lead, so if the source of lead in the sediment is much less bioavailable than lead acetate, the HQs would be conservative.

Lead accumulates primarily in bone tissues; this lead accumulation can affect bone formation and growth but also affects hemesynthesis and blood pressure, causes neurotoxicity and reproductive effects, and causes histopathological changes in kidney and liver cells. The high daily dose estimate of ingested lead to the river otter using the maximum sediment and prey concentrations in the South Otter Sluice Aquatic unit was 0.056 mg/kg/day. The dose exceeded the low TRV for lead, which was based on a NOEL for reproductive effects in white rats (Krasovskii and others 1979), and exceeded a dose (allometrically converted to 0.004 mg/kg/day for the river otter) that was associated with an effect level for reproductive endpoints in the same study. Section of TRVs was based on quality of the study and

endpoints, which are considered the most ecologically relevant. The allometric conversion of the TRV from a rodent-equivalent dose to an otter-equivalent dose takes into account metabolic differences between species, but additional reasons may explain differences between species sensitivity to a chemical. Therefore, it is useful to evaluate the modeled dose with studies of other animals. The high modeled dose for the river otter was below an equivalent NOEL for endpoints of plasma levels, hematopoietic effects, and bone growth in beagle dogs fed lead acetate for 13 weeks (Delaquerriere-Richardson and others 1982). The modeled doses were also below a NOEL for reproductive effects in mice where the endpoint was measured as pup weight at birth (Draski and others 1989).

Nickel

No immediate and significant risk (HQ_1 and HQ_5 less than 1.0), or probable risk (HQ_3 less than 1.0), was indicated from nickel for the river otter at the South Otter Sluice Aquatic unit. A potential risk (HQ_2 greater than 1.0) was indicated for the river otter from nickel at the South Otter Sluice Aquatic unit. The HQ_2 was not high (1.36) and ambient concentrations of nickel yielded an HQ_2 of 0.99 for the river otter. The HQ_4 for nickel was less than 1.0, indicating little or no risk was posed to the typical river otter, where the typical dose was calculated using average life history parameters of body weight and ingestion rates and a conservative SUF. The TRV for nickel was determined by applying an uncertainty factor of 10 to a low-effect level for reproductive effects in rats using nickel chloride. Therefore, while the area high dose estimates for the otter in the South Otter Sluice Aquatic unit exceeded this NOEL, the doses were not associated with a known effect level. In addition, forms of nickel in sediment and soil are not expected to be as bioavailable or as readily absorbed from the gastrointestinal tract as nickel chloride. As a result, sources of nickel in the South Otter Sluice Aquatic unit are not expected to pose a risk to the river otter.

Selenium

Selenium may pose a slight potential risk (HQ_2 greater than 1.0) to the river otter at the South Otter Sluice Aquatic unit according to the food-chain model assumptions; however, little or no risk (HQ_4 less than 1.0) was indicated for the typical river otter based on a model incorporating average life history parameters. Also, using the 95th percent UCL for selenium concentration in sediment, instead of the measured maximum sediment concentration, resulted in little or no potential risk to the river otter because the HQ_2 was 0.96. Selenium, therefore, is not a concern to the river otter.

PCDDs and PCDFs

A potential risk (HQ_2 equal to 2.4 and HQ_4 equal to 1.1) from PCDDs and PCDFs was indicated for the river otter in the South Otter Sluice Aquatic unit based on the maximum concentration of dioxins in sediment. Using actual detected concentrations only to calculate a TEQ resulted in little or no risk (HQ_2 and HQ_4 less than 1.0). Fish tissue residues of PCDDs and PCDFs were not elevated as compared to RMP fish data (SFEI 1997).

The low TRV was based on a multi-generational study of fertility and pup weight of rats at birth and was a no-effect level. The low-effect level was 10 times greater than the low TRV. The modeled dose of dioxins to the otter was therefore not associated with reduced fertility or low birth weight. Dioxins, however, are known to cause several sublethal effects in animals including endocrine effects, immunotoxicity, and carcinogenicity at low exposures.

15.4.8.2 Risk to the Great Blue Heron in the South Otter Sluice Aquatic Unit

No immediate or significant risk (HQ_1 and HQ_5 less than 1.0) was indicated for the Great Blue Heron from exposure to chemicals present in the South Otter Sluice Aquatic unit. The potential risks (HQ_2 and HQ_4 greater than 1.0) to the heron from chemicals in the South Otter Sluice Aquatic unit are described in the following sections.

Lead

A potential risk (HQ_2 and HQ_4 greater than 1.0) was indicated for the heron from exposure to lead in the South Otter Sluice Aquatic unit. The HQ_2 and HQ_4 for the heron were high, 344 and 285, respectively. The HQs for ambient concentrations of lead were also high in the South Otter Sluice Aquatic unit (HQ_2 equals 146 and HQ_4 equals 127), indicating potential risk to the heron from ambient concentrations of lead. Most of the modeled dose of lead was from incidental sediment ingestion, rather than from prey; low prey concentrations indicate low bioavailability of this chemical. Model assumptions are particularly conservative because the TRV for lead was based on a study using lead acetate, a highly bioavailable form of lead, whereas forms of lead in sediment and soil are typically 10 to 20 percent less bioavailable than lead acetate (O'Flaherty 1998). The low TRV for lead was based on an endpoint of decreased egg production in Japanese quail. The high TRV was associated with

decreased egg production in chickens. The high and typical modeled doses of lead to the heron did not exceed the high TRV.

Lead can also have central nervous system, gastrointestinal, and neuromuscular effects. Lead also targets the kidneys, possibly causing renal effects at high doses. In birds, lead has been shown to decrease levels of ALAD, involved in hemesynthesis, at doses lower than the low TRV and therefore lower than the modeled dose to the heron in the South Otter Sluice Aquatic unit. Decreased ALAD levels may result in anemia. This endpoint, however, was not selected for the low TRV because it was not considered as ecologically relevant as reproductive effects.

Mercury

A potential risk (HQ_2 equals 2.19 and HQ_4 equals 1.81) was indicated for the Great Blue Heron from mercury when modeled using the maximum sediment concentration at the South Otter Sluice Aquatic unit according to the assumptions of the food-chain model; however, the HQs were only slightly above 1.0. The maximum sediment concentration in the South Otter Sluice Aquatic unit was 18.5 mg/kg, but the 95th percent UCL was 0.82 mg/kg. As a result, the risk from mercury is not widespread. Also, the TRV for mercury was based on methyl mercury, a highly bioavailable and toxic organic form of mercury. The mercury in the sediment was measured as total mercury and includes other forms of mercury besides organic forms. Mercury concentrations were low in fish in the South Otter Sluice Aquatic unit and 83 percent of the modeled dose to the heron was from sediment ingestion.

PCDDs and PCDFs

A potential risk to the Great Blue Heron was indicated using high and typical dose parameters (HQ_2 equal to 6.35 and HQ_4 equal to 5.26) from PCDDs and PCDFs in the South Otter Sluice Aquatic unit according to the model assumptions. The risk to the Great Blue Heron from dioxins appeared to be greater than to the rail according to the allometrically converted dose. However, Great Blue Herons have been shown to be more resistant to dioxins than other species of birds (Hart and others 1991). The high and typical modeled doses are between a NOEL and LOEL for decreased egg production. At levels below decreased egg production, dioxins have been associated with subcutaneous edemas and depressed growth of chick embryos (Hart and others 1991); however, other contaminants were simultaneously present. Dioxins are known to cause many different effects at very low doses, including endocrine disruption and immunotoxic effects. The mere presence of dioxins suggests that

sublethal effects can occur. As explained previously under risk to the otter from PCDDs and PCDFs, the levels of dioxins in otter and heron prey (fish) are not elevated at the site when compared to regional values and the dose was modeled conservatively using one-half the DL for nondetects.

15.4.8.3 Risk to the California Black Rail in the South Otter Sluice Aquatic Unit

No chemical posed a significant or immediate, or probable risk (HQ_1, HQ_3, and HQ_5 less than 1.0 for the California Black Rail. A discussion of the risk to the rail for each chemical where the HQ_2 was greater than 1.0 follows.

Lead

A potential risk to the California Black Rail (HQ_2 greater than 1.0) was indicated from lead at the South Otter Sluice Aquatic unit. Although the HQ_2 was 186 for lead concentrations in the South Otter Sluice Aquatic unit, the ambient concentrations of lead in the Tidal Area also reflected a potential risk to the rail because the ambient HQ_2 is 79.6. Most of the modeled dose in both cases was from incidental sediment ingestion; prey tissues did not contribute significantly to the dose (about 1 to 2 percent). The modeled doses of lead from South Otter Sluice Aquatic unit exceeded the NOEL (allometrically converted equivalent) for reproductive effects in the Japanese Quail. Effects on growth, survival, and reproduction are unlikely at these doses; however, other sublethal systemic effects of lead toxicity, such as hematopoietic effects, may be manifested in the rail at the South Otter Sluice Aquatic unit.

Mercury

A slight potential risk (HQ_2 equal to 1.04) was indicated for the California Black Rail from mercury using very conservative assumptions in a model that incorporated maximum sediment and tissue concentrations; however, the HQ_2 was only slightly above 1.0. The maximum sediment concentration (18.5 mg/kg) in the South Otter Sluice Aquatic unit was over a magnitude higher than the 95th percent UCL (0.82 mg/kg). As a result, the risk from mercury was probably much less than indicated by the conservatively determined area dose. The TRV for mercury was based on methyl mercury, a highly bioavailable and toxic organic form of mercury. The mercury in the sediment was measured as total mercury and likely included less toxic forms of mercury than the organic forms. The model assumptions are conservative and the HQ_2 only slightly exceeded 1.0; therefore, mercury is not expected to be a concern to rails in the South Otter Sluice Aquatic unit.

PCDDs and PCDFs

A potential risk (HQ_2 greater than 1.0) was indicated for the California Black Rail from exposure to PCDDs and PCDFs at the South Otter Sluice Aquatic unit. The maximum HQ_2 using the maximum concentrations in the South Otter Sluice Aquatic unit was 3.6. The HQ_3 was less than 1.0, so the conservative high dose does not exceed the high TRV. Model assumptions were conservative; the dioxins were summed using one-half the detection limit for nondetected PCDDs and PCDFs, which contributed significantly to the total concentrations in TEQs. If only detected concentrations were considered, little or no risk to the rail from dioxins would be indicated. Dioxins, however, are known to be potent at very low levels causing endocrine disruption and effects on the immune system. While effects on the endocrine and immune system are possible from exposures found in the South Otter Sluice Aquatic unit, the modeled dose using conservative assumptions was not associated with a dose that produced reproductive effects in pheasants.

15.4.8.4 Summary of Risk to Representative Receptors from Chemical Exposures in the South Otter Sluice Aquatic Unit

No immediate or significant risk (HQ_1, HQ_3, and HQ_5 less than 1.0) was indicated for the river otter, Great Blue Heron, or California Black Rail from any chemical in sediment of the South Otter Sluice Aquatic unit. A potential risk (HQ_2 and HQ_4 greater than 1.0) was indicated for the river otter from lead, nickel, and selenium, and PCDDs and PCDFs; for the Great Blue Heron from lead, mercury, and PCDDs and PCDFs; and for the California Black Rail from lead, mercury, and PCDDs and PCDFs at the South Otter Sluice Aquatic unit. None of the HQs was much greater than 1.0, except lead, and the model assumptions for the risk from lead are especially conservative.

Dioxins are ubiquitous in the environment but are not frequently measured because sensitive methods of analysis are relatively new and prohibitively expensive for routine analysis. As a result, regional data are scarce. Ambient sediment concentrations were not available from the RWQCB (1998) for dioxins. However, the concentrations of PCDDs and PCDFs in fish and clam tissue samples collected from the South Otter Sluice Aquatic unit were in the range of reported concentrations for fish collected from San Francisco Bay (State Water Quality Control Board and others 1996). The fish tissues for the South Otter Sluice Aquatic unit ranged from 0.4 to 0.9 ng/kg TEQs, and the range reported for fish from San Francisco Bay was 0.15 to 1.75 ng/kg, where the lower end of the range is halibut concentrations and the upper end is white croaker. Stormwater runoff contributes 98 percent of the

dioxins to the San Francisco Bay; some dischargers are regulated by a limit of 0.013 to 120 pg/L TEQ (RWQCB 1998). Atmospheric transport of dioxins from incinerators and nearby gasoline refineries are other likely sources of dioxins to the South Otter Sluice Aquatic unit. In the Wood Hogger Terrestrial unit, adjacent to the South Otter Sluice, wood was burned at an old incinerator site and may be a potential local source.

15.5 BACK-CALCULATION OF CONCENTRATIONS INDICATING NO RISK

Conservative food-chain model parameters used in the high or average dose calculation were further evaluated to determine the sediment or soil concentrations that would be required to indicate no risk (HQ less than or equal to 1.0). Specifically, soil or sediment concentrations were "back-calculated" from Tidal Area HQ_2s (for special status species) or HQ_4s (for typical representative receptors) to determine the concentration of a chemical that would produce an HQ less than or equal to 1.0. An evaluation of the soil or sediment concentration in the context of ambient concentrations and model assumptions can assist in risk management decisions. From a risk management context, back-calculated soil concentrations could be used in setting cleanup goals unless they prove to be unfeasible when the value is below the ambient concentration.

The back-calculated soil or sediment concentration is calculated by dividing the "unremediated" soil or sediment concentration by its HQ_2 (or HQ_4). For example, if the soil concentration yields an HQ_2 of 10, the soil concentration would need to be 10 times lower for the HQ_2 to be equal to 1.0. Thus, the back-calculated soil concentration is a threshold below which there is no risk. The prey tissue concentration is part of the dose, so this simplified back-calculation makes an assumption that the prey concentration will decrease proportionally with the soil concentration (if the soil is remediated). It is assumed a relationship exists between the soil concentration and the prey concentration, otherwise the merits of soil remediation would not be evaluated.

Table 15-1 summarizes the back-calculated concentrations for all chemicals that exceeded ambient concentrations in at least one sample location. When the back-calculated concentration is below ambient, as is the case with lead and nickel, the result indicates that cleanup cannot be conducted to levels that pose no risk under the assumptions of the food-chain model. When the back-calculated concentration of a chemical greatly exceeds ambient, the result implies that a cleanup could significantly contribute to reducing risk to receptors. Further assessment of the back-calculated concentration to evaluate areas posing risk is presented in Section 15.6.

15.6 IDENTIFICATION OF CHEMICALS OF ECOLOGICAL CONCERN AND AREAS POSING RISK

Based on the food-chain model results, all HQ_1 (low dose/high TRV), HQ_3 (high dose/high TRV), and HQ_5 (typical dose/high TRV) values were less than 1.0, indicating that there is no immediate or significant risk to any individual or typical receptor from the chemicals in any of the Tidal Area sites. To assess the areas posing a potential risk (that is, HQ_2 or HQ_4 value greater than 1.0), soil or sediment sample locations that contribute an incremental risk were identified. Sample locations that were identified as posing an incremental risk were those at which risk from a chemical to at least one receptor was indicated (that is, HQ_2 or HQ_4 value greater than 1.0), and the chemical concentration exceeded both the Tidal Area and San Francisco Bay (RWQCB 1998) ambient concentrations.

The locations where a potential incremental risk was identified for the Tidal Area are shown on Exhibit 18. Specifically, Exhibit 18 shows locations where the HQ_2 (special status species only) or the HQ_4 (typical receptors) is greater than 1.0 for birds and mammals. These HQ values were based on the maximum concentrations of site chemicals, as well as the maximum prey concentrations, and are therefore conservative representations of risk. HQ values for each sampling location, as well as areawide HQ values for each habitat unit (presented in boxes), are illustrated on Exhibit 18.

Ambient HQ values for selected metals are also provided in the legend on Exhibit 18. These ambient HQs characterize the incremental risk attributable to ambient conditions. Calculation of ambient HQs allows for comparison of the incremental risk associated with ambient conditions to that associated with site-specific concentrations of chemicals detected in soils. As shown on Exhibit 18, the ambient HQs for lead and nickel exceeded 1.0 for some receptors, indicating that even under ambient conditions, lead and nickel in soil pose an incremental risk based on the food-chain model assumptions.

As an additional line of evidence to assess the food-chain model results, soil or sediment concentrations were also "back-calculated" from Tidal Area HQ_2s (for special status species) or HQ_4s (for typical representative receptors) to determine the concentration of a chemical that would produce no risk (that is, an HQ less than or equal to 1.0). As discussed in Section 15.5, a back-calculated concentration that is below ambient indicates that cleanup cannot be conducted to levels that pose no risk under the assumptions of the food-chain model (that is, the HQ is greater than 1.0 even when ambient concentrations are used in the food-chain model). Conversely, when the back-calculated concentration

of a chemical greatly exceeds ambient, cleanup could significantly contribute to reducing risk to receptors.

The back-calculated concentrations are compared against both the maximum and the ambient concentrations of chemicals at the Tidal Area in Tables 15-1. Only the back-calculated HQ_2 values are presented in the tables since this value results in a lower concentration than the back-calculated HQ_4 value. Table 15-2 provides information for the terrestrial habitat units, and compares values against the Tidal Area ambient (99 percent UCL) concentrations. Table 15-3 provides information for the aquatic habitat units, and compares values against the RWQCB ambient sediment rather than the Tidal Area ambient levels because RWQCB criteria are more appropriate for aquatic environments. As shown on Tables 15-2 and 15-3, the back-calculated concentration for lead and nickel is below ambient, indicating that to achieve an HQ value of 1.0, cleanup to a level below the ambient concentration would be required.

The following paragraphs discuss the results of the food-chain model and identify risk drivers for birds and mammals in the Tidal Area. Additional information, including food-chain model assumptions, tissue residue results, back-calculated concentrations indicating no risk, and regional and ambient data are discussed as appropriate to assist in interpreting the food-chain model results.

Lead

As shown on Exhibit 18, lead poses a potential risk to birds and mammals at several locations across the Tidal Area. Lead was the only chemical where the HQ_2 and HQ_4 values were above 10.0 (with a maximum HQ_2 of 3,627 for the R Area Terrestrial unit). However, it should be noted that the TRV for lead was based on a laboratory study that used lead acetate; lead in soil is expected to be 10 to 20 percent as bioavailable as lead acetate (O'Flaherty 1998). As a result, the model is conservative and likely overestimates actual risks. This is supported by the fact that, as noted above, the back-calculated concentration for lead (0.24 mg/kg for Tidal Area aquatic habitats) that is associated with no risk is well below the ambient concentration (43.2 mg/kg based on RWQCB sediment data), indicating that to achieve an HQ value of 1.0, cleanup to well below ambient would be required. Therefore, lead is not considered to be a risk driver for birds and mammals at the Tidal Area.

Mercury

Mercury was also determined to pose a potential risk to birds and mammals, at two locations on the southern border between the Wood Hogger Terrestrial and South Otter Sluice Aquatic units where the HQ value was greater than 1.0. Although the risk calculated was low (HQ_2 just above 1.0 and HQ_4 less than 2.0 for the rail and heron), mercury is discussed in detail here because of its potential to bioaccumulate. It should be noted that the TRV for mercury which was used to calculate the HQ values was based on methyl mercury, a highly bioavailable and toxic organic form of mercury. The mercury in the site sediment, however, was measured as total mercury and includes other forms of mercury besides organic forms. As a result, the HQ values calculated for mercury likely overestimate the actual risk at the site. As another line of evidence, the concentrations of mercury in fish tissue collected from Otter Sluice (see Table 12-2) were evaluated to assess potential bioaccumulation of mercury; the data indicate that the concentrations of mercury in fish tissue were comparable to regional fish tissue data from the RMP (SFEI 1997). Therefore, mercury is not considered to be a risk driver for birds and mammals at the Tidal Area.

Other Inorganic COPECs

The HQ_2 and HQ_4 values that exceeded 1.0 for the remaining metals on Exhibit 18 (cadmium, copper, lead, manganese, nickel, and selenium) were only slightly above 1.0. In addition, they were present only in isolated locations throughout the site. Therefore, these metals are not considered to be risk drivers for birds and mammals at the Tidal Area.

Dioxins (PCDDs and PCDFs)

Soils within the southeast corner of the Wood Hogger Terrestrial unit pose a potential risk (HQ_2 or HQ_4 greater than 1.0) from dioxins (PCDDs and PCDFs) to birds and mammals, as shown on Exhibit 18. However, it should be noted that the model used to assess risk from dioxins was conservative, since the model used one-half of the detection limit for PCDDs and PCDFs even if these chemicals were not detected. Evaluation of the food-chain modeling results indicates that the majority of the calculated risks attributable to PCDDs and PCDFs were from locations that were actually below detection limits. If only detected concentrations were considered in the model, little or no risk from dioxins would be indicated. Therefore, dioxin is not considered a risk driver for birds and mammals at the Tidal Area

Other Organic COPECs

As shown on Exhibit 18, no other organic chemicals were identified that posed a potential risk (that is, all HQ_2 or HQ_4 values were less than 1.0 for organic chemicals). Therefore, these organic chemicals are not considered to be risk drivers for birds and mammals at the Tidal Area.

16.0 CONCLUSIONS AND RECOMMENDATIONS

This QEA evaluated whether chemicals at the Tidal Area sites present a significant risk to ecological receptors and whether the risk warrants further evaluation or a response action. A weight-of-evidence approach was used to identify receptors at risk from site chemicals. Tables 16-1 and 16-2 summarize the lines of evidence used in the weight-of-evidence approach, based on habitat area and assessment endpoints, respectively. The main objectives of the risk characterization process were to identify (1) receptors at immediate or potential risk, and (2) the spatial distribution of exposure point concentrations that present the greatest potential for risk. Information and data used in the weight-of-evidence approach included the following:

- Analytical chemistry
- Toxicity tests
- Tissue residues
- Food-chain analysis
- Literature reviews

COPECs for each receptor group were identified using screening methods described in Section 5.0. COPECs for plants, soil biota, and invertebrates were identified by screening inorganic chemicals against RWCQB ambient concentrations (1998), Tidal Area ambient (99th percent UCL) concentrations, and ER-Ls. COPECs for fish and aquatic herpetofauna were identified by screening surface water data against AWQCs. For all receptors except birds and mammals, chemicals that exceeded the screening values, or for which no screening value was available, were identified as COPECs. Chemicals that exceeded ambient concentrations in soils or sediments were considered COPECs for birds or mammals and were evaluated using food-chain modeling.

A food-chain analysis, using site-specific prey, soil, and sediment concentrations, was used to estimate the daily dose to representative avian and mammalian receptors. Estimated doses of chemicals were compared to TRVs as the primary line of evidence for evaluating risk to birds and mammals at the site. The food-chain analysis used to evaluate exposure of representative receptors to site contamination was based on the HQ approach, where site-specific daily doses were compared to TRVs (HQ equal to

ingested dose/TRV). Section 15.0 presented the HQ approach and the risk evaluation to birds and mammals.

COECs for each receptor group were identified by evaluating the frequency and magnitude of exceedances of benchmarks and by evaluating toxicity and bioaccumulation. Once COECs were identified for each receptor group, risk was assessed using a weight-of-evidence approach focused on the lines of evidence specific to each receptor group. Tables 16-1 and 16-2 present the weight-of-evidence summary by habitat unit and assessment endpoint, respectively. The weight of evidence by site is provided in the following subsections.

16.1 RISK ASSESSMENT CONCLUSIONS

The following subsections summarize the weight of evidence for Tidal Area sites, based on the aquatic and terrestrial habitat units that are present within each site. Otter Sluice is evaluated separately in the following discussion.

16.1.1 Tidal Area Landfill Site

Soil, sediment, leachate, and surface water samples were collected only from the perimeter of the Tidal Area Landfill Site as part of the QEA. The Tidal Area Landfill has progressed to the ROD phase, and is being addressed separately. However, the potential risk from chemicals at the perimeter of the landfill as a potential source to the adjacent R Area Disposal Site, is evaluated as part of this report.

No inorganic chemicals exceeded the ER-M values in more than one sample. For organic chemicals, exceedances of the ER-M for total PCBs and total chlordanes were based on the use of one-half the detection limit, versus actual detections. Statistical evaluations were also conducted on the data to evaluate extreme or outlier values that may indicate site releases. Lead and arsenic were identified as outliers in two of eight soil samples. Arsenic and copper were identified as extreme values in one sample. Maximum soil concentrations of nickel, zinc, DDTs, chlordanes, and LMW PAHs exceeded the ER-M. Organic HIs based on ER-Ls in soil samples ranged from 4.3 to 153.

In surface water, aluminum, copper, and nickel, exceeded AWQCs in at least one sampling quarter. Of the organic chemicals detected in surface water, only chlordanes and PAHs exceeded AWQCs; however, it should be noted that exceedances were based on one-half the detection limit if these chemicals were not actually detected in the samples.

Pickleweed was not collected from the Tidal Area Landfill Site, but was collected from the adjacent R Area Disposal Site where soil conditions are similar. Neither arsenic nor lead were detected in pickleweed from the R Area Disposal Site. Copper levels were below risk thresholds in the R Area Disposal Site in plants collocated with high soil concentrations of copper. Therefore, none of the inorganic COPECs are expected to pose a risk to plants in this unit.

Zinc could pose a potential risk to soil biota including earthworms according to soil benchmarks (CDFG PRGs). However, zinc is considered to pose minimal risk at this site due to the neutral pH of the soil and the scattered distribution of zinc.

Based on the food-chain model results, all HQ_1 (low dose/high TRV), HQ_3 (high dose/high TRV), and HQ_5 (typical dose/high TRV) values were less than 1.0, indicating that there is no immediate or significant risk to birds and mammals from the chemicals at the Tidal Area Landfill.

Based on the available lines of evidence, risk to ecological receptors at the perimeter of the Tidal Area Landfill is considered minimal, and no response action is recommended.

16.1.2 R Area Disposal Site

Soil, sediment, leachate, surface water, and tissue samples were collected throughout the R Area Disposal Site as part of the QEA. Inorganic and organic chemicals that exceeded ER-M values in a few samples included lead, zinc, and 4,4-DDT. Based on statistical analyses, lead and arsenic were identified as outliers in single soil and sediment samples. Barium, cobalt, manganese, and nickel were identified as extreme values in single samples. Lead exceeded ambient values in many samples, but exceeded the ER-M in just five of 94 soil samples. The maximum lead concentration was measured near the railroad tracks, near Froid Road (sample location RADSBG08). However, lead was (1) infrequently detected at elevated concentrations; (2) highest in areas of limited ecological value; (3) largely unavailable due to neutral pH; and (4) not likely to migrate out of the bermed R Area Disposal Site. Because the maximum concentration of lead is at a location with poor habitat quality and there are limited pathways to receptors of concern, it will not be evaluated further. Of the organic chemicals detected, only DDTs and chlordanes exceeded ER-Ms.

In surface water, lead, mercury, and zinc exceeded AWQCs in at least one sampling quarter. Of the organic chemicals detected in surface water, only chlordanes exceeded AWQCs; however, it should be

noted that the exceedance of chlordanes was based on one-half the detection limit if these chemicals were not actually detected in the samples.

Lead was not detected in pickleweed tissues collected from the R Area Disposal Site, but did exceed AWQCs in surface waters, indicating some risk to fish and herpetofauna in aquatic portions of the R Area Disposal Site. Lead was detected in rodent tissues from the R Area Disposal Site. Based on the food-chain model results, all HQ_1 (low dose/high TRV), HQ_3 (high dose/high TRV), and HQ_5 (typical dose/high TRV) values were less than 1.0, indicating that there is no immediate or significant risk to birds and mammals from the chemicals at the R Area Disposal Site.

Limited risk to soil biota and terrestrial invertebrates was identified; however, this was based on a few limited exceedances of the ER-Ms. Review of the chemical distributions did not reflect widespread contamination nor indicate a potential source for these exceedances.

Based on the available lines of evidence, risk to ecological receptors at the R Area Disposal Site is considered minimal, and no response action is recommended.

16.1.3 Froid and Taylor Roads Site

Soil, sediment, leachate, surface water, and tissue samples were collected throughout the Froid and Taylor Roads Site as part of the QEA. No inorganic chemicals exceeded the ER-M values in more than one sample. For organic chemicals, exceedances of the ER-M were based on the use of one-half the detection limit, versus actual detections. Based on statistical analyses, aluminum, lead, and manganese were identified as outliers in single soil and sediment samples. Lead and zinc were identified as extreme values in single samples. Chlordanes exceeded ER-M in four soil and sediment samples, with a maximum concentration of technical chlordanes (mix of chlordane and closely related chemicals) of 190 μg/kg. The organic chemical HI, based on the concentrations of organic chemicals divided by their ER-Ls, was 156.6.

Chlordane levels in fish and amphipods collected at the site were lower than fish and invertebrate tissues reported in the RMP data (SFEI 1997). Based on the food-chain model results, all HQ_1 (low dose/high TRV), HQ_3 (high dose/high TRV), and HQ_5 (typical dose/high TRV) values were less than 1.0 using the maximum concentrations of chlordanes, indicating that there is no immediate or significant risk to birds and mammals from the chemicals at the Froid and Taylor Roads Site.

Limited risk to soil biota and terrestrial invertebrates was identified; however, this was based on a few limited exceedances of the ER-Ms. Review of the chemical distributions did not reflect widespread contamination nor indicate a potential source for these exceedances. Chlordane is expected to remain in place, as no culverts transport surface waters from the terrestrial to the aquatic unit.

Based on the available lines of evidence, risk to ecological receptors at the Froid and Taylor Roads Site is considered minimal, and no response action is recommended.

16.1.4 Wood Hogger Site

Soil, sediment, leachate, surface water, and tissue samples were collected throughout the Wood Hogger Site as part of the QEA. Inorganic and organic chemicals that exceeded ER-M values in a few samples included mercury and 4,4-DDT. For total DDT, total chlordanes, total PAHs, and total PCBs, exceedances of the ER-M were based on the use of one-half the detection limit, versus actual detections. Based on statistical analyses, antimony, lead, and zinc were identified as outliers in single soil and sediment samples. Antimony, cadmium, copper, lead, mercury, selenium, and zinc were identified as extreme values in single samples.

Elevated concentrations of chemicals at the Wood Hogger Site are clustered in the southwest corner, near the former incinerator. The maximum organic HI of 483 at the Wood Hogger Site (sample location WHSSB015) was based on comparisons to ER-Ls. Dieldrin, at 6.0 μg/kg, contributed 62 percent of the HI; the ER-L for dieldrin (0.02 μg/kg) is conservative and Long and Morgan (1991) place a low confidence in the ER-L. DDTs, dieldrin, chlordanes, PCBs, and dioxins are ubiquitous and persistent in San Francisco Bay (SFEI 1997), as well as in the Tidal Area.

Selected inorganic chemicals exceeded soil benchmarks for terrestrial invertebrates, and may pose a risk to organisms living in direct contact with the soil. However, the Wood Hogger is a disturbed site, used for industrial purposes with limited ecological relevance. The habitat quality is poor in the southwest corner of the Wood Hogger due to previous industrial activity. Soil tilth and nutrient availability are also poor. Nutrient deficiency in copper and zinc were also indicated in pickleweed tissues.

The field sampling event of 1998 was implemented in part to address the Navy's concerns that dioxins present at the Wood Hogger Site were being transported into Otter Sluice and taken up by fish. In fact,

dioxin levels in fish tissues from Otter Sluice did not differ from those caught in San Francisco Bay. In addition, dioxins were below the detection limits in sediments in Otter Sluice.

Based on the food-chain model results, all HQ_1 (low dose/high TRV), HQ_3 (high dose/high TRV), and HQ_5 (typical dose/high TRV) values were less than 1.0 using the maximum concentrations of chemicals at the site. There was a potential risk (HQ_2 or HQ_4 greater than 1.0) to birds and mammals from dioxins. However, it should be noted that the model used to assess risk from dioxins was conservative, since the model used one-half of the detection limit for PCDDs and PCDFs even if these chemicals were not detected. Evaluation of the food-chain modeling results indicates that the majority of the calculated risks attributable to PCDDs and PCDFs were from locations that were actually below detection limits. If only detected concentrations were considered in the model, little or no risk from dioxins would be indicated. Therefore, dioxin is not considered a risk driver for birds and mammals.

Based on the available lines of evidence, risk to ecological receptors at the Wood Hogger Site is considered minimal, and no response action is recommended.

16.1.5 Otter Sluice

Sediment, leachate, surface water, tissue, and bioassay samples were collected throughout Otter Sluice as part of the QEA. No inorganic chemicals exceeded the ER-M values in more than one sample. For organic chemicals, exceedances of the ER-M for total PAHs were based on the use of one-half the detection limit, versus actual detections. Based on statistical analyses, aluminum and arsenic were identified as outliers in single soil and sediment samples. Antimony, arsenic, copper, chromium, lead, mercury, molybdenum, and selenium were identified as extreme values in single samples.

In surface water, aluminum, chromium, copper, lead, mercury, nickel, and zinc exceeded AWQCs in at least one sampling quarter. Of the organic chemicals detected in surface water, 4,4-DDT, dieldrin, endrin, heptachlor, total chlordanes, and total PAHs exceeded AWQCs. It should be noted that the exceedance of chlordanes and PAHs was based on one-half the detection limit if these chemicals were not actually detected in the samples.

Chlorinated pesticides, DDTs, PCBs, and dioxins detected in fish and clam tissues were within the range of reported values for fish and/or bivalves in Suisun Bay or nearby Grizzly Bay. Dioxins were not detected in Otter Sluice sediments.

Six of 45 sediment samples exceeded the ER-M for mercury (0.71 ppm) in Otter Sluice. The maximum mercury concentration in sediments of South Otter Sluice was 18.5 mg/kg. Mercury was detected in sediments along a gradient in Otter Sluice near the southwestern boundary of the Wood Hogger Site.

Based on the food-chain model results, all HQ_1 (low dose/high TRV), HQ_3 (high dose/high TRV), and HQ_5 (typical dose/high TRV) values were less than 1.0 using the maximum concentrations of chemicals at the site. A potential risk (HQ_2 or HQ_4 greater than 1.0) to birds and mammals from mercury was also determined to pose a potential risk to birds and mammals at two locations on the southern border between the Wood Hogger Site and South Otter Sluice. Although the risk calculated was low (HQ_2 just above 1.0 and HQ_4 less than 2.0 for the rail and heron), mercury is discussed in detail here because of its potential to bioaccumulate. It should be noted that the TRV for mercury, which was used to calculate the HQ values, was based on methyl mercury, a highly bioavailable and toxic organic form of mercury. The mercury in the site sediment, however, was measured as total mercury and includes other forms of mercury besides organic forms. As a result, the HQ values calculated for mercury likely overestimate the actual risk at the site. As another line of evidence, the concentrations of mercury in fish tissue collected from Otter Sluice (see Table 12-2) were evaluated to assess potential bioaccumulation of mercury; the data indicate that the concentrations of mercury in fish tissue were comparable to regional fish tissue data from the RMP (SFEI 1997). Therefore, mercury is not considered to be a risk driver for birds and mammals at the Tidal Area.

The sediments from Otter Sluice were also tested using a SWI test with topsmelt embryo. The two SWI topsmelt tests performed on samples adjacent to the southwest corner of Otter Sluice had the highest hatching success, and were not significantly different than controls. The remaining SWI tests showed toxicity; however, results were inconclusive due to potential confounding factors. Statistical evaluations indicated that the topsmelt data did not correlate well with sediment chemistry. Whole sediment amphipod bioassays were also conducted in Otter Sluice; no sediment samples from Otter Sluice were found to be toxic to amphipods.

Based on the available lines of evidence, risk to ecological receptors at Otter Sluice is considered minimal, and no response action is recommended.

16.2 UNCERTAINTY ANALYSIS

Uncertainty plays an important role in risk-based decision-making and is therefore incorporated explicitly into the risk characterization. Identifying known sources of uncertainty is more useful than using conservative default assumptions because potential error is made more explicit in the risk management process (Suter 1993).

Three sources of uncertainty in ERAs are described in Suter (1993):

1. Mistakes in execution of assessment activities (errors such as incorrect measurements, data recording errors, and computational errors)

2. Imperfect knowledge of factors that could be known (ignorance about some aspect of the ecosystem that may be relevant such as assumptions used in dose models, practical constraints on the ability to measure everything, and lack of knowledge on toxicological effects of all chemicals on all species)

3. Inherent randomness of the world (stochasticity in physical or biological processes that may affect assumptions or actual risk such as variation in population parameters or rainfall patterns)

The complexity of ecological systems tends to increase the level of uncertainty involved in ERAs as compared to HHRAs. Using realistic assumptions and multiple lines of evidence is the best approach to reducing the uncertainty associated with ERA conclusions. The following sections briefly review some sources of uncertainty with this risk assessment.

16.2.1 Sampling and Data Analysis

Sample data collected from the site must be used to evaluate conditions of the whole site; all measured parameters are therefore only estimates with associated error. The sample size was more than adequate for characterization of soil and sediment concentrations. Thus, the nature and extent of contamination was considered well characterized, leaving little uncertainty in this regard. The relatively high detection limits for some organic chemicals is the main source of uncertainty in the interpretation of site concentrations of some organics.

Data were validated and determined to be of high usability, data computations and summary tables were double checked. Data quality, as identified and defined in the QAPP, was not considered an important source of uncertainty.

16.2.2 Screening Values

Screening values, including ambient values, ER-Ls, and AWQCs, used to identify COPECs and determine level of risk to receptors include multiple sources of uncertainty. Although these values were based on numerous studies, they include taxa not relevant to site receptors, and only represent an estimate of real effects. Effects on receptors at the site may be underestimated or overestimated based on this approach; however, currently this is the best method available for preliminary screening of chemical levels. These types of screening values were not available for all chemicals; some COPECs could not be adequately evaluated given current knowledge. Most of the screening values employed were based on single contaminant scenarios; the effect of multiple chemical stressors operating synergistically or antagonistically was not incorporated into this level of screening.

Screening values are based on total concentrations and do not address uncertainty associated with chemical speciation (some forms are more toxic than others) or level of bioavailability of chemicals. In general, this type of uncertainty is expected to have resulted in an overestimation of risk at the Tidal Area sites.

16.2.3 Toxicity Tests

Toxicity tests are a standard methodology in risk assessment; however, laboratory bioassays do not exactly duplicate exposure and toxicity in the field. Noncontaminant stressors, such as grain size and ammonia, can also confound interpretation of results.

16.2.4 Hazard Quotients and Hazard Indices

The HQ and HI approach used in comparing site chemicals to screening values or ingested doses to TRVs is commonly employed in ERAs (EPA 1992; Tiebout and Brugger 1995). An HQ greater than 1.0 is generally considered to indicate a potential for risk; however, the HQ cannot be used to gauge either the probability or magnitude of effects. The HQ approach has been criticized (Tiebout and Brugger 1995) and caution should be exercised in the interpretation of HQs.

16.2.5 Tissue Residue Data

Tissues from plants, invertebrates and vertebrates were analyzed for target chemicals. These field-collected tissue samples provide an empirical measure of the transfer of chemicals from the

physical matrix to biological tissue. Deviations from collocation of tissue and sediment can limit the interpretation of bioaccumulation. The sampling design for the Tidal Area sites included collocated tissue and abiotic samples as much as was practicable.

The use of models to estimate exposure of receptors to chemicals and the associated accumulation of target chemicals in tissues is a predominant source of uncertainty that was addressed empirically with the collection of site-specific tissue samples to reduce the degree of uncertainty in exposure and in the biological fate of target chemicals. However, variable parameters such as ingestion rates and body size contribute to the uncertainty in the output of the food-chain model.

The principal tools for evaluating exposure to vertebrate receptors center on food-chain analysis. The biological, and more specifically, the physiological basis of uptake, depuration, and incorporation of target chemicals into receptor tissues is poorly understood, yet the food-chain analysis yields a conservative estimate of ingested dose in the absence of quantitative estimates of assimilation efficiency.

16.2.6 Uncertainty Associated with the Evaluation of Risk to Birds and Mammals

Uncertainty associated with the derivation and use of TRVs is described in "Development of Toxicity Reference Values as Part of a Regional Approach for Conducting Ecological Risk Assessments at Naval Facilities in California" (EFA WEST 1998). Allometric conversion was incorporated into the derivation of TRVs for site-specific receptors; use of this type of body scaling to extrapolate between taxa is a source of uncertainty, as the underlying assumption that a given effect on a small bird is the same as on a larger bird per unit body weight may not be true.

The use of allometric conversions in interspecies extrapolations has already been discussed (see Section 15.3.1). The use of assessment endpoint species as surrogates for other related or ecologically similar taxa is supported by current guidance; however, it should be recognized that differences among taxa are not accounted for in this type of analysis and that uncertainty exists in regard to assessments of risk to whole communities based on detailed analysis of relatively few taxa.

Individuals within a population vary in several life history and behavioral traits. The dose models incorporated some of this variability by estimating high, low, and typical values for most model parameters. However, the majority of these models are focused on adult individuals and may not

accurately represent ingestion of chemicals by small juvenile stages that may feed in a different manner. Even among adults of the same population, there may be considerable individual variation in factors that affect exposure.

The ingestion rates and receptor body weight are considered "life-history" parameters. Literature-reported values were used for each life-history parameter. The available literature may provide only one number, a set of numbers or a range for each parameter. Sometimes data from surrogate species are used when data are unavailable for a specific receptor. Because of the uncertainty and/or variability in reported life-history parameters, upper and lower boundaries and sometimes average values are substituted in the dose model.

The SUF is a ratio of the size of the habitat range for an individual compared to the site being evaluated in the risk assessment. For an animal with a small foraging area, such as the salt marsh harvest mouse, it is assumed that the animal will spend 100 percent of its time on the site, and the SUF is set equal to 1.0. A lower SUF has the effect of "diluting" the dose if the site is more contaminated than the rest of the environment in which the animal feeds. This was taken into consideration when applying SUFs less than 1.0.

Uncertainty exists in predicting risk when concentrations are below detection. However, for some chemicals the tissue concentrations can be used to estimate non-detected sediment concentrations. Concentrations of chlorinated dioxins/furans are generally about an order of magnitude greater in sediments than in tissues of aquatic biota (Rifkin and Bouwer 1994). The average BAF of 11 literature-reported values for fish was 0.09 (Rifkin and Bouwer 1994). The BAFs for 1,2,3,4,6,7,8,9-OCDD in tissues from the Tidal Area were 0.024 for clam, and 0.004 for fish (based on concentration, not TEQ). OCDD was found in higher concentrations in clam and fish tissues from the Tidal Area than were other dioxin congeners. Bonn (1998) reported that OCDD and furans were found in greater concentrations than were less-chlorinated dioxins and furans in sediments. Although it is not expected that all congeners would have the same BAF, if the BAFs for the OCDD are used to estimate the overall concentration of PCDD and PCDF in sediment, the sediments would contain a maximum of 0.23 μg/kg TEQ, or less than 10 percent of the calculated TEQs based on summing with one-half the detection limit for nondetects. If the BAF is accurate, then the HQs should be 10 percent of what is calculated, supporting the conclusion that PCDDs and PCDFs pose little or no risk to any receptor.

The food-chain model approximates the oral exposure of a chemical to a receptor. Exposure routes of inhalation and dermal absorption are thus not included. For most chemicals under most circumstances, inhalation and dermal absorption are expected to contribute only negligibly to the total dose.

Bioavailability is a major aspect of uncertainty because laboratory experiments are designed for (biased towards) achieving toxic effects. Laboratory animals are dosed with soluble forms of metals, for example, in order to achieve maximum exposure (absorption and accumulation) of the chemical. Metals complexed in soils and sediments typically are not as bioavailable as soluble salts. For example, the TRVs for lead were based on laboratory studies using lead acetate (a soluble lead salt). The relative bioavailability of lead from soils contaminated with lead from mine tailings is about 10 to 20 percent as bioavailable as lead acetate mixed in soil (O'Flaherty 1998). Therefore, when possible, tissue residue data from animals collected from the site need to be evaluated in order to test certain hypotheses with respect to bioavailability.

TRVs were derived for total PCBs based on toxicological studies using commercial mixtures of PCBs (Aroclors). In the environment, the relative amount of the individual congeners may have changed from the original Aroclor mixtures due to differential partitioning or degradation rates of the individual congeners. The difference between the composition of the PCB mixtures (Aroclors) tested in the toxicology studies upon which the TRVs are based and the composition of congeners present in the environmental samples adds to uncertainty in predicting the actual risk to the receptors.

In general, the effect of mixtures of chemicals is not addressed; rather, the effects of each chemical are evaluated individually. However, an assumption is often made that the combined effect of chemicals of similar modes of action will result in an additive effect (the combined effect on the organism is equal to the sum of the individual chemicals present). This is often not the case. There could be synergistic or antagonistic effects of chemical mixtures. Synergistic means that the combined effect is more than additive; the presence of one chemical can enhance the effect of another. Antagonism means that the combined effect of two or more chemicals is less than what would be predicted by summing the total. Non-additive effects can occur when chemicals compete for active binding sites, or when the presence of one type of chemical either up-regulates or down-regulates a gene which is involved in the mechanism of action of another type of chemical. The Tidal Area QEA addressed the uncertainty resulting from non-additivity of effects by conducting two toxicity tests.

Tissue residues are used to reduce the uncertainty resulting from the biases of laboratory studies. The effects of mixtures, the issue of bioavailability, and in general, the differences between animals exposed in the laboratory and the field can be addressed by evaluating tissue residues of surrogate species such as the house mouse as a proxy for the salt marsh harvest mouse.

16.3 RECOMMENDATIONS

As discussed in Section 1.0, the objective of the QEA was to identify risk to ecological receptors resulting from site activities at the Tidal Area. Based on agency comments on the draft QEA (PRC 1997), additional sampling was conducted to address data gaps that were identified. The objectives of the 1998 field investigation were developed in a series of meetings held with the regulatory agencies in early 1998. It was agreed that the overall objectives would be to focus on following data gaps:

- Characterize the nature, extent, and toxicity of potential contamination in Otter Sluice by collecting sediment, surface water, and tissue samples, and conducting bioassays.
- Characterize the nature and extent of dioxins associated with historical incineration near the Wood Hogger, and analyze rodent tissues from this site for metals, pesticides, and dioxins.
- Provide site-specific dose estimates of chemicals ingested by birds and mammals for comparison to TRVs by analyzing tissues of resident animals.
- Document the presence or absence of several special-status species through field surveys.

To meet these objectives, additional data was collected to characterize the nature, extent, toxicity, and potential contamination in the Tidal Area sites, including Otter Sluice. In addition to collecting soil, sediment, and surface water samples, tissue samples were collected and bioassays conducted to support the Navy's evaluation of risk at the Tidal Area sites. In addition, ecological surveys were conducted to evaluate the presence or absence of special-status species.

A weight-of-evidence approach was used to evaluate all of the data available and useable for risk assessment. Tables 16-1 and 16-2 summarize the contribution of several lines of evidence to risk characterization. Based on the weight-of-evidence evaluation, sufficient environmental data exist to support a decision for the Tidal Area.

The recommendations for each site based on the weight of evidence is as follows.

Tidal Area Landfill Site (Site 1)

The Tidal Area Landfill has progressed to the ROD phase, based on a presumptive remedy (capping), and is being addressed separately from the other Tidal Area sites. However, the risk from chemicals at the perimeter of the landfill as a potential source of chemicals to the adjacent R Area Disposal Site is evaluated as part of this report. Lines of evidence evaluated during the QEA included soil, sediment, leachate, and surface water chemistry; and assessment of risks to plants, invertebrates, herpetofauna, birds, and mammals. Based on the weight of evidence, chemicals from the landfill do not pose a risk to ecological receptors to adjacent Tidal Area sites. Therefore, no further evaluation or response action is recommended for the perimeter of the Tidal Area Landfill.

R Area Disposal Site (Site 2)

Lines of evidence evaluated during the QEA for the R Area Disposal Site included soil, sediment, leachate, surface water, and tissue chemistry; and assessment of risks to plants, invertebrates, herpetofauna, birds, and mammals. Based on the weight of evidence, chemicals from the R Area Disposal Site do not pose a risk to ecological receptors. Therefore, no further evaluation or response action is recommended for the R Area Disposal Site.

If restoring tidal connections becomes a future management option in order to return the diked wetland to its former status as a tidal wetland, the potential consequences of renewing links between the Suisun Bay and the Tidal Area wetlands with known contamination history should be considered.

Froid and Taylor Roads Site (Site 9)

Lines of evidence evaluated during the QEA for the Froid and Taylor Roads Site included soil, sediment, leachate, surface water, and tissue chemistry; and assessment of risks to plants, invertebrates, fish, herpetofauna, birds, and mammals. Based on the weight of evidence, chemicals from the Froid and Taylor Roads Site do not pose a risk to ecological receptors. Therefore, no further evaluation or response action is recommended for the Froid and Taylor Roads Site.

Wood Hogger Site (Site 11)

Lines of evidence evaluated during the QEA for the Wood Hogger Site included soil, sediment, leachate, surface water, and tissue chemistry; and assessment of risks to plants, invertebrates,

herpetofauna, birds, and mammals. Based on the weight of evidence, chemicals from the Wood Hogger Site pose minimal risk to ecological receptors. Therefore, no further evaluation or response action is recommended for the Wood Hogger Site.

Otter Sluice

Otter Sluice was evaluated as a separate habitat unit for the Tidal Area sites. Lines of evidence evaluated during the QEA for the Otter Sluice included soil, sediment, leachate, surface water, and tissue chemistry; bioassays; and assessment of risks to plants, invertebrates, fish, herpetofauna, birds, and mammals. Based on the weight of evidence, chemicals pose minimal risk to ecological receptors in Otter Sluice. Therefore, no further evaluation or response action is recommended for Otter Sluice.

Summary of Recommendations

The objectives of the QEA, which were developed in a series of meetings held with the regulatory agencies, were to identify risk to ecological receptors resulting from site activities at the Tidal Area. Based on the weight-of-evidence evaluation, sufficient environmental data exist to support a decision for the Tidal Area. Decisions for a Comprehensive Environmental Response, Compensation, and Liability Act site, such as the Tidal Area, reflect input by all parties involved in the risk assessment process, including the Navy, EPA, DTSC, RWQCB, USFWS, NOAA, CDFG, and the public. The Navy's recommendation is that no further evaluation or response action be required for the Tidal Area sites.

REFERENCES

Abbasi, S.A. and R. Soni. 1983. "Stress-Induced Enhancement of Reproduction in Earthworm Octochaetus pattoni Exposed to Chromium (VI) and Mercury (II) - Implications in Environmental Management." *International Journal of Environmental Studies*. Volume 22. Pages 43-47.

Ables, E.D. 1969. "Home Range Studies of Red Foxes (*Vulpes vulpes*)." *Journal of Mammalogy*. Volume 50. Pages 108 through 120.

Adriano, D.C. 1986. *Trace Elements in the Terrestrial Environment*. Springer Verlag. New York.

Agency for Toxic Substances and Disease Registry (ATSDR). 1990. "Toxicological Profile for Barium." U.S. Department of Health and Human Services, Public Health Service, ATSDR. Atlanta, Georgia.

ATSDR. 1992. "Toxicological Profile for Thallium." U.S. Department of Health and Human Services, Public Health Service, ATSDR. Atlanta, Georgia.

ATSDR. 1993c. "Toxicological Profile for Phenol." U.S. Department of Health and Human Services, Public Health Service, ATSDR. Atlanta, Georgia.

ATSDR. 1995a. "Toxicological Profile for Aluminum." U.S. Department of Health and Human Services, Public Health Service, ATSDR. Atlanta, Georgia.

ATSDR. 1995b. "Toxicological Profile for Antimony." U.S. Department of Health and Human Services, Public Health Service, ATSDR. Atlanta, Georgia.

ATSDR. 1995c. "Toxicological Profile for Phenol." U.S. Department of Health and Human Services, Public Health Service, ATSDR. Atlanta, Georgia.

ATSDR. 1995d. "Toxicological Profile for Lead." U.S. Department of Health and Human Services, Public Health Service, ATSDR. Atlanta, Georgia.

Amdur, M.O., J. Doull, and C.D. Klaassen. 1991. *Casarett and Doull's Toxicology: The Basic Science of Poisons*. Fourth Edition. McGraw-Hill Inc. New York.

ASTM. 1995. "Standard Test Methods for Measuring the Toxicity of Sediment-Associated Contaminants with Freshwater Invertebrates." ASTM E 1706. *Annual Book of Standards, ASTM*. West Conshohocken, Pennsylvania.

ASTM. 1997. "Standard Guide for Measuring the Presence of Planar Organic Compounds Which Induce CYP1A, Using Reporter Gene Test Systems." *Annual Book of ASTM Standards*. Volume 11.05. ASTM. Philadelphia, Pennsylvania.

Anderson, A. 1970. "A Preliminary Study of the Relationship of Saltponds and Wildlife – South San Francisco Bay." California Department of Fish and Game (CDFG). Volume 56. Number 4. Pages 240 through 252.

Anderson, J.W. 1995. "Using a Biomarker (P450 RGS) Test Method on Environmental Samples." In: *Techniques in Aquatic Toxicology*. G.K. Ostrander, Editor. Lewis Publishers/CRC Press, Inc. Boca Raton, Florida.

Anderson, B.S., D.P.Middaugh, J.W. Hunt, and S.L. Turpen. 1991. "Copper Toxicity to Sperm, Embryos, and Larvae of Topsmelt Atherinops affinis, with Notes on Induced Spawning." *Marine Environmental Research*. Volume 31. Pages 17 through 35.

Anderson, J.W., S.S. Rossi, R.H. Tukey, T. Vu, and L.C. Quattrochi. 1995. "A Biomarker, P450 RGS, for Assessing the Induction Potential of Environmental Samples." *Environmental Toxicology and Chemistry*. Volume 14. Pages 1,159 through 1,169.

Anderson, B.S., J.W. Hunt, M. Hester, and B.M. Phillips. 1996. "Assessment of Sediment Toxicity at the Sediment-Water Interface." In: *Techniques in Aquatic Toxicology*. G.K. Ostrander, Editor. CRC Press, Boca Raton, Florida. Pages 609 through 623.

Angus, T.H. 1991. "Criteria for Choosing Indicator Species for Ecological Risk Assessments at Superfund Sites." 101/F-90/051. U.S. Environmental Protection Agency, Office of the Administrator. Washington, D.C.

Ankley, G.T., N.A. Thomas, D.M. DiToro, D.J. Mahoney, W.J. Berry, R.C. Swartz, R.A. Hoke, A.W. Garrison, H.E. Allen, and C.S. Zarba. 1994. "Assessing Potential Bioavailability of Metals in Sediments: A Proposed Approach." *Environmental Management*. Volume 18. Number 3. Pages 331 through 337.

Arthur, J.F. and M.D. Ball. 1979. "Factors Influencing the Entrapment of Suspended Material in the San Francisco Bay-Delta Estuary." In: *San Francisco Bay: Urbanized Estuary*. T.J. Conomos, Editor. Pacific Division, American Association for the Advancement of Science. San Francisco, California.

Arthur, M.F. and J.I. Frea. 1988. "Microbial Activity in Soils Contaminated with 2,3,7,8-TCDD." *Environmental Toxicology and Chemistry*. Volume 7. Pages 5 through 13.

Balling, S.S. and V.H. Resh. 1983. "The Influence of Mosquito Control Recirculation Ditches on Plant Biomass, Production, and Composition in Two San Francisco Bay Salt Marshes." *Estuarine Coastal Shelf Science*. Volume 16. Pages 151 through 161.

Bay Basin Plan (California Regional Water Quality Control Board, San Francisco Bay Region) . 1986. "Water Quality Control Plan." Oakland, California. December.

Beeby, A. 1991. "Toxic Metal Uptake and Essential Metal Regulation in Terrestrial Invertebrates: A Review." In: *Metal Ecotoxicology - Concepts and Applications*. M.C. Newman and A.W. McIntosh, Editors. Advances in Trace Substances Research, Lewis Publishers. Chelsea, Michigan.

REFERENCES (Continued)

Bengtsson, G.T., T. Gunnarsson, and S.Rundgren. 1986. "Effects of Metal Pollution on the Earthworm *Dendrobaena rubida* in Acidified Soils." *Water, Soil, and Air Pollution*. Volume 28. Pages 361 through 383.

Benson, W.H., L.L Williams, C.T. Jafvert, J. Kukkonen, M.R. Servos, A. Spacie, and J.A. Noblet. 1994. "Synopsis of Discussion Session: Influences of Particulate and Dissolved Material on the Bioavailability of Organic Compounds". In: *Bioavailability: Physical, Chemical, and Biological Interactions*. J.L. Hamelink and others, Editors. Lewis Publishers. Boca Raton, Florida.

Bent, A.C. 1962. *Life Histories of North American Birds of Prey, Part 1*. Dover Publications. New York, New York.

Bent, A.C. 1937. *Life Histories of North American Birds of Prey, Order Falconiformes* (Part 1). Smithsonian Institution, United States National Museum, Bulletin 167. U.S. Government Printing Office. Washington, D.C.

Bent, A.C. 1926. *Life Histories of North American Marsh Birds*. United States National Museum, Bulletin 135. Pages 101 through 131.

Beyer, W.N., E. Connor, and S. Gerould. 1994. "Estimates of Soil Ingestion by Wildlife." *Journal of Wildlife Management*. Volume 58. Pages 375 through 382.

Beyer, W.N., G.H. Heinz, and A.W. Redmon-Norwood. 1996. *Environmental Contaminants in Wildlife: Interpreting Tissue Concentrations*. Lewis Publishers. Boca Raton, Florida.

Bias, M.A. 1994. "Ecology of the Salt Marsh Harvest Mouse in San Pablo Bay." Doctoral Dissertation. University of California, Berkeley, California. 243 Pages.

Bildstein, K.L. 1987. "Behavioral Ecology of Red-Tailed Hawks (*Buteo jamaicensis*), Rough-Legged Hawks (*Buteo lagopus*), Northern Harriers (*Circus cyaneus*), and American Kestrels (*Falco sparverius*) in South Central Ohio." *Ohio Biological Survey Biological Notes*. Volume 18.

Bildstein, K.L. 1988. "Northern Harrier (*Circus cyaneus*)." *Handbook of North American Birds*. R.S. Palmer, Editor. Yale University Press, New Haven, Connecticut. Volume 4. Pages 251 through 303.

Bollag, J.M. and W. Barabasc. 1979. "Effect of Heavy Metals on the Denitrification Process in Soil." *Journal of Environmental Quality*. Volume 8. Number 2. Pages 196 through 201.

Bonn, B.A. 1998. "Polychlorinated Dibenzo-p-dioxin and Dibenzofuran Concentration Profiles in Sediment and Fish Tissue of the Willamette Basin, Oregon." *Environmental Science and Technology*. Volume 32. Number 6. Pages 729 through 735.

Brabb, E.E., H.S. Soneman, and J.R. Switzer. 1971. "Preliminary Geologic Map of the Mt. Diablo-Byron Area, Contra Costa County, Alameda, and San Joaquin Counties, California." U.S. Geological Survey Basic Data Contribution 28.

REFERENCES (Continued)

Brown, L. and D. Amadon. 1968. *Eagles, Hawks, and Falcons of the World.* Volume 1. Hamlyn Publishing Group Limited. Feltham, Middlesex, Great Britain.

Burt, W.H. 1964. *A Field Guide to the Mammals.* 2nd Edition, Houghton Mifflin Company. Boston, Massachusetts. 284 pages.

Burt, W.H. and R.P. Grossenheider. 1976. A Field Guide to the Mammals of America North of Mexico. Houghton Mifflin Company. Boston, Massachusetts. 289 pages.

Butler, R.W. 1992. "Great Blue Heron." *The Birds of North America.* Number 25.

California Department of Fish and Game (CDFG). 1987. "Delta Outflow Effects on the Abundance and Distribution of San Francisco Bay Fish and Invertebrates, 1980-1985." CDFG Exhibit 60 for the State Water Resources Control Board 1987 Water Quality/Water Rights Proceedings on the San Francisco Bay/Sacramento-San Joaquin Delta. Sacramento, California. Page 345.

CDFG. 1997. "Department of Fish and Game's Recommended Soil Preliminary Remediation Goals (PRG) for Initial Risk Assessment Screening." July.

California Department of Toxic Substances Control (DTSC). 1996. "Guidance for Ecological Assessment at Hazardous Waste Sites an Permitted Facilities." Part A: Overview and Part B: Scoping Assessment. State of California, Environmental Protection Agency, Department of Toxic Substances Control.

California Division of Water Resources and the U.S. Bureau of Reclamation. 1994. "Biological Assessment: Effects of the Central Valley Project and State Water Project on Delta Smelt and Sacramento Splittail." Sacramento, California.

California Native Plant Society (CNPS). 1994. *Inventory of Rare and Endangered Vascular Plants in California.* M.W. Skinner and B.M. Pavlik, Editors. CNPS Special Publication. Number 1. 5th Edition. Page 338.

RWQCB. 1996. "Evaluation of Sediment Toxicity Tests and Reference Sites in San Francisco Bay." Internal Draft Report. May.

RWQCB. 1998. "Ambient Concentrations of Toxic Chemicals in Sediments." April.

Cameron, G.N. 1972. "Analysis of Insect Trophic Diversity in Two Salt Marsh Communities." *Ecology.* Volume 53. Pages 58 through 73.

Casarett, L.J. and J. Doull. 1991. *Casarett and Doull's Toxicology: The Basic Science of Poisons.* Fourth Edition. M.O. Amdur, J.Doull, and C.D. Klaassen (Editors). Pergamon Press. New York.

Cerniglia, C.E. and M.A. Heitkamp. 1989. "Microbial Degradation of PAH in the Aquatic Environment." In: *Metabolism of Polycyclic Aromatic Hydrocarbons.* Varanasi, U., Editor. CRC Press. Boca Raton, Florida.

Cikutovic, M.A., L.C. Fitzpatrick, B.J. Venables, and A.J. Goven. 1993. "Sperm Count in Earthworms (*Lumbricus terrestris*) as a Biomarker for Environmental Toxicology: Effects of Cadmium and Chlordane." *Environmental Pollution.* Volume 81. Pages 123 through 125.

Cogswell, H.L. and G. Christman. 1977. *Water Birds of California.* University of California Press. Berkeley, California.

Connell, D.W. 1990. "Evaluation of the Bioconcentration Factor, Biomagnification Factor, and Related Physiochemical Properties of Organic Compounds". In: *Bioaccumulation of Xenobiotic Compounds.* D.W. Connell, Editor. CRC Press. Boca Raton, Florida.

Conomos, T.J. 1979. "Properties and Circulation of San Francisco Bay Waters." In: *San Francisco Bay: The Urbanized Estuary.* T.J. Conomos, Editor. Pacific Division, American Association Advancement of Science. San Francisco, California. Pages 47 through 84.

Cowardin, L.M., V. Carter, E.C. Golet, and E.T. LaRoe. 1979. "Classification of Wetlands and Deepwater Habitats of the United States." U.S. Fish and Wildlife Service (USFWS), U.S. Department of the Interior. FWS/0BS-79/31. Volume 131. Page 103.

Crabtree, M. and C.G. Thelander. 1994. *Life on the Edge.* Heyday Books. Berkeley, California. 550 Pages.

Craighead, J.J. and F.C. Craighead, Jr. 1956. *Hawks, Owls and Wildlife.* Stackpole. New York.

Cuneo, K.L.C. 1987. *San Francisco Salt Marsh Vegetation, Geography, and Ecology: A Baseline for Use in Impact Assessment and Restoration Planning.* Doctoral Dissertation. University of California, Berkeley. Page 264.

Datamost Corporation. 1995. STATMOST: Statistical Analysis and Graphics, Version 3.5. Salt Lake City, Utah.

Del Hoyo, J., A. Elliot, and J. Sargatal (Editors). 1995. *Handbook of the Birds of the World.* Volume 2. Lynx Edicions. Barcelona, Spain.

Demayo, A. and M.C. Taylor. 1981. "Guidelines for Surface Water Quality." *Inorganic Chemicals Substances: Copper.* Environment Canada. Inland Waters Directorate, Water Quality Branch. Ottawa, Canada. Volume 1.

Dibblee, T.W., Jr. 1980a. "Preliminary Geologic Map of the Clayton Quadrangle, Contra Costa County, California." *U.S. Geological Survey Open File Report 80-547.*

Dibblee, T.W., Jr. 1980b. "Preliminary Geologic Map of the Honker Bay Quadrangle, Solano and Contra Costa Counties, California." *U.S. Geological Survey Open File Report 80-009.*

Dibblee, T.W., Jr. 1980c. "Preliminary Geologic Map of the Walnut Creek Quadrangle, Contra Costa County, California." *U.S. Geological Survey Open File Report 80-351.*

REFERENCES (Continued)

Dibblee, T.W., Jr. 1981. "Preliminary Geologic Map of Mare Island Quadrangle, Solano and Contra Costa Counties, California." U.S. Geological Survey (USGS) Open File Report 81-0234.

Dindal, D.L. 1990. *Soil Biology Guide.* John Wiley and Sons, New York.

DiToro, D.M., J.D. Mahoney, D.J. Hansen, K.J. Scott, M.B. Hicks, S.M Mayr, and M.S. Redmond. 1990. "Toxicity of Cadmium in Sediments: The Role of Acid Volatile Sulfide." *Environmental Toxicology and Chemistry.* Volume 9. Pages 1,487 through 1,502.

Dunning, J.B., Jr. *CRC Handbook of Avian Body Masses.* CRC Press, Boca Raton, Florida.

Earth Science Associates. 1982. "Seismotectonic Study of Contra Loma Dam and Vicinity." Report to the U.S. Bureau of Reclamation by Earth Science Associates.

Ecology and Environment. 1983. "Initial Assessment Study of Naval Shipyard, Mare Island, Vallejo, California." Prepared for Navy Assessment and Control of Installation Pollutants Department. March.

Eddleman, W.R., R.E. Flores, and M.L. Legare. 1994. *Black Rail.* The Birds of North America. Number 123.

Efroymson, R.A. and others. 1997. "PRGs for Ecological Endpoints." U.S. Department of Energy. August.

Ehrlich, P.R., D.S. Dobkin, and D. Wheye. 1988. *The Birder's Handbook.* Simon and Schuster Inc. New York.

Eisler, R. 1987. "Mercury Hazards to Fish, Wildlife, and Invertebrates: A Synoptic Review." USFWS. *Biological Report.* Volume 85. Number 1.10.

EFA WEST. 1998. "Development of Toxicity Reference Values for Conducting Ecological Risk Assessments at Naval Facilities in California, Interim Final Technical Memorandum." EFA WEST, Naval Facilities Engineering Command, U.S. Department of the Navy. San Bruno, California. September.

English, S.M. 1978. "Distribution and Ecology of Great Blue Heron Colonies on the Willamette River, Oregon." Pages 235-244. In: *Wading Birds.* A, Sprunt, J. Ogden and S. Winckler, Editors. Res. Report Number 7. National Audubon Society, New York.

Erickson, R.J., D.A. Benoit, V.R. Mattson, H.P. Nelson, and E.N. Leonard. 1994. "The Effects of Water Chemistry on the Toxicity of Copper to Fathead Minnows." *Environmental Toxicology and Chemistry.* Volume 15. Number 2. Pages 181 through 193.

Federal Register. 1993. "Endangered and Threatened Wildlife and Plants: Determination of Threatened Status for the Delta Smelt." Volume 58. Number 42. March 5.

REFERENCES (Continued)

Federation of American Scientists. 1999. Micronutrients and Agriculture Online. Online database accessed 5/12/99 at www.fas.org/mnp/micro/html#nato

Fisher, S.W. 1995. "Mechanisms of Bioaccumulation in Aquatic Systems". *Reviews of Environmental Contamination and Toxicology*. Volume 142. Pages 87 through 117.

Fisler, G.F. 1965. "Adaptation and Speciation in Harvest Mice of the Marshes of San Francisco Bay." *University of California Publ. Zool.* Volume 77. Pages 1 through 108.

Florida Agricultural Information Retrieval Services (FAIRS). 1999. Online database accessed 5/12/99 at http://hammock.ifas.ufl.edu/txt/fairs/1131

Forbes, L.S. 1982. "Prey Manipulation in the Great Blue Heron." *The Murrelet*. Volume 63. Number 3. Pages 89 through 90.

Forsyth, D.J., T.J. Peterle, and W. Bandy. 1983. "Persistence and Transfer of Cl-DDT in the Soil and Biota of an Old Field Ecosystem: A Six Year Balance Study." *Ecology*. Volume 64. Number 6. Pages 1,620 through 1,636.

Foy, C.D., R.L. Chaney, and M.C. White. 1978. "The Physiology of Metal Toxicity in Plants." *Annual Review of Plant Physiology*. Volume 29. Pages 511 through 566.

Freda, J. 1991. "The Effects of Aluminum and Other Metals on Amphibians." *Environmental Pollution*. Volume 71. Pages 305 through 328.

Freeze, R.A. and J. Cherry. 1979. *Groundwater*. Prentice-Hall, Inc. Englewood Cliffs, New Jersey.

Fritzell, E.K. and K.J. Haroldson. 1982. Urocyon Cinereoargenteus. *Mammal Species No.* Volume 189. Pages 1 through 8.

Galehouse, J.S., B.D. Brown, B. Pierce, and J.J. Thordsen. 1982. "Changes in Movement Rates on Certain East Bay Faults." Proceedings on the Conference on Earthquake Hazards in the Eastern San Francisco Bay Area. *California Division of Mines and Geology Special Report 62.*

Gasaway, W.C. and I.O. Buss. 1972. "Zinc Toxicity in the Mallard Duck." *Journal of Wildlife Management*. Volume36. Number 4. Pages 1,107 through 1,117.

Ghosh, A.R. and P. Chakrabarati. 1992. "Scanning Electron Microscopic Probe Into the Cellular Injury in the Alimentary Canal of *Notopterus notopterus* (Pallas) After Cadmium Intoxication." *Ecotoxicology and Environmental Safety*. Volume 23. Pages 147 through 160.

Gill, F.B. 1990. *Ornithology*. W.H. Freeman and Company. New York, New York.

Greene, A.S. and G.T. Chandler 1994. "Meiofaunal Bioturbation Effects on the Partitioning of Sediment-Associated Cadmium." *Journal of Experimental Marine Biology and Ecology*. Volume 180. Pages 59 through 70.

Grillitsch, B. and G. Linder. In Press. "Ecotoxicology of Metals." In: *Ecotoxicology of Amphibians and Reptiles*. Sparling, D., G. Linder, and C. Bishop (editors). Society of Environmental Toxicology and Chemistry (SETAC) Press. Pensacola, Florida.

Grinnell, J. and A.H. Miller. 1944. *The Distribution of the Birds of California*. Reprinted by Artemisia Press. Lee Vining, California.

Gunderson, D.T., S. Bustaman, W.K. Seim, and L.R. Curtis. 1994. "pH, Hardness, and Humic Acid Influence Aluminum Toxicity to Rainbow Trout (*Oncorhynchus mykiss*) in Weakly Alkaline Waters." *Candian Journal of Aquatic Sciences*. Volume 51. Pages 1,345 through 1,355.

Hamel, S., B. Buckely, and P. Lioy. 1998. "Bioaccessibility of Metals in Soils for Different Liquid to Solid Ratios in Synthetic Gastric Fluid." *Environmental Science and Technology*. Volume 32. Pages 358 through 362.

Hamerstrom, R., F.N. Hamerstrom, and C.J. Burke. 1985. "Effect of Voles on Mating Systems in a Central Wisconsin Population of Harriers." *Wilson Bulletin*. Volume 97. Pages 332 through 346.

Hamilton, R.B.. 1975. "Comparative Behavior of the American Avocet and the Black-Necked Stilt (Recurvirostridae)." *Ornithology Monographs*. Volume 17. Page 97.

Harr, J.R., J.F. Boone, I.J. Tinsley, P.H. Weswig, and R.S. Yamamoto. 1966. "Selenium Toxicity in Rats." *Symposium: Selenium in Biomedicine*. 1st International Symposium. Oregon State University.

H.T. Harvey and Associates. 1996. "Concord Naval Weapons Station Small Mammal Characterization. Appendix E." Prepared for PRC Environmental Management, Inc., San Francisco, California. In: PRC 1996. "Draft After Remediation (Year 1) Remedial Action Monitoring Report, Litigation Area, Naval Weapons Station Concord.

H.T. Harvey and Associates. 1997. "California Black Rails at NWS Concord: Standardized Survey Protocol and Estimates of Abundance."

H.T. Harvey and Associates. 1998. "California Black Rail Surveys at NWS Concord. Summer 1998." December 29.

Harvey, T.E. and others. 1992. "Status and Trends Report on Wildlife of the San Francisco Estuary." San Francisco Estuary Project (SFEP). USFWS.

Hausenbuiller, R.L. 1978. *Soil Science Principles and Practices*. Wm. C. Brown Co. Dubuque, Iowa. Pages 177 through 180.

Hawker, D.W. 1990. "Bioaccumulation of Metallic Substances and Organometallic Compounds." *Bioaccumulation of Xenobiotic Compounds*. D.W. Connell, Editor. CRC Press. Boca Raton, Florida.

REFERENCES (Continued)

Heaton-Jones, T.G., Homer, B.L., Heaton-Jones, D.L., and S.F. Sundlof. 1997. "Mercury Distribution in American Alligators (*Alligator mississippiensis*) in Florida." *Journal of Zoology and Wildlife Medicine*. Volume 28. Pages 62 through 70.

Herbold, B. and P.B. Moyle. 1989. "The Ecology of the Sacramento-San Joaquin Delta: A Community Profile." USFWS Biological Report 85(7.22). Page 106.

Hickman, J.C., Editor. 1993. *The Jepson Manual, Higher Plants of California*. University of California Press. Berkeley, California. Page 1,400.

Hilderbrand, D.C., R. Der, W.T. Griffin, and M.S. Fahim.. 1973. "Effect of Lead Acetate on Reproduction." *American Journal of Obstetrics and Gynecology*. Volume 115. Pages 1,058 through 1,065.

Hinde, T.E. 1954. "The Vertical Distribution of Salt March Phanerogams in Relation to Tide Levels." *Ecological Monographs*. Volume 24. Number 2. Pages 209 through 225.

Hobson, K., P. Perrine, E.B. Roberts, M.L. Foster, and P. Woodin. 1985. "A Breeding Season Survey of Salt Marsh Yellowthroats (*Geothlypis trichas sinuosa*) in the San Francisco Bay Region." USFWS. Contract No. 84-57. Sacramento, California. Page 93.

Hockman, J.G. and J.A. Chapman. 1983. "Comparative Feeding Habits of Red Foxes (*Vulpes vulpes*) and Gray Foxes (*Urocyon cinereoargenteus*) in Maryland." *The American Midland Naturalist*. Volume 110. Number 2. Pages 276 through 285.

Holland, R.F. 1986. "Preliminary Descriptions of the Terrestrial Natural Communities of California." California Department of Fish and Game (CDFG). Sacramento.

Hong, J., U. Forstner, and W. Calmano. 1994. "Effects of Redox Processes on Acid-Producing Potential and Metal Mobility in Sediment." J.L. Hamelink, P.F. Landrum, H.L. Bergman, and W.H. Benson, Editors. *Bioavailability: Physical, Chemical, and Biological Interactions*. Lewis Publishers. Boca Raton, Florida.

Hopkin and Hames. 1994. "Zinc, Among a Cocktail of Metal Pollutants, is Responsible for the Absence of the Terrestrial Isopod *Porcellia scaber* from the Vicinity of a Primary Smelting Works." *Ecotoxicology*. Volume 2. Pages 68 through 78.

Horne, M.T. and W.A. Dunson. 1995. "Effects of Low pH, Metals, and Water Hardness on Larval Amphibians." *Archives of Environmental Contamination Toxicology*. Volume 29. Pages 500 through 505.

Hunchak-Kariouk, K, Schweitzer, L., and Suffet, I. 1997. "Partitioning of 2,2',4,4'-Tetrachlorobiphenyl by Dissolved Organic Matter in Oxic and Anoxic Porewaters." *Environmental Science and Technology*. Volume 31. Pages 639 through 645.

Hunter, B.A., M.S. Johnson, and D.J. Thompson. 1987. "Ecotoxicology of Copper and Cadmium in a Contaminated Grassland Ecosystem: I. Soil and Vegetation Contamination: II. Invertebrates." *Journal of Applied Ecology*. Volume 24. Pages 573 through 599.

Ibis Environmental Services (Ibis). 1999. "Small-Mammal Trapping Survey Tidal Areas Sites, Weapons Station, Seal Beach Detachment Concord, California." Prepared for Tetra Tech EM Inc (TtEMI). January.

Ingles, L.G. 1965. *Mammals of the Pacific States: California, Oregon, and Washington*. Stanford University Press. California.

International Technology Corporation (IT). 1992. "Draft Site Investigation Report, Tidal Area Sites, Naval Weapons Station Concord, California." Prepared for Hazardous Waste Remediation Actions Program. Martin Marietta Energy Systems, Inc.

Jarman, W.M, K.A. Hobson, C.E. Bacon, and E.B. McLaren. 1996. "Influence of Trophic Position and Feeding Location on Contaminant Levels in the Gulf of the Farallones Food Web Revealed by Stable Isotope Analysis." *Environmental Science and Technology*. Volume 30. Pages 654 through 659.

Jamil, K. and S. Hussain. 1992. "Biotransfer of Metals to the Insect *Neochetina eichhornae* Via Aquatic Plants." *Archives of Environmental Contamination and Toxicology*. Volume 22. Pages 459 through 463.

Jarmon, W.M., K.A. Hobson, W.J. Sydeman, C.E. Bacon, and E.B. McLaren. 1996. "Influence of Trophic Position and Feeding Location on Contaminant Levels in the Gulf of Farallones Food Web Revealed by Stable Isotope Analysis." *Environmental Science and Technology*. Volume 30. Pages 654 through 659.

Jenne, E.A. and S.N Luoma.. 1977. "Factors Affecting the Availability of Sediment-Bound Cadmium to the Estuarine, Deposit-Feeding Clam, *Macoma baltica*." In: *Radioecology and Energy Resources: Proceedings of the Fourth National Symposium on Radioecology*. C.E. Cushing, Editor. Dowden, Hutchinson, and Ross, Inc. Stroudsburg, Pennsylvania.

Jones and Stokes. 1982. "A Natural Resources Survey, Naval Weapons Station Concord, California." Prepared for the Natural Resources Management Branch, Western Division, Naval Facilities Engineering Command, San Bruno, California. Contract Number N624-81-C-8764.

Josselyn, M.N. 1983. "The Ecology of San Francisco Bay Tidal Marshes: A Community Profile." U.S. Fish and Wildlife Service (USFWS), Division of Biological Services. Washington, D.C. FWS/OBS-83/23. Page 102.

Juma, N.G. 1998. "The Pedosphere and Its Dynamics: Ecological Functions in Soil, Medium for Plant Growth." Accessed online on 5/12/99 at http://www.soils.rr.ualberta.ca/pedosphere/content/section02./cfm

Kabata-Pendias, A. and H. Pendias. 1984. *Trace Elements in Soils and Plants*. CRC Press, Inc. Boca Raton, Florida.

Keran, D. 1981. "The Incidence of Man-Caused and Natural Mortalities to Raptors." *Raptor Research*. Volume 15. Pages 108 through 112.

Khalil, M.A., H.M. Abdel-Lateif, B.M.Bayoumi, N.M. van Straalen, and C.A.M. van Gestel. 1996. "Effects of Metals and Metal Mixtures on Survival and Cocoon Production of the Earthworm *Aporrectodea calginosa*." *Pedobiologia*. Volume 40. Pages 548 through 556.

Khalid, B.Y. and J. Tinsley. 1980. "Some Effects of Nickel Toxicity on Rye Grass." *Plant and Soil*. Volume 70. Pages 335 through 345.

Khera, K.S. and Tabacova, S.A. 1973. "Effects of Methylmercuric Chloride on the Progeny of Mice and Rats Treated Before or During Gestation." *Food and Cosmetics Toxicology*. Volume 11. Number 2. Pages 245 through 254.

Knezovich, J.P. 1994. "Chemical and Biological Factors Affecting Bioavailability of Contaminants in Seawater." *Bioavailability: Physical, Chemical, and Biological Interactions*. J.L. Hamelink and Others, Editors. Lewis Publishers. Boca Raton, Florida.

Krasovskii, G.N., L.Y. Vasukovich, and O.G. Chariev. 1979. "Experimental Study of Biological Effects of Lead and Aluminum Following Oral Administration." *Environmental Health Perspectives*. Volume 30. Pages 355 through 371.

Landa, E.R. and S.C. Fang. 1978. "Effect of Mercuric Chloride on Carbon Mineralization in Soils." *Plant Soil*. Volume 49. Pages 179 through 183.

Laudenslayer, W.F., Jr, W.E. Grenfell, Jr., and D.C. Zeiner. 1991. "A Check List of the Amphibians, Reptiles, Birds, and Mammals of California." CDFG. Volume 77. Number 3. Pages 109 through 141.

La Voilette, J.W. and W.B. Wigginton. 1983. "Tectonic Relationship of the Calaveras and Concord Faults (abs)." Abstracts and Programs for the 26th Annual Meeting of the Association of Engineering Geologists.

Linder, G., E. Ingham, C.J. Brandt, and G. Henderson. 1992. "Evaluation of Terrestrial Indicators for Use in Ecological Risk Assessments (ERA) at Hazardous Waste Sites." U.S. Environmental Protection Agency (EPA)/600/R-92/183. EPA, Environmental Research Laboratory. Corvallis, Oregon.

Linder, G., C. Callahan, and G. Pascoe. 1993. "A Strategy for ERAs for Superfund: Biological Methods for Evaluating Soil Contamination." *Superfund Risk Assessment in Soil Contamination Studies*. ASTM STP 1158. K.B. Hoddinott, Editor. ASTM. Philadelphia, Pennsylvania. Pages 288 through 308.

Linder, G., M. Bollman, C. Gillett, R. King, J. Nwosu, S. Ott, D. Wilborn, G. Henderson, T. Pfleeger, T. Darrow, and D. Lightfoot. 1994a. "The Role of Preliminary Field and Laboratory Studies for ERAs in Wetland and Terrestrial Habitats: Two Case Studies." J.S. Hughes, G.R Biddinger, and E. Mones, Editors. *Environmental Toxicology and Risk Assessment.* ASTM STP 1218. ASTM. Philadelphia, Pennsylvania. Volume 3. Pages 61 through 78.

Linder, G., G. Henderson, and E. Ingham. 1996a. "Metal Toxicity in the Rhizosphere. Part 1: Soil Ecology and Revegetation of Disturbed Mining Lands of the Western U.S." *Hortus West.* Volume 7. Number 1. Pages 6 through 10 and 38 through 51.

Linder, G., G. Henderson, and G. Pascoe. 1996b. "Metal Toxicity in the Rhizosphere. Part 2: Improving Soil Tilth and Plant Nutrition to Enhance Revegetation of Disturbed Mining Lands of the Western U.S." *Hortus West.* Volume 7. Number 2. Pages 6 through 9 and 50 through 58.

Linder, G. and B. Grillitsch (in press). "Ecotoxicology of Metals." In: *Ecotoxicology of Amphibians and Reptiles.* Sparling, D.W., C. Bishop, and G. Linder (Editors).

Long, E.R. and Morgan, L.G. 1991. The Potential for Biological Effects of Sediment-Sorbed Contaminants Tested in the National Status and Trends Program. NOAA Technical Memorandum; NOS OMA 52. August 1991. Seattle, Washington.

Long, E.R., D.D. MacDonald, S.L. Smith, and F.D. Calder. 1995. "Incidence of Adverse Biological Effects Within Ranges of Chemical Concentrations in Marine and Estuarine Sediments." *Environmental Management.* Volume 19. Number 1. Pages 81 through 97.

Luoma, S.N. 1986. "A Comparison of Two Methods for Determining Copper Partitioning in Oxidized Sediments." *Marine Chemistry.* Volume 20. Pages 45 through 59.

Luoma, S.N. and G.W. Bryan. 1978. "Factors Controlling the Availability of Sediment-Bound Lead to Esturarine Bivalve *Scrobicularia plana.*" *Journal of the Marine Biological Association of the United Kingdom.* Volume 58. Pages 793 through 802.

Luoma, S.N. and G.W. Bryan. 1981. "A Statistical Study of Environmental Factors Controlling Concentrations of Heavy Metals in the Burrowing Bivalve *Scrobicularia plana* and the Polychaete *Nereis diversicolor.*" *Estuarine, Coastal, and Shelf Science.* Volume 15. Pages 95 through 108.

Luoma, S.N. and J.A. Davis. 1983. "Requirements for Modeling Trace Metal Partitioning in Oxidized Estuarine Sediments." *Marine Chemistry.* Volume 12. Pages 159 through 181.

Lyman, W.J. 1982. "Adsorption Coefficient for Soils and Sediments." In: *Handbook of Chemical Property Estimation Methods.* W.J. Lyman, W.F. Reehl, and D.H. Rosenblatt, Editors. McGraw-Hill Book Co. New York, New York. Pages 4-1 through 4-33.

Ma, W.C. 1982. "The Influence of Soil Properties and Worm-Related Factors on the Concentration of Heavy Metals in Earthworms." *Pedobiologia.* Volume 24. Pages 109 through 119.

MacDonald, D.A., M.B. Matta, L.J. Field, C. Cairncoss, and M.D. Munn. 1992. "The Coastal Resource Coordinators Bioassessment Manual." Report Number HAZMAT 93-1. National Oceanic and Atmospheric Administration (NOAA). Seattle, Washington.

MacWhirter, B.R., and K.L. Bilstein. 1996. "Northern Harrier." *The Birds of North America*. Number 210.

Mahall, B.E. and R.B. Park. 1976. "The Ecotone Between *Spartina foliosa* and *Salicornia virginica* in Salt Marshes of Northern San Francisco Bay. III. Soil Aeration and Tidal Immersion." *Journal of Ecology*. Volume 64. Pages 811 through 819.

Major, J.T. and Shernburne, J.A. 1987. "Interspecific Relationships of Coyotes, Bobcats, and Red Foxes in Western Maine." *Journal of Wildlife Management*. Volume 51. Pages 606 through 616.

Marschner, H. 1986. *Mineral Nutrition of Higher Plants*. Academic Press, Inc. New York.

Mayer, F.L., L.L. Marking, T.D. Bills, and G.E. Howe. 1994. "Physicochemical Factors Affecting Toxicity in Freshwater: Hardness, pH, and Temperature." In: *Bioavailability: Physical, Chemical, and Biological Interactions*. J.L. Hamelink and others, Editors. Lewis Publishers. Boca Raton, Florida.

McElroy, A.E., J.W. Farrington, and J.M. Teal. 1989. "Bioavailability of Polycyclic Aromatic Hydrocarbons in the Aquatic Environment." *Metabolism of Polycyclic Aromatic Hydrocarbons*. CRC Press. Boca Raton, Florida.

McLachlan, M.S. 1995. "A Simple Model to Predict Accumulation of PCDD/Fs in an Agricultural Food Chain." *Chemoshphere*. Volume 34. Numbers 5 to 7. Pages 1,263 through 1,276.

McNulty, H.R., B.S. Anderson, J.W. Hunt, S.L. Turpen, and M.M. Singer. 1994. "Age-Specific Toxicity of Copper to Larval Topsmelt *Atherinops affinis*." *Environmental Toxicology and Chemistry*. Volume 13. Pages 487 through 492.

Meyer, J.S., W. Davison, B. Sundby, J.T. Oris, D.J. Lauren, U. Forstner, J. Hong, and D.G. Crosby. 1994. "Synopsis of Discussion Session: The Effects of Variable Redox Potentials, pH, and Light on Bioavailability in Dynamic Water-Sediment Environments." J.L. Hamelink and Others, Editors. *Bioavailability: Physical, Chemical, and Biological Interactions*. Lewis Publishers. Boca Raton, Florida.

Meyers-Schone, L. and B.T. Walton. 1994. "Turtles as Monitors of Chemical Contaminants in the Environment." *Reviews of Environmental Contamination and Toxicology*. Volume 135. Pages 93 through 153.

Miles, C.D., J.R. Brandle, D.J. Daniel, O. Chu-Der, P.D. Schnore, and D.J. Uhlik.. 1972. "Inhibition of Photosystem II in Isolated Chloroplasts by Lead." *Phant Physiology*. Volume 49. Pages 820 through 825.

Morgan, G.W., F.W. Edens, P. Thaxton, and C.R. Parkhurst. 1975. "Toxicity of Dietary Lead in Japanese Quail." *Poultry Science*. Volume 54. Pages 1,636 through 1,642.

Morrissey, R.E., J.C. Lamb, R.W. Morris, R.E. Chapin, Dushyant, K. Gulati, and J.J. Heindel. 1989. "Results and Evaluations of 48 Continuous Breeding Reproduction Studies Conducted in Mice." *Fundamental and Applied Toxicology*. Volume 13. Pages 747 through 777.

Mukherji, S. and B. Das Gupta. 1972. "Characterization of Copper Toxicity in Lettuce Seedlings." *Physiologia Plantatarum*. Volume 27.

Munshower, L. 1994. *Practical Handbook of Disturbed Land Revegetation*. CRC Press, Inc. Boca Raton, Florida.

Nagy, K.A. 1987. "Field Metabolic Rate and Food Requirement Scaling in Mammals and Birds." *Ecological Monographs*. Volume 57. Pages 111 through 128.

National Oceanic and Atmospheric Administration (NOAA). 1991. "The Potential for Biological Effects of Sediment-Sorbed Contaminants Tested in the National Status and Trends Program." Technical Memorandum NOS OMA 52. NOAA, Office of Oceanography on Marine Assessment. Seattle, Washington.

Naval Energy and Environment Support Activity (NEESA). 1988. "Sampling and Chemical Analysis Quality Assurance Requirements for the Navy Installation Restoration Program." Prepared by Martin Marietta Energy Systems, Inc. Second Revision.

Newman, M.C. and C.H. Jagoe. 1994. "Ligands and the Bioavailability of Metals in Aquatic Environments." *Bioavailability: Physical, Chemical, and Biological Interpretations*. J.L. Hamelink and Others, Editors. Lewis Publishers. Boca Raton, Florida.

Nichols, F.H. 1977. "Natural and Anthropogenic Influences on Benthic Community Structure in San Francisco Bay." In: *San Francisco Bay: The Urbanized Estuary*. T.J. Conomos, A.E. Leviton, and M. Berson, Editors. 58th Annual Meeting, Pacific Division/American Association for the Advancement of Science. June 12 to 16.

Nichols, F.H. and M.M. Pamatmat. 1988. "The Ecology of the Soft-Bottom Benthos of San Francisco Bay: A Community Profile." *Biological Report 85(7.19)*. Page 73.

Nisbet, R.M., E.B. Muller, A.J. Brooks, and P. Hosseini. 1997. "Models Relating Individual and Population Response to Contaminants."

Ockenden, W.A., E. Steinnes, C. Parker, K.C. Jones. 1998. "Observations on Persistent Organic Pollutants in Plants: Implications for Their Use as Passive Air Samplers and for POP Cycling." *Environmental Science and Technology*. Volume 32. Number 18. Pages 2,721 through 2,726.

O'Flaherty, E.J. 1998. "Physiologically Based Models of Metal Kinetics". 1998. *Critical Reviews in Toxicology*. Volume 28. Number 3. Pages 271 through 317.

O'Neil, L.J.. 1988. "Feasibility Study of Contamination Remediation at the Naval Weapons Station Concord, California. Volume II: Biological Assessment." U.S. Army Waterways Experiment Station. Miscellaneous Paper EL-86-3. Vicksburg, MS. 50 Pages.

Opresko, D.M., B.E. Sample, and G.W. Suter. 1993. "Toxicological Benchmarks for Wildlife."

Pacific Eco-Risk Laboratory (PERL). 1999. Person communication Between S. Ogle, Director, PERL and June Mire, TtEMI.

Paine, J.M., M.J. McKee, and M.E. Ryan. 1993. "Toxicity and Bioaccumulation of Soil PCBs in Cricket: Comparison of Laboratory and Field Studies." *Environmental Toxicology and Chemistry*. Volume 12. Pages 2,097 through 2,103.

Palmer, R.S. 1962. *Handbook of North American Birds*. Volume 1. Yale University Press. New Haven, Connecticut. Pages 391 through 403.

Palmer, R.S. 1988. *Handbook of North American Birds*. Volume 4. Yale University Press. New Haven, Connecticut.

Pascoe, G.A. and J.A. Dalsoglio. 1994a. "Planning and Implementation of a Comprehensive Ecological Risk Assessment at the Milltown Reservoir-Clark Fork River Superfund Site, Montana." *Environmental Toxicology and Chemistry*. Volume 13. Pages 1,943 through 1,956.

Pascoe, G.A., R.J. Blanchet, G. Linder, D. Palawski, W.G. Brumbaugh, T.J. Canfield, N.E. Kemble, C.G. Ingersoll, A. Farag and J.A. Dalsoglio. 1994b. "Characterization of Ecological Risks at the Milltown Reservoir-Clark Fork River Superfund Site, Montana." *Environmental Toxicology and Chemistry*. Volume 13. Pages 2,043 through 2,058.

Pascoe, G.A., R.J. Blanchet and G. Linder. 1994c. "Bioavailability of Metals and Arsenic to Small Mammals at a Mining Waste-Contaminated Wetland." *Archives of Environmental Contamination and Toxicology*. Volume 27. Pages 44 through 50.

Pascoe, G.A., R.J. Blancher, and G. Linder. 1996. "Food-Chain Analysis of Exposures and Risks to Wildlife at a Metals-Contaminated Wetland." *Archives of Environmental Contamination and Toxicology*. Volume 30. Pages 306 through 318.

Pastorok, R.A., M.K. Butcher, and R.D. Nielsen. 1996. "Modeling Wildlife Exposure to Toxic Chemicals: Trends and Recent Advances. Human and Ecological Risk Assessment." In Press.

Pearcy, R.W., D.E. Bayer, and S.L. Ustin. 1981. "Salinity-Productivity Relationships of Selected Plant Species form the Suisun Marsh, California." California Water Resources Center, University of California, Davis. Page 42.

Peterson, D.H., T.J. Conomos, W.W. Broenkow, and P.C. Doherty. 1975. "Location of the Non-Tidal Current Null Zone in Northern San Francisco Bay." *Estuarine and Coastal Science*. Volume 3. Pages 1 through 11.

Perez-Coll, C.S., Herkovits, J., and A. Salibian. 1986. "Teratogenic Effects of Cadmium on *Bufo Arenarum* During Gastrulation." "*Experientia*." Volume 42. Pages 1,174 through 1,176.

Pratt, P.F. 1966. "Vanadium." In: *Diagnostic Criteria for Plants and Soils*. H.D. Chapman, Editor. University of California, Division of Agricultural Sciences, Riverside. Pages 480 through 483.

PRC Environmental Management, Inc. (PRC). 1993. "Draft Work Plan Volume II, Qualitative Ecological Assessment, Remedial Investigation/Feasibility Study, Tidal Area Sites, Naval Weapons Station Concord, California." September 16.

PRC. 1994. "Draft Final Work Plan, Volume I, Remedial Investigation/Feasibility Study (RI/FS) Tidal Area Sites, Naval Weapons Station Concord, California." December.

PRC. 1995a. "RI/FS Tidal Area Sites Draft Final Work Plan, Volume II (QEA), Naval Weapons Station Concord, California." February.

PRC. 1995b. "RI/FS Tidal Area Sites Draft Final Field Sampling Plan, Naval Weapons Station Concord, California."

PRC. 1995c. "Draft Final Quality Assurance Project Plan, RI/FS Tidal Area Sites, Naval Weapons Station Concord, California." February.

PRC. 1995d. Field Survey Observations. SOMA Corporation, IBIS International, and PRC.

PRC. 1996a. "Estimation of Ambient Metals Concentrations in the Tidal Area Soils. Technical Memorandum. Naval Weapons Station Concord, California." March.

PRC 1996b. "Qualitative Ecological Assessment Report (Draft). Litigation Area, Naval Weapons Station Concord, California." December 10.

PRC. 1997. "Draft RI Report, Tidal Area Sites 1, 2, 9, and 11, Naval Weapons Station Concord, California." Volumes 1-4. April.

Punzo, F. 1993. "Effect of Mercuric Chloride on Fertilization and Larval Development in the River Frog, *Rana heckscheri* (Wright) (Anura: Ranidae)." *Bulletin of Environmental Contamination Toxicology*. Volume 51. Pages 575 through 581.

Rasile, D. 1995. "Cross Generation Lead Ingestion; Behavioral and Physiological Effects in Mice." *Brain Research Bulletin*. Volume 36. Number 5. Pages 473 through 482.

Ross, P., G.A. Burton, Jr., M. Greene, K. Ho, P. Meier, and L. Sweet. 1997. "Interlaboratory Precision Study of a Whole Sediment Toxicity Test with the Luminescent Bacterium *Vibrio Fischeri*." *Environmental Toxicology and Chemistry*. In Press.

Safe, S. 1990. "A Perspective on Toxicity Equivalency Factors for PCBs. In: *Workshop Report on Toxicity on Toxicity Equivalency Factors for Polychlorinated Biphenyl Congeners*. EPA 625/3-91/020. Eastern Research Group, Inc. EPA Contract No. 68-C8-0036.

Sample, B.E., D.M. Opresko, and G.W. Suter II. 1996. "Toxicological Benchmarks for Wildlife: 1996 Revision." ES/ER/TM-86/R3. Oak Ridge National Laboratory. Oak Ridge, Tennessee.

Sample, B.E., G.W. Suter II, R.A. Efroymson, and D.S. Jones. 1998. "A Guide to the ORNL Ecotoxicological Screening Benchmarks: Background, Development, and Application." Environmental Sciences Division Publication No. 4783. Oak Ridge National Laboratory. Oak Ridge, Tennessee.

San Francisco Estuary Institute (SFEI). 1997. Online Database. Data of 1997 from the Regional Monitoring Plan (RMP). Accessed 1999.

San Francisco Estuary Project (SFEP). 1991. "Status and Trends on Wetlands and Related Habitats in the San Francisco Estuary." Association of Bay Area Governments. San Francisco State University and USFWS.

SFEP. 1992. "Status and Trends on Wildlife of the San Francisco Estuary." Association of Bay Area Governments. San Francisco State University and USFWS.

Schweitzer, L. 1998. "Bioavailability and Toxicity of Polychlorinated Biphenyls to Sea Urchins." Doctoral Thesis. University of California Los Angeles.

Shellhammer, H.S. 1989. "Salt Marsh Harvest Mice, Urban Development, and Rising Sea Levels." *Conservation Biology*. Volume 3. Number 1. Pages 59 through 65.

Shellhammer, H.S. 1997. Personal Communication with Anne Flannery, IBIS Environmental Services. January.

Shellhammer, H.S., R. Jackson, W. Davilla, A. Gilroy, H.T. Harvey, and L. Simmons. 1982. "Habitat Preferences of Salt Marsh Harvest Mice (*Reithrodontomys raviventris*)." J. Wasmann, Editor. *Biology*. Number 40. Pages 102 through 104.

Shuford, W.D. 1993. "The Marin County Breeding Bird Atlas: A Distributional and Natural History of Coastal California Birds." *California Avifauna Series 1*. Bushtit Books. Bolinas, California. 479 Pages.

Simms, J.D., K.F. Fox, J.A. Bartow, and E.J. Helley. 1973. "Preliminary Geologic Map of Solano County and Parts of Napa, Contra Costa, Marin, and Yolo Counties, California." USGS Miscellaneous Field Studies Map MF-484.

Simmons, R. and P.C. Smith. 1985. "Do Northern Harriers (*Circus cyaneus*) Choose Nest Sites Adaptively?" *Canadian Journal of Zoology*. Volume 63. Pages 494 through-498.

Simmons, R. and others. 1986. "The Influence of Microtines on Polygyny, Productivity, Age, and Provisioning of Breeding Northern Harriers: A 5-Year Study." *Canadian Journal of Zoology* Volume 64. Pages 2,447 through 2,456.

Smith, J.P. and K. Berg. 1988. "Inventory of Rare and Endangered Vascular Plants of California." *CNPS Special Publication*. Number 1. 4th Edition. Page 161.

Smith, D.G., and J.R. Murphy. 1973. "Breeding Ecology of Raptors in the Eastern Great Basin of Utah." Brigham Young University. *Provo. Sci. Bull. Biol. Ser.* Volume 18. Number 3. 76 Pages.

Smith, M.K., E.L. George, J.A. Stober, H.A. Feng, and G.L. Kimmel. 1993. "Perinatal Toxicity Associated with Nickel Chloride Exposure." *Environmental Research*. Volume 61. Pages 200 through 211.

Sparling, D.W. and T.P. Lowe. 1996. "Environmental Hazards of Aluminum to Plants, Invertebrates, Fish, and Wildlife." *Reviews of Environmental Contamination and Toxicology*. Volume 145. Pages 1 through 127.

Spiker, E.C. and L.E. Schemel. 1979. "Distribution and Stable-Isotope Composition of Carbon in San Francisco Bay." In: *San Francisco Bay: The Urbanized Estuary*. T.J. Conomos, Editor. Pacific Division, American Association Advancement of Science. Pages 195 through 212.

Spitsbergen, J.M., M.K. Walker, J.R. Olson, and R.E. Peterson. 1991. "Pathological Alterations in Early Life Stages of Lake Trout (*Salvelinus namaycush*) Exposed to 2,3,7,8-Tetrachlorodibenzo-p-dioxin as Fertilized Eggs." *Aquatic Toxicology*. Volume 19. Pages 875 through 883.

Srivastava, A.K. and J. Mishra. 1987. "Heptachlor Induced Haematological and Biochemical Changes in the Indian Catfish (*Heteropneustes fossilis*)." *Acta Hydrobiologia*. Volume 29.

Stokes, D.W. and L.Q. Stokes. 1996. *Stokes Field Guide to Birds*. Little, Brown, and Company. Boston, Massachusetts. 519 Pages.

Storm and others. 1976. "Morphology, Reproduction, Dispersal, and Mortality of Midwestern Red Fox Populations." *Wildlife Monographs*. Volume 49. Pages 1 through 82.

Strickler-Shaw, S. and D.H. Taylor. 1990. "Sublethal Exposure to Lead Inhibits Acquisition and Retention of Discriminate Avoidance Learning in Green Frog (*Rana clamitans*) Tadpoles." *Environmental Toxicology and Chemistry*. Volume 9. Pages 47 through 52.

Suffett, I.H., L.L Williams, C.T. Jafvert, J. Kukkonen, M.R. Servos, A. Spacie, and J.A. Noblet. 1994. "Synopsis of Discussion Section: Influences of Particulate and Dissolved Material on the Bioavailability of Organic Compounds". In: *Bioavailability: Physical, Chemical, and Biological Interactions*. J.L. Hamelink and others, Editors. Lewis Publishers. Boca Raton, Florida.

Suter, G.W. and C.L. Tsao. 1996. "Toxicological Benchmarks for Screening Potential Contaminants of Concern for Effects on Aquatic Biota." Prepared by Oak Ridge National Laboratory for the U.S. Department of Energy. Contract #DE-AC05-8401221400.

Suter and others. 1999. "Ecological Risk Assessment in a Large River-Reservoir: Fish Community." *Environmental Toxicology and Chemistry*. Volume 18. Number 4. Pages 589 through 598.

Temeles, E.J. 1989. "Effect of Prey Consumption on Foraging Activity of Northern Harriers." *The Auk*. Volume 106. Number 3. Pages 353 through 357.

Terres, J.K. 1980. *The Audubon Society Encyclopedia of North American Birds*. Alfred A. Knopf. Page 499.

Tessier, A. and P.G.C. Campbell. 1987. "Partitioning of Trace Metals in Sediments: Relationships with Bioavailability." *Hydrobiologia*. Volume 149. Pages 43 through 52.

Tessier, A., P.G.C. Campbell, J.C. Auclair, and M. Bisson. 1984. "Relationships Between the Partitioning of Trace Metals in Sediments and Their Accumulation in the Tissues of the Freshwater Mollusc *Elliptio complanata* in a Mining Area." *Canadian Journal of Fish and Aquatic Science*. Volume 41. Pages 1,463 through 1,472.

Tetra Tech EM Inc. (TtEMI). 1998a. "Field Sampling Addendum, Concord Naval Weapons Station, Tidal Area Sites 2, 9, and 11." February.

TtEMI. 1998b. "Confirmation Groundwater Sampling in the Tidal Area Sites, Technical Memorandum, Naval Weapons Station Concord, California."

TtEMI. 1998c. Field Logbook. Pages 1 through 14. June 11 to 14.

TtEMI. 1998d. "Draft Record of Decision, Tidal Area Landfill". September 28.

TtEMI. 1998e. Personal Observation at Tidal Area. June Mire, TtEMI.

TtEMI. 1999. "Draft RI Report, Tidal Area Sites 1, 2, 9, and 11, Naval Weapons Station, Seal Beach Detachment, Concord, California." Volume I. June.

Thompson, B., J. Hunt, K. Taberski, B. Phillips. 1997. "Relationship Between Sediment Toxicity and Contamination in San Francisco Bay." Annual Report for San Francisco Estuary Institute (SFEI).

Trapp, G.R. and D.L. Hallberg. 1975. "Ecology of the Gray Fox (*Urocyon cinereoargenteus*): A Review." M.W. Fox, Editor. *The Wild Canids*. Van Nostrand, Reinhold Company. New York, New York. Pages 164 through 178.

University of Arizona. 1999. "Characterization of Wildlife and Plant Communities for Weapons Support Facility Seal Beach, Detachment Concord; July to November 1988 Results." Prepared for the Natural Resources Management Branch, EFA WEST, San Bruno, California. February.

U.S. Army Corps of Engineers (USACE). 1987. "Corps of Engineers Wetland Delineation Manual. Final Report." *U.S. Waterways Experiment Station Report Y-87-1*.

USACE. 1989. "Factors Influencing Bioaccumulation of Sediment-Associated Contaminants by Aquatic Organisms: Factors Related to Contaminants." Environmental Effects of Dredging Technical Notes. EEDP-01-17. July.

EPA. 1986. "Test Methods for Evaluating Solid Waste. Third Edition SW-846." Revisions of Specific Methods through 1996. November.

EPA. 1988. Geo-EAS (Geostatistical Environmental Assessment Software). User's Guide. 600/4-88/033. EPA, Environmental Monitoring Systems Laboratory, Las Vegas, Nevada.

EPA. 1989. "Short-Term Methods for Estimating the Chronic Toxicity of Effluents and Receiving Waters to Freshwater Organisms. Second Edition." EPA/600/4-89/001. EPA, Environmental Monitoring Systems Laboratory. Cincinnati, Ohio.

EPA. 1992. "A Framework for Ecological Risk Assessment."

EPA. 1993. *Wildlife Exposure Factor Handbook Volume I.* Office of Research and Development. Washington D.C. EPA/600/R-93/187a. December.

EPA. 1994a. "Methods for Measuring the Toxicity and Bioaccumulation of Sediment-Associated Contaminants with Freshwater Invertebrates." EPA 600/R-94/024. Duluth, Minnesota.

EPA. 1994b. "Health Assessment Document for 2,3,7,8-Tetrachlorodibenzo-p-dioxin (TCDD) and Related Compounds. Volume III of III." Review Draft. EPA/600/Bp-92/001c.

EPA. 1995. "Protocols for Short-Term Toxicity Screening of Hazardous Waste Sites."

EPA. 1997. "ERA Guidance for Superfund: Process for Designing and Conducting ERAs. Interim Final." Washington, DC. EPA540-R-97-006.

EPA. 1998. "Guidelines for Ecological Risk Assessment." EPA/630/R-95/002F. Washington D.C.

EPA and USACE. 1994. Evaluation of Dredged Materials Proposed for Discharge in Waters of the U.S.-Testing Manual (Draft). Inland Testing Manual. EPA-823-B-94-002.

U.S. Fish and Wildlife Service (USFWS). 1981. *Pacific Coast Ecology Inventory – User's Guide and Information Base.* FWS/OBS-81/30. USFWS, U.S. Department of Interior. Page 159.

USFWS. 1992a. "Endangered and Threatened Wildlife and Plants; 90-Day Finding and Commencement of Status Reviews for a Petition to List the California Tiger Salamander." Federal Register 57(224): 54545-54546.

USFWS. 1992b. "Endangered and Threatened Wildlife and Plants; 90-Day Finding and Commencement of Status Reviews for a Petition to List the Western Pond Turtle and California Red-Legged Frog." Federal Register 57(193): 45761-45762.

USFWS. 1994. "Formal Endangered Species Consultation on the South Delta Temporary Barrier in Old River at the San Joaquin River." Public Notice 199300507. Department of Water Resources, Sacramento-San Joaquin Delta, San Joaquin County, California. Letter to Art Champ, Chief, Regulatory Division, Sacramento District, U.S. Army Corps of Engineers, Dated March 24.

U.S. Soil Conservation Service (SCS). 1977. "Soil Survey of Contra Costa County, California."

SCS. 1991. "Hydric Soils of the United States." *Miscellaneous Publication 1491*. SCS in Cooperation with the National Technical Committee for Hydric Soils.

Van Gestel, C.A.M. and W.A. Van Dis. 1988. "The Influence of Soil Characteristics on the Toxicity of Four Chemicals to the Earthworm *Eisenia Fetida andrei* (Oligochaeta)." *Biology and Fertility of Soils*. Volume 6. Pages 262 through 265.

Wallace, A., R.M. Romney, J.W. Cha, S.M. Soufi, and F.M. Caudhry. 1977. "Nickel Phytotoxicity in Relationship to Soil pH Manipulation and Chelating Agents." *Communications in Soil Science and Plant Analysis*. Volume 8. Number 9. Pages 757 through 764.

Walton, B.T., T.A. Anderson, M.S. Hendricks, and S.S. Talmage. 1989. "Physiochemical Properties as Predictors of Organic Chemical Effects on Soil Microbial Respiration." *Environmental Toxicology and Chemistry*. Volume 8. Pages 53 through 63.

Waterways Experiment Station (WES). 1986. "Remedial Investigation of Contaminant Mobility at Naval Weapons Station Concord, California." *Miscellaneous Paper EL-86-2*. USACE WES, Vicksburg, Mississippi.

WES. 1988a. "Remedial Investigation of Contaminant Mobility at Naval Weapons Station Concord, California. Subtitle Appendix 2.5 - 1986/87 Data." *Miscellaneous Paper EL-86-2*. USACE WES, Vicksburg, Mississippi.

WES. 1988b. "Feasibility Study of Contamination Remediation at Naval Weapons Station Concord, California." *Miscellaneous Paper EL-86-3*. USACE WES, Vicksburg, Mississippi.

Weaver, C.S. and D.P. Hill. 1979. "Earthquake Swarms and Crustal Spreading Along Major Strike-Slip Faults in California." *Pure and Applied Geophysics*. Volume 117. Page 51.

Welch, L.E. 1977. "Soil Survey of Contra Costa County, California." USDA SCS and the University of California Agricultural Experiment Station. 122 Pages and 54 Map Sheets.

Western Ecological Services Company (WESCO). 1979. "Habitat Relationships of the Salt Marsh Harvest Mouse in the Pittsburg 8 and 9 Study Area, Contra Costa County, California." PGE801. 36 Pages and Appendices.

WESCO. 1993. "Phase 1 Site-Wide Qualitative Habitat and Receptor Characterization NAS Moffett Field." Unpublished Report Prepared for Montgomery Watson, Inc. 86 Pages and Appendices.

WESCO. 1995. "Qualitative Habitat Characterization Report, Tidal Area Sites, Naval Weapons Station Concord, California (Draft)." Prepared for PRC. March.

Whitaker, J.O. 1980. *The Audubon Society Field Guide to North American Mammals*. Alfred A. Knopf. New York, New York. 745 pages.

Will, M.E. and G.W. Suter II. 1995. "Toxicological Benchmarks for Screening Potential Contaminants of Concern for Effects on Terrestrial Plants: 1995 Revision." ES/ER/TM-85/R2. Oak Ridge National Laboratory. Oak Ridge, Tennessee.

Will, M.E., G.W. Suter II, R.A. Efroymson, and A.C. Wooten. 1997. "Toxicological Benchmarks for Screening Contaminants of Potential Concern for Effects on Terrestrial Plants: 1997 Revision." Oak Ridge National Laboratory. Oak Ridge, Tennessee. ES/ER/TM-85/R3. 128 Pages.

Wilson, D.O. 1977. "Nitrification in Three Soils Amended with Zinc Sulfate." *Soil Biology and Biochemistry*. Volume 9. Pages 277 through 280.

World Health Organization (WHO). 1996. "WHO Toxic Equivalency Factors (TEF) for Dioxin-Like Compounds for Humans and Wildlife." WHO European Center for Environmental Health.

Zeiner, D.C., Laundenslayer Jr., W.F. and K.E. Mayer (Editors). 1988. *California's Wildlife, Volume I: Amphibians and Reptiles*.

Zeiner, D.C., W.F. Laudenslayer, Jr., K.E. Mayer, and M. White (Editors). 1990a. *California's Wildlife. Volume II: Birds*. California Statewide Wildlife Habitat Relationships System. CDFG, Sacramento, California. November.

Zeiner, D.C., W.F. Laudenslayer, Jr., K.E. Mayer, and M. White (Editors). 1990b. *California's Wildlife. Volume III: Mammals*. California Statewide Wildlife Habitat Relationships System. CDFG, Sacramento, California. November.

TABLE 3-1

TERRESTRIAL AND WETLAND PLANT SPECIES
OBSERVED AT THE TIDAL AREA SITES
TIDAL AREA QEA, NWS SBD CONCORD

Common Name	Scientific Name
Scarlet Pimpernel	*Anagallis arvensis*
Asparagus	*Asparagus officinale*
Giant Reed	*Arundo donax*
Australian Salt Bush	*Atriplex semibaccata*
Spearscale (Fathen)	*Atriplex triangularis*
Slender Wild Oat	*Avena barbata*
Wild Oat	*Avena fatua*
Coyote Brush	*Baccharis pilularis*
Black Mustard	*Brassica nigra*
Ripgut Grass	*Bromus diandrus*
Soft Chess	*Bromus hordeaceus*
Foxtail Chess	*Bromus madritensis* ssp. *rubens*
Italian Thistle	*Carduus pycnocephalus*
Yellow Star-Thistle	*Centaurea solstitialis*
Goosefoot	*Chenopodium* sp.
Chicory	*Cichorium intybus*
Bull Thistle	*Cirsium vulgare*
Bindweed	*Convolvulus arvensis*
Brass Buttons	*Cotula coronopifolia*
Parasitic Dodder	*Cuscuta salina*
Artichoke Thistle	*Cynara cardunculus*
Bermuda Grass	*Cynodon dactylon*
Saltgrass	*Distichlis spicata*
Fireweed	*Epilobium brachycarpum*
Red Stemmed Filaree	*Erodium cicutarium*
Fennel	*Foeniculum vulgare*
Alkali Heath	*Frankenia salina*
Gumplant	*Grindelia* sp.

TABLE 3-1 (Continued)

TERRESTRIAL AND WETLAND PLANT SPECIES OBSERVED AT THE TIDAL AREA SITES TIDAL AREA QEA, NWS SBD CONCORD

Common Name	Scientific Name
Mediterranean Barley	*Hordeum marinum* ssp. *gussoneanum*
Hare Barley	*Hordeum marinum* ssp. *leporinum*
Jaumea	*Jaumea carnosa*
Baltic Rush	*Juncus balticus*
Prickly Lettuce	*Lactuca serriola*
Perennial Peppergrass	*Lepidium latifolium*
Creeping Wild Rye	*Leymus triticoides*
Marsh Rosemary	*Limonium californicum*
Annual Ryegrass	*Lolium multiflorum*
Perennial Ryegrass	*Lolium perenne*
Birdfoot Trefoil	*Lotus corniculatus*
Arroyo Lupine	*Lupinus succulentus*
Cheeseweed	*Malva parviflora*
California Burclover	*Medicago polymorpha*
White Sweetclover	*Melilotus alba*
Yellow Sourclover	*Melilotus officinalis*
Dallis Grass	*Paspalum dilatatum*
Harding Grass	*Phalaris aquatica*
Bristly Ox-Tongue	*Picris echioides*
Smilo Grass	*Piptatherum miliaceum*
English Plantain	*Plantago lanceolata*
Annual Beard Grass	*Polypogon monspeliensis*
Slender-leaved Pond Weed	*Potamogeton filiformis*
Wild Radish	*Raphanus sativus*
Curly Dock	*Rumex crispus*
Pickleweeed	*Salicornia virginica*
Russian Thistle	*Salsola tragus*
California Bulrush	*Scirpus californicus*

TABLE 3-1 (Continued)

TERRESTRIAL AND WETLAND PLANT SPECIES OBSERVED AT THE TIDAL AREA SITES TIDAL AREA QEA, NWS SBD CONCORD

Common Name	Scientific Name
Alkali Bulrush	*Scirpus robustus*
Prickly Sow's Ear	*Sonchus asper*
Salsify	*Tragopogon porrifolius*
Narrow-Leaved Cattail	*Typha angustifolia*
Broad-Leaved Cattail	*Typha latifolia*
Stinging Nettle	*Urtica* sp.

References:

1. University of Arizona. 1999. "Characterization of Wildlife and Plant Communities for Weapons Support Facility Seal Beach, Detachment Concord: July to November 1988 Results." Prepared for the Natural Resources Management Branch, Naval Facilities Engineering Command, Engineering Field Activity West, San Bruno, California. February.
2. O'Neil, L.J. 1988. "Feasibility Study of Contamination Remediation at Naval Weapons Station, Concord, California. Volume II: Biological Assessment." U.S. Army Waterways Experiment Station. Miscellaneous Paper EL 86-3. Vicksburg, MS. 50 Pages.
3. Jones and Stokes. 1982. "A Natural Resources Survey, Naval Weapons Station Concord, California." Prepared for the Natural Resources Management Branch, Western Division, Naval Facilities Engineering Command, San Bruno, California. Contract Number N 624-81-C-8764.
4. WESCO. 1995. "Qualitative Habitat Characterization Report, Tidal Area Sites, Naval Weapons Station Concord (Draft)." Prepared for PRC Environmental Management, Inc. March.

TABLE 3-2

TERRESTRIAL AND WETLAND AQUATIC INVERTEBRATES AND FISH OCCURRING OR POTENTIALLY OCCURRING AT THE TIDAL AREA SITES
TIDAL AREA QEA, NWS SBD CONCORD

Common Name	Scientific Name	Occurrence at the Tidal Area Sites
Aquatic Invertebrates		
Oligochaete Worms	*Oligochaeta* spp.	P
Polychaete Worms	*Nereis limnicola*	O
	Streblospio benedicti	P
	Nereis succinea	P
	Boccardia ligerica	P
Amphipod Crustacean	*Traskorchestia* sp.	O
	Corophium spinicorne	O
	Anisogammarus confervicolus	O
Copepod	*Eurytemora affinis*	O
Isopod	*Gnorisphaeroma oregonensis*	O
Brackish-water Crab	*Rhithropanopeus harrisii*	P
Opossum Shrimp	*Neomysis awatschensis*	O
Bay Shrimp	*Crangon nigricauda*	O
	Paleomon macrodactylus	V
Blood Worm	*Chironomus stigmaterus*	O
Chironomid Larvae	*Chironomus* spp.	O
	Procladius spp.	O
Water Boatman	*Trichocorixa reticulata*	O
Water Scavenger Beetle	*Tropisternis* sp.	O
Dragonfly Nymph	*Anax* sp.	O
Soldierfly Larvae	*Odontomyia/Hedriodiscus* sp.	V
Freshwater Snail	*Fontelicella stearnsiana*	O
Clam	*Macoma balthica*	O
	Corbicula fluminea	P

TABLE 3-2 (Continued)

TERRESTRIAL AND WETLAND AQUATIC INVERTEBRATES AND FISH OCCURRING OR POTENTIALLY OCCURRING AT THE TIDAL AREA SITES
TIDAL AREA QEA, NWS SBD CONCORD

Common Name	Scientific Name	Occurrence at the Tidal Area Sites
Fishes		
Striped Bass	*Morone saxatilis*	O
Sacramento Blackfish	*Orthodon microlepidotus*	P
Sacramento Splittail	*Pogonichtys macrolepidotus*	P
American Shad	*Alosa sapidissima*	P
Carp	*Cyprinus carpio*	P
Goldfish	*Carassius auratus*	P
Sacramento Squawfish	*Ptychocheilus grandis*	P
Sacramento Sucker	*Catostomus occidentalis*	P
White Catfish	*Ameiurus catus*	P
Black Crappie	*Pomoxis nigromaculatus*	P
Bluegill	*Lepomis macrochirus*	P
Prickly Sculpin	*Cottus asper*	P
Brown Bullhead	*Ameiurus nebulosus*	P
Hitch	*Lavinia exilicauda*	P
Pacific Lamprey	*Lampetra tridentatus*	P
White Sturgeon	*Acipenser transmontanus*	P
Green Sturgeon	*Acipenser medirosfris*	P
Chinook (King) Salmon	*Oncorhynchus tshawytscha*	P
Rainbow Trout (steelhead)	*Oncorhynchus mykiss*	P
Delta Smelt	*Hypomesus transpacificus*	P
Three-Spine Stickleback	*Gasterosteus aculeatus*	O
Threadfin Shad	*Dorosoma petenense*	P
Longfin Smelt	*Spirinchus thaleichthys*	P
Tule Perch	*Hysteracarpus traski*	O
Topsmelt	*Atherinops affinis*	O
Yellowfin Goby	*Acanthogobius flavimanus*	O
Longjaw Mudsucker	*Gillichthys mirabilis*	P

TABLE 3-2 (Continued)

TERRESTRIAL AND WETLAND AQUATIC INVERTEBRATES AND FISH OCCURRING OR POTENTIALLY OCCURRING AT THE TIDAL AREA SITES TIDAL AREA QEA, NWS SBD CONCORD

Common Name	Scientific Name	Occurrence at the Tidal Area Sites
Fishes (Continued)		
Staghorn Sculpin	*Leptocottus armatus*	O
Mosquitofish	*Gambusia affinis*	O

Notes:

O Observed

P Potential habitat at Tidal Area sites

V Occurs in the vicinity

References:

1. University of Arizona. 1999. "Characterization of Wildlife and Plant Communities for Weapons Support Facility Seal Beach, Detachment Concord; July to November 1988 Results." Prepared for the Natural Resources Management Branch, Naval Facilities Engineering Command, Engineering Field Activity West, San Bruno, California. February.
2. O'Neil, L.J. 1988. "Feasibility Study of Contamination Remediation at the Naval Weapons Station, Concord, California; Volume II: Biological Assessment." U.S. Army Waterways Experiment Station. Misc. Paper EL-86-3. Vicksburg, MS. 50 Pages.
3. Jones and Stokes. 1982. "A Natural Resources Survey, Naval Weapons Station Concord, California." Prepared for the Natural Resources Management Branch, Western Division, Naval Facilities Engineering Command, San Bruno, California. Contract Number N 624-81-C-8764.
4. WESCO. 1995. "Qualitative Habitat Characterization Report, Tidal Area Sites, Naval Weapons Station Concord (Draft)." Prepared for PRC Environmental Management, Inc. March.

TABLE 3-3

TERRESTRIAL AND WETLAND AMPHIBIANS, REPTILES, BIRDS, AND MAMMALS OCCURRING OR POTENTIALLY OCCURRING AT THE TIDAL AREA SITES TIDAL AREA QEA, NWS SBD CONCORD

Common Name	Scientific Name	Occurrence at the Tidal Area Sites
Amphibians and Reptiles		
California Slender Salamander	*Batrachoceps attenuatus*	V
Western Toad	*Bufo boreas*	V
Pacific Tree Frog	*Hyla regilla*	O
Western Pond Turtle	*Clemmys marmorata*	O
Western Fence Lizard	*Sceloporus occidentalis*	O
Southern Alligator Lizard	*Gerrhonotus multicarinatus*	V
California Whipsnake	*Masticophis lateralis*	V
Ringneck Snake	*Diadophis punctatus*	V
Gopher Snake	*Pituophis melanoleucus*	V
Western Rattlesnake	*Crotalus viridis*	V
Common Kingsnake	*Lampropeltis getulus*	V
Pond Slider	*Pseudemys scripta*	V
Birds		
Red-throated Loon	*Gavia stellata*	P
Common Loon	*Gavia immer*	P
Pied-billed Grebe	*Podilymbus podiceps*	O
Horned Grebe	*Podiceps auritus*	V
Red-necked Grebe	*Podiceps grisegena*	P
Eared Grebe	*Podiceps nigricollis*	V
Western Grebe	*Aechmophorus occidentalis*	P
Clark's Grebe	*Aechmophorus clarkii*	P
American White Pelican	*Pelecanus erythrorhynchos*	O
California Brown Pelican	*Pelecanus occidentalis*	P
Double-crested Cormorant	*Phalacrocorax auritus*	O
American Bittern	*Botaurus lentiginosus*	V
Great Blue Heron	*Ardea herodias*	O
Great Egret	*Casmerodius albus*	O
Snowy Egret	*Egretta thula*	O

TABLE 3-3 (Continued)

TERRESTRIAL AND WETLAND AMPHIBIANS, REPTILES, BIRDS, AND MAMMALS OCCURRING OR POTENTIALLY OCCURRING AT THE TIDAL AREA SITES TIDAL AREA QEA, NWS SBD CONCORD

Common Name	Scientific Name	Occurrence at the Tidal Area Sites
Birds (Continued)		
Cattle Egret	*Bubulcus ibis*	P
White-faced Ibis	*Plegadis chihi*	V
Green-backed Heron	*Butorides striatus*	V
Black-crowned Night Heron	*Nycticorax nycticorax*	O
Tundra swan	*Cygnus columbianus*	V
Mute swan	*Cygnus olor*	V
Canada Goose	*Branta canadensis*	O
Green-winged Teal	*Anas crecca*	V
Mallard	*Anas platyrhynchos*	O
Northern Pintail	*Anas acuta*	V
Blue-winged Teal	*Anas discors*	O
Cinnamon Teal	*Anas cyanoptera*	O
Northern Shoveler	*Anas clypeata*	P
Gadwall	*Anas strepera*	O
Eurasian Wigeon	*Anas penelope*	P
American Wigeon	*Anas americana*	V
Canvasback	*Aythya valisineria*	V
Greater Scaup	*Aythya marila*	V
Lesser Scaup	*Aythya affinis*	V
Common Goldeneye	*Bucephala clangula*	V
Bufflehead	*Bucephala albeola*	V
Ruddy Duck	*Oxyura jamaicensis*	V
Ring-necked Duck	*Aythya collaris*	V
Red-breasted Merganser	*Mergus serrator*	P
Turkey Vulture	*Cathartes aura*	O
Black-shouldered Kite	*Elanus caerulens*	O
White-tailed Kite	*Elanus leucurus*	O
Northern Harrier	*Circus cyaneus*	O

TABLE 3-3 (Continued)

TERRESTRIAL AND WETLAND AMPHIBIANS, REPTILES, BIRDS, AND MAMMALS OCCURRING OR POTENTIALLY OCCURRING AT THE TIDAL AREA SITES TIDAL AREA QEA, NWS SBD CONCORD

Common Name	Scientific Name	Occurrence at the Tidal Area Sites
Birds (Continued)		
Red-tailed Hawk	*Buteo jamaicensis*	V
Red-shouldered Hawk	*Buteo lineatus*	V
Rough-legged Hawk	*Buteo lagopus*	V
Ferruginous hawk	*Buteo regalis*	V
Golden Eagle	*Aquila chrysaetos*	V
American Kestrel	*Falco sparverius*	O
Merlin	*Falco columbarius*	P
American Peregrine Falcon	*Falco peregrinus anatum*	P
California quail	*Callipepla california*	V
Ring-necked Pheasant	*Phasianus coturniculus*	O
California Black Rail	*Laterallus jamaicensis*	O
California Clapper Rail	*Rallus longirostris obsoletus*	V
Virginia Rail	*Rallus limicola*	O
Sora	*Porzana carolina*	V
Common Moorhen	*Gallinula chloropus*	P
American Coot	*Fulica americana*	V
Common Snipe	*Gallinago gallinago*	V
Black-bellied Plover	*Pluvialis squatarola*	P
Western Snowy Plover (Coastal Population)	*Charadrius alexandrinus nivosus*	P
Semipalmated Plover	*Charadrius semipalmatus*	P
Killdeer	*Charadrius vociferus*	O
Black-necked Stilt	*Himantopus mexicanus*	O
American Avocet	*Recurvirostra americana*	V
Greater Yellowlegs	*Tringa melanoleuca*	V
Lesser Yellowlegs	*Tringa flavipes*	P
Willet	*Catoptrophorus semipalmatus*	P
Whimbrel	*Numenius phaeopus*	P
Long-billed Curlew	*Numenius americanus*	V

TABLE 3-3 (Continued)

TERRESTRIAL AND WETLAND AMPHIBIANS, REPTILES, BIRDS, AND MAMMALS OCCURRING OR POTENTIALLY OCCURRING AT THE TIDAL AREA SITES TIDAL AREA QEA, NWS SBD CONCORD

Common Name	Scientific Name	Occurrence at the Tidal Area Sites
Birds (Continued)		
Marbled Godwit	*Limosa fedoa*	P
Red Knot	*Calidris canutus*	P
Sanderling	*Calidris alba*	O
Western Sandpiper	*Calidris mauri*	P
Least Sandpiper	*Calidris minutilla*	P
Spotted Sandpiper	*Actitis macularia*	V
Dunlin	*Calidris alpina*	P
Short-billed Dowitcher	*Limnodromus griseus*	P
Long-billed Dowitcher	*Limnodromus scolopaceus*	O
Bonaparte's Gull	*Larus philadelphia*	O
Mew Gull	*Larus canus*	P
Ring-billed Gull	*Larus delawarensis*	V
California Gull	*Larus californicus*	V
Herring Gull	*Larus argentatus*	O
Thayer's Gull	*Larus thayeri*	P
Western Gull	*Larus occidentalis*	V
Glaucous-winged Gull	*Larus glaucescens*	P
Caspian Tern	*Sterna caspia*	O
Elegant Tern	*Sterna elegans*	P
Common Tern	*Sterna hirundo*	P
Forster's Tern	*Sterna forsteri*	V
Least Tern	*Sterna antillarum*	P
Rock Dove	*Columba livia*	O
Mourning Dove	*Zenaida macroura*	O
Barn Owl	*Tyto alba*	V
Western Screech Owl	*Otus kennicottii*	V
Great Horned Owl	*Bubo virginianus*	O
Burrowing Owl	*Athene cunicularia*	V

TABLE 3-3 (Continued)

TERRESTRIAL AND WETLAND AMPHIBIANS, REPTILES, BIRDS, AND MAMMALS OCCURRING OR POTENTIALLY OCCURRING AT THE TIDAL AREA SITES TIDAL AREA QEA, NWS SBD CONCORD

Common Name	Scientific Name	Occurrence at the Tidal Area Sites
Birds (Continued)		
Short-eared Owl	*Asio flammeus*	V
White-throated Swift	*Aeronautes saxatalis*	P
Anna's Hummingbird	*Calypte anna*	V
Allen's Hummingbird	*Selasphorus sasin*	P
Belted Kingfisher	*Ceryle alcyon*	O
Northern Flicker	*Colaptes auratus*	V
Western Kingbird	*Tyrannus verticalis*	V
Black Phoebe	*Sayornis nigricans*	O
Say's Phoebe	*Sayornis saya*	V
California Horned Lark	*Eremophila alpestris*	V
Tree Swallow	*Tachycineta bicolor*	O
Violet-green Swallow	*Tachycineta thalassina*	P
Cliff Swallow	*Hirundo pyrrhonota*	O
Barn Swallow	*Hirundo rustica*	O
Northern Rough-winged Swallow	*Stelgidopteryx serripennis*	V
Scrub Jay	*Aphelocoma coerulescens*	V
Steller's Jay	*Cyanocitta stelleri*	V
American Crow	*Corvus brachyrhynchos*	V
Common Raven	*Corvus corax*	V
House Wren	*Troglodytes aedon*	V
Marsh Wren	*Cistothorus palustris*	O
Rock Wren	*Salpinctes obsoletus*	V
Western Bluebird	*Sialia mexicana*	V
American Robin	*Turdus migratorius*	V
Northern Mockingbird	*Mimus polyglottos*	O
Loggerhead Shrike	*Lanius ludovicianus*	O
European Starling	*Sturnus vulgaris*	O

TABLE 3-3 (Continued)

TERRESTRIAL AND WETLAND AMPHIBIANS, REPTILES, BIRDS, AND MAMMALS OCCURRING OR POTENTIALLY OCCURRING AT THE TIDAL AREA SITES TIDAL AREA QEA, NWS SBD CONCORD

Common Name	Scientific Name	Occurrence at the Tidal Area Sites
Birds (Continued)		
Orange-crowned Warbler	*Vermivora celata*	V
Yellow-rumped Warbler	*Dendroica coronata*	V
Yellow Warbler	*Dendroica petechia*	V
Wilson's Warbler	*Wilsonia pusilla*	V
Saltmarsh Common Yellowthroat	*Geothlypis trichas sinuosa*	O
Black-headed Grosbeak	*Pheucticus melanocephalus*	V
Lazuli Bunting	*Passerina amoena*	V
Spotted Towhee	*Pipilo maculatus*	V
California Towhee	*Pipilo crissalis*	O
Savannah Sparrow	*Passerculus sandwichensis*	V
Suisun Song Sparrow	*Melospiza melodia maxillaris*	O
Fox Sparrow	*Passerell ailiaca*	V
Lincoln's Sparrow	*Melospiza lincolnii*	V
Lark Sparrow	*Chondestes grammacus*	V
Golden-crowned Sparrow	*Zonotrichia atricapilla*	V
White-crowned Sparrow	*Zonotrichia leucophrys*	V
Dark-eyed Junco	*Junco hyemalis*	V
Red-winged Blackbird	*Agelaius phoeniceus*	O
Tri-colored Blackbird	*Agelaius tricolor*	V
Western Meadowlark	*Sturnella neglecta*	O
Brewer's Blackbird	*Euphagus cyanocephalus*	O
Brown-headed Cowbird	*Molothrus ater*	V
House Finch	*Carpodacus mexicanus*	O
Lesser Goldfinch	*Cardelis psaltria*	V
American Goldfinch	*Carduelis tristis*	O
House Sparrow	*Passer domesticus*	V

TABLE 3-3 (Continued)

TERRESTRIAL AND WETLAND AMPHIBIANS, REPTILES, BIRDS, AND MAMMALS OCCURRING OR POTENTIALLY OCCURRING AT THE TIDAL AREA SITES TIDAL AREA QEA, NWS SBD CONCORD

Common Name	Scientific Name	Occurrence at the Tidal Area Sites
Mammals		
Virginia Opossum	*Didelphis virginiana*	V
Vagrant Shrew	*Sorex vagrans*	P
Ornate Shrew	*Sorex ornatus*	V
Broad-footed Mole	*Scapanus latimanus*	V
Yuma Myotis	*Myotis yumanensis*	P
Long-eared Myotis	*Myotis evotis*	P
Long-legged Myotis	*Myotis volans*	P
California Myotis	*Myotis californicus*	P
Western Pipistrelle	*Pipistrellus hesperus*	P
Big Brown Bat	*Eptesicus fuscus*	P
Red Bat	*Lasiurus borealis*	P
Townsend's Big Eared Bat	*Plecotus townsendii*	P
Pallid Bat	*Antrozous pallidus*	P
Brazilian Free-tailed Bat	*Tadarida brasiliensis*	P
Desert Cottontail	*Sylvilagus audubonii*	P
Black-tailed Hare	*Lepus californicus*	O
California Ground Squirrel	*Spermophilus beecheyi*	V
Fox Squirrel	*Sciurus niger*	V
Botta's Pocket Gopher	*Thomomys bottae*	V
Beaver	*Castor canadensis*	V
Western Harvest Mouse	*Reithrodontomys megalotis*	O
Salt Marsh Harvest Mouse	*Reithrodontomys raviventris halicoetes*	O
Deer Mouse	*Peromyscus maniculatus*	O
California Vole	*Microtus californicus*	O
Muskrat	*Ondatra zibethicus*	V
Black Rat	*Rattus rattus*	P

TABLE 3-3 (Continued)

TERRESTRIAL AND WETLAND AMPHIBIANS, REPTILES, BIRDS, AND MAMMALS OCCURRING OR POTENTIALLY OCCURRING AT THE TIDAL AREA SITES TIDAL AREA QEA, NWS SBD CONCORD

Common Name	Scientific Name	Occurrence at the Tidal Area Sites
Mammals (Continued)		
Norway Rat	*Rattus norvegicus*	O
House Mouse	*Mus musculus*	O
Coyote	*Canis latrans*	O
Red Fox	*Vulpes vulpes*	O
Gray Fox	*Urocyon cinereoargenteus*	O
Raccoon	*Procyon lotor*	O
Long-tailed Weasel	*Mustela frenata*	V
American Badger	*Taxidea taxus*	P
Striped Skunk	*Mephitis mephitis*	O
River Otter	*Lutra canadensis*	O
Feral Cat	*Felis cattus*	O

Notes:

O Observed

P Potentially occurring at Tidal Area

V Occurs in the vicinity

References:

1. University of Arizona. 1999. "Characterization of Wildlife and Plant Communities for Weapons Support Facility Seal Beach, Detachment Concord; July to November 1988 Results." Prepared for the Natural Resources Management Branch, Naval Facilities Engineering Command, Engineering Field Activity West, San Bruno, California. February.
2. O'Neil, L.J. 1988. "Feasibility Study of Contamination Remediation at the Naval Weapons Station, Concord, California. Volume II: Biological Assessment." U.S. Army Waterways Experiment Station. Misc. Paper EL-86-3. Vicksburg, MS. 50 Pages.
3. Jones and Stokes. 1982. "A Natural Resources Survey, Naval Weapons Station Concord, California." Prepared for the Natural Resources Management Branch, Western Division, Naval Facilities Engineering Command, San Bruno, California. Contract Number N 624-81-C-8764.
4. WESCO. 1995. "Qualitative Habitat Characterization Report, Tidal Area Sites, Naval Weapons Station Concord (Draft)." Prepared for PRC Environmental Management, Inc. March.
5. Zeiner, D.C. and Others. 1988. "California's Wildlife: Volume I. Amphibians and Reptiles." California Department of Fish and Game (CDFG). Sacramento, California. May.
6. Zeiner and Others. 1990a. "California's Wildlife: Volume II. Birds." CDFG. Sacramento, California. November.
7. Zeiner and Others. 1990b. "California's Wildlife: Volume III. Mammals." CDFG. Sacramento, California. April.

TABLE 3-4

SPECIAL STATUS SPECIES OCCURRING OR POTENTIALLY OCCURRING AT THE TIDAL AREA SITES TIDAL AREA QEA, NWS SBD CONCORD

Species	State Classification	Federal Classification	Occurrence at the Tidal Area
Plants			
Suisun Marsh Aster *(Aster lentus)*	CNPS list 1B	Species of Special Concern	P
Suisun Thistle (*Cirisium hydrophilium* var. *hydrophilium*)	CNPS list 1B	Endangered	P
Soft Bird's Beak (*Cordylanthus mollis* ssp. *Mollis*)	CNPS list 1B/ State Listed Rare	Endangered	P
Small Spikerush (*Eleocharis parvula*)	CNPS list 4	None	P
Delta Tule Pea (*Lathyrus jepsonii* ssp. *jepsonii*)	CNPS list 1B	Species of Special Concern	P
Mason's Quillwort (*Lilaeopsis masonii*)	CNPS list 1B/ State Listed Rare	Species of Special Concern	P
Marsh Gumplant (*Grindelia stricta var. angustifolia*)	CNPS list 1B	None	O
Delta Mudwort (*Limosella subulata*)	CNPS list 2	None	P
Fish			
Winter-Run Chinook Salmon (*Oncorhynchus tshawytscha*)	Endangered	Endangered	P
Delta Smelt (*Hypomesus transpacificus*)	Threatened	Threatened	P
Sacramento Splittail (*Pogonichtys macrolepidotus*)	Species of Special Concern	Proposed Threatened	P
Longfin Smelt (*Spirinchus thaleichthys*)	Species of Special Concern	Species of Special Concern	P
Reptiles and Amphibians			
Western Pond Turtle (*Clemmys marmorata*)	Species of Special Concern	Species of Special Concern	O

TABLE 3-4 (Continued)

SPECIAL STATUS SPECIES OCCURRING OR POTENTIALLY OCCURRING AT THE TIDAL AREA SITES TIDAL AREA QEA, NWS SBD CONCORD

Species	State Classification	Federal Classification	Occurrence at the Tidal Area
Birds			
California Gull (*Larus californicus*)	Species of Special Concern	None	V
White-faced Ibis (*Plegadis chihi*)	Species of Special Concern	Species of Special Concern	V
Loggerhead Shrike (*Lanius ludovicianus*)	Species of Special Concern	Species of Special Concern	O
Salt Marsh Common Yellowthroat (*Geothlypis trichas sinuosa*)	Species of Special Concern	Species of Concern	Possibly O
Suisun Song Sparrow (*Melospiza melodia maxillaris*)	Species of Special Concern	Species of Concern	O
Northern Harrier (*Circus cyaneus*)	Species of Special Concern	None	O
Merlin (*Falco columbarius*)	Species of Special Concern	None	P
California Black Rail (*Laterallus jamaicensis coturniculus*)	Threatened	Species of Special Concern	O
California Clapper Rail (*Rallus longirostris obsoletus*)	Endangered	Endangered	P
Golden Eagle (*Aquila chrysaetos*)	Species of Special Concern	None	V
Burrowing Owl (*Athene cunicularia*)	Species of Special Concern	Species of Special Concern	V
Short-eared Owl (*Asio flammeus*)	Species of Special Concern	None	V
Mammals			
Salt Marsh Harvest Mouse (*Reithrodontomys raviventris halicoetes*)	Endangered	Endangered	O
Pallid Bat (*Antrozous pallidus*)	Species of Special Concern	None	V

TABLE 3-4 (Continued)

SPECIAL STATUS SPECIES OCCURRING OR POTENTIALLY OCCURRING AT THE TIDAL AREA SITES TIDAL AREA QEA, NWS SBD CONCORD

Species	State Classification	Federal Classification	Occurrence at the Tidal Area
Mammals			
Suisun ornate shrew	Species of Special Concern	None	P
Townsend's Big-Eared Bat (*Plecotus townsendii*)	Species of Special Concern	Species of Concern	V

Notes:

O Observed

P Potential habitat at Tidal Area

V Occurs in the vicinity

References:

1. California Department of Fish and Game Natural Diversity Database (NDDB). 1999.
2. University of Arizona. 1999. "Characterization of Wildlife and Plant Communities for Weapons Support Facility Seal Beach, Detachment Concord; July to November 1988 Results." Prepared for the Natural Resources Management Branch, Naval Facilities Engineering Command, Engineering Field Activity West, San Bruno, California. February.
3. O'Neil, L.J. 1988. "Feasibility Study of Contamination Remediation at the Naval Weapons Station, Concord, California. Volume II: Biological Assessment." U.S. Army Waterways Experiment Station. Misc. Paper EL-86-3. Vicksburg, MS. 50 Pages.
4. Jones and Stokes. 1982. "A Natural Resources Survey, Naval Weapons Station Concord, California." Prepared for the Natural Resources Management Branch, Western Division, Naval Facilities Engineering Command, San Bruno, California. Contract Number N 624-81-C-8764.
5. WESCO. 1995. "Qualitative Habitat Characterization Report, Tidal Area Sites, Naval Weapons Station Concord (Draft)." Prepared for PRC Environmental Management, Inc. March.
6. Zeiner, D.C. and Others. 1988. "California's Wildlife: Volume I. Amphibians and Reptiles." California Department of Fish and Game (CDFG). Sacramento, California. May.
7. Zeiner and Others. 1990a. "California's Wildlife: Volume II. Birds." CDFG. Sacramento, California. November.
8. Zeiner and Others. 1990b. "California's Wildlife: Volume III. Mammals." CDFG. Sacramento, California. April.

TABLE 4-1

NUMBER OF CHEMISTRY SAMPLES BY SITE AND MATRIX
TIDAL AREA QEA, NWS SBD CONCORD

	1995 – Number of Samples						1998 – Number of Samples			
	CTO 281					CTO 283	CTO 033	CTO 217		
Site	Sediment	Soil	Surface Water	WET-Acid	WET-DI	Soil	Soil	Sediment	Soil	Surface Water
Froid & Taylor Roads	0	27	10	2	9	0	0	0	0	3
Otter Sluice	0	0	0	0	0	0	0	0	0	16
R Area Disposal	2	152	52	9	22	0	0	3	3	0
SMWU 37	0	0	0	0	0	23	0	0	0	0
Tidal Area Landfill	0	24	0	0	0	0	0	0	0	0
Wood Hogger	3	114	25	9	21	0	13	3	1	0

Notes:

CTO Contract task order
DI Deionized water
SMWU Solid waste management unit
WET Waste extraction test

TABLE 4-2

NUMBER OF BIOLOGICAL AND TISSUE SAMPLES BY SITE
TIDAL AREA QEA, NWS SBD CONCORD

Site	1995 – Number of Samples			1998 – Number of Samples						
	CTO 287			CTO 217						
	Microtox (Solid Phase)	Microtox (Aqueous)	Cytochrome P450	Amphipod Tissue	Clam Tissue	Fish Tissue	Pickleweed Tissue	Mouse Tissue	Amphipod Bioassay	Topsmelt Bioassay
Froid & Taylor Roads	9	9		1	0	1	0	0	2	0
Otter Sluice	0	0	0	0	7	7	0	0	0	7
R Area Disposal	20	20	20	0	0	0	4	3	0	0
SMWU 37	0	0	0	0	0	0	0	0	0	0
Tidal Area Landfill	0	0	0	0	0	0	0	0	0	0
Wood Hogger	20	20	20	0	0	0	1	3	0	0

Notes:

CTO Contract task order

SMWU Solid waste management unit

TABLE 4-3

ANALYSES PERFORMED ON 1995 RI AND QEA SAMPLES
TIDAL AREA, NWS SBD CONCORD

			Organic Compounds										Inorganics		Extractions		Biological Tests			Physical Tests						Misc.
Matrix	Sample Location	Depth (feet bgs)	Aromatic Volatiles	Dioxin	Explosives	Pesticides/ PCBs	Low Level Pesticides/ PCBs	SVOC	Low Level SVOC	TPH-e	TPH-p	VOC	Hex. Chromium	Total Metals	WET-Acid	WET-DI	Microtox (Solid Phase)	Microtox (Aqueous)	Cytochrome P450	Geoph.	Grain Size	Percent Moisture	pH	Total Suspended Solids	TOC	Sulfide
Sediment	Site 1 - R Area Disposal																									
	RADSL001	0 - 0.5	NA	NA	NA	NA	1	NA	1	NA	NA	NA	NA	1	1	1	NA	NA	NA	1	1	1	1	NA	1	1
	RADSL002	0 - 0.5	NA	NA	NA	NA	1	NA	1	NA	NA	NA	NA	1	1	1	NA	NA	NA	1	1	1	1	NA	1	1
	Site 11 - Wood Hogger		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	WHSSL001	0 - 0.5	NA	NA	NA	NA	1	NA	1	NA	NA	NA	NA	1	1	1	NA	NA	NA	1	1	1	1	NA	1	1
	WHSSL002	0 - 0.5	NA	NA	NA	NA	1	NA	1	NA	NA	NA	NA	1	1	1	NA	NA	NA	1	1	1	1	NA	1	1
	WHSSL003	0 - 0.5	NA	NA	NA	NA	1	NA	1	NA	NA	NA	NA	1	1	1	NA	NA	NA	1	1	1	1	NA	1	1
	Sediment Sample Total:		0	0	0	0	5	0	5	0	0	0	0	5	5	5	0	0	0	5	5	5	5	0	5	5
Soil	Site 1 - Tidal Area Landfill																									
	TLSSB001	0 - 0.5	NA	NA	1	NA	1	NA	1	NA	NA	NA	1	1	NA	NA	NA	NA	NA	1	1	1	1	NA	1	1
		1.3 - 2.5	NA	NA	1	1	NA	1	NA	NA	NA	1	1	1	NA	NA	NA	NA	NA	1	1	1	1	NA	1	1
		3.9 - 4.5	NA	NA	1	1	NA	1	NA	NA	NA	1	1	1	NA	NA	NA	NA	NA	NA	NA	1	1	NA	1	1
	TLSSB002	0 - 0.5	NA	NA	1	NA	1	NA	1	NA	NA	NA	1	1	NA	NA	NA	NA	NA	1	1	1	1	NA	1	1
		1.3 - 2.5	NA	NA	1	1	NA	1	NA	NA	NA	1	1	1	NA	NA	NA	NA	NA	1	1	1	1	NA	1	1
		4.3 - 5.5	NA	NA	1	1	NA	1	NA	NA	NA	1	1	1	NA	NA	NA	NA	NA	1	1	1	1	NA	1	1
	TLSSB003	0 - 0.5	NA	NA	1	NA	1	NA	1	NA	NA	NA	1	1	NA	NA	NA	NA	NA	1	1	1	1	NA	1	1
		1.5 - 2.5	NA	NA	1	1	NA	1	NA	NA	NA	1	1	1	NA	NA	NA	NA	NA	NA	NA	1	1	NA	1	1
		4.5 - 5.3	NA	NA	1	1	NA	1	NA	NA	NA	1	1	1	NA	NA	NA	NA	NA	NA	NA	1	1	NA	1	1
	TLSSB004	0 - 0.5	NA	NA	1	NA	1	NA	1	NA	NA	NA	1	1	NA	NA	NA	NA	NA	1	1	1	1	NA	1	1
		1.3 - 2.4	NA	NA	1	1	1	1	1	NA	NA	1	1	1	NA	NA	NA	NA	NA	1	1	1	1	NA	1	1
		4.3 - 5.5	NA	NA	1	1	NA	1	NA	NA	NA	1	1	1	NA	NA	NA	NA	NA	1	1	1	1	NA	1	1
	TLSSB005	0 - 0.5	NA	NA	1	NA	1	NA	1	NA	NA	NA	1	1	NA	NA	NA	NA	NA	1	1	1	1	NA	1	1
		.9 - 2	NA	NA	1	1	NA	1	NA	NA	NA	1	1	1	NA	NA	NA	NA	NA	1	1	1	1	NA	1	1
		4.5 - 5.8	NA	NA	1	1	NA	1	NA	NA	NA	1	1	1	NA	NA	NA	NA	NA	1	1	1	1	NA	1	1
	TLSSB006	0 - 0.5	NA	NA	1	NA	1	NA	1	NA	NA	NA	1	1	NA	NA	NA	NA	NA	NA	NA	1	1	NA	1	1
		1.3 - 2	NA	NA	1	1	NA	1	NA	NA	NA	1	1	1	NA	NA	NA	NA	NA	NA	NA	1	1	NA	1	1
		4.5 - 6	NA	NA	1	1	NA	1	NA	NA	NA	1	1	1	NA	NA	NA	NA	NA	1	1	1	1	NA	1	1
	TLSSB007	0 - 0.5	NA	NA	1	NA	NA	NA	NA	NA	NA	NA	1	1	NA	NA	NA	NA	NA	1	1	NA	1	NA	1	1
		1.5 - 2.3	NA	NA	1	1	NA	1	NA	NA	NA	1	1	1	NA	NA	NA	NA	NA	NA	NA	1	1	NA	1	1
		4.5 - 5.3	NA	NA	1	1	NA	1	NA	NA	NA	1	1	1	NA	NA	NA	NA	NA	NA	NA	1	1	NA	1	1
	TLSSB008	0 - 0.5	NA	NA	1	NA	1	NA	1	NA	NA	NA	1	1	NA	NA	NA	NA	NA	1	1	1	1	NA	1	1
		1.5 - 2.7	NA	NA	1	1	NA	1	NA	NA	NA	1	1	1	NA	NA	NA	NA	NA	1	1	1	1	NA	1	1
		4.5 - 5.7	NA	NA	1	1	NA	1	NA	NA	NA	1	1	1	NA	NA	NA	NA	NA	1	1	1	1	NA	1	1
	Site 1 Soil Sample Total:		0	0	24	16	8	16	8	0	0	16	24	24	0	0	0	0	0	17	17	23	24	0	24	24
	Site 2 - R Area Disposal																									
	RADSB001	0 - 0.5	NA	NA	NA	NA	1	NA	1	NA	NA	NA	NA	1	NA	NA	NA	NA	NA	NA	NA	1	1	NA	1	1
	RADSB002	0 - 0.5	NA	NA	1	NA	1	NA	1	NA	NA	NA	NA	1	NA	NA	NA	NA	NA	NA	NA	1	1	NA	1	1
	RADSB003	0 - 0.5	NA	NA	NA	NA	1	NA	1	NA	NA	NA	NA	1	NA	NA	NA	NA	NA	NA	NA	1	1	NA	1	1
	RADSB004	0 - 0.5	NA	NA	NA	NA	1	NA	1	NA	NA	NA	NA	1	NA	NA	NA	NA	NA	NA	NA	1	1	NA	1	1
	RADSB005	0 - 0.5	NA	NA	NA	NA	1	NA	1	NA	NA	NA	NA	1	NA	NA	NA	NA	NA	NA	NA	1	1	NA	1	1
	RADSB006	0 - 0.5	NA	NA	NA	NA	1	NA	1	NA	NA	NA	NA	1	NA	NA	NA	NA	NA	NA	NA	1	1	NA	1	1
	RADSB007	0 - 0.5	NA	NA	1	NA	1	NA	1	NA	NA	NA	NA	1	NA	NA	NA	NA	NA	NA	NA	1	1	NA	1	1
	RADSB008	0 - 0.5	NA	NA	1	NA	1	NA	1	NA	NA	NA	NA	1	NA	NA	NA	NA	NA	NA	NA	1	1	NA	1	1
	RADSB009	0 - 0.5	NA	NA	1	NA	1	NA	1	NA	NA	NA	NA	1	NA	NA	NA	NA	NA	NA	NA	1	1	NA	1	1
	RADSB010	0 - 0.5	NA	NA	1	NA	1	NA	1	NA	NA	NA	NA	1	NA	NA	NA	NA	NA	NA	NA	1	1	NA	1	1
	RADSB011	0 - 0.5	NA	NA	1	NA	1	NA	1	NA	NA	NA	NA	1	NA	NA	NA	NA	NA	NA	NA	1	1	NA	1	1
	RADSB012	0 - 0.5	NA	NA	NA	NA	1	NA	1	NA	NA	NA	NA	1	NA	NA	NA	NA	NA	NA	NA	1	1	NA	1	1
	RADSB013	0 - 0.5	NA	NA	NA	NA	1	NA	1	NA	NA	NA	1	1	NA	NA	NA	NA	NA	NA	NA	1	1	NA	1	1
	RADSB014	0 - 0.5	NA	NA	NA	NA	1	NA	1	NA	NA	NA	NA	1	NA	NA	NA	NA	NA	NA	NA	1	1	NA	1	1
	RADSB015	0 - 0.5	NA	NA	NA	NA	1	NA	1	NA	NA	NA	NA	1	NA	NA	NA	NA	NA	NA	NA	1	1	NA	1	1
	RADSB016	0 - 0.5	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	1	NA	NA	NA	NA	NA	NA	NA	NA	1	NA	NA	NA
	RADSB017	0 - 0.5	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	1	NA	NA	NA	NA	NA	NA	NA	NA	1	NA	NA	NA
	RADSB018	0 - 0.5	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	1	NA	NA	NA	NA	NA	NA	NA	NA	1	NA	NA	NA
	RADSB019	0 - 0.5	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	1	NA	NA	NA	NA	NA	NA	NA	NA	1	NA	NA	NA
	RADSB020	0 - 0.5	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	1	NA	NA	NA	NA	NA	NA	NA	NA	1	NA	NA	NA
	RADSB021	0 - 0.5	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	1	NA	NA	NA	NA	NA	NA	NA	NA	1	NA	NA	NA
	RADSB022	0 - 0.5	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	1	NA	NA	NA	NA	NA	NA	NA	NA	1	NA	NA	NA
	RADSB023	0 - 0.5	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	1	NA	NA	NA	NA	NA	NA	NA	NA	1	NA	NA	NA
	RADSB024	0 - 0.5	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	1	NA	NA	NA	NA	NA	NA	NA	NA	1	NA	NA	NA
	RADSB025	0 - 0.5	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	1	NA	NA	NA	NA	NA	NA	NA	NA	1	NA	NA	NA

TABLE 4-3

ANALYSES PERFORMED ON 1995 RI AND QEA SAMPLES
TIDAL AREA, NWS SBD CONCORD

			Organic Compounds										Inorganics		Extractions		Biological Tests			Physical Tests						Misc.
Matrix	Sample Location	Depth (feet bgs)	Aromatic Volatiles	Dioxin	Explosives	Pesticides/ PCBs	Low Level Pesticides/ PCBs	SVOC	Low Level SVOC	TPH-e	TPH-p	VOC	Hex. Chromium	Total Metals	WET-Acid	WET-DI	Microtox (Solid Phase)	Microtox (Aqueous)	Cytochrome P450	Geoph.	Grain Size	Percent Moisture	pH	Total Suspended Solids	TOC	Sulfide
Soil	Site 2 - R Area Disposal (Continued)																									
	RADSB026	0 - 0.5	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	1	NA	NA	NA	NA	NA	NA	NA	NA	1	NA	NA	NA
	RADSB027	0 - 0.5	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	1	NA	NA	NA	NA	NA	NA	NA	NA	1	NA	NA	NA
	RADSB028	0 - 0.5	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	1	NA	NA	NA	NA	NA	NA	NA	NA	1	NA	NA	NA
	RADSB029	0 - 0.5	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	1	NA	NA	NA	NA	NA	NA	NA	NA	1	NA	NA	NA
	RADSB030	0 - 0.5	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	1	NA	NA	NA	NA	NA	NA	NA	NA	1	NA	NA	NA
	RADSBA01	0 - 0.5	NA	NA	NA	NA	1	NA	1	NA	NA	NA	NA	1	NA	1	1	1	1	1	1	1	1	NA	1	1
	RADSBA02	0 - 0.5	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	1	NA	NA	NA	NA	NA	NA	NA	NA	1	NA	NA	NA
	RADSBA03	0 - 0.5	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	1	NA	NA	NA	NA	NA	NA	NA	NA	1	NA	NA	NA
	RADSBA04	0 - 0.5	NA	NA	NA	NA	1	NA	1	NA	NA	NA	NA	1	NA	NA	NA	NA	NA	NA	NA	1	1	NA	1	1
	RADSBA05	0 - 0.5	NA	NA	NA	NA	1	NA	1	NA	NA	NA	NA	1	NA	NA	NA	NA	NA	NA	NA	1	1	NA	1	1
	RADSBA06	0 - 0.5	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	1	NA	NA	NA	NA	NA	NA	NA	NA	1	NA	NA	NA
	RADSBA07	0 - 0.5	NA	NA	NA	NA	1	NA	1	NA	NA	NA	NA	1	NA	1	1	1	1	1	1	1	1	NA	1	1
	RADSBA08	0 - 0.5	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	1	NA	NA	NA	NA	NA	NA	NA	NA	1	NA	NA	NA
	RADSBB01	0 - 0.5	NA	NA	NA	NA	1	NA	1	NA	NA	NA	NA	1	NA	NA	NA	NA	NA	NA	NA	1	1	NA	1	1
	RADSBB02	0 - 0.5	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	1	NA	NA	NA	NA	NA	NA	NA	NA	1	NA	NA	NA
	RADSBB03	0 - 0.5	NA	NA	NA	NA	1	NA	1	NA	NA	NA	NA	1	NA	NA	NA	NA	NA	NA	NA	1	1	NA	1	1
	RADSBB04	0 - 0.5	NA	NA	NA	NA	1	NA	1	NA	NA	NA	1	1	1	1	1	1	1	1	1	1	1	NA	1	1
		.9 - 1.5	NA	NA	NA	1	NA	1	NA	NA	NA	1	NA	1	NA	NA	NA	NA	NA	1	1	1	1	NA	1	1
		4 - 5.2	NA	NA	NA	1	NA	1	NA	NA	NA	1	NA	1	NA	NA	NA	NA	NA	1	1	1	1	NA	1	1
	RADSBB05	0 - 0.5	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	1	NA	NA	NA	NA	NA	NA	NA	NA	1	NA	NA	NA
	RADSBB06	0 - 0.5	NA	NA	NA	NA	1	NA	1	NA	NA	NA	1	1	1	1	1	1	1	1	1	1	1	NA	1	1
		1.2 - 2	NA	NA	NA	1	NA	1	NA	NA	NA	1	NA	1	NA	NA	NA	NA	NA	NA	NA	NA	1	NA	NA	1
	RADSBB07	0 - 0.5	NA	NA	NA	NA	1	NA	1	NA	NA	NA	NA	1	NA	NA	NA	NA	NA	NA	NA	1	1	NA	1	1
	RADSBB08	0 - 0.5	NA	NA	NA	NA	1	NA	1	NA	NA	NA	NA	1	NA	1	1	1	1	1	1	1	1	NA	1	1
		1.5 - 2	NA	NA	NA	1	NA	1	NA	NA	NA	1	NA	1	NA	NA	NA	NA	NA	NA	NA	1	1	NA	1	1
	RADSBC03	0 - 0.5	NA	NA	NA	NA	1	NA	1	NA	NA	NA	NA	1	NA	NA	NA	NA	NA	NA	NA	1	1	NA	1	1
	RADSBC04	0 - 0.5	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	1	NA	NA	NA	NA	NA	NA	NA	NA	1	NA	NA	NA
	RADSBC05	0 - 0.5	NA	NA	NA	NA	1	NA	1	NA	NA	NA	1	1	NA	1	1	1	1	1	1	1	1	NA	1	1
		1.1 - 2	NA	NA	NA	1	NA	1	NA	NA	NA	1	NA	1	NA	NA	NA	NA	NA	NA	NA	NA	1	NA	1	1
	RADSBC06	0 - 0.5	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	1	NA	NA	NA	NA	NA	NA	NA	NA	1	NA	NA	NA
	RADSBC07	0 - 0.5	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	1	NA	NA	NA	NA	NA	NA	NA	NA	1	NA	NA	NA
	RADSBC08	0 - 0.5	NA	NA	NA	NA	1	NA	1	NA	NA	NA	NA	1	NA	NA	NA	NA	NA	NA	NA	1	1	NA	1	1
	RADSBD03	0 - 0.5	NA	NA	NA	NA	1	NA	1	NA	NA	NA	NA	1	NA	NA	NA	NA	NA	NA	NA	1	1	NA	1	1
	RADSBD04	0 - 0.5	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	1	NA	NA	NA	NA	NA	NA	NA	NA	1	NA	NA	NA
	RADSBD05	0 - 0.5	NA	NA	NA	NA	1	NA	1	NA	NA	NA	1	1	NA	1	1	1	1	1	1	1	1	NA	1	1
		1.2 - 2	NA	NA	NA	1	NA	1	NA	NA	NA	1	NA	1	NA	NA	NA	NA	NA	NA	NA	NA	1	NA	1	1
	RADSBD06	0 - 0.5	NA	NA	NA	NA	1	NA	1	NA	NA	NA	1	1	1	1	1	1	1	1	1	1	1	NA	1	1
		.6 - 1	NA	NA	NA	1	NA	1	NA	NA	NA	1	NA	1	NA	NA	NA	NA	NA	NA	NA	NA	1	NA	1	1
		4.5 - 5.7	NA	NA	NA	1	NA	1	NA	NA	NA	1	NA	1	NA	NA	NA	NA	NA	1	1	NA	1	NA	1	1
	RADSBD07	0 - 0.5	NA	NA	NA	NA	1	NA	1	NA	NA	NA	NA	1	NA	NA	NA	NA	NA	NA	NA	1	1	NA	1	1
	RADSBD08	0 - 0.5	NA	NA	NA	NA	1	NA	1	NA	NA	NA	NA	1	NA	NA	NA	NA	NA	NA	NA	1	1	NA	1	1
	RADSBE02	0 - 0.5	NA	NA	NA	NA	1	NA	1	NA	NA	NA	NA	1	NA	NA	NA	NA	NA	NA	NA	1	1	NA	1	1
	RADSBE03	0 - 0.5	NA	NA	NA	NA	1	NA	1	NA	NA	NA	NA	1	1	1	1	1	1	1	1	1	1	NA	1	1
		1.5 - 2.3	NA	NA	NA	1	NA	1	NA	NA	NA	1	NA	1	NA	NA	NA	NA	NA	NA	NA	NA	1	NA	1	1
	RADSBE04	0 - 0.5	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	1	NA	NA	NA	NA	NA	NA	NA	NA	1	NA	NA	NA
	RADSBE05	0 - 0.5	NA	NA	NA	NA	1	NA	1	NA	NA	NA	NA	1	NA	NA	NA	NA	NA	NA	NA	1	1	NA	1	1
	RADSBE06	0 - 0.5	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	1	NA	NA	NA	NA	NA	NA	NA	NA	1	NA	NA	NA
	RADSBE07	0 - 0.5	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	1	NA	NA	NA	NA	NA	NA	NA	NA	1	NA	NA	NA
	RADSBE08	0 - 0.5	NA	NA	NA	NA	1	NA	1	NA	NA	NA	NA	1	NA	NA	NA	NA	NA	NA	NA	1	1	NA	1	1
	RADSBF02	0 - 0.5	NA	NA	NA	NA	1	NA	1	NA	NA	NA	NA	1	NA	NA	NA	NA	NA	NA	NA	1	1	NA	1	1
	RADSBF03	0 - 0.5	NA	NA	NA	NA	1	NA	1	NA	NA	NA	NA	1	NA	NA	NA	NA	NA	NA	NA	1	1	NA	1	1
	RADSBF04	0 - 0.5	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	1	NA	NA	NA	NA	NA	NA	NA	NA	1	NA	NA	NA
	RADSBF05	0 - 0.5	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	1	NA	NA	NA	NA	NA	NA	NA	NA	1	NA	NA	NA
	RADSBF06	0 - 0.5	NA	NA	NA	NA	1	NA	1	NA	NA	NA	NA	1	NA	1	1	1	1	1	1	1	1	NA	1	1
	RADSBF07	0 - 0.5	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	1	NA	NA	NA	NA	NA	NA	NA	NA	1	NA	NA	NA
	RADSBF08	0 - 0.5	NA	NA	NA	NA	1	NA	1	NA	NA	NA	NA	1	NA	NA	NA	NA	NA	NA	NA	1	1	NA	1	1
	RADSBG02	0 - 0.5	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	1	NA	NA	NA	NA	NA	NA	NA	NA	1	NA	NA	NA
	RADSBG03	0 - 0.5	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	1	NA	NA	NA	NA	NA	NA	NA	NA	1	NA	NA	NA

TABLE 4-3

ANALYSES PERFORMED ON 1995 RI AND QEA SAMPLES
TIDAL AREA, NWS SBD CONCORD

			Organic Compounds										Inorganics		Extractions		Biological Tests			Physical Tests						Misc.
Matrix	Sample Location	Depth (feet bgs)	Aromatic Volatiles	Dioxin	Explosives	Pesticides/ PCBs	Low Level Pesticides/ PCBs	SVOC	Low Level SVOC	TPH-e	TPH-p	VOC	Hex. Chromium	Total Metals	WET-Acid	WET-DI	Microtox (Solid Phase)	Microtox (Aqueous)	Cytochrome P450	Geoph.	Grain Size	Percent Moisture	pH	Total Suspended Solids	TOC	Sulfide
Soil	Site 2 - R Area Disposal (Continued)																									
	RADSBG04	0 - 0.5	NA	NA	NA	NA	1	NA	1	NA	NA	NA	1	1	NA	1	1	1	1	1	1	1	1	NA	1	1
		1 - 2	NA	NA	NA	1	NA	1	NA	NA	NA	1	NA	1	NA	NA	NA	NA	NA	1	1	NA	1	NA	1	1
		4.5 - 5.8	NA	NA	NA	1	NA	1	NA	NA	NA	1	NA	1	NA	NA	NA	NA	NA	1	1	NA	1	NA	1	1
	RADSBG05	0 - 0.5	NA	NA	NA	NA	1	NA	1	NA	NA	NA	NA	1	NA	NA	NA	NA	NA	NA	NA	1	1	NA	1	1
	RADSBG06	0 - 0.5	NA	NA	NA	NA	1	NA	1	NA	NA	NA	NA	1	NA	NA	NA	NA	NA	NA	NA	1	1	NA	1	1
	RADSBG07	0 - 0.5	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	1	NA	NA	NA	NA	NA	NA	NA	NA	1	NA	NA	NA
	RADSBG08	0 - 0.5	NA	NA	NA	NA	1	NA	1	NA	NA	NA	1	1	NA	1	1	1	1	1	1	1	1	NA	1	1
		.7 - 2	NA	NA	NA	1	NA	1	NA	NA	NA	1	NA	1	NA	NA	NA	NA	NA	1	1	1	1	NA	1	1
		4 - 5.3	NA	NA	NA	1	NA	1	NA	NA	NA	1	NA	1	NA	NA	NA	NA	NA	1	1	1	1	NA	1	1
	RADSBH02	0 - 0.5	NA	NA	NA	NA	1	NA	1	NA	NA	NA	NA	1	NA	NA	NA	NA	NA	NA	NA	1	1	NA	1	1
	RADSBH03	0 - 0.5	NA	NA	NA	NA	1	NA	1	NA	NA	NA	NA	1	NA	NA	NA	NA	NA	NA	NA	1	1	NA	1	1
	RADSBH04	0 - 0.5	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	1	NA	NA	NA	NA	NA	NA	NA	NA	1	NA	NA	NA
	RADSBH05	0 - 0.5	NA	NA	NA	NA	1	NA	1	NA	NA	NA	NA	1	NA	NA	NA	NA	NA	NA	NA	1	1	NA	1	1
	RADSBH06	0 - 0.5	NA	NA	NA	NA	1	NA	1	NA	NA	NA	1	1	1	1	1	1	1	1	1	1	1	NA	1	1
		1.5 - 2	NA	NA	NA	1	NA	1	NA	NA	NA	1	NA	1	NA	NA	NA	NA	NA	NA	NA	NA	1	NA	1	1
	RADSBH07	0 - 0.5	NA	NA	NA	NA	1	NA	1	NA	NA	NA	NA	1	NA	NA	NA	NA	NA	NA	NA	1	1	NA	1	1
	RADSBH08	0 - 0.5	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	1	NA	NA	NA	NA	NA	NA	NA	NA	1	NA	NA	NA
	RADSBI01	0 - 0.5	NA	NA	NA	NA	1	NA	1	NA	NA	NA	NA	1	NA	NA	NA	NA	NA	NA	NA	1	1	NA	1	1
	RADSBI02	0 - 0.5	NA	NA	NA	NA	1	NA	1	NA	NA	NA	NA	1	NA	1	1	1	1	1	1	1	1	NA	1	1
	RADSBI03	0 - 0.5	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	1	NA	NA	NA	NA	NA	NA	NA	NA	1	NA	NA	NA
	RADSBI04	0 - 0.5	NA	NA	NA	NA	1	NA	1	NA	NA	NA	1	1	1	1	1	1	1	1	1	1	1	NA	1	1
		1.5 - 2	NA	NA	NA	1	NA	1	NA	NA	NA	1	NA	1	NA	NA	NA	NA	NA	NA	NA	NA	1	NA	1	1
	RADSBI05	0 - 0.5	NA	NA	NA	NA	1	NA	1	NA	NA	NA	NA	1	NA	NA	NA	NA	NA	NA	NA	1	1	NA	1	1
	RADSBI06	0 - 0.5	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	1	NA	NA	NA	NA	NA	NA	NA	NA	1	NA	NA	NA
	RADSBI07	0 - 0.5	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	1	NA	NA	NA	NA	NA	NA	NA	NA	1	NA	NA	NA
	RADSBI08	0 - 0.5	NA	NA	NA	NA	1	NA	1	NA	NA	NA	1	1	NA	1	1	1	1	1	1	1	1	NA	1	1
		1.5 - 2	NA	NA	NA	1	NA	1	NA	NA	NA	1	NA	1	NA	NA	NA	NA	NA	NA	NA	NA	1	NA	1	1
	RADSBJ01	0 - 0.5	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	1	NA	NA	NA	NA	NA	NA	NA	NA	1	NA	NA	NA
	RADSBJ02	0 - 0.5	NA	NA	NA	NA	1	NA	1	NA	NA	NA	1	1	NA	1	1	1	1	1	1	1	1	NA	1	1
		1 - 2.2	NA	NA	NA	1	NA	1	NA	NA	NA	1	NA	1	NA	NA	NA	NA	NA	1	1	NA	1	NA	1	1
		4.7 - 6	NA	NA	NA	1	NA	1	NA	NA	NA	1	NA	1	NA	NA	NA	NA	NA	1	1	NA	1	NA	1	1
	RADSBJ03	0 - 0.5	NA	NA	NA	NA	1	NA	1	NA	NA	NA	NA	1	NA	NA	NA	NA	NA	NA	NA	1	1	NA	1	1
	RADSBJ04	0 - 0.5	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	1	NA	NA	NA	NA	NA	NA	NA	NA	1	NA	NA	NA
	RADSBJ06	0 - 0.5	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	1	NA	NA	NA	NA	NA	NA	NA	NA	1	NA	NA	NA
	RADSBJ07	0 - 0.5	NA	NA	NA	NA	1	NA	1	NA	NA	NA	NA	1	NA	1	1	1	1	1	1	1	1	NA	1	1
	RADSBJ08	0 - 0.5	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	1	NA	NA	NA	NA	NA	NA	NA	NA	1	NA	NA	NA
	RADSBK01	0 - 0.5	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	1	NA	NA	NA	NA	NA	NA	NA	NA	1	NA	NA	NA
	RADSBK02	0 - 0.5	NA	NA	NA	NA	1	NA	1	NA	NA	NA	NA	1	NA	NA	NA	NA	NA	NA	NA	1	1	NA	1	1
	RADSBK03	0 - 0.5	NA	NA	NA	NA	1	NA	1	NA	NA	NA	NA	1	NA	NA	NA	NA	NA	NA	NA	1	1	NA	1	1
	RADSBK04	0 - 0.5	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	1	NA	NA	NA	NA	NA	NA	NA	NA	1	NA	NA	NA
	RADSBK07	0 - 0.5	NA	NA	NA	NA	1	NA	1	NA	NA	NA	NA	1	NA	NA	NA	NA	NA	NA	NA	1	1	NA	1	1
	RADSBK08	0 - 0.5	NA	NA	NA	NA	1	NA	1	NA	NA	NA	1	1	1	1	1	1	1	1	1	1	1	NA	1	1
		1.3 - 2	NA	NA	NA	1	NA	1	NA	NA	NA	1	NA	1	NA	NA	NA	NA	NA	NA	NA	NA	1	NA	1	1
	RADSBL03	0 - 0.5	NA	NA	NA	NA	1	NA	1	NA	NA	NA	NA	1	NA	NA	NA	NA	NA	NA	NA	1	1	NA	1	1
	RADSBL08	0 - 0.5	NA	NA	NA	NA	1	NA	1	NA	NA	NA	NA	1	NA	NA	NA	NA	NA	NA	NA	1	1	NA	1	1
	RADSBM08	0 - 0.5	NA	NA	NA	NA	1	NA	1	NA	NA	NA	1	1	NA	1	1	1	1	1	1	1	1	NA	1	1
		1.3 - 2	NA	NA	NA	1	NA	1	NA	NA	NA	1	NA	1	NA	NA	NA	NA	NA	NA	NA	NA	1	NA	1	1
	RADSBN08	0 - 0.5	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	1	NA	NA	NA	NA	NA	NA	NA	NA	1	NA	NA	NA
	Site 2 Soil Sample Total:		**0**	**0**	**6**	**20**	**65**	**20**	**65**	**0**	**0**	**20**	**14**	**131**	**7**	**20**	**20**	**20**	**20**	**29**	**29**	**70**	**131**	**0**	**84**	**85**
	Site 9 - Froid and Taylor Roads																									
	FTSSB001	0 - .3	NA	NA	NA	NA	1	NA	1	1	NA	NA	NA	1	NA	1	1	1	1	1	1	1	1	NA	1	1
		.35 - 1.3	NA	NA	1	1	NA	1	NA	1	NA	1	NA	1	NA	NA	NA	NA	NA	1	1	NA	1	NA	1	1
	FTSSB002	0 - 0.5	NA	NA	NA	NA	1	NA	1	1	NA	NA	NA	1	1	1	1	1	1	1	1	1	1	NA	1	1
		.75 - 1.8	NA	NA	1	1	NA	1	NA	1	NA	1	NA	1	NA	NA	NA	NA	NA	1	1	NA	1	NA	1	1
	FTSSB003	0 - .25	NA	NA	NA	NA	1	NA	1	1	NA	NA	NA	1	NA	1	1	1	1	1	1	1	1	NA	1	1
		.75 - 1.75	NA	NA	1	1	NA	1	NA	1	NA	1	NA	1	NA	NA	NA	NA	NA	NA	NA	NA	1	NA	1	1
	FTSSB004	0 - 0.5	NA	NA	NA	NA	1	NA	1	1	NA	NA	1	1	NA	1	1	1	1	1	1	1	1	NA	1	1
		1.5 - 2.5	NA	NA	1	1	NA	1	NA	1	NA	1	NA	1	NA	NA	NA	NA	NA	1	1	NA	1	NA	1	1

TABLE 4-3

ANALYSES PERFORMED ON 1995 RI AND QEA SAMPLES
TIDAL AREA, NWS SBD CONCORD

			Organic Compounds										Inorganics		Extractions		Biological Tests			Physical Tests						Misc.
Matrix	Sample Location	Depth (feet bgs)	Aromatic Volatiles	Dioxin	Explosives	Pesticides/ PCBs	Low Level Pesticides/ PCBs	SVOC	Low Level SVOC	TPH-e	TPH-p	VOC	Hex. Chromium	Total Metals	WET-Acid	WET-DI	Microtox (Solid Phase)	Microtox (Aqueous)	Cytochrome P450	Geoph.	Grain Size	Percent Moisture	pH	Total Suspended Solids	TOC	Sulfide
Soil	Site 9 - Froid and Taylor Roads (Continued)																									
	FTSSB005	0 - 0.5	NA	NA	NA	NA	1	NA	1	1	NA	NA	NA	1	NA	1	1	1	1	1	1	1	1	NA	1	1
		2 - 3	NA	NA	1	1	NA	1	NA	1	NA	1	NA	1	NA	NA	NA	NA	NA	NA	NA	NA	1	NA	1	1
	FTSSB006	0 - 0.5	NA	NA	NA	NA	1	NA	1	1	NA	NA	NA	1	NA	1	1	1	1	1	1	1	1	NA	1	1
		1.1 - 2	NA	NA	1	1	NA	1	NA	1	NA	1	NA	1	NA	NA	NA	NA	NA	1	1	NA	1	NA	1	1
	FTSSB007	0 - .25	NA	NA	NA	NA	1	NA	1	1	NA	NA	1	1	1	1	1	1	1	1	1	1	1	NA	1	1
		1.5 - 2.3	NA	NA	1	1	NA	1	NA	1	NA	1	NA	1	NA	NA	NA	NA	NA	NA	NA	NA	1	NA	1	1
	FTSSB008	0 - 0.5	NA	NA	NA	NA	1	NA	1	1	NA	NA	NA	1	NA	1	1	1	1	1	1	1	1	NA	1	1
		1.2 - 1.75	NA	NA	1	1	NA	1	NA	1	NA	1	NA	1	NA	NA	NA	NA	NA	NA	NA	NA	1	NA	1	1
	FTSSB009	0 - .12	NA	NA	NA	NA	1	NA	1	1	NA	NA	NA	1	NA	1	1	1	1	1	1	1	1	NA	1	1
		.12 - 1.3	NA	NA	1	1	NA	1	NA	1	NA	1	NA	1	NA	NA	NA	NA	NA	NA	1	NA	1	NA	1	1
	Site 9 Soil Sample Total:		0	0	9	9	9	9	9	18	0	9	2	18	2	9	9	9	9	13	14	9	18	0	18	18
	Site 11 - Wood Hogger																									
	WHSSB001	0 - 0.5	NA	NA	NA	NA	1	NA	1	NA	NA	NA	NA	1	NA	NA	NA	NA	NA	NA	NA	1	1	NA	1	1
	WHSSB002	0 - 0.5	NA	NA	NA	NA	1	NA	1	NA	NA	NA	NA	1	NA	NA	NA	NA	NA	NA	NA	1	1	NA	1	1
	WHSSB003	0 - 0.5	NA	NA	NA	NA	1	NA	1	NA	NA	NA	NA	1	NA	NA	NA	NA	NA	NA	NA	1	1	NA	1	1
	WHSSB004	0 - 0.5	NA	NA	NA	NA	1	NA	1	NA	NA	NA	NA	1	NA	NA	NA	NA	NA	NA	NA	1	1	NA	1	1
	WHSSB005	0 - 0.5	NA	NA	NA	NA	1	NA	1	NA	NA	NA	1	1	NA	NA	NA	NA	NA	NA	NA	1	1	NA	1	1
	WHSSB006	0 - 0.5	NA	NA	NA	NA	1	NA	1	NA	NA	NA	NA	1	NA	NA	NA	NA	NA	NA	NA	1	1	NA	1	1
	WHSSB007	0 - 0.5	NA	NA	NA	NA	1	NA	1	NA	NA	NA	NA	1	NA	NA	NA	NA	NA	NA	NA	1	1	NA	1	1
	WHSSB008	0 - 0.5	NA	NA	NA	NA	1	NA	1	NA	NA	NA	1	1	NA	NA	NA	NA	NA	NA	NA	1	1	NA	1	1
	WHSSB009	0 - 0.5	NA	NA	NA	NA	1	NA	1	NA	NA	NA	NA	1	NA	NA	NA	NA	NA	NA	NA	1	1	NA	1	1
	WHSSB010	0 - 0.5	NA	NA	NA	NA	1	NA	1	NA	NA	NA	NA	1	NA	NA	NA	NA	NA	NA	NA	1	1	NA	1	1
	WHSSB011	0 - 0.5	NA	NA	NA	NA	1	NA	1	NA	NA	NA	NA	1	NA	NA	NA	NA	NA	NA	NA	1	1	NA	1	1
	WHSSB012	0 - 0.5	NA	NA	NA	NA	1	NA	1	NA	NA	NA	NA	1	NA	NA	NA	NA	NA	NA	NA	1	1	NA	1	1
	WHSSB013	0 - 0.5	NA	NA	NA	NA	1	NA	1	NA	NA	NA	NA	1	NA	NA	NA	NA	NA	NA	NA	1	1	NA	1	1
	WHSSB014	0 - 0.5	NA	NA	NA	NA	1	NA	1	NA	NA	NA	NA	1	NA	NA	NA	NA	NA	NA	NA	1	1	NA	1	1
	WHSSB015	0 - 0.5	NA	NA	NA	NA	1	NA	1	NA	NA	NA	NA	1	NA	NA	NA	NA	NA	NA	NA	1	1	NA	1	1
	WHSSB016	0 - 0.5	NA	NA	NA	NA	1	NA	1	NA	NA	NA	NA	1	NA	NA	NA	NA	NA	NA	NA	1	1	NA	1	1
	WHSSB017	0 - 0.5	NA	NA	NA	NA	1	NA	1	NA	NA	NA	NA	1	NA	NA	NA	NA	NA	NA	NA	1	1	NA	1	1
	WHSSB018	0 - 0.5	NA	NA	NA	NA	1	NA	1	NA	NA	NA	NA	1	NA	NA	NA	NA	NA	NA	NA	1	1	NA	1	1
	WHSSB019	0 - 0.5	NA	1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	1	NA	NA	NA	NA
	WHSSB020	0 - 0.5	NA	1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	1	NA	NA	NA	NA
	WHSSB021	0 - 0.5	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	1	NA	NA	NA	NA	NA	NA	NA	NA	1	NA	NA	NA
	WHSSB022	0 - 0.5	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	1	NA	NA	NA	NA	NA	NA	NA	NA	1	NA	NA	NA
	WHSSB023	0 - 0.5	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	1	NA	NA	NA	NA	NA	NA	NA	NA	1	NA	NA	NA
	WHSSB024	0 - 0.5	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	1	NA	NA	NA	NA	NA	NA	NA	NA	1	NA	NA	NA
	WHSSB025	0 - 0.5	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	1	NA	NA	NA	NA	NA	NA	NA	NA	1	NA	NA	NA
	WHSSB026	0 - 0.5	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	1	NA	NA	NA	NA	NA	NA	NA	NA	1	NA	NA	NA
	WHSSB027	0 - 0.5	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	1	NA	NA	NA	NA	NA	NA	NA	NA	1	NA	NA	NA
	WHSSB028	0 - 0.5	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	1	NA	NA	NA	NA	NA	NA	NA	NA	1	NA	NA	NA
	WHSSB029	0 - 0.5	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	1	NA	NA	NA	NA	NA	NA	NA	NA	1	NA	NA	NA
	WHSSB030	3.2 - 3.5	1	NA	NA	NA	NA	1	NA	1	1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	WHSSB050	0 - 0.5	NA	NA	NA	NA	NA	1	NA	NA	NA	NA	NA	1	NA	NA	NA	NA	NA	NA	NA	1	NA	NA	NA	NA
		2 - 2.5	NA	NA	NA	NA	NA	1	NA	NA	NA	NA	NA	1	NA	NA	NA	NA	NA	NA	NA	1	NA	NA	NA	NA
	WHSSB051	0 - 0.5	NA	NA	NA	NA	NA	1	NA	NA	NA	NA	NA	1	NA	NA	NA	NA	NA	NA	NA	1	NA	NA	NA	NA
		2 - 2.5	NA	NA	NA	NA	NA	1	NA	NA	NA	NA	NA	1	NA	NA	NA	NA	NA	NA	NA	1	NA	NA	NA	NA
	WHSSBA02	0 - 0.5	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	1	NA	NA	NA	NA	NA	NA	NA	NA	1	NA	NA	NA
	WHSSBA04	0 - 0.5	NA	NA	NA	NA	1	NA	1	NA	NA	NA	NA	1	NA	1	1	1	1	1	1	1	1	NA	1	1
	WHSSBA06	0 - 0.5	NA	NA	NA	NA	1	NA	1	NA	NA	NA	1	1	NA	1	1	1	1	NA	1	1	1	NA	1	1
		1 - 2	NA	NA	NA	1	NA	1	NA	NA	NA	1	NA	1	NA	NA	NA	NA	NA	NA	NA	NA	1	NA	1	NA
		4.5 - 5	NA	NA	NA	1	NA	1	NA	NA	NA	1	NA	1	NA	NA	NA	NA	NA	NA	NA	NA	1	NA	1	NA
		9 - 10.9	NA	NA	NA	1	NA	1	NA	NA	NA	1	NA	1	NA	NA	NA	NA	NA	1	1	NA	1	NA	1	1
		13 - 14	NA	NA	NA	1	NA	1	NA	NA	NA	1	NA	1	NA	NA	NA	NA	NA	NA	NA	NA	1	NA	1	NA
	WHSSBA08	0 - 0.5	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	1	NA	NA	NA	NA	NA	NA	NA	NA	1	NA	NA	NA
	WHSSBB01	0 - 0.5	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	1	NA	NA	NA	NA	NA	NA	NA	NA	1	NA	NA	NA
	WHSSBB03	0 - 0.5	NA	NA	NA	NA	1	NA	1	NA	NA	NA	NA	1	1	1	1	1	1	1	1	1	1	NA	1	1
	WHSSBB05	0 - 0.5	NA	NA	NA	NA	1	NA	1	NA	NA	NA	NA	1	NA	NA	NA	NA	NA	NA	NA	1	1	NA	1	1
	WHSSBB07	0 - 0.5	NA	NA	NA	NA	1	NA	1	NA	NA	NA	NA	1	1	1	1	1	1	1	1	1	1	NA	1	1

TABLE 4-3

ANALYSES PERFORMED ON 1995 RI AND QEA SAMPLES
TIDAL AREA, NWS SBD CONCORD

			Organic Compounds										Inorganics		Extractions		Biological Tests			Physical Tests						Misc.
Matrix	Sample Location	Depth (feet bgs)	Aromatic Volatiles	Dioxin	Explosives	Pesticides/ PCBs	Low Level Pesticides/ PCBs	SVOC	Low Level SVOC	TPH-e	TPH-p	VOC	Hex. Chromium	Total Metals	WET-Acid	WET-DI	Microtox (Solid Phase)	Microtox (Aqueous)	Cytochrome P450	Geoph.	Grain Size	Percent Moisture	pH	Total Suspended Solids	TOC	Sulfide
Soil	Site 11 - Wood Hogger (Continued)																									
	WHSSBC02	0 - 0.5	NA	NA	NA	NA	1	NA	1	NA	NA	NA	1	1	NA	1	1	1	1	1	1	1	1	NA	1	1
		1.3 - 2	NA	NA	1	1	NA	1	NA	NA	NA	1	NA	1	NA	NA	NA	NA	NA	NA	NA	NA	1	NA	1	1
		4 - 5.5	NA	NA	1	1	NA	1	NA	NA	NA	1	NA	1	NA	NA	NA	NA	NA	1	1	NA	1	NA	1	1
		8.8 - 10	NA	NA	NA	1	NA	1	NA	NA	NA	1	NA	1	NA	NA	NA	NA	NA	1	1	NA	1	NA	1	1
	WHSSBC04	0 - 0.5	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	1	NA	NA	NA	NA	NA	NA	NA	NA	1	NA	NA	NA
	WHSSBC06	0 - 0.5	NA	NA	NA	NA	1	NA	1	NA	NA	NA	NA	1	NA	NA	NA	NA	NA	NA	NA	1	1	NA	1	1
	WHSSBC08	0 - 0.5	NA	NA	NA	NA	1	NA	1	NA	NA	NA	NA	1	1	1	1	1	1	1	1	1	1	NA	1	1
	WHSSBD01	0 - 0.5	NA	NA	NA	NA	1	NA	1	NA	NA	NA	NA	1	NA	NA	NA	NA	NA	NA	NA	1	1	NA	1	1
	WHSSBD03	0 - 0.5	NA	NA	NA	NA	1	NA	1	NA	NA	NA	NA	1	NA	1	1	1	1	1	1	1	1	NA	1	1
		1.5 - 2	NA	NA	1	1	NA	1	NA	NA	NA	1	NA	1	NA	NA	NA	NA	NA	NA	NA	NA	1	NA	1	1
		4.5 - 5.8	NA	NA	1	1	NA	1	NA	NA	NA	1	NA	1	NA	NA	NA	NA	NA	1	1	NA	1	NA	1	1
		9.5 - 10.4	NA	NA	NA	1	NA	1	NA	NA	NA	1	NA	1	NA	NA	NA	NA	NA	1	1	NA	1	NA	1	1
		18.5 - 20	NA	NA	NA	1	NA	1	NA	NA	NA	1	NA	1	NA	NA	NA	NA	NA	NA	NA	NA	1	NA	1	1
	WHSSBD07	0 - 0.5	NA	NA	NA	NA	1	NA	1	NA	NA	NA	NA	1	NA	NA	NA	NA	NA	NA	NA	1	1	NA	1	1
		1.5 - 2.3	NA	NA	NA	1	NA	1	NA	1	1	1	NA	1	NA	NA	NA	NA	NA	NA	NA	NA	1	NA	1	1
		4.5 - 5.3	NA	NA	NA	1	NA	1	NA	1	1	1	NA	1	NA	NA	NA	NA	NA	NA	NA	NA	1	NA	1	1
		9.3 - 10	NA	NA	NA	1	NA	1	NA	1	1	1	NA	1	NA	NA	NA	NA	NA	NA	NA	NA	1	NA	1	1
	WHSSBE02	0 - 0.5	NA	NA	NA	NA	1	NA	1	NA	NA	NA	NA	1	NA	1	1	1	1	1	1	1	1	NA	1	1
	WHSSBE04	0 - 0.5	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	1	NA	NA	NA	NA	NA	NA	NA	NA	1	NA	NA	NA
	WHSSBE06	0 - 0.5	NA	NA	NA	NA	1	NA	1	NA	NA	NA	NA	1	NA	1	1	1	1	1	1	1	1	NA	1	1
	WHSSBE08	0 - 0.5	NA	NA	NA	NA	1	NA	1	NA	NA	NA	1	1	NA	1	1	1	1	1	1	1	1	NA	1	1
		2.5 - 4	NA	NA	NA	1	NA	1	NA	NA	NA	1	NA	1	NA	NA	NA	NA	NA	NA	NA	NA	1	NA	1	NA
		5.5 - 6.5	NA	NA	NA	1	NA	1	NA	NA	NA	1	NA	1	NA	NA	NA	NA	NA	NA	NA	NA	1	NA	1	NA
		9 - 10.3	NA	NA	NA	1	NA	1	NA	NA	NA	1	NA	1	NA	NA	NA	NA	NA	NA	NA	NA	1	NA	1	1
	WHSSBE08A	0 - 0.5	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	1	1	1	NA	NA	NA	NA	NA	NA	NA
	WHSSBF03	0 - 0.5	NA	NA	NA	NA	1	NA	1	NA	NA	NA	1	1	1	1	1	1	1	1	1	1	1	NA	1	1
		1.5 - 2.3	NA	NA	1	1	NA	1	NA	NA	NA	1	NA	1	NA	NA	NA	NA	NA	NA	NA	NA	1	NA	1	1
		4.5 - 5.9	NA	NA	1	1	NA	1	NA	NA	NA	1	NA	1	NA	NA	NA	NA	NA	1	1	NA	1	NA	1	1
		9.5 - 10.8	NA	NA	1	1	NA	1	NA	NA	NA	1	NA	1	NA	NA	NA	NA	NA	1	1	NA	1	NA	1	1
	WHSSBF07	0 - 0.5	NA	NA	NA	NA	1	NA	1	NA	NA	NA	NA	1	NA	NA	NA	NA	NA	NA	NA	1	1	NA	1	1
	WHSSBG02	0 - 0.5	NA	NA	NA	NA	1	NA	1	NA	NA	NA	NA	1	NA	NA	NA	NA	NA	NA	NA	1	1	NA	1	1
	WHSSBG06	0 - 0.5	NA	NA	NA	NA	1	NA	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	NA	1	1
		1.1 - 2	NA	NA	1	1	NA	1	NA	1	1	1	NA	1	NA	NA	NA	NA	NA	NA	NA	NA	1	NA	1	1
		4.5 - 5	NA	NA	1	1	NA	1	NA	1	1	1	NA	1	NA	NA	NA	NA	NA	1	1	NA	1	NA	1	1
		9 - 11	NA	NA	NA	1	NA	1	NA	NA	NA	1	NA	1	NA	NA	NA	NA	NA	1	1	NA	1	NA	1	1
	WHSSBG06A	0 - 0.5	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	1	1	1	NA	NA	NA	NA	NA	NA	NA
	WHSSBG08	0 - 0.5	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	1	NA	NA	NA	NA	NA	NA	NA	NA	1	NA	NA	NA
	WHSSBH03	0 - 0.5	NA	NA	NA	NA	1	NA	1	NA	NA	NA	NA	1	NA	NA	NA	NA	NA	NA	NA	1	1	NA	1	1
	WHSSBH07	0 - 0.5	NA	NA	NA	NA	1	NA	1	NA	NA	NA	1	1	NA	1	1	1	1	1	1	1	1	NA	1	1
		4 - 5	NA	NA	1	1	NA	1	NA	NA	NA	1	NA	1	NA	NA	NA	NA	NA	NA	NA	NA	1	NA	1	1
		8 - 10.1	NA	NA	NA	1	NA	1	NA	NA	NA	1	NA	1	NA	NA	NA	NA	NA	1	1	NA	1	NA	1	1
		1.3 - 2.3	NA	NA	1	1	NA	1	NA	NA	NA	NA	NA	1	NA	NA	NA	NA	NA	NA	NA	NA	1	NA	1	1
	WHSSBI02	0 - 0.5	NA	NA	NA	NA	1	NA	1	NA	NA	NA	NA	1	NA	1	1	1	1	1	1	1	1	NA	1	1
	WHSSBI06	0 - 0.5	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	1	NA	NA	NA	NA	NA	NA	NA	NA	1	NA	NA	NA
	WHSSBI08	0 - 0.5	NA	NA	NA	NA	1	NA	1	NA	NA	NA	NA	1	NA	NA	NA	NA	NA	NA	NA	1	1	NA	1	1
	WHSSBJ05	0 - 0.5	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	1	NA	NA	NA	NA	NA	NA	NA	NA	1	NA	NA	NA
	WHSSBJ07	0 - 0.5	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	1	NA	NA	NA	NA	NA	NA	NA	NA	1	NA	NA	NA
	WHSSBK04	0 - 0.5	NA	NA	NA	NA	1	NA	1	NA	NA	NA	NA	1	NA	NA	NA	NA	NA	NA	NA	1	1	NA	1	1
	WHSSBK06	0 - 0.5	NA	NA	NA	NA	1	NA	1	NA	NA	NA	1	1	1	1	1	1	1	1	1	1	1	NA	1	1
		1.5 - 2.3	NA	NA	1	1	NA	1	NA	NA	NA	1	NA	1	NA	NA	NA	NA	NA	NA	NA	NA	1	NA	1	1
		4.5 - 5.3	NA	NA	1	1	NA	1	NA	NA	NA	1	NA	1	NA	NA	NA	NA	NA	1	1	NA	1	NA	1	1
		9.5 - 10.4	NA	NA	NA	1	NA	1	NA	NA	NA	1	NA	1	NA	NA	NA	NA	NA	1	1	NA	1	NA	1	1
	WHSSBK08	0 - 0.5	NA	NA	NA	NA	1	NA	1	NA	NA	NA	NA	1	NA	1	1	1	1	1	1	1	1	NA	1	1
	WHSSBL05	0 - 0.5	NA	NA	NA	NA	1	NA	1	NA	NA	NA	NA	1	NA	1	1	1	1	1	1	1	1	NA	1	1
	WHSSBL07	0 - 0.5	NA	NA	NA	NA	1	NA	1	NA	NA	NA	NA	1	NA	NA	NA	NA	NA	NA	NA	1	1	NA	1	1
	WHSSBM04	0 - 0.5	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	1	NA	NA	NA	NA	NA	NA	NA	NA	1	NA	NA	NA
	WHSSBM06	0 - 0.5	NA	NA	NA	NA	1	NA	1	NA	NA	NA	NA	1	NA	NA	NA	NA	NA	NA	NA	1	1	NA	1	1

TABLE 4-3

ANALYSES PERFORMED ON 1995 RI AND QEA SAMPLES
TIDAL AREA, NWS SBD CONCORD

			Organic Compounds										Inorganics		Extractions		Biological Tests			Physical Tests						Misc.
Matrix	Sample Location	Depth (feet bgs)	Aromatic Volatiles	Dioxin	Explosives	Pesticides/ PCBs	Low Level Pesticides/ PCBs	SVOC	Low Level SVOC	TPH-e	TPH-p	VOC	Hex. Chromium	Total Metals	WET-Acid	WET-DI	Microtox (Solid Phase)	Microtox (Aqueous)	Cytochrome P450	Geoph.	Grain Size	Percent Moisture	pH	Total Suspended Solids	TOC	Sulfide
Soil	Site 11 - Wood Hogger (Continued)																									
	WHSSBM08	0 - 0.5	NA	NA	NA	NA	1	NA	1	NA	NA	NA	1	1	NA	1	1	1	1	1	1	1	1	NA	1	1
		1 - 1.7	NA	NA	1	1	NA	1	NA	NA	NA	1	NA	1	NA	NA	NA	NA	NA	NA	NA	NA	1	NA	1	1
		4.1 - 5.2	NA	NA	1	1	NA	1	NA	NA	NA	1	NA	1	NA	NA	NA	NA	NA	1	1	NA	1	NA	1	1
		9 - 10.5	NA	NA	NA	1	NA	1	NA	NA	NA	1	NA	1	NA	NA	NA	NA	NA	1	1	NA	1	NA	1	1
	Site 11 Soil Sample Total:		1	2	15	32	47	37	47	7	7	32	10	102	6	18	20	20	20	31	32	53	98	0	79	74
	Solid Waste Management Unit 37 (Within Wood Hogger Site)																									
	S37-01	0 - 1	NA	NA	1	1	NA	1	NA	NA	NA	1	NA	1	NA	NA	NA	NA	NA	NA	NA	1	1	NA	1	NA
	S37-02	0 - 1	NA	NA	1	1	NA	1	NA	NA	NA	1	NA	1	NA	NA	NA	NA	NA	NA	NA	1	1	NA	1	NA
		4 - 5	NA	NA	1	1	NA	1	NA	NA	NA	1	NA	1	NA	NA	NA	NA	NA	NA	NA	1	1	NA	1	NA
	S37-03	0 - 1	NA	NA	1	1	NA	1	NA	NA	NA	1	NA	1	NA	NA	NA	NA	NA	NA	NA	1	1	NA	1	NA
		5 - 6	NA	NA	1	1	NA	1	NA	NA	NA	1	NA	1	NA	NA	NA	NA	NA	NA	NA	1	1	NA	1	NA
	S37-04	0 - 1	NA	NA	1	1	NA	1	NA	NA	NA	1	NA	1	NA	NA	NA	NA	NA	NA	NA	1	1	NA	1	NA
		5 - 6	NA	NA	1	1	NA	1	NA	NA	NA	1	NA	1	NA	NA	NA	NA	NA	NA	NA	1	1	NA	1	NA
	S37-05	.5 - 1.5	NA	NA	1	1	NA	1	NA	NA	NA	1	NA	1	NA	NA	NA	NA	NA	NA	NA	1	1	NA	1	NA
		5 - 6	NA	NA	1	1	NA	1	NA	NA	NA	1	NA	1	NA	NA	NA	NA	NA	NA	NA	1	1	NA	1	NA
	S37-06	.5 - 1.5	NA	NA	1	1	NA	1	NA	NA	NA	1	NA	1	NA	NA	NA	NA	NA	NA	NA	1	1	NA	1	NA
		5 - 6	NA	NA	1	1	NA	1	NA	NA	NA	1	NA	1	NA	NA	NA	NA	NA	NA	NA	1	1	NA	1	NA
	S37-07	0 - 1	NA	NA	1	1	NA	1	NA	NA	NA	1	NA	1	NA	NA	NA	NA	NA	NA	NA	1	1	NA	1	NA
		5 - 6	NA	NA	1	1	NA	1	NA	NA	NA	1	NA	1	NA	NA	NA	NA	NA	NA	NA	1	1	NA	1	NA
	S37-08	0 - 1	NA	NA	1	1	NA	1	NA	NA	NA	1	NA	1	NA	NA	NA	NA	NA	NA	NA	1	1	NA	1	NA
		5 - 6	NA	NA	1	1	NA	1	NA	NA	NA	1	NA	1	NA	NA	NA	NA	NA	NA	NA	1	1	NA	1	NA
	S37-09	0 - 1	NA	NA	1	1	NA	1	NA	NA	NA	1	NA	1	NA	NA	NA	NA	NA	NA	NA	1	1	NA	1	NA
		4.5 - 5.5	NA	NA	1	1	NA	1	NA	NA	NA	1	NA	1	NA	NA	NA	NA	NA	NA	NA	1	1	NA	1	NA
	S37-10	.5 - 1	NA	NA	1	1	NA	1	NA	NA	NA	1	NA	1	NA	NA	NA	NA	NA	NA	NA	1	1	NA	1	NA
		3 - 4	NA	NA	1	1	NA	1	NA	NA	NA	1	NA	1	NA	NA	NA	NA	NA	NA	NA	1	1	NA	1	NA
	S37-11	.5 - 1.5	NA	NA	1	1	NA	1	NA	NA	NA	1	NA	1	NA	NA	NA	NA	NA	NA	NA	1	1	NA	1	NA
		5 - 6	NA	NA	1	1	NA	1	NA	NA	NA	1	NA	1	NA	NA	NA	NA	NA	NA	NA	1	1	NA	1	NA
	S37-12	.5 - 1.5	NA	NA	1	1	NA	1	NA	NA	NA	1	NA	1	NA	NA	NA	NA	NA	NA	NA	1	1	NA	1	NA
		5 - 6	NA	NA	1	1	NA	1	NA	NA	NA	1	NA	1	NA	NA	NA	NA	NA	NA	NA	1	1	NA	1	NA
	SWMU 37 Soil Sample Total:		0	0	23	23	0	23	0	0	0	23	0	23	0	0	0	0	0	0	0	23	23	0	23	0
	Soil Total:		1	2	77	100	129	105	129	25	7	100	50	298	15	47	49	49	49	90	92	178	294	0	228	201
Surface Water	Site 2 - R Area Disposal																									
	RADSW001	Q1	NA	NA	1	1	NA	1	NA	NA	NA	1	NA	1	NA	NA	NA	NA	NA	NA	NA	NA	NA	1	1	NA
		Q2	NA	NA	1	1	NA	1	NA	NA	NA	1	NA	1	NA	NA	NA	NA	NA	NA	NA	NA	NA	1	1	NA
		Q3	NA	NA	1	1	NA	1	NA	NA	NA	1	NA	1	NA	NA	NA	NA	NA	NA	NA	NA	NA	1	1	NA
		Q4	NA	NA	1	1	NA	1	NA	NA	NA	1	NA	1	NA	NA	NA	NA	NA	NA	NA	NA	NA	1	1	NA
	RADSW002	Q1	NA	NA	1	1	NA	1	NA	NA	NA	1	NA	1	NA	NA	NA	NA	NA	NA	NA	NA	NA	1	1	NA
		Q2	NA	NA	1	1	NA	1	NA	NA	NA	1	NA	1	NA	NA	NA	NA	NA	NA	NA	NA	NA	1	1	NA
		Q3	NA	NA	1	1	NA	1	NA	NA	NA	1	NA	1	NA	NA	NA	NA	NA	NA	NA	NA	NA	1	1	NA
		Q4	NA	NA	1	1	NA	1	NA	NA	NA	1	NA	1	NA	NA	NA	NA	NA	NA	NA	NA	NA	1	1	NA
	RADSW003	Q1	NA	NA	1	1	NA	1	NA	NA	NA	1	NA	1	NA	NA	NA	NA	NA	NA	NA	NA	NA	1	1	NA
		Q2	NA	NA	1	1	NA	1	NA	NA	NA	1	NA	1	NA	NA	NA	NA	NA	NA	NA	NA	NA	1	1	NA
		Q3	NA	NA	1	1	NA	1	NA	NA	NA	1	NA	1	NA	NA	NA	NA	NA	NA	NA	NA	NA	1	1	NA
		Q4	NA	NA	1	1	NA	1	NA	NA	NA	1	NA	1	NA	NA	NA	NA	NA	NA	NA	NA	NA	1	1	NA
	RADSW004	Q1	NA	NA	1	1	NA	1	NA	NA	NA	1	NA	1	NA	NA	NA	NA	NA	NA	NA	NA	NA	1	1	NA
		Q2	NA	NA	1	1	NA	1	NA	NA	NA	1	NA	1	NA	NA	NA	NA	NA	NA	NA	NA	NA	1	1	NA
		Q3	NA	NA	1	1	NA	1	NA	NA	NA	1	NA	1	NA	NA	NA	NA	NA	NA	NA	NA	NA	1	1	NA
		Q4	NA	NA	1	1	NA	1	NA	NA	NA	1	NA	1	NA	NA	NA	NA	NA	NA	NA	NA	NA	1	1	NA
	RADSW005	Q1	NA	NA	1	1	NA	1	NA	NA	NA	1	NA	1	NA	NA	NA	NA	NA	NA	NA	NA	NA	1	1	NA
		Q2	NA	NA	1	1	NA	1	NA	NA	NA	1	NA	1	NA	NA	NA	NA	NA	NA	NA	NA	NA	1	1	NA
		Q3	NA	NA	1	1	NA	1	NA	NA	NA	1	NA	1	NA	NA	NA	NA	NA	NA	NA	NA	NA	1	1	NA
		Q4	NA	NA	NA	NA	NA	NA	NA	NA	NA	1	NA	1	NA	NA	NA	NA	NA	NA	NA	NA	NA	1	1	NA
	RADSW006	Q1	NA	NA	1	1	NA	1	NA	NA	NA	1	NA	1	NA	NA	NA	NA	NA	NA	NA	NA	NA	1	1	NA
		Q2	NA	NA	1	1	NA	1	NA	NA	NA	1	NA	1	NA	NA	NA	NA	NA	NA	NA	NA	NA	1	1	1
		Q3	NA	NA	1	1	NA	1	NA	NA	NA	1	NA	1	NA	NA	NA	NA	NA	NA	NA	NA	NA	1	1	NA
		Q4	NA	NA	1	1	NA	1	NA	NA	NA	1	NA	1	NA	NA	NA	NA	NA	NA	NA	NA	NA	1	1	NA

TABLE 4-3

ANALYSES PERFORMED ON 1995 RI AND QEA SAMPLES
TIDAL AREA, NWS SBD CONCORD

			Organic Compounds										Inorganics		Extractions		Biological Tests			Physical Tests						Misc.
Matrix	Sample Location	Depth (feet bgs)	Aromatic Volatiles	Dioxin	Explosives	Pesticides/ PCBs	Low Level Pesticides/ PCBs	SVOC	Low Level SVOC	TPH-e	TPH-p	VOC	Hex. Chromium	Total Metals	WET-Acid	WET-DI	Microtox (Solid Phase)	Microtox (Aqueous)	Cytochrome P450	Geoph.	Grain Size	Percent Moisture	pH	Total Suspended Solids	TOC	Sulfide
Surface Water	Site 2 - R Area Disposal (Continued)																									
	RADSW007	Q1	NA	NA	1	1	NA	1	NA	NA	NA	1	NA	1	NA	NA	NA	NA	NA	NA	NA	NA	NA	1	1	NA
		Q3	NA	NA	1	1	NA	1	NA	NA	NA	1	NA	1	NA	NA	NA	NA	NA	NA	NA	NA	NA	1	1	NA
	RADSW008	Q3	NA	NA	1	1	NA	1	NA	NA	NA	1	NA	1	NA	NA	NA	NA	NA	NA	NA	NA	NA	1	1	NA
		Q4	NA	NA	1	1	NA	1	NA	NA	NA	1	NA	1	NA	NA	NA	NA	NA	NA	NA	NA	NA	1	1	NA
	RADSW009	Q3	NA	NA	1	1	NA	1	NA	NA	NA	1	NA	1	NA	NA	NA	NA	NA	NA	NA	NA	NA	1	1	NA
		Q4	NA	NA	1	1	NA	1	NA	NA	NA	1	NA	1	NA	NA	NA	NA	NA	NA	NA	NA	NA	1	1	NA
	RADSW010	Q1	NA	NA	1	1	NA	1	NA	NA	NA	1	NA	1	NA	NA	NA	NA	NA	NA	NA	NA	NA	1	1	NA
		Q3	NA	NA	1	1	NA	1	NA	NA	NA	1	NA	1	NA	NA	NA	NA	NA	NA	NA	NA	NA	1	1	NA
		Q4	NA	NA	1	1	NA	1	NA	NA	NA	1	NA	1	NA	NA	NA	NA	NA	NA	NA	NA	NA	1	1	NA
	RADSW011	Q1	NA	NA	1	1	NA	1	NA	NA	NA	1	NA	1	NA	NA	NA	NA	NA	NA	NA	NA	NA	1	1	NA
		Q3	NA	NA	1	1	NA	1	NA	NA	NA	1	NA	1	NA	NA	NA	NA	NA	NA	NA	NA	NA	1	1	NA
		Q4	NA	NA	1	1	NA	1	NA	NA	NA	1	NA	1	NA	NA	NA	NA	NA	NA	NA	NA	NA	1	1	NA
	RADSW012	Q3	NA	NA	1	1	NA	1	NA	NA	NA	1	NA	1	NA	NA	NA	NA	NA	NA	NA	NA	NA	1	1	NA
	RADSW013	Q1	NA	NA	1	1	NA	1	NA	NA	NA	1	NA	1	NA	NA	NA	NA	NA	NA	NA	NA	NA	1	1	NA
		Q3	NA	NA	1	1	NA	1	NA	NA	NA	1	NA	1	NA	NA	NA	NA	NA	NA	NA	NA	NA	1	1	NA
	RADSW014	Q1	NA	NA	1	1	NA	1	NA	NA	NA	1	NA	1	NA	NA	NA	NA	NA	NA	NA	NA	NA	1	1	NA
		Q3	NA	NA	1	1	NA	1	NA	NA	NA	1	NA	1	NA	NA	NA	NA	NA	NA	NA	NA	NA	1	1	NA
		Q4	NA	NA	1	1	NA	1	NA	NA	NA	1	NA	1	NA	NA	NA	NA	NA	NA	NA	NA	NA	1	1	NA
	RADSW015	Q1	NA	NA	1	1	NA	1	NA	NA	NA	1	NA	1	NA	NA	NA	NA	NA	NA	NA	NA	NA	1	1	NA
		Q3	NA	NA	1	1	NA	1	NA	NA	NA	1	NA	1	NA	NA	NA	NA	NA	NA	NA	NA	NA	1	1	NA
		Q4	NA	NA	1	1	NA	1	NA	NA	NA	1	NA	1	NA	NA	NA	NA	NA	NA	NA	NA	NA	1	1	NA
	RADSW016	Q1	NA	NA	1	1	NA	1	NA	NA	NA	1	NA	1	NA	NA	NA	NA	NA	NA	NA	NA	NA	1	1	NA
		Q3	NA	NA	1	1	NA	1	NA	NA	NA	1	NA	1	NA	NA	NA	NA	NA	NA	NA	NA	NA	1	1	NA
		Q4	NA	NA	1	1	NA	1	NA	NA	NA	1	NA	1	NA	NA	NA	NA	NA	NA	NA	NA	NA	1	1	NA
	RADSW017	Q1	NA	NA	1	1	NA	1	NA	NA	NA	1	NA	1	NA	NA	NA	NA	NA	NA	NA	NA	NA	1	1	NA
		Q3	NA	NA	1	1	NA	1	NA	NA	NA	1	NA	1	NA	NA	NA	NA	NA	NA	NA	NA	NA	1	1	NA
		Q4	NA	NA	1	1	NA	1	NA	NA	NA	1	NA	1	NA	NA	NA	NA	NA	NA	NA	NA	NA	1	1	NA
	Site 2 SW Sample Total:		**0**	**0**	**50**	**50**	**0**	**50**	**0**	**0**	**0**	**51**	**0**	**51**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**51**	**51**	**1**
	Site 9 - Froid and Taylor Roads																									
	FTSSW001	Q1	NA	NA	1	1	NA	1	NA	1	NA	1	NA	1	NA	NA	NA	NA	NA	NA	NA	NA	NA	1	1	NA
		Q2	NA	NA	1	1	NA	1	NA	1	NA	1	NA	1	NA	NA	NA	NA	NA	NA	NA	NA	NA	1	1	1
		Q3	NA	NA	1	1	NA	1	NA	1	NA	1	NA	1	NA	NA	NA	NA	NA	NA	NA	NA	NA	1	1	NA
		Q4	NA	NA	1	1	NA	1	NA	1	NA	1	NA	1	NA	NA	NA	NA	NA	NA	NA	NA	NA	1	1	NA
	FTSSW002	Q1	NA	NA	1	1	NA	1	NA	1	NA	1	NA	1	NA	NA	NA	NA	NA	NA	NA	NA	NA	1	1	NA
		Q3	NA	NA	1	1	NA	1	NA	1	NA	1	NA	1	NA	NA	NA	NA	NA	NA	NA	NA	NA	1	1	NA
	Site 9 SW Sample Total:		**0**	**0**	**6**	**6**	**0**	**6**	**0**	**6**	**0**	**6**	**0**	**6**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**6**	**6**	**1**
	Site 11 - Wood Hogger																									
	WHSSW001	Q1	NA	NA	1	1	NA	1	NA	NA	NA	1	NA	1	NA	NA	NA	NA	NA	NA	NA	NA	NA	1	1	NA
		Q2	NA	NA	1	1	NA	1	NA	NA	NA	1	NA	1	NA	NA	NA	NA	NA	NA	NA	NA	NA	1	1	NA
		Q3	NA	NA	1	1	NA	1	NA	NA	NA	1	NA	1	NA	NA	NA	NA	NA	NA	NA	NA	NA	1	1	NA
		Q4	NA	NA	1	1	NA	1	NA	NA	NA	1	NA	1	NA	NA	NA	NA	NA	NA	NA	NA	NA	1	1	NA
	WHSSW002	Q1	NA	NA	1	1	NA	1	NA	NA	NA	1	NA	1	NA	NA	NA	NA	NA	NA	NA	NA	NA	1	1	NA
		Q2	NA	NA	1	1	NA	1	NA	NA	NA	1	NA	1	NA	NA	NA	NA	NA	NA	NA	NA	NA	1	1	NA
		Q3	NA	NA	1	1	NA	1	NA	NA	NA	1	NA	1	NA	NA	NA	NA	NA	NA	NA	NA	NA	1	1	NA
		Q4	NA	NA	1	1	NA	1	NA	NA	NA	1	NA	1	NA	NA	NA	NA	NA	NA	NA	NA	NA	1	1	NA
	WHSSW003	Q1	NA	NA	1	1	NA	1	NA	NA	NA	1	NA	1	NA	NA	NA	NA	NA	NA	NA	NA	NA	1	1	NA
		Q2	NA	NA	1	1	NA	1	NA	NA	NA	1	NA	1	NA	NA	NA	NA	NA	NA	NA	NA	NA	1	1	NA
		Q3	NA	NA	1	1	NA	1	NA	NA	NA	1	NA	1	NA	NA	NA	NA	NA	NA	NA	NA	NA	1	1	NA
		Q4	NA	NA	1	1	NA	1	NA	NA	NA	1	NA	1	NA	NA	NA	NA	NA	NA	NA	NA	NA	1	1	NA
	WHSSW004	Q1	NA	NA	1	1	NA	1	NA	NA	NA	1	NA	1	NA	NA	NA	NA	NA	NA	NA	NA	NA	1	1	1
		Q2	NA	NA	1	1	NA	1	NA	NA	NA	1	NA	1	NA	NA	NA	NA	NA	NA	NA	NA	NA	1	1	NA
		Q3	NA	NA	1	1	NA	1	NA	NA	NA	1	NA	1	NA	NA	NA	NA	NA	NA	NA	NA	NA	1	1	NA
		Q4	NA	NA	1	1	NA	1	NA	NA	NA	1	NA	1	NA	NA	NA	NA	NA	NA	NA	NA	NA	1	1	NA
	WHSSW005	Q1	NA	NA	1	1	NA	1	NA	NA	NA	1	NA	1	NA	NA	NA	NA	NA	NA	NA	NA	NA	1	1	NA
		Q2	NA	NA	1	1	NA	1	NA	NA	NA	1	NA	1	NA	NA	NA	NA	NA	NA	NA	NA	NA	1	1	NA
		Q3	NA	NA	1	1	NA	1	NA	NA	NA	1	NA	1	NA	NA	NA	NA	NA	NA	NA	NA	NA	1	1	NA
		Q4	NA	NA	1	1	NA	1	NA	NA	NA	1	NA	1	NA	NA	NA	NA	NA	NA	NA	NA	NA	1	1	NA

TABLE 4-3

ANALYSES PERFORMED ON 1995 RI AND QEA SAMPLES
TIDAL AREA, NWS SBD CONCORD

			Organic Compounds										Inorganics		Extractions		Biological Tests			Physical Tests						Misc.
Matrix	Sample Location	Depth (feet bgs)	Aromatic Volatiles	Dioxin	Explosives	Pesticides/ PCBs	Low Level Pesticides/ PCBs	SVOC	Low Level SVOC	TPH-e	TPH-p	VOC	Hex. Chromium	Total Metals	WET-Acid	WET-DI	Microtox (Solid Phase)	Microtox (Aqueous)	Cytochrome P450	Geoph.	Grain Size	Percent Moisture	pH	Total Suspended Solids	TOC	Sulfide
Surface Water	Site 11 - Wood Hogger (Continued)																									
	WHSSW006	Q1	NA	NA	1	1	NA	1	NA	NA	NA	1	NA	1	NA	NA	NA	NA	NA	NA	NA	NA	NA	1	1	NA
		Q2	NA	NA	1	1	NA	1	NA	NA	NA	1	NA	1	NA	NA	NA	NA	NA	NA	NA	NA	NA	1	1	NA
		Q3	NA	NA	1	1	NA	1	NA	NA	NA	1	NA	1	NA	NA	NA	NA	NA	NA	NA	NA	NA	1	1	NA
		Q4	NA	NA	1	1	NA	1	NA	NA	NA	1	NA	1	NA	NA	NA	NA	NA	NA	NA	NA	NA	1	1	NA
	Site 11 SW Sample Total:		0	0	24	24	0	24	0	0	0	24	0	24	0	0	0	0	0	0	0	0	0	24	24	1
	Total Surface Water Samples:		0	0	80	80	0	80	0	6	0	81	0	81	0	0	0	0	0	0	0	0	0	81	81	3

Notes:

bgs Below ground surface
Geoph Moisutre content, permeability, soil bulk density, specific gravity
NA Not analyzed
PCB Polychlorinated biphenyl
SVOC Semivolatile organic compound
TOC Total organic carbon

TPH-e Total petroleum hydrocarbons, extractable
TPH-p Total petroleum hydrocarbons, purgeables
VOC Volatile organic compound
WET-Acid Waste extraction test using hydrochloric acid
WET-DI Waste extraction test using deionized water

* Surface water samples were collected over four quarters. Q1 = first quarter; Q2 = second quarter; Q3 = third quarter; Q4 = fourth quarter

TABLE 4-4

ANALYSES PERFORMED ON 1998 RI AND QEA SAMPLES
TIDAL AREA, NWS SBD CONCORD

		Inorganics	Organics					Other parameters				Biological Tests	
Matrix	Sample Location	Metals	SVOC	Pesticides/ PCBs	Chlordane	Low Level Pesticides/ PCBs	Dioxins	TOC	pH	SEM/AVS	Grain Size	Amphipod Bioassay	Topsmelt Bioassay
Soil (0-0.5 ft.)	Site 9 - Froid and Taylor Roads Site												
	FTSSB100	NA	NA	NA	1	NA	NA	NA	NA	NA	NA	NA	NA
	FTSSB101	NA	NA	NA	1	NA	NA	NA	NA	NA	NA	NA	NA
	Site 11 - Wood Hogger												
	WHSSB009	NA	NA	NA	NA	NA	1	NA	NA	NA	NA	NA	NA
	WHSSB010	NA	NA	NA	NA	NA	1	NA	NA	NA	NA	NA	NA
	WHSSB016	NA	NA	NA	NA	NA	1	NA	NA	NA	NA	NA	NA
	WHSSB008	NA	NA	NA	NA	NA	1	NA	NA	NA	NA	NA	NA
	WHSSB017	NA	NA	NA	NA	NA	1	NA	NA	NA	NA	NA	NA
	WHSSB019	NA	NA	NA	NA	NA	1	NA	NA	NA	NA	NA	NA
	WHSS007	NA	NA	NA	NA	NA	1	NA	NA	NA	NA	NA	NA
	WHSSB023	NA	NA	NA	NA	NA	1	NA	NA	NA	NA	NA	NA
	WHSSB018	NA	NA	NA	NA	NA	1	NA	NA	NA	NA	NA	NA
	Soil Sample Total:	0	0	0	2	0	9	0	0	0	0	0	0
Sediment (0-0.5ft.)	Site 9 - Froid and Taylor Roads Site												
	FTSSL102	1	1	1	NA	NA	NA	NA	NA	NA	NA	NA	NA
	FTSSL103	1	1	1	NA	NA	NA	NA	NA	NA	NA	NA	NA
	FTSSL104	1	1	1	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Otter Sluice												
	OSLSL001	1	1	NA	NA	1	NA	1	1	1	1	1	1
	OSLSL002	1	1	NA	NA	1	NA	1	1	1	1	1	1
	OSLSL003	1	1	NA	NA	1	NA	1	1	1	1	1	1
	OSLSL004	1	1	NA	NA	1	NA	1	1	1	1	1	1
	OSLSL005	1	1	NA	NA	1	1	1	1	1	1	1	1
	OSLSL006	1	1	NA	NA	1	1	1	1	1	1	1	1
	OSLSL007	1	1	NA	NA	1	1	1	1	1	1	1	1
	OSLSL008	1	1	NA	NA	1	1	1	1	1	1	NA	NA
	OSLSL009	1	1	NA	NA	1	NA	1	1	1	1	NA	NA
	Sediment Sample Total:	12	12	3	0	9	4	9	9	9	9	7	7
Surface Water	Site 9 - Froid and Taylor Roads Site												
	FTSSL102	1	1	1	NA	NA	NA	NA	NA	NA	NA	NA	NA
	FTSSL103	1	1	1	NA	NA	NA	NA	NA	NA	NA	NA	NA
	FTSSL104	1	1	1	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Otter Sluice												
	OSLSL001	1	1	1	NA	NA	NA	NA	NA	NA	NA	NA	NA
	OSLSL002	1	1	1	NA	NA	NA	NA	NA	NA	NA	NA	NA
	OSLSL003	1	1	1	NA	NA	NA	NA	NA	NA	NA	NA	NA
	OSLSL004	1	1	1	NA	NA	NA	NA	NA	NA	NA	NA	NA
	OSLSL005	1	1	1	NA	NA	NA	NA	NA	NA	NA	NA	NA
	OSLSL006	1	1	1	NA	NA	NA	NA	NA	NA	NA	NA	NA
	OSLSL007	1	1	1	NA	NA	NA	NA	NA	NA	NA	NA	NA
	OSLSL008	1	1	1	NA	NA	NA	NA	NA	NA	NA	NA	NA
	OSLSL009	1	1	1	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Surface Water Sample Total:	12	12	12	0	0	0	0	0	0	0	0	0
Fish Tissue	Site 9 - Froid and Taylor Roads Site												
	FTSTI105	1	NA	1	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Otter Sluice												
	OSLSL002	1	NA	NA	NA	1	NA	NA	NA	NA	NA	NA	NA
	OSLSL004	1	NA	NA	NA	1	NA	NA	NA	NA	NA	NA	NA
	OSLSL005	1	NA	NA	NA	1	NA	NA	NA	NA	NA	NA	NA
	OSLSL006	1	NA	NA	NA	1	1	NA	NA	NA	NA	NA	NA
	OSLSL007	1	NA	NA	NA	1	1	NA	NA	NA	NA	NA	NA
	Fish Tissue Sample Total:	6	0	1	0	5	2	0	0	0	0	0	0

TABLE 4-4

ANALYSES PERFORMED ON 1998 RI AND QEA SAMPLES
TIDAL AREA, NWS SBD CONCORD

		Inorganics	Organics					Other parameters				Biological Tests	
Matrix	Sample Location	Metals	SVOC	Pesticides/ PCBs	Chlordane	Low Level Pesticides/ PCBs	Dioxins	TOC	pH	SEM/AVS	Grain Size	Amphipod Bioassay	Topsmelt Bioassay
Clam Tissue	Otter Sluice												
	OSLSL002	1	NA	NA	NA	1	NA	NA	NA	NA	NA	NA	NA
	OSLSL004	1	NA	NA	NA	1	NA	NA	NA	NA	NA	NA	NA
	OSLSL005	1	NA	NA	NA	1	NA	NA	NA	NA	NA	NA	NA
	OSLSL006	1	NA	NA	NA	1	1	NA	NA	NA	NA	NA	NA
	OSLSL007	1	NA	NA	NA	1	1	NA	NA	NA	NA	NA	NA
Clam Tissue Sample Total:		5	0	0	0	5	2	0	0	0	0	0	0
Amphipod Tissue	Site 9 - Froid and Taylor Roads Site												
	FTSTI105	1	NA	1	NA	NA	NA	NA	NA	NA	NA	NA	NA
Amphipod Tissue Sample Total:		1		1									
Pickleweed Tissue	Site 2 - R Area Disposal												
	RADTI501	1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	RADTI502	1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	RADTI503	1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Site 11 - Wood Hogger												
	WHSTI509	1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Pickleweed Tissue Sample Total:		4	0	0	0	0	0	0	0	0	0	0	0
Rodent Tissue	Site 2 - R Area Disposal												
	RAC1 (composite)	1	NA	NA	NA	1	NA	NA	NA	NA	NA	NA	NA
	RAC2 (composite)	1	NA	NA	NA	1	NA	NA	NA	NA	NA	NA	NA
	RAC3 (composite)	1	NA	NA	NA	1	NA	NA	NA	NA	NA	NA	NA
	Site 11 - Wood Hogger												
	WHC1 (composite)	1	NA	NA	NA	1	1	NA	NA	NA	NA	NA	NA
	WHC2 (composite)	1	NA	NA	NA	1	1	NA	NA	NA	NA	NA	NA
	WHC3 (composite)	1	NA	NA	NA	1	1	NA	NA	NA	NA	NA	NA
Rodent Tissue Sample Total:		6	0	0	0	6	3	0	0	0	0	0	0

Notes:

NA Not analyzed
PCB Polychlorinated biphenyl
SEM/AVS Simultaneously Extractable Metals / Acid Volatile Sulfide
SVOC Semivolatile organic compound
TOC Total organic carbon

TABLE 4-5

SPECIES COMPOSITION OF FISH TISSUE COMPOSITE SAMPLES
TIDAL AREA QEA, NWS SBD CONCORD

Sample Location	Fish Species
Froid and Taylor Roads	
FTSTI103	Sculpin (Family Cottidae) Stickleback (*Gasterosteus aculeatus*)
Otter Sluice	
OSLSL002	Sculpin (Family Cottidae) Stickleback (*Gasterosteus aculeatus*)
OSLSL004	Sculpin (Family Cottidae)
OSLSL005	Mosquito fish (*Gambusio affinis*) Stickleback (*Gasterosteus aculeatus*) Sculpin (Family Cottidae)
OSLSL006	Stickleback (*Gasterosteus aculeatus*) Mosquito fish (*Gambusio affinis*)
OSLSL007	Mosquito fish (*Gambusio affinis*) Stickleback (*Gasterosteus aculeatus*) Sculpin (Family Cottidae) Tule Perch (*Hysterocarpus traski*)

TABLE 4-6

RATIONALE FOR SELECTING RODENT TRAPPING TARGET LOCATIONS AND RODENT TISSUE COMPOSITE SAMPLES TIDAL AREA QEA, NWS SBD CONCORD

Soil Sample Locations Targeted for Rodent Trapping	Rationale for Selecting Soil Sample Target Locations	Rodent Composite Sample ID	Rodent Species Composition of Samples (# of individuals)
R Disposal Area Site			
RADSB010 and RADSB011	Elevated concentrations of DDT and other organic chemicals compared to other R Area soil samples	RAC1	MUMU (8)
RADSBD05	Elevated concentrations of DDT and other organic chemicals compared to other R Area soil samples	RAC2	MUMU (9)
RADSBF06	Elevated concentrations of lead and other inorganic chemicals compared to other R Area soil samples	RAC3	MUMU (8)
Wood Hogger Site			
WHSB009, WHSB014, and WHSB016	Elevated concentrations of organic and inorganic chemicals compared to other Wood Hogger Site soil samples	WHC1 WHC2	WHC1: MUMU (6), PEMA (2) WHC2: MUMU (6), PEMA (3)
WHSBA02 and WHSB002	Elevated concentrations of inorganic chemicals compared to other Wood Hogger Site soil samples	WHC3	MUMU (2)

Notes:

MUMU *Mus musculus* (house mouse)
PEMA Peromyscus maniculatus (deer mouse)
WCV Wetland Cover Values

TABLE 5-1

SCREENING VALUES FOR SOIL AND SEDIMENT
TIDAL AREA QEA, NWS SBD CONCORD

Analyte	Concord Tidal Area Ambient (99 UCL)[a]	San Francisco Bay Sediment Ambient RWQCB (1998)[b]	Long and Others (1995)[c]	
			ER-L	ER-M
Inorganic Constituents (mg/kg dry weight)				
Aluminum	27,300	NA	NA	NA
Antimony	2.20	NA	2.00[d]	25[d]
Arsenic	27	15.3	8.20	70
Barium	530	NA	NA	NA
Beryllium	0.18	NA	NA	NA
Cadmium	1.90	0.33	1.20	9.60
Chromium	82.1	112	81	370
Cobalt	36	NA	NA	NA
Copper	81	68.1	34	270
Lead	95	43.2	46.7	218
Manganese	1,500	NA	NA	NA
Mercury	0.32	0.43	0.15	0.71
Molybdenum	6.6	NA	NA	NA
Nickel	120	112	20.9	51.6
Selenium	NA	0.64	0.70[d]	1.40[d]
Silver	NA	0.58	1.00	3.70
Thallium	2.20	NA	NA	NA
Vanadium	96	NA	NA	NA
Zinc	264	158	150	410
Organic Compounds (μg/kg dry weight)				
PCBs/Pesticides				
Total PCBs	NA	14.8	22.7	180
4,4'-DDD	NA	NA	2.00[d]	20[d]
4,4'-DDE	NA	NA	2.20	27
4,4'-DDT	NA	NA	1.00[d]	7.00[d]
Total DDTs	NA	7.00	1.58	46.1
Total BHCs	NA	0.78	NA	NA
Total Chlordanes	NA	1.10	0.50[d]	6.00[d]
Dieldrin	NA	0.44	0.02[d]	8.00[d]

TABLE 5-1

SCREENING VALUES FOR SOIL AND SEDIMENT
TIDAL AREA QEA, NWS SBD CONCORD

Analyte	Concord Tidal Area Ambient (99 UCL)[a]	San Francisco Bay Sediment Ambient RWQCB (1998)[b]	Long and Others (1995)[c]	
			ER-L	ER-M
Organic Compounds (μg/kg dry weight) (Continued)				
PCBs/Pesticides (Continued)				
Endrin	NA	NA	0.02[d]	45[d]
Hexachlorobenzene	NA	0.48	NA	NA
SVOAs				
1-Methylnaphthalene	NA	12.1	NA	NA
1-Methylphenanthrene	NA	31.7	NA	NA
2-Methylnaphthalene	NA	19.4	70	670
2,6-Dimethylnaphthalene	NA	12.1	NA	NA
Acenaphthene	NA	26.6	16	500
Acenaphthylene	NA	31.7	44	640
Anthracene	NA	88	85.3	1,100
Benzo(a)anthracene	NA	244	261	1,600
Benzo(a)pyrene	NA	412	430	1,600
Benzo(b)fluoranthene	NA	371	NA	NA
Benzo(e)pyrene	NA	294	NA	NA
Benzo(g,h,i)perylene	NA	310	NA	NA
Benzo(k)fluoranthene	NA	258	NA	NA
Chrysene	NA	289	384	2,800
Dibenzo(a,h)anthracene	NA	32.7	63.4	260
Fluoranthene	NA	514	600	5,100
Fluorene	NA	25.3	19	540
Indeno(1,2,3-cd) pyrene	NA	382	NA	NA
Naphthalene	NA	55.8	160	2,100
Perylene	NA	145	NA	NA
Phenanthrene	NA	237	240	1,500
Pyrene	NA	665	665	2,600

TABLE 5-1

SCREENING VALUES FOR SOIL AND SEDIMENT
TIDAL AREA QEA, NWS SBD CONCORD

Analyte	Concord Tidal Area Ambient (99 UCL)[a]	San Francisco Bay Sediment Ambient RWQCB (1998)[b]	Long and Others (1995)[c]	
			ER-L	ER-M
Organic Compounds (μg/kg dry weight) (Continued)				
SVOAs (Continued)				
Sum HMW PAHs	NA	3,060	1,700	9,600
Sum LMW PAHs	NA	434	552	3,160
Total PAHs	NA	3,390	4,022	44,792

Notes:

BHC	Hexachlorocyclohexane	mg/kg	Milligrams per kilogram
DDD	Dichlorodiphenyldichloroethane	NA	Not available
DDE	Dichlorodiphenyldichloroethene	PAH	Polynuclear aromatic hydrocarbon
DDT	Dichlorodiphenyltrichloroethane	PCB	Polychlorinated biphenyl
ER-L	Effects-range low	RWQCB	California Regional Water Quality Control Board
ER-M	Effects-range median	SVOA	Semivolatile organic analyte
HMW	High molecular weight	UCL	Upper confidence limit
LMW	Low molecular weight	μg/kg	Micrograms per kilogram

a PRC Environmental Management, Inc. 1996a. "Technical Memorandum, Ambient Metal Concentrations in the Tidal Area Soils."

b RWQCB. 1998. "Ambient Concentrations of Toxic Chemicals in San Francisco Bay Sediments." May.

c Long, E.R., D.D. MacDonald, S.L. Smith, and F.D. Calder. 1995. "Incidence of Adverse Biological Effects Within Ranges of Chemical Concentrations in Marine and Estuarine Sediments." Environmental Management. Vol. 19. No. 1. Pages 81-97.

d National Oceanic and Atmospheric Administration (NOAA). 1991. "The Potential for Biological Effects of Sediment-Sorbed Contaminants Tested in the National Status and Trends Program." NOAA, Office of Oceanography and Marine Assessment. Seattle, Washington. Technical Memorandum NOS OMA 52. (Also cited as Long and Morgan 1990.)

TABLE 5-2

SCREENING VALUES FOR SURFACE WATER
TIDAL AREA QEA, NWS SBD CONCORD

Analyte	EPA (1997) Proposed State of California Water Quality Criteria		EPA (1998) National Recommended Water Quality Criteria		Bay Basin Plan (1986) Objectives Upstream of San Pablo Bay	Concord QEA Guidance Values[*]
	Saltwater CCC	Freshwater CCC	Saltwater CCC	Freshwater CCC	Surface Water CCC	
Metals (μg/L)						
Aluminum	NA	NA	NA	87[a,k]	NA	**87**
Arsenic	36[b]	150[b]	36[b]	150[b]	190	**36**
Cadmium	9.3[b]	2.2[b,c]	9.3[b]	2.2[b,c]	1.1[c]	**1.1**
Chromium III	NA	180[b,c]	NA	74[b,c]	NA	**86[d]**
Chromium VI	50[b]	11[b]	50[b]	11[b]	11	**11[d]**
Copper	3.1[b]	9[b,c]	3.1[b]	9[b,c]	6.5	**3.2[d]**
Lead	8.1[b]	2.5[b,c]	8.1[b]	2.5[b,c]	3.2[c]	**3.1[d]**
Mercury	0.94[b]	0.77[b]	0.94[b]	0.77[b]	0.025	**0.025**
Nickel	8.2[b]	52[b,c]	8.2[b]	52[b,c]	56	**8.2[d]**
Selenium	71[b]	5.0[a]	71[b]	5.0[a]	NA	**5**
Silver	1.9[b,e]	3.4[b,c,e]	1.9[b,e]	3.4[b,c,e]	1.2	**0.22[d,f]**
Zinc	81[b]	120[b,c]	81[b]	120[b,c]	58[c]	**58**
Organic Compounds (μg/L)						
4,4'-DDT	0.001	0.001	0.001	0.001	NA	**0.001**
Aldrin	1.3[e]	3.0[e]	1.3[e]	3.0[e]	NA	**0.13[f]**
Total Chlordane	0.004	0.0043	0.004	0.0043	NA	**0.004**
Chloropyrifos	NA	NA	0.0056	0.041	NA	**0.0056**
Cyanide	1.0[g]	5.2[g]	1.0[g]	5.2[g]	NA	**1.0**
Demeton	NA	NA	0.1	0.1	NA	**0.1**
Dieldrin	0.0019	0.056	0.0019	0.056	NA	**0.0019**
Endosulfan I	0.0087	0.056	0.0087	0.056	NA	**0.0087**
Endosulfan II	0.0087	0.056	0.0087	0.056	NA	**0.0087**
Endrin	0.0023	0.036	0.0023	0.036	NA	**0.0023**
Guthion	NA	NA	0.01	0.01	NA	**0.01**
Heptachlor	0.0036	0.0038	0.0036	0.0038	NA	**0.0036**
Heptachlor Epoxide	0.0036	0.0038	0.0036	0.0038	NA	**0.0036**
Lindane	0.16[e]	0.95[e]	0.16[e]	0.95[e]	NA	**0.016[f]**
Malathion	NA	NA	NA	0.1	NA	**0.10**
Methoxychlor	NA	NA	0.03	0.03	NA	**0.03**
Mirex	NA	NA	0.001	0.001	NA	**0.001**
Parathion	NA	NA	NA	0.013	NA	**0.013**
PCBs[h]	0.03	0.014	0.03	0.014	NA	**0.014**
Pentachlorophenol	7.9	15[i]	7.9	15[i]	NA	**7.4[j]**
Total PAHs	NA	NA	NA	NA	15	**15**
TBT	NA	NA	0.01	0.063	NA	**0.01**

TABLE 5-2

SCREENING VALUES FOR SURFACE WATER
TIDAL AREA QEA, NWS SBD CONCORD

Notes:

CCC	Criteria continuous concentration (4-day average concentration chronic limit)	NA	Not available
		NTR	National Toxics Rule
CMC	Criteria maximum concentration (short-term concentration acute limit)	PAH	Polynuclear aromatic hydrocarbon
		PCB	Polychlorinated biphenyl
CTR	California Toxics Rule	TBT	Tributyltin
DDT	Dichlorodiphenyltrichloroethane	µg/L	Micrograms per liter
EPA	U.S. Environmental Protection Agency		

* Lowest total recoverable concentrations based on either EPA (1997) saltwater or freshwater, EPA (1998) saltwater or freshwater, Bay Basin Plan (1986).

a Criterion expressed in terms of total recoverable form.

b Criterion expressed in terms of the dissolved metal in the water column.

c Criterion is hardness dependent. This value corresponds to a total hardness of 100 mg/L as $CaCO_3$ in the water body.

d Guidance value expressed as total recoverable concentration. Converted from EPA (1998) dissolved metals criterion using conversion factor.

e Because there is no proposed CCC for this chemical, the CMC is used.

f Value is 10 percent of the lowest CMC (see note e).

g Criterion is expressed as µg free cyanide (CN)/L.

h The PCB criteria in the CTR and NTR apply to Aroclors-1016, -1221, -1232, -1242, -1248, -1254, and -1260.

i Criterion expressed as a function of pH, and calculated as follows: CCC = exp(1.005[pH]-5.134). This value corresponds to a pH of 7.8.

j Guidance value is based on a site-specific pH of 7.1 (see note i).

k Criterion valid only for water in the pH range of 6.5 to 9.0. Aluminum may be less toxic at high pH and hardness, but the effects are not well quantified at this time.

TABLE 6-1

TIDAL AREA LANDFILL PERIMETER
SUMMARY OF CHEMICALS IN SOIL AND SEDIMENT COMPARED TO SCREENING VALUES
TIDAL AREA QEA, NWS SBD CONCORD

Analyte	Depth[a]	Number of Samples Collected[b]	Number of Nondetect Results	Maximum Detected Conc.[b]	Location of Maximum Detection	Top Depth of Sample (ft. bgs)	Tidal Area Ambient Value (99UCL)[c]	SF Bay Ambient Value[d]	ER-L[e]	ER-M[e]	Number of Samples that Exceed Tidal Area Ambient Value[f]	Number of Samples that Exceed SF Bay Ambient Value[f]	Number of Samples that Exceed ER-L[f]	Number of Samples that Exceed ER-M[f]
Inorganic Chemicals (mg/kg)														
Aluminum	Surface	8	0	27,400	TLSSB004	1.3	27,300	NA	NA	NA	1/8	NA	NA	NA
	Subsurface	8	0	29,400	TLSSB003	4.5	27,300	NA	NA	NA	1/8	NA	NA	NA
Antimony	Surface	7	4	3.1	TLSSB007	0.0	2.2	NA	2.0	25	2/7	NA	2/7	0/7
	Subsurface	5	4	1.2	TLSSB008	4.5	2.2	NA	2.0	25	0/5	NA	0/5	0/5
Arsenic	Surface	8	0	57.6	TLSSB007	0.0	27	15.3	8.2	70	3/8	5/8	8/8	0/8
	Subsurface	8	0	17.2	TLSSB008	4.5	27	15.3	8.2	70	0/8	1/8	4/8	0/8
Barium	Surface	8	0	436	TLSSB004	0.0	530	NA	NA	NA	0/8	NA	NA	NA
	Subsurface	8	0	90.5	TLSSB006	4.5	530	NA	NA	NA	0/8	NA	NA	NA
Beryllium	Surface	8	5	0.56	TLSSB004	1.3	0.18	NA	NA	NA	2/8	NA	NA	NA
	Subsurface	8	8	ND	ND	0.0	0.18	NA	NA	NA	ND	ND	ND	ND
Cadmium	Surface	8	3	5.8	TLSSB002	0.0	1.9	0.33	1.2	9.6	3/8	4/8	3/8	0/8
	Subsurface	8	8	ND	ND	0.0	1.9	0.33	1.2	9.6	ND	ND	ND	ND
Chromium	Surface	8	0	83.4	TLSSB006	1.3	82.1	112	81	370	2/8	0/8	2/8	0/8
	Subsurface	8	1	92.5	TLSSB003	4.5	82.1	112	81	370	3/8	0/8	3/8	0/8
Cobalt	Surface	8	0	33.5	TLSSB002	1.3	36	NA	NA	NA	0/8	NA	NA	NA
	Subsurface	8	0	29.4	TLSSB005	4.5	36	NA	NA	NA	0/8	NA	NA	NA
Copper	Surface	8	0	264	TLSSB007	0.0	81	68.1	34	270	3/8	3/8	7/8	0/8
	Subsurface	8	0	39.4	TLSSB008	4.5	81	68.1	34	270	0/8	0/8	2/8	0/8
Lead	Surface	8	0	156	TLSSB007	0.0	95	43.2	46.7	218	2/8	5/8	5/8	0/8
	Subsurface	8	1	24.9	TLSSB001	3.9	95	43.2	46.7	218	0/8	0/8	0/8	0/8
Manganese	Surface	8	0	1,000	TLSSB006	1.3	1,500	NA	NA	NA	0/8	NA	NA	NA
	Subsurface	8	0	843	TLSSB006	4.5	1,500	NA	NA	NA	0/8	NA	NA	NA
Mercury	Surface	8	4	0.48	TLSSB004	0.0	0.32	0.43	0.15	0.71	2/8	1/8	3/8	0/8
	Subsurface	8	8	ND	ND	0.0	0.32	0.43	0.15	0.71	ND	ND	ND	ND
Molybdenum	Surface	8	4	4.2	TLSSB005	0.9	6.6	NA	NA	NA	0/8	NA	NA	NA
	Subsurface	8	6	3.4	TLSSB007	4.5	6.6	NA	NA	NA	0/8	NA	NA	NA
Nickel	Surface	8	0	131	TLSSB002	0.0	120	112	20.9	51.6	1/8	1/8	8/8	8/8
	Subsurface	8	0	105	TLSSB006	4.5	120	112	20.9	51.6	0/8	0/8	8/8	6/8
Selenium[g]	Surface	8	8	ND	ND	0.0	NA	0.64	0.7	1.4	ND	ND	ND	ND
	Subsurface	8	8	ND	ND	0.0	NA	0.64	0.7	1.4	ND	ND	ND	ND
Silver	Surface	8	7	1.2	TLSSB007	0.0	NA	0.58	1.0	3.7	NA	1/8	1/8	0/8
	Subsurface	8	8	ND	ND	0.0	NA	0.58	1.0	3.7	ND	ND	ND	ND
Thallium	Surface	8	6	2.2	TLSSB005	0.9	2.2	NA	NA	NA	0/8	NA	NA	NA
	Subsurface	8	7	1.7	TLSSB006	4.5	2.2	NA	NA	NA	0/8	NA	NA	NA
Vanadium	Surface	8	0	108	TLSSB006	0.0	96	NA	NA	NA	1/8	NA	NA	NA
	Subsurface	8	0	100	TLSSB003	4.5	96	NA	NA	NA	1/8	NA	NA	NA
Zinc	Surface	8	0	743	TLSSB002	0.0	264	158	150	410	2/8	5/8	5/8	1/8
	Subsurface	8	1	102	TLSSB008	4.5	264	158	150	410	0/8	0/8	0/8	0/8

TABLE 6-1

TIDAL AREA LANDFILL PERIMETER
SUMMARY OF CHEMICALS IN SOIL AND SEDIMENT COMPARED TO SCREENING VALUES
TIDAL AREA QEA, NWS SBD CONCORD

Analyte	Depth[a]	Number of Samples Collected[b]	Number of Nondetect Results	Maximum Detected Conc.[b]	Location of Maximum Detection	Top Depth of Sample (ft. bgs)	Tidal Area Ambient Value (99UCL)[c]	SF Bay Ambient Value[d]	ER-L[e]	ER-M[e]	Number of Samples that Exceed Tidal Area Ambient Value[f]	Number of Samples that Exceed SF Bay Ambient Value[f]	Number of Samples that Exceed ER-L[f]	Number of Samples that Exceed ER-M[f]
Low Detection Limit PCBs (µg/kg)														
PCB-18 (2,2',5)	Surface	7	3	2.4	TLSSB002	0.0	NA	NA	NA	NA	NA	NA	NA	NA
PCB-28 (2,4,4')	Surface	7	6	2.3	TLSSB002	0.0	NA	NA	NA	NA	NA	NA	NA	NA
PCB-44 (2,2',3,5')	Surface	7	5	2.9	TLSSB002	0.0	NA	NA	NA	NA	NA	NA	NA	NA
PCB-52 (2,2',5,5')	Surface	7	3	2.3	TLSSB002	0.0	NA	NA	NA	NA	NA	NA	NA	NA
PCB-66 (2,3',4,4')	Surface	7	5	3.5	TLSSB002	0.0	NA	NA	NA	NA	NA	NA	NA	NA
PCB-77 (3,3',4,4')	Surface	7	4	1.2	TLSSB002	0.0	NA	NA	NA	NA	NA	NA	NA	NA
PCB-101 (2,2',3,5,5')	Surface	7	2	2.2	TLSSB002	0.0	NA	NA	NA	NA	NA	NA	NA	NA
PCB-105 (2,3,3',4,4')	Surface	7	2	1.6	TLSSB002	0.0	NA	NA	NA	NA	NA	NA	NA	NA
PCB-118 (2,3',4,4',5)	Surface	7	2	4.2	TLSSB002	0.0	NA	NA	NA	NA	NA	NA	NA	NA
PCB-128 (2,2',3,3',4,4')	Surface	7	5	0.82	TLSSB002	0.0	NA	NA	NA	NA	NA	NA	NA	NA
PCB-138 (2,2',3,4,4',5')	Surface	7	2	3.1	TLSSB002	0.0	NA	NA	NA	NA	NA	NA	NA	NA
PCB-153 (2,2',4,4',5,5')	Surface	7	2	2.2	TLSSB002	0.0	NA	NA	NA	NA	NA	NA	NA	NA
PCB-170 (2,2',3,3',4,4',5)	Surface	7	6	0.54	TLSSB002	0.0	NA	NA	NA	NA	NA	NA	NA	NA
PCB-180 (2,2',3,4,4',5,5')	Surface	7	2	1.5	TLSSB001	0.0	NA	NA	NA	NA	NA	NA	NA	NA
PCB-187 (2,2',3,4',5,5',6)	Surface	7	2	0.71	TLSSB002	0.0	NA	NA	NA	NA	NA	NA	NA	NA
PCB-195 (2,2',3,3',4,4',5,	Surface	7	6	0.68	TLSSB002	0.0	NA	NA	NA	NA	NA	NA	NA	NA
PCB-206 (2,2',3,3',4,4',5,	Surface	7	4	0.54	TLSSB008	0.0	NA	NA	NA	NA	NA	NA	NA	NA
Total PCBs	Surface	7	0	32.805	TLSSB002	0.0	NA	14.8	22.7	180	NA	2/7	1/7	0/7
CLP PCBs (µg/kg)														
Total PCBs	Surface	8	0	640	TLSSB002	1.3	NA	14.8	22.7	180	NA	8/8	8/8	8/8
	Subsurface	8	0	795	TLSSB002	4.3	NA	14.8	22.7	180	NA	8/8	8/8	8/8
Low Detection Limit Pesticides (µg/kg)														
2,4'-DDD	Surface	7	2	12	TLSSB001	0.0	NA	NA	NA	NA	NA	NA	NA	NA
2,4'-DDE	Surface	7	5	0.93	TLSSB002	0.0	NA	NA	NA	NA	NA	NA	NA	NA
2,4'-DDT	Surface	7	6	0.98	TLSSB001	0.0	NA	NA	NA	NA	NA	NA	NA	NA
4,4'-DDD	Surface	7	2	27	TLSSB001	0.0	NA	NA	2.0	20	NA	NA	4/7	1/7
4,4'-DDE	Surface	7	2	5.7	TLSSB002	0.0	NA	NA	2.2	27	NA	NA	3/7	0/7
4,4'-DDT	Surface	7	3	2.2	TLSSB001	0.0	NA	NA	1.0	7.0	NA	NA	1/7	0/7
Total DDTs	Surface	7	0	48.125	TLSSB001	0.0	NA	7.0	1.58	46.1	NA	4/7	5/7	1/7
Aldrin	Surface	7	5	1.6	TLSSB001	0.0	NA	NA	NA	NA	NA	NA	NA	NA
Total BHCs	Surface	7	0	0.345	TLSSB001	0.0	NA	0.78	NA	NA	NA	0/7	NA	NA
alpha-Chlordane	Surface	7	2	5.1	TLSSB002	0.0	NA	NA	NA	NA	NA	NA	NA	NA

TABLE 6-1

TIDAL AREA LANDFILL PERIMETER
SUMMARY OF CHEMICALS IN SOIL AND SEDIMENT COMPARED TO SCREENING VALUES
TIDAL AREA QEA, NWS SBD CONCORD

Analyte	Depth[a]	Number of Samples Collected[b]	Number of Nondetect Results	Maximum Detected Conc.[b]	Location of Maximum Detection	Top Depth of Sample (ft. bgs)	Tidal Area Ambient Value (99UCL)[c]	SF Bay Ambient Value[d]	ER-L[e]	ER-M[e]	Number of Samples that Exceed Tidal Area Ambient Value[f]	Number of Samples that Exceed SF Bay Ambient Value[f]	Number of Samples that Exceed ER-L[f]	Number of Samples that Exceed ER-M[f]
Low Detection Limit Pesticides (µg/kg) (Continued)														
Total Chlordanes	Surface	7	0	5.1	TLSSB002	0.0	NA	1.1	0.5	6	NA	5/7	5/7	0/7
Dieldrin	Surface	7	4	2.2	TLSSB001	0.0	NA	0.44	0.02	8	NA	3/7	3/7	0/7
Heptachlor	Surface	7	5	0.77	TLSSB004	1.3	NA	NA	NA	NA	NA	NA	NA	NA
Hexachlorobenzene	Surface	7	5	2.0	TLSSB001	0.0	NA	0.48	NA	NA	NA	2/7	NA	NA
Mirex	Surface	7	5	0.53	TLSSB002	0.0	NA	NA	NA	NA	NA	NA	NA	NA
trans-Nonachlor	Surface	7	2	3.9	TLSSB002	0.0	NA	NA	NA	NA	NA	NA	NA	NA
CLP Pesticides (µg/kg)														
Total DDTs	Surface	8	0	24	TLSSB002	1.3	NA	7.0	1.58	46.1	NA	8/8	8/8	0/8
	Subsurface	8	0	30	TLSSB002	4.3	NA	7.0	1.58	46.1	NA	8/8	8/8	0/8
Total BHCs	Surface	8	0	15.8	TLSSB002	1.3	NA	0.78	NA	NA	NA	8/8	NA	NA
	Subsurface	8	0	19.6	TLSSB002	4.3	NA	0.78	NA	NA	NA	8/8	NA	NA
Total Chlordanes	Surface	8	0	7.9	TLSSB002	1.3	NA	1.1	0.5	6.0	NA	8/8	8/8	2/8
	Subsurface	8	0	9.8	TLSSB002	4.3	NA	1.1	0.5	6.0	NA	8/8	8/8	3/8
Low Detection Level SVOAs (µg/kg)														
2,6-Dimethylnaphthalene	Surface	7	6	30	TLSSB004	0.0	NA	12.1	NA	NA	NA	1/7	NA	NA
Benzo(a)anthracene	Surface	7	4	68	TLSSB004	0.0	NA	244	261	1,600	NA	0/7	0/7	0/7
Benzo(a)pyrene	Surface	7	6	68	TLSSB004	0.0	NA	412	430	1,600	NA	0/7	0/7	0/7
Benzo(b)fluoranthene	Surface	7	4	85	TLSSB008	0.0	NA	371	NA	NA	NA	0/7	NA	NA
Benzo(e)pyrene	Surface	7	4	47	TLSSB006	0.0	NA	294	NA	NA	NA	0/7	NA	NA
Benzo(g,h,i)perylene	Surface	7	6	66	TLSSB004	0.0	NA	310	NA	NA	NA	0/7	NA	NA
Benzo(k)fluoranthene	Surface	7	4	75	TLSSB004	0.0	NA	258	NA	NA	NA	0/7	NA	NA
Benzoic acid	Surface	7	2	1,100	TLSSB004	1.3	NA	NA	NA	NA	NA	NA	NA	NA
Butylbenzylphthalate	Surface	7	6	45	TLSSB006	0.0	NA	NA	NA	NA	NA	NA	NA	NA
Chrysene	Surface	7	4	110	TLSSB008	0.0	NA	289	384	2,800	NA	0/7	0/7	0/7
Fluoranthene	Surface	7	3	150	TLSSB002	0.0	NA	514	600	5,100	NA	0/7	0/7	0/7
Indeno(1,2,3-cd)pyrene	Surface	7	6	47	TLSSB004	0.0	NA	382	NA	NA	NA	0/7	NA	NA
Perylene	Surface	7	6	39	TLSSB004	0.0	NA	145	NA	NA	NA	0/7	NA	NA
Phenanthrene	Surface	7	4	41	TLSSB008	0.0	NA	237	240	1,500	NA	0/7	0/7	0/7
Phenol	Surface	7	6	19,000	TLSSB004	1.3	NA	NA	NA	NA	NA	NA	NA	NA
Pyrene	Surface	7	4	1,300	TLSSB004	1.3	NA	665	665	2,600	NA	1/7	1/7	0/7
Total HMW PAHs	Surface	7	0	8,450	TLSSB004	1.3	NA	3,060	1,700	9,600	NA	1/7	1/7	0/7
Total LMW PAHs	Surface	7	0	5,850	TLSSB004	1.3	NA	434	552	3,160	NA	7/7	7/7	2/7
Total PAHs	Surface	7	0	14,300	TLSSB004	1.3	NA	3,390	4,022	44,792	NA	2/7	2/7	0/7

TABLE 6-1

TIDAL AREA LANDFILL PERIMETER
SUMMARY OF CHEMICALS IN SOIL AND SEDIMENT COMPARED TO SCREENING VALUES
TIDAL AREA QEA, NWS SBD CONCORD

Analyte	Depth[a]	Number of Samples Collected[b]	Number of Nondetect Results	Maximum Detected Conc.[b]	Location of Maximum Detection	Top Depth of Sample (ft. bgs)	Tidal Area Ambient Value (99UCL)[c]	SF Bay Ambient Value[d]	ER-L[e]	ER-M[e]	Number of Samples that Exceed Tidal Area Ambient Value[f]	Number of Samples that Exceed SF Bay Ambient Value[f]	Number of Samples that Exceed ER-L[f]	Number of Samples that Exceed ER-M[f]
CLP SVOAs (µg/kg)														
Phenol	Surface	8	4	3,700	TLSSB002	1.3	NA	NA	NA	NA	NA	NA	NA	NA
	Subsurface	8	4	11,000	TLSSB001	3.9	NA	NA	NA	NA	NA	NA	NA	NA
Total HMW PAHs	Surface	8	0	7,500	TLSSB002	1.3	NA	3,060	1,700	9,600	NA	6/8	8/8	0/8
	Subsurface	8	0	10,000	TLSSB002	4.3	NA	3,060	1,700	9,600	NA	7/8	8/8	1/8
Total LMW PAHs	Surface	8	0	5,250	TLSSB002	1.3	NA	434	552	3,160	NA	8/8	8/8	6/8
	Subsurface	8	0	7,000	TLSSB002	4.3	NA	434	552	3,160	NA	8/8	8/8	5/8
Total PAHs	Surface	8	0	12,750	TLSSB002	1.3	NA	3,390	4,022	44,792	NA	8/8	8/8	0/8
	Subsurface	8	0	17,000	TLSSB002	4.3	NA	3,390	4,022	44,792	NA	8/8	8/8	0/8
CLP VOAs (µg/kg)														
2-Butanone	Surface	8	7	390	TLSSB004	1.3	NA	NA	NA	NA	NA	NA	NA	NA
Acetone	Surface	8	6	580	TLSSB007	1.5	NA	NA	NA	NA	NA	NA	NA	NA
Carbon disulfide	Surface	8	7	97	TLSSB007	1.5	NA	NA	NA	NA	NA	NA	NA	NA
	Subsurface	8	2	120	TLSSB004	4.3	NA	NA	NA	NA	NA	NA	NA	NA
Chloromethane	Subsurface	8	5	48	TLSSB001	3.9	NA	NA	NA	NA	NA	NA	NA	NA

Notes:
Where total values were calculated (for example, total PCBs, total DDTs, etc.) 1/2 of the standard quantitation limit (SQL) was used for nondetected analytes.

bgs Below ground surface
BHC Hexachlorocyclohexane
CLP Contract Laboratory Program
Conc. Concentration
DDD Dichlorodiphenyldichloroethane
DDE Dichlorodiphenyldichloroethene
DDT Dichlorodiphenyltrichloroethane
ER-L Effects range-low
ER-M Effects range-median
ft. feet
HMW High molecular weight
LMW Low molecular weight
mg/kg Millgrams per kilogram
NA Screening value not available
ND Nondetected
PAH Polycyclic aromatic hydrocarbon
PCB Polychlorinated biphenyl
SVOA Semivolatile organic analyte
UCL Upper confidence limit
µg/kg Micrograms per kilogram
VOA Volatile organic analyte

a Surface samples are those collected between 0 and 3 feet bgs; subsurface samples are those collected greater than 3 feet bgs.
b If more than one sample was analyzed in the surface and subsurface depth ranges, only the highest result from the interval is reported and used in the data set.
c PRC Environmental Management, Inc (PRC). 1996a. "Estimation of Ambient Metals Concentrations in the Tidal Area Soils. Technical Memorandum. Naval Weapons Station, Concord, California." March.
d San Francisco Bay Regional Water Quality Control Board (RWQCB). 1998. "Ambient Concentrations of Toxic Chemicals in Sediments." April.
e National Oceanic and Atmospheric Administration (NOAA). 1991. "The Potential for Biological Effects of Sediment-Sorbed Contaminants Tested in the National Status and Trends Program." Technical Memorandum NOS OMA 52. NOAA, Office of Oceanography and Marine Assessment. Seattle, Washington.
Long, E.R., D. D. MacDonald, S.L. Smith, F.D. Calder. 1995. "Incidence of Adverse Biological Effects Within Ranges of Chemical Concentrations in Marine and Estuarine Sediments." *Environmental Management*. Volume 19. Number 1. Pages 81 through 97.
f Number of samples that exceeded screening value / number of samples
g Detection limits were below screening values for all chemicals except selenium. The median detection limit for selenium exceeded the ER-L value.

TABLE 6-2

TIDAL AREA LANDFILL, SUMMARY OF CHEMICALS IN SURFACE WATER COMPARED TO SCREENING VALUES
TIDAL AREA QEA, NWS SBD CONCORD

Analyte	Unit	Quarter Sampled	Total Number of Samples	Minimum Concentration Detected	Maximum Concentration Detected	Mean Concentration Detected	Location of Maximum Detection	Concord Tidal Area QEA Screening Value	Number of Samples that Exceed the Screening Value
Inorganic Chemicals (all values in μg/L)									
Aluminum	LFSW	Jul-95	4	158.00	158.00	158.00	RADSW015	87	1/4
	LFSW	Oct-95	NA	NA	NA	NA	---	87	NA
	LFSW	Jan-96	4	349.00	349.00	349.00	RADSW01	87	1/4
	LFSW	Apr/May-96	4	47.60	1,370.00	686.15	RADSW016	87	3/4
	LFSW	Jun-98	NA	NA	NA	NA	---	87	NA
Arsenic	LFSW	Jul-95	4	16.70	16.70	16.70	RADSW017	36	0/4
	LFSW	Oct-95	NA	NA	NA	NA	---	36	NA
	LFSW	Jan-96	4	1.60	3.30	2.70	RADSW014	36	0/4
	LFSW	Apr/May-96	4	5.40	15.90	10.03	RADSW017	36	0/4
	LFSW	Jun-98	NA	NA	NA	NA	---	36	NA
Barium	LFSW	Jul-95	4	161.00	316.00	229.75	RADSW016	None[a]	---
	LFSW	Oct-95	NA	NA	NA	NA	---	None[a]	NA
	LFSW	Jan-96	4	48.60	230.00	154.65	RADSW016	None[a]	---
	LFSW	Apr/May-96	4	81.70	282.00	182.93	RADSW015	None[a]	---
	LFSW	Jun-98	NA	NA	NA	NA	---	None[a]	NA
Cadmium	LFSW	Jul-95	4	ND	ND	ND	---	1.1	0/4
	LFSW	Oct-95	NA	NA	NA	NA	---	1.1	NA
	LFSW	Jan-96	4	ND	ND	ND	---	1.1	0/4
	LFSW	Apr/May-96	4	0.42	1.80	1.11	RADSW016	1.1	1/4
	LFSW	Jun-98	NA	NA	NA	NA	---	1.1	NA
Chromium	LFSW	Jul-95	4	ND	ND	ND	---	86	0/4
	LFSW	Oct-95	NA	NA	NA	NA	---	86	NA
	LFSW	Jan-96	4	ND	ND	ND	---	86	0/4
	LFSW	Apr/May-96	4	3.20	5.50	4.35	RADSW016	86	0/4
	LFSW	Jun-98	NA	NA	NA	NA	---	86	NA
Cobalt	LFSW	Jul-95	4	2.50	3.40	2.95	RADSW016	None[a]	—
	LFSW	Oct-95	NA	NA	NA	NA	---	None[a]	NA
	LFSW	Jan-96	4	3.50	7.50	4.93	RADSW014	None[a]	---
	LFSW	Apr/May-96	4	2.80	9.70	5.28	RADSW016	None[a]	---
	LFSW	Jun-98	NA	NA	NA	NA	---	None[a]	NA

TABLE 6-2

TIDAL AREA LANDFILL, SUMMARY OF CHEMICALS IN SURFACE WATER COMPARED TO SCREENING VALUES
TIDAL AREA QEA, NWS SBD CONCORD

Analyte	Unit	Quarter Sampled	Total Number of Samples	Minimum Concentration Detected	Maximum Concentration Detected	Mean Concentration Detected	Location of Maximum Detection	Concord Tidal Area QEA Screening Value	Number of Samples that Exceed the Screening Value
Inorganic Chemicals (all values in µg/L) (Continued)									
Copper	LFSW	Jul-95	4	ND	ND	ND	---	3.2	0/4
	LFSW	Oct-95	NA	NA	NA	NA	---	3.2	NA
	LFSW	Jan-96	4	10.30	14.50	11.98	RADSW014	3.2	4/4
	LFSW	Apr/May-96	4	5.80	9.20	7.63	RADSW016	3.2	3/4
	LFSW	Jun-98	NA	NA	NA	NA	---	3.2	NA
Iron	LFSW	Jul-95	4	2,030.0	5,830.0	3,850.0	RADSW017	None[a]	---
	LFSW	Oct-95	NA	NA	NA	NA	---	None[a]	NA
	LFSW	Jan-96	4	292.0	3,740.0	1,414.0	RADSW014	None[a]	---
	LFSW	Apr/May-96	4	2,670.0	23,200.0	9,872.5	RADSW016	None[a]	---
	LFSW	Jun-98	NA	NA	NA	NA	---	None[a]	NA
Lead	LFSW	Jul-95	4	2.30	2.30	2.30	RADSW014	3.1	0/4
	LFSW	Oct-95	NA	NA	NA	NA	---	3.1	NA
	LFSW	Jan-96	4	ND	ND	ND	---	3.1	0/4
	LFSW	Apr/May-96	4	2.90	2.90	2.90	RADSW016	3.1	0/4
	LFSW	Jun-98	NA	NA	NA	NA	---	3.1	NA
Manganese	LFSW	Jul-95	4	1,420.00	3,180.00	1,942.50	RADSW017	None[a]	---
	LFSW	Oct-95	NA	NA	NA	NA	---	None[a]	NA
	LFSW	Jan-96	4	560.00	1,750.00	1,147.50	RADSW014	None[a]	---
	LFSW	Apr/May-96	4	749.00	3,140.00	2,392.25	RADSW017	None[a]	---
	LFSW	Jun-98	NA	NA	NA	NA	---	None[a]	NA
Molybdenum	LFSW	Jul-95	4	8.10	10.20	8.93	RADSW015	None[a]	---
	LFSW	Oct-95	NA	NA	NA	NA	---	None[a]	NA
	LFSW	Jan-96	4	6.60	6.60	6.60	RADSW015	None[a]	---
	LFSW	Apr/May-96	4	7.80	19.80	13.15	RADSW016	None[a]	---
	LFSW	Jun-98	NA	NA	NA	NA	---	None[a]	NA
Nickel	LFSW	Jul-95	4	ND	ND	ND	---	8.2	0/4
	LFSW	Oct-95	NA	NA	NA	NA	---	8.2	NA
	LFSW	Jan-96	4	6.60	26.80	17.43	RADSW014	8.2	3/4
	LFSW	Apr/May-96	4	17.20	28.60	21.50	RADSW016	8.2	3/4
	LFSW	Jun-98	NA	NA	NA	NA	---	8.2	NA

TABLE 6-2

TIDAL AREA LANDFILL, SUMMARY OF CHEMICALS IN SURFACE WATER COMPARED TO SCREENING VALUES
TIDAL AREA QEA, NWS SBD CONCORD

Analyte	Unit	Quarter Sampled	Total Number of Samples	Minimum Concentration Detected	Maximum Concentration Detected	Mean Concentration Detected	Location of Maximum Detection	Concord Tidal Area QEA Screening Value	Number of Samples that Exceed the Screening Value
Inorganic Chemicals (all values in µg/L) (Continued)									
Selenium	LFSW	Jul-95	4	ND	ND	ND	---	None[a]	---
	LFSW	Oct-95	NA	NA	NA	NA	---	None[a]	NA
	LFSW	Jan-96	4	2.50	2.50	2.50	RADSW017	None[a]	---
	LFSW	Apr/May-96	4	ND	ND	ND	---	None[a]	---
	LFSW	Jun-98	NA	NA	NA	NA	---	None[a]	NA
Vanadium	LFSW	Jul-95	4	ND	ND	ND	---	None[a]	---
	LFSW	Oct-95	NA	NA	NA	NA	---	None[a]	NA
	LFSW	Jan-96	4	ND	ND	ND	---	None[a]	---
	LFSW	Apr/May-96	4	1.80	10.50	5.98	RADSW016	None[a]	---
	LFSW	Jun-98	NA	NA	NA	NA	---	None[a]	NA
Zinc	LFSW	Jul-95	4	ND	ND	ND	---	58	0/4
	LFSW	Oct-95	NA	NA	NA	NA	---	58	NA
	LFSW	Jan-96	4	48.00	48.00	48.00	RADSW014	58	0/4
	LFSW	Apr/May-96	4	11.80	35.00	24.07	RADSW016	58	0/4
	LFSW	Jun-98	NA	NA	NA	NA	---	58	NA
Total BHC	LFSW	Jul-95	4	0.10	0.10	0.10	RADSW014	None[a]	---
	LFSW	Oct-95	NA	NA	NA	NA	---	None[a]	NA
	LFSW	Jan-96	4	0.10	0.10	0.10	RADSW014	None[a]	---
	LFSW	Apr/May-96	4	0.10	0.10	0.10	RADSW014	None[a]	---
	LFSW	Jun-98	NA	NA	NA	NA	---	None[a]	NA
Total Chlordanes	LFSW	Jul-95	4	0.05	0.05	0.05	RADSW014	0.004	4/4
	LFSW	Oct-95	NA	NA	NA	NA	---	0.004	NA
	LFSW	Jan-96	4	0.05	0.05	0.05	RADSW014	0.004	4/4
	LFSW	Apr/May-96	4	0.05	0.05	0.05	RADSW014	0.004	4/4
	LFSW	Jun-98	NA	NA	NA	NA	---	0.004	NA
Total DDTs	LFSW	Jul-95	4	0.15	0.15	0.15	RADSW014	None[a]	---
	LFSW	Oct-95	NA	NA	NA	NA	---	None[a]	NA
	LFSW	Jan-96	4	0.15	0.15	0.15	RADSW014	None[a]	---
	LFSW	Apr/May-96	4	0.15	0.15	0.15	RADSW014	None[a]	---
	LFSW	Jun-98	NA	NA	NA	NA	---	None[a]	NA

TABLE 6-2

TIDAL AREA LANDFILL, SUMMARY OF CHEMICALS IN SURFACE WATER COMPARED TO SCREENING VALUES
TIDAL AREA QEA, NWS SBD CONCORD

Analyte	Unit	Quarter Sampled	Total Number of Samples	Minimum Concentration Detected	Maximum Concentration Detected	Mean Concentration Detected	Location of Maximum Detection	Concord Tidal Area QEA Screening Value	Number of Samples that Exceed the Screening Value
CLP Pesticides (all values in μg/L)									
Total PCBs	LFSW	Jul-95	4	1.75	1.75	1.75	RADSW014	None[a]	---
	LFSW	Oct-95	NA	NA	NA	NA	---	None[a]	NA
	LFSW	Jan-96	4	1.75	1.75	1.75	RADSW014	None[a]	---
	LFSW	Apr/May-96	4	1.75	1.75	1.75	RADSW014	None[a]	---
	LFSW	Jun-98	NA	NA	NA	NA	---	None[a]	NA
CLP SVOAs (all values in μg/L)									
Total HMW PAHs	LFSW	Jul-95	4	50.00	50.00	50.00	RADSW014	None[a]	---
	LFSW	Oct-95	NA	NA	NA	NA	—	None[a]	NA
	LFSW	Jan-96	4	50.00	200.00	87.50	RADSW016	None[a]	---
	LFSW	Apr/May-96	4	50.00	50.00	50.00	RADSW014	None[a]	---
	LFSW	Jun-98	NA	NA	NA	NA	—	None[a]	NA
Total LMW PAHs	LFSW	Jul-95	4	35.00	35.00	35.00	RADSW014	None[a]	---
	LFSW	Oct-95	NA	NA	NA	NA	---	None[a]	NA
	LFSW	Jan-96	4	35.00	350.00	113.75	RADSW016	None[a]	---
	LFSW	Apr/May-96	4	35.00	35.00	35.00	RADSW014	None[a]	---
	LFSW	Jun-98	NA	NA	NA	NA	---	None[a]	NA
Total PAHs	LFSW	Jul-95	4	85.00	85.00	85.00	RADSW014	15	4/4
	LFSW	Oct-95	NA	NA	NA	NA	---	15	NA
	LFSW	Jan-96	4	85.00	550.00	201.25	RADSW016	15	4/4
	LFSW	Apr/May-96	4	85.00	85.00	85.00	RADSW014	15	4/4
	LFSW	Jun-98	NA	NA	NA	NA	---	15	NA

Notes: For all surface water screening values please refer to Table 5-2.

BHC Hexachlorocyclohexane
CLP Contract laboratory program
DDT Dichlorodiphenyltrichloroethane
HMW High molecular weight
LMW Low molecular weight
NA Not analyzed
ND Not detected
PAH Polynuclear aromatic hydrocarbon
PCB Polychlorinated biphenyl
SVOA Semivolatile organic analyte
VOA Volatile organic analyte
μg/L Microgram per liter

a No screening value is available
--- Not applicable

TABLE 6-3

R AREA - TERRESTRIAL UNIT
SUMMARY OF CHEMICALS IN SOIL AND SEDIMENT COMPARED TO SCREENING VALUES
TIDAL AREA QEA, NWS SBD CONCORD

Analyte	Depth[a]	Number of Samples Collected[b]	Number of Nondetect Results	Maximum Detected Conc.[b]	Location of Maximum Detection	Top Depth of Sample (ft. bgs)	Tidal Area Ambient Value (99UCL)[c]	SF Bay Ambient Value[d]	ER-L[e]	ER-M[e]	Number of Samples that Exceed Tidal Area Ambient Value[f]	Number of Samples that Exceed SF Bay Ambient Value[f]	Number of Samples that Exceed ER-L[f]	Number of Samples that Exceed ER-M[f]
Inorganic Chemicals (mg/kg)														
Aluminum	Surface	94	0	33,700	RADSBF05	0.0	27,300	NA	NA	NA	9/94	NA	NA	NA
	Subsurface	5	0	17,500	RADSBB04	4.0	27,300	NA	NA	NA	0/5	NA	NA	NA
Antimony	Surface	94	27	5.6	RADSB008	0.0	2.2	NA	2.0	25	9/94	NA	13/94	0/94
	Subsurface	5	5	ND	ND	ND	2.2	NA	2.0	25	ND	ND	ND	ND
Arsenic	Surface	94	0	42	RADSBJ04	0.0	27	15.3	8.2	70	5/94	24/94	66/94	0/94
	Subsurface	5	0	25.7	RADSBG08	4.0	27	15.3	8.2	70	0/5	1/5	3/5	0/5
Barium	Surface	94	0	7,705	RADSBE07	0.0	530	NA	NA	NA	1/94	NA	NA	NA
	Subsurface	5	0	114	RADSBJ02	4.7	530	NA	NA	NA	0/5	NA	NA	NA
Beryllium	Surface	94	78	0.57	RADSB025	0.0	0.18	NA	NA	NA	10/94	NA	NA	NA
	Subsurface	5	5	ND	ND	ND	0.18	NA	NA	NA	ND	ND	ND	ND
Cadmium	Surface	94	91	0.83	RADSBD05	0.0	1.9	0.33	1.2	9.6	0/94	3/94	0/94	0/94
	Subsurface	5	5	ND	ND	ND	1.9	0.33	1.2	9.6	ND	ND	ND	ND
Chromium	Surface	94	5	101	RADSBE03	0.0	82.1	112	81	370	11/94	0/94	12/94	0/94
	Subsurface	5	1	69.2	RADSBD06	4.5	82.1	112	81	370	0/5	0/5	0/5	0/5
Cobalt	Surface	94	0	108	RADSBH06	1.5	36	NA	NA	NA	2/94	NA	NA	NA
	Subsurface	5	0	11.6	RADSBG04	4.5	36	NA	NA	NA	0/5	NA	NA	NA
Copper	Surface	94	0	87.8	RADSBE07	0.0	81	68.1	34	270	2/94	12/94	66/94	0/94
	Subsurface	5	0	29.1	RADSBD06	4.5	81	68.1	34	270	0/5	0/5	0/5	0/5
Lead	Surface	94	0	1,160	RADSBG08	0.7	95	43.2	46.7	218	18/94	53/94	47/94	5/94
	Subsurface	5	0	11.8	RADSBG08	4.0	95	43.2	46.7	218	0/5	0/5	0/5	0/5
Manganese	Surface	94	0	6,300	RADSBI08	1.5	1,500	NA	NA	NA	1/94	NA	NA	NA
	Subsurface	5	0	1,450	RADSBJ02	4.7	1,500	NA	NA	NA	0/5	NA	NA	NA
Mercury	Surface	94	20	0.58	RADSB012	0.0	0.32	0.43	0.15	0.71	13/94	4/94	36/94	0/94
	Subsurface	5	4	0.07	RADSBJ02	4.7	0.32	0.43	0.15	0.71	0/5	0/5	0/5	0/5
Molybdenum	Surface	94	67	17.8	RADSBH06	1.5	6.6	NA	NA	NA	2/94	NA	NA	NA
	Subsurface	5	1	6.2	RADSBG08	4.0	6.6	NA	NA	NA	0/5	NA	NA	NA
Nickel	Surface	94	0	242	RADSBH06	1.5	120	112	20.9	51.6	4/94	6/94	94/94	85/94
	Subsurface	5	0	58.9	RADSBB04	4.0	120	112	20.9	51.6	0/5	0/5	5/5	1/5
Selenium[g]	Surface	94	92	1.3	RADSB029	0.0	NA	0.64	0.70	1.40	NA	2/94	2/94	0/94
	Subsurface	5	4	2.8	RADSBG08	4.0	NA	0.64	0.70	1.40	NA	1/5	1/5	1/5
Silver	Surface	94	86	0.72	RADSBE07	0.0	NA	0.58	1.0	3.7	2/94	2/94	0/94	0/94
	Subsurface	5	5	ND	ND	ND	NA	0.58	1.0	3.7	ND	ND	ND	ND
Thallium	Surface	94	85	5.4	RADSBI08	1.5	2.2	NA	NA	NA	2/94	NA	NA	NA
	Subsurface	5	4	0.74	RADSBJ02	4.7	2.2	NA	NA	NA	0/5	NA	NA	NA
Vanadium	Surface	94	0	130	RADSBE03	0.0	96	NA	NA	NA	4/94	NA	NA	NA
	Subsurface	5	0	82.7	RADSBG04	4.5	96	NA	NA	NA	0/5	NA	NA	NA
Zinc	Surface	94	0	959	RADSB017	0.0	264	158	150	410	5/94	25/94	27/94	2/94
	Subsurface	5	0	72.2	RADSBB04	4.0	264	158	150	410	0/5	0/5	0/5	0/5
Low Detection Limit PCBs (µg/kg)														
PCB-8 (2,4')	Surface	54	39	3.7	RADSBF02	0.0	NA	NA	NA	NA	NA	NA	NA	NA
PCB-18 (2,2',5)	Surface	54	48	0.39	RADSBH02	0.0	NA	NA	NA	NA	NA	NA	NA	NA
PCB-28 (2,4,4')	Surface	54	52	0.48	RADSBI01	0.0	NA	NA	NA	NA	NA	NA	NA	NA
PCB-44 (2,2',3,5')	Surface	54	51	0.28	RADSBD06	0.0	NA	NA	NA	NA	NA	NA	NA	NA
PCB-52 (2,2',5,5')	Surface	54	43	0.33	RADSBG06	0.0	NA	NA	NA	NA	NA	NA	NA	NA
PCB-66 (2,3',4,4')	Surface	54	41	1.0	RADSBL03	0.0	NA	NA	NA	NA	NA	NA	NA	NA

TABLE 6-3

R AREA - TERRESTRIAL UNIT
SUMMARY OF CHEMICALS IN SOIL AND SEDIMENT COMPARED TO SCREENING VALUES
TIDAL AREA QEA, NWS SBD CONCORD

Analyte	Depth[a]	Number of Samples Collected[b]	Number of Nondetect Results	Maximum Detected Conc.[b]	Location of Maximum Detection	Top Depth of Sample (ft. bgs)	Tidal Area Ambient Value (99UCL)[c]	SF Bay Ambient Value[d]	ER-L[e]	ER-M[e]	Number of Samples that Exceed Tidal Area Ambient Value[f]	Number of Samples that Exceed SF Bay Ambient Value[f]	Number of Samples that Exceed ER-L[f]	Number of Samples that Exceed ER-M[f]
Low Detection Limit PCBs (µg/kg) (Continued)														
PCB-77 (3,3',4,4')	Surface	54	40	1.3	RADSBE03	0.0	NA	NA	NA	NA	NA	NA	NA	NA
PCB-101 (2,2',3,5,5')	Surface	54	35	1.00	RADSBD05	0.0	NA	NA	NA	NA	NA	NA	NA	NA
PCB-105 (2,3,3',4,4')	Surface	54	38	1.2	RADSBL03	0.0	NA	NA	NA	NA	NA	NA	NA	NA
PCB-118 (2,3',4,4',5)	Surface	54	36	1.3	RADSBL03	0.0	NA	NA	NA	NA	NA	NA	NA	NA
PCB-126 (3,3',4,4',5)	Surface	54	41	3.7	RADSBF03	0.0	NA	NA	NA	NA	NA	NA	NA	NA
PCB-128 (2,2',3,3',4,4')	Surface	54	47	0.58	RADSBC05	0.0	NA	NA	NA	NA	NA	NA	NA	NA
PCB-138 (2,2',3,4,4',5')	Surface	54	31	1.7	RADSBC05	0.0	NA	NA	NA	NA	NA	NA	NA	NA
PCB-153 (2,2',4,4',5,5')	Surface	54	33	1.8	RADSBL03	0.0	NA	NA	NA	NA	NA	NA	NA	NA
PCB-170 (2,2',3,3',4,4',5)	Surface	54	49	0.9	RADSBL03	0.0	NA	NA	NA	NA	NA	NA	NA	NA
PCB-180 (2,2',3,4,4',5,5')	Surface	54	39	1.9	RADSBL03	0.0	NA	NA	NA	NA	NA	NA	NA	NA
PCB-187 (2,2',3,4',5,5',6)	Surface	54	41	0.77	RADSBL03	0.0	NA	NA	NA	NA	NA	NA	NA	NA
PCB-195 (2,2',3,3',4,4',5,6)	Surface	54	51	0.39	RADSBF08	0.0	NA	NA	NA	NA	NA	NA	NA	NA
PCB-206 (2,2',3,3',4,4',5,5',)	Surface	54	37	1.1	RADSBL03	0.0	NA	NA	NA	NA	NA	NA	NA	NA
PCB-209 (2,2',3,3',4,4',5,5',6)	Surface	54	52	0.38	RADSBL03	0.0	NA	NA	NA	NA	NA	NA	NA	NA
Total PCBs	Surface	54	0	14.055	RADSBL03	0.0	NA	14.8	22.7	180	NA	0/54	0/54	0/54
CLP PCBs (µg/kg)														
Total PCBs	Surface	15	0	565	RADSBE03	1.5	NA	14.8	22.7	180	NA	15/15	15/15	10/15
	Subsurface	5	0	520	RADSBB04	4.0	NA	14.8	22.7	180	NA	5/5	5/5	4/5
Low Detection Limit Pesticides (µg/kg)														
2,4'-DDD	Surface	54	30	6.5	RADSB010	0.0	NA	NA	NA	NA	NA	NA	NA	NA
2,4'-DDE	Surface	54	40	1.2	RADSB011	0.0	NA	NA	NA	NA	NA	NA	NA	NA
2,4'-DDT	Surface	54	23	5.0	RADSB011	0.0	NA	NA	NA	NA	NA	NA	NA	NA
4,4'-DDD	Surface	54	22	26	RADSB011	0.0	NA	NA	2.0	20	NA	NA	11/54	1/54
4,4'-DDE	Surface	54	9	8.7	RADSB010	0.0	NA	NA	2.2	27	NA	NA	8/54	0/54
4,4'-DDT	Surface	54	16	28	RADSB011	0.0	NA	NA	1.0	7.0	NA	NA	22/54	6/54
Total DDTs	Surface	54	0	73.2	RADSB011	0.0	NA	7.0	1.58	46.1	NA	15/54	36/54	2/54
Aldrin	Surface	54	44	0.75	RADSBH07	0.0	NA	NA	NA	NA	NA	NA	NA	NA
gamma-BHC (Lindane)	Surface	54	47	0.89	RADSBG04	0.0	NA	NA	NA	NA	NA	NA	NA	NA
Total BHCs	Surface	54	0	0.89	RADSBG04	0.0	NA	0.78	NA	NA	NA	1/54	NA	NA
alpha-Chlordane	Surface	54	26	2.5	RADSBD05	0.0	NA	NA	NA	NA	NA	NA	NA	NA
Total Chlordanes	Surface	54	0	2.5	RADSBD05	0.0	NA	1.1	0.5	6.0	NA	7/54	16/54	0/54
Dieldrin	Surface	54	38	2.0	RADSB011	0.0	NA	0.44	0.02	8.0	NA	10/54	16/54	0/54
Heptachlor	Surface	54	52	0.43	RADSBC05	0.0	NA	NA	NA	NA	NA	NA	NA	NA
Heptachlor Epoxide	Surface	54	46	0.95	RADSBI02	0.0	NA	NA	NA	NA	NA	NA	NA	NA
Hexachlorobenzene	Surface	54	36	1.6	RADSB011	0.0	NA	0.48	NA	NA	NA	7/54	NA	NA
Mirex	Surface	54	41	1.3	RADSB011	0.0	NA	NA	NA	NA	NA	NA	NA	NA
trans-Nonachlor	Surface	54	28	2.4	RADSBH06	0.0	NA	NA	NA	NA	NA	NA	NA	NA
CLP Pesticides (µg/kg)														
Total DDTs	Surface	15	0	21	RADSBE03	1.5	NA	7.0	1.58	46.1	NA	10/15	15/15	0/15
	Subsurface	5	0	19.5	RADSBB04	4.0	NA	7.0	1.58	46.1	NA	4/5	5/5	0/5
Total BHCs	Surface	15	0	14.4	RADSBE03	1.5	NA	0.78	NA	NA	NA	15/15	NA	NA
	Subsurface	5	0	12.8	RADSBB04	4.0	NA	0.78	NA	NA	NA	5/5	NA	NA
Total Chlordanes	Surface	15	0	7.2	RADSBE03	1.5	NA	1.1	0.5	6.0	NA	15/15	15/15	1/15
	Subsurface	5	0	6.4	RADSBB04	4.0	NA	1.1	0.5	6.0	NA	5/5	5/5	1/5

TABLE 6-3

R AREA - TERRESTRIAL UNIT
SUMMARY OF CHEMICALS IN SOIL AND SEDIMENT COMPARED TO SCREENING VALUES
TIDAL AREA QEA, NWS SBD CONCORD

Analyte	Depth[a]	Number of Samples Collected[b]	Number of Nondetect Results	Maximum Detected Conc.[b]	Location of Maximum Detection	Top Depth of Sample (ft. bgs)	Tidal Area Ambient Value (99UCL)[c]	SF Bay Ambient Value[d]	ER-L[e]	ER-M[e]	Number of Samples that Exceed Tidal Area Ambient Value[f]	Number of Samples that Exceed SF Bay Ambient Value[f]	Number of Samples that Exceed ER-L[f]	Number of Samples that Exceed ER-M[f]
Low Detection Level SVOAs (µg/kg)														
1-Methylphenanthrene	Surface	54	53	37	RADSB007	0.0	NA	31.7	NA	NA	NA	1/54	NA	NA
2,4-Dimethylphenol	Surface	54	53	24	RADSBI04	0.0	NA	NA	NA	NA	NA	NA	NA	NA
4-Methylphenol	Surface	54	52	280	RADSBB04	0.0	NA	NA	NA	NA	NA	NA	NA	NA
Acenaphthene	Surface	54	52	18	RADSB008	0.0	NA	26.6	16	500	NA	0/54	1/54	0/54
Anthracene	Surface	54	52	100	RADSB007	0.0	NA	88	85.3	1,100	NA	1/54	1/54	0/54
Benzo(a)anthracene	Surface	54	47	440	RADSB007	0.0	NA	244	261	1,600	NA	2/54	2/54	0/54
Benzo(a)pyrene	Surface	54	46	320	RADSB007	0.0	NA	412	430	1,600	NA	0/54	0/54	0/54
Benzo(b)fluoranthene	Surface	54	45	390	RADSB008	0.0	NA	371	NA	NA	NA	1/54	NA	NA
Benzo(e)pyrene	Surface	54	47	230	RADSB007	0.0	NA	294	NA	NA	NA	0/54	NA	NA
Benzo(g,h,i)perylene	Surface	54	47	220	RADSB007	0.0	NA	310	NA	NA	NA	0/54	NA	NA
Benzo(k)fluoranthene	Surface	54	48	320	RADSB007	0.0	NA	258	NA	NA	NA	2/54	NA	NA
Benzoic Acid	Surface	54	42	920	RADSBE03	0.0	NA	NA	NA	NA	NA	NA	NA	NA
Bis(2-ethylhexyl)phthalate	Surface	54	52	180	RADSB011	0.0	NA	NA	NA	NA	NA	NA	NA	NA
Carbazole	Surface	54	52	40	RADSB007	0.0	NA	NA	NA	NA	NA	NA	NA	NA
Chrysene	Surface	54	43	440	RADSB007	0.0	NA	289	384	2,800	NA	2/54	2/54	0/54
Dibenz(a,h)anthracene	Surface	54	49	94	RADSB007	0.0	NA	32.7	63.4	260	NA	4/54	2/54	0/54
Dibenzothiophene	Surface	54	53	23	RADSB007	0.0	NA	NA	NA	NA	NA	NA	NA	NA
Diethylphthalate	Surface	54	53	160	RADSB011	0.0	NA	NA	NA	NA	NA	NA	NA	NA
Fluoranthene	Surface	54	42	1,100	RADSB007	0.0	NA	514	600	5,100	NA	2/54	2/54	0/54
Indeno(1,2,3-cd)pyrene	Surface	54	47	190	RADSB007	0.0	NA	382	NA	NA	NA	0/54	NA	NA
Isophorone	Surface	54	53	38	RADSBI04	0.0	NA	NA	NA	NA	NA	NA	NA	NA
Naphthalene	Surface	54	53	18	RADSB008	0.0	NA	55.8	160	2,100	NA	0/54	5/54	0/54
Perylene	Surface	54	50	95	RADSB008	0.0	NA	145	NA	NA	NA	0/54	NA	NA
Phenanthrene	Surface	54	47	660	RADSB007	0.0	NA	237	240	1,500	NA	2/54	2/54	0/54
Pyrene	Surface	54	43	680	RADSB007	0.0	NA	665	665	2,600	NA	1/54	1/54	0/54
Total HMW PAHs	Surface	54	0	4,481	RADSB007	0.0	NA	3,060	1,700	9,600	NA	3/54	0/54	0/54
Total LMW PAHs	Surface	54	0	2,835	RADSBB04	0.0	NA	434	552	3,160	NA	23/54	18/54	0/54
Total PAHs	Surface	54	0	6,615	RADSBB04	0.0	NA	3,390	4,022	44,792	NA	6/54	4/54	0/54
CLP SVOAs (µg/kg)														
Acenaphthene	Surface	15	14	660	RADSBG08	0.7	NA	26.6	16	500	NA	1/15	1/15	1/15
Anthracene	Surface	15	14	1,200	RADSBG08	0.7	NA	88	85.3	1,100	NA	1/15	1/15	1/15
Benzo(a)anthracene	Surface	15	13	2,000	RADSBG08	0.7	NA	244	261	1,600	NA	2/15	2/15	1/15
Benzo(a)pyrene	Surface	15	14	1,500	RADSBG08	0.7	NA	412	430	1,600	NA	1/15	1/15	0/15
Benzo(b)fluoranthene	Surface	15	13	2,300	RADSBG08	0.7	NA	371	NA	NA	NA	1/15	NA	NA
Benzo(g,h,i)perylene	Surface	15	14	520	RADSBG08	0.7	NA	310	NA	NA	NA	1/15	NA	NA
Benzo(k)fluoranthene	Surface	15	14	820	RADSBG08	0.7	NA	258	NA	NA	NA	1/15	NA	NA
Carbazole	Surface	15	14	1,100	RADSBG08	0.7	NA	NA	NA	NA	NA	NA	NA	NA
Chrysene	Surface	15	13	1,800	RADSBG08	0.7	NA	289	384	2,800	NA	2/15	1/15	0/15
Dibenzofuran	Surface	15	14	500	RADSBG08	0.7	NA	NA	NA	NA	NA	NA	NA	NA
Fluoranthene	Surface	15	13	5,000	RADSBG08	0.7	NA	514	600	5,100	NA	2/15	2/15	0/15
Fluorene	Surface	15	14	600	RADSBG08	0.7	NA	25.3	19	540	NA	1/15	1/15	1/15
Indeno(1,2,3-cd)pyrene	Surface	15	14	530	RADSBG08	0.7	NA	382	NA	NA	NA	1/15	NA	NA
Naphthalene	Surface	15	14	300	RADSBG08	0.7	NA	55.8	160	2,100	NA	1/15	1/15	0/15
Phenanthrene	Surface	15	13	5,900	RADSBG08	0.7	NA	237	240	1,500	NA	2/15	2/15	1/15
Phenol	Surface	15	13	600	RADSBH06	1.5	NA	NA	NA	NA	NA	NA	NA	NA
Pyrene	Surface	15	13	4,300	RADSBG08	0.7	NA	665	665	2,600	NA	1/15	1/15	1/15

TABLE 6-3

R AREA - TERRESTRIAL UNIT
SUMMARY OF CHEMICALS IN SOIL AND SEDIMENT COMPARED TO SCREENING VALUES
TIDAL AREA QEA, NWS SBD CONCORD

Analyte	Depth[a]	Number of Samples Collected[b]	Number of Nondetect Results	Maximum Detected Conc.[b]	Location of Maximum Detection	Top Depth of Sample (ft. bgs)	Tidal Area Ambient Value (99UCL)[c]	SF Bay Ambient Value[d]	ER-L[e]	ER-M[e]	Number of Samples that Exceed Tidal Area Ambient Value[f]	Number of Samples that Exceed SF Bay Ambient Value[f]	Number of Samples that Exceed ER-L[f]	Number of Samples that Exceed ER-M[f]
CLP SVOAs (µg/kg) (Continued)														
Total HMW PAHs	Surface	15	0	18,985	RADSBG08	0.7	NA	3,060	1,700	9,600	NA	9/15	14/15	1/15
	Subsurface	5	0	6,500	RADSBB04	4.0	NA	3,060	1,700	9,600	NA	4/5	5/5	0/5
Total LMW PAHs	Surface	15	0	9,090	RADSBG08	0.7	NA	434	552	3,160	NA	15/15	15/15	4/15
	Subsurface	5	0	4,550	RADSBB04	4.0	NA	434	552	3,160	NA	5/5	5/5	2/5
Total PAHs	Surface	15	0	28,075	RADSBG08	0.7	NA	3,390	4,022	44,792	NA	14/15	10/15	0/15
	Subsurface	5	0	11,050	RADSBB04	4.0	NA	3,390	4,022	44,792	NA	5/5	4/5	0/5
CLP VOAs (µg/kg)														
2-Butanone	Surface	15	14	43	RADSBB06	1.2	NA	NA	NA	NA	NA	NA	NA	NA
	Subsurface	5	4	73	RADSBD06	4.5	NA	NA	NA	NA	NA	NA	NA	NA
Carbon Disulfide	Surface	15	14	45	RADSBI08	1.5	NA	NA	NA	NA	NA	NA	NA	NA
	Subsurface	5	2	160	RADSBB04	4.0	NA	NA	NA	NA	NA	NA	NA	NA
Chloromethane	Surface	15	14	14	RADSBH06	1.5	NA	NA	NA	NA	NA	NA	NA	NA

Notes:
Where total values were calculated (for example, total PCBs, total DDTs, etc.) 1/2 of the standard quantitation limit (SQL) was used for Nondetected analytes.

bgs Below ground surface
BHC Hexachlorocyclohexane
CLP Contract Laboratory Program
Conc. Concentration
DDD Dichlorodiphenyldichloroethane
DDE Dichlorodiphenyldichloroethene
DDT Dichlorodiphenyltrichloroethane
ER-L Effects range-low
ER-M Effects range-median
ft. feet
HMW High molecular weight
LMW Low molecular weight
mg/kg Milligrams per kilogram
NA Screening value not available
ND Nondetected
PAH Polycyclic aromatic hydrocarbon
PCB Polychlorinated biphenyl
SVOA Semivolatile organic analyte
UCL Upper confidence limit
µg/kg Micrograms per kilogram
VOA Volatile organic analyte

a Surface samples are those collected between 0 and 3 feet bgs; subsurface samples are those collected greater than 3 feet bgs.
b If more than one sample was analyzed in the surface and subsurface depth ranges, only the highest result from the interval is reported and used in the data set.
c PRC Environmental Management, Inc (PRC). 1996a. "Estimation of Ambient Metals Concentrations in the Tidal Area Soils. Technical Memorandum. Naval Weapons Station, Concord, California." March.
d San Francisco Bay Regional Water Quality Control Board (RWQCB). 1998. "Ambient Concentrations of Toxic Chemicals in Sediments." April.
e National Oceanic and Atmospheric Administration (NOAA). 1991. "The Potential for Biological Effects of Sediment-Sorbed Contaminants Tested in the National Status and Trends Program." Technical Memorandum NOS OMA 52. NOAA, Office of Oceanography and Marine Assessment. Seattle, Washington.
Long, E.R., D. D. MacDonald, S.L. Smith, F.D. Calder. 1995. "Incidence of Adverse Biological Effects Within Ranges of Chemical Concentrations in Marine and Estuarine Sediments." *Environmental Management*. Volume 19. Number 1. Pages 81 through 97.
f Number of samples that exceeded screening value / number of samples
g Detection limits were below screening values for all chemicals except selenium. The median detection limit for selenium exceeded the ER-L value.

TABLE 6-4

R AREA - TERRESTRIAL AND AQUATIC UNIT
SUMMARY OF CHEMICALS IN SOIL AND SEDIMENT COMPARED TO SCREENING VALUES
TIDAL AREA QEA, NWS SBD CONCORD

	Depth[a]	Number of Samples Collected[b]	Number of Nondetect Results	Maximum Detected Conc.[b]	Location of Maximum Detection	Top Depth of Sample (ft. bgs)	Tidal Area Ambient Value (99UCL)[c]	SF Bay Ambient Value[d]	ER-L[e]	ER-M[e]	Number of Samples that Exceed Tidal Area Ambient Value[f]	Number of Samples that Exceed SF Bay Ambient Value[f]	Number of Samples that Exceed ER-L[f]	Number of Samples that Exceed ER-M[f]
Inorganic Constituents (mg/kg)														
Aluminum	Surface	3	0	16,800	RADSBN08	0.0	27300	NA	NA	NA	0/3	NA	NA	NA
Antimony	Surface	3	1	0.87	RADSBN08	0.0	2.2	NA	2.0	25	0/3	NA	0/3	0/3
Arsenic	Surface	3	0	25.1	RADSB013	0.0	27	15.3	8.2	70	0/3	1/3	1/3	0/3
Barium	Surface	3	0	174	RADSB027	0.0	530	NA	NA	NA	0/3	NA	NA	NA
Beryllium	Surface	3	3	ND	ND	ND	0.18	NA	NA	NA	ND	ND	ND	ND
Cadmium	Surface	3	3	ND	ND	ND	1.9	0.33	1.2	9.6	ND	ND	ND	ND
Chromium	Surface	3	0	65.5	RADSB013	0.0	82.1	112	81	370	0/3	0/3	0/3	0/3
Cobalt	Surface	3	0	21.9	RADSB013	0.0	36	NA	NA	NA	0/3	NA	NA	NA
Copper	Surface	3	0	55.3	RADSB013	0.0	81	68.1	34	270	0/3	0/3	1/3	0/3
Lead	Surface	3	0	41	RADSB013	0.0	95	43.2	46.7	218	0/3	0/3	0/3	0/3
Manganese	Surface	3	0	859	RADSBN08	0.0	1,500	NA	NA	NA	0/3	NA	NA	NA
Mercury	Surface	3	3	ND	ND	ND	0.32	0.43	0.15	0.71	ND	ND	ND	ND
Molybdenum	Surface	3	3	ND	ND	ND	6.6	NA	NA	NA	ND	ND	ND	ND
Nickel	Surface	3	0	89.7	RADSB013	0.0	120	112	20.9	51.6	0/3	0/3	3/3	2/3
Selenium[g]	Surface	3	3	ND	ND	ND	NA	0.64	0.70	1.40	ND	ND	ND	ND
Silver	Surface	3	3	ND	ND	ND	NA	0.58	1.0	3.7	ND	ND	ND	ND
Thallium	Surface	3	3	ND	ND	ND	2.2	NA	NA	NA	ND	ND	ND	ND
Vanadium	Surface	3	0	94.7	RADSB013	0.0	96	NA	NA	NA	0/3	NA	NA	NA
Zinc	Surface	3	0	424	RADSB013	0.0	264	158	150	410	1/3	1/3	1/3	1/3
Low Detection Limit PCBs (µg/kg)														
PCB-18 (2,2',5)	Surface	1	0	0.13	RADSB013	0.0	NA	NA	NA	NA	NA	NA	NA	NA
PCB-52 (2,2',5,5')	Surface	1	0	0.18	RADSB013	0.0	NA	NA	NA	NA	NA	NA	NA	NA
PCB-66 (2,3',4,4')	Surface	1	0	0.24	RADSB013	0.0	NA	NA	NA	NA	NA	NA	NA	NA
PCB-101 (2,2',3,5,5')	Surface	1	0	0.23	RADSB013	0.0	NA	NA	NA	NA	NA	NA	NA	NA
PCB-105 (2,3,3',4,4')	Surface	1	0	0.27	RADSB013	0.0	NA	NA	NA	NA	NA	NA	NA	NA
PCB-118 (2,3',4,4',5)	Surface	1	0	0.32	RADSB013	0.0	NA	NA	NA	NA	NA	NA	NA	NA
PCB-138 (2,2',3,4,4',5')	Surface	1	0	0.58	RADSB013	0.0	NA	NA	NA	NA	NA	NA	NA	NA
PCB-153 (2,2',4,4',5,5')	Surface	1	0	0.45	RADSB013	0.0	NA	NA	NA	NA	NA	NA	NA	NA
PCB-180 (2,2',3,4,4',5,5')	Surface	1	0	0.41	RADSB013	0.0	NA	NA	NA	NA	NA	NA	NA	NA
PCB-206 (2,2',3,3',4,4',5,5')	Surface	1	0	0.22	RADSB013	0.0	NA	NA	NA	NA	NA	NA	NA	NA
Total PCBs	Surface	1	0	3.73	RADSB013	0.0	NA	14.8	22.7	180	NA	0/1	0/1	0/1
Low Detection Limit Pesticides (µg/kg)														
2,4'-DDD	Surface	1	0	0.72	RADSB013	0.0	NA	NA	NA	NA	NA	NA	NA	NA
4,4'-DDE	Surface	1	0	0.72	RADSB013	0.0	NA	NA	2.2	27	NA	NA	0/1	0/1
Total DDTs	Surface	1	0	1.72	RADSB013	0.0	NA	7.0	1.58	46.1	NA	0/1	1/1	0/1
Aldrin	Surface	1	0	0.32	RADSB013	0.0	NA	NA	NA	NA	NA	NA	NA	NA
Total BHCs	Surface	1	0	0.07	RADSB013	0.0	NA	0.78	NA	NA	NA	0/1	NA	NA
alpha-Chlordane	Surface	1	0	2.3	RADSB013	0.0	NA	NA	NA	NA	NA	NA	NA	NA
Total Chlordanes	Surface	1	0	2.3	RADSB013	0.0	NA	1.1	0.5	6.0	NA	1/1	1/1	0/1
Dieldrin	Surface	1	0	0.37	RADSB013	0.0	NA	0.44	0.02	8.0	NA	0/1	1/1	0/1
Hexachlorobenzene	Surface	1	0	0.21	RADSB013	0.0	NA	0.48	NA	NA	NA	0/1	NA	NA
Mirex	Surface	1	0	0.33	RADSB013	0.0	NA	NA	NA	NA	NA	NA	NA	NA
trans-Nonachlor	Surface	1	0	1.9	RADSB013	0.0	NA	NA	NA	NA	NA	NA	NA	NA

TABLE 6-4

R AREA - TERRESTRIAL AND AQUATIC UNIT
SUMMARY OF CHEMICALS IN SOIL AND SEDIMENT COMPARED TO SCREENING VALUES
TIDAL AREA QEA, NWS SBD CONCORD

	Depth[a]	Number of Samples Collected[b]	Number of Nondetect Results	Maximum Detected Conc.[b]	Location of Maximum Detection	Top Depth of Sample (ft. bgs)	Tidal Area Ambient Value (99UCL)[c]	SF Bay Ambient Value[d]	ER-L[e]	ER-M[e]	Number of Samples that Exceed Tidal Area Ambient Value[f]	Number of Samples that Exceed SF Bay Ambient Value[f]	Number of Samples that Exceed ER-L[f]	Number of Samples that Exceed ER-M[f]
Low Detection Level SVOAs (µg/kg)														
Benzo(a)anthracene	Surface	1	0	89	RADSB013	0.0	NA	244	261	1,600	NA	0/1	0/1	0/1
Benzo(a)pyrene	Surface	1	0	97	RADSB013	0.0	NA	412	430	1,600	NA	0/1	0/1	0/1
Benzo(b)fluoranthene	Surface	1	0	200	RADSB013	0.0	NA	371	NA	NA	NA	0/1	NA	NA
Benzo(e)pyrene	Surface	1	0	110	RADSB013	0.0	NA	294	NA	NA	NA	0/1	NA	NA
Benzo(g,h,i)perylene	Surface	1	0	110	RADSB013	0.0	NA	310	NA	NA	NA	0/1	NA	NA
Benzo(k)fluoranthene	Surface	1	0	84	RADSB013	0.0	NA	258	NA	NA	NA	0/1	NA	NA
Chrysene	Surface	1	0	180	RADSB013	0.0	NA	289	384	2,800	NA	0/1	0/1	0/1
Fluoranthene	Surface	1	0	220	RADSB013	0.0	NA	514	600	5,100	NA	0/1	0/1	0/1
Indeno(1,2,3-cd)pyrene	Surface	1	0	92	RADSB013	0.0	NA	382	NA	NA	NA	0/1	NA	NA
Phenanthrene	Surface	1	0	120	RADSB013	0.0	NA	237	240	1,500	NA	0/1	0/1	0/1
Pyrene	Surface	1	0	190	RADSB013	0.0	NA	665	665	2,600	NA	0/1	0/1	0/1
Total HMW PAHs	Surface	1	0	1,832	RADSB013	0.0	NA	3,060	1,700	9,600	NA	0/1	1/1	0/1
Total LMW PAHs	Surface	1	0	1,960	RADSB013	0.0	NA	434	552	3,160	NA	1/1	1/1	0/1
Total PAHs	Surface	1	0	3,792	RADSB013	0.0	NA	3,390	4,022	44,792	NA	1/1	0/1	0/1

Notes:
Where total values were calculated (for example, total PCBs, total DDTs, etc.) 1/2 of the standard quantitation limit (SQL) was used for Nondetected analytes.

bgs Below ground surface
BHC Hexachlorocyclohexane
CLP Contract Laboratory Program
Conc. Concentration
DDD Dichlorodiphenyldichloroethane
DDE Dichlorodiphenyldichloroethene
DDT Dichlorodiphenyltrichloroethane
ER-L Effects range-low
ER-M Effects range-median
ft. feet
HMW High molecular weight
LMW Low molecular weight
mg/kg Milligrams per kilogram
NA Screening value not available
ND Nondetected
PAH Polycyclic aromatic hydrocarbon
PCB Polychlorinated biphenyl
SVOA Semivolatile organic analyte
UCL Upper confidence limit
µg/kg Micrograms per kilogram
VOA Volatile organic analyte

a Surface samples are those collected between 0 and 3 feet bgs; subsurface samples are those collected greater than 3 feet bgs.
b If more than one sample was analyzed in the surface and subsurface depth ranges, only the highest result from the interval is reported and used in the data set.
c PRC Environmental Management, Inc (PRC). 1996a. "Estimation of Ambient Metals Concentrations in the Tidal Area Soils. Technical Memorandum. Naval Weapons Station, Concord, California." March.
d San Francisco Bay Regional Water Quality Control Board (RWQCB). 1998. "Ambient Concentrations of Toxic Chemicals in Sediments." April.
e National Oceanic and Atmospheric Administration (NOAA). 1991. "The Potential for Biological Effects of Sediment-Sorbed Contaminants Tested in the National Status and Trends Program." Technical Memorandum NOS OMA 52. NOAA, Office of Oceanography and Marine Assessment. Seattle, Washington.
Long, E.R., D. D. MacDonald, S.L. Smith, F.D. Calder. 1995. "Incidence of Adverse Biological Effects Within Ranges of Chemical Concentrations in Marine and Estuarine Sediments." *Environmental Management*. Volume 19. Number 1. Pages 81 through 97.
f Number of samples that exceeded screening value / number of samples
g Detection limits were below screening values for all chemicals except selenium. The median detection limit for selenium exceeded the ER-L value.

TABLE 6-5

R AREA DISPOSAL SITE, SUMMARY OF CHEMICALS IN SURFACE WATER COMPARED TO SCREENING VALUES
TIDAL AREA QEA, NWS SBD CONCORD

Analyte	Unit	Quarter Sampled	Total Number of Samples	Minimum Concentration Detected	Maximum Concentration Detected	Mean Concentration Detected	Location of Maximum Detection	Concord Tidal Area QEA Screening Value	Number of Samples that Exceed the Screening Value
Inorganic Chemicals (all values in µg/L)									
Aluminum	RASW	Jul-95	4	678.00	5,570.00	3,124.00	RADSW010	87	2/4
	RASW	Oct-95	NA	NA	NA	NA	---	87	NA
	RASW	Jan-96	7	141.00	682.00	366.33	RADSW012	87	6/7
	RASW	Apr/May-96	4	84.20	704.00	283.05	RADSW010	87	3/4
	RASW	Jun-98	NA	NA	NA	NA	---	87	NA
Arsenic	RASW	Jul-95	4	22.00	23.90	22.95	RADSW011	36	0/4
	RASW	Oct-95	NA	NA	NA	NA	---	36	NA
	RASW	Jan-96	7	1.50	3.60	2.60	RADSW008	36	0/7
	RASW	Apr/May-96	4	5.10	22.90	10.00	RADSW010	36	0/4
	RASW	Jun-98	NA	NA	NA	NA	---	36	NA
Barium	RASW	Jul-95	4	22.90	133.00	86.23	RADSW011	None[a]	---
	RASW	Oct-95	NA	NA	NA	NA	—	None[a]	NA
	RASW	Jan-96	7	39.80	87.80	51.49	RADSW010	None[a]	---
	RASW	Apr/May-96	4	50.00	114.00	80.20	RADSW010	None[a]	---
	RASW	Jun-98	NA	NA	NA	NA	---	None[a]	NA
Cadmium	RASW	Jul-95	4	ND	ND	ND	---	1.1	0/4
	RASW	Oct-95	NA	NA	NA	NA	---	1.1	NA
	RASW	Jan-96	7	1.80	1.80	1.80	RADSW013	1.1	1/7
	RASW	Apr/May-96	4	0.65	8.30	3.54	RADSW010	1.1	3/4
	RASW	Jun-98	NA	NA	NA	NA	---	1.1	NA
Chromium	RASW	Jul-95	4	ND	ND	ND	----	86	0/4
	RASW	Oct-95	NA	NA	NA	NA	---	86	NA
	RASW	Jan-96	7	ND	ND	ND	---	86	0/7
	RASW	Apr/May-96	4	1.40	6.30	3.85	RADSW010	86	0/4
	RASW	Jun-98	NA	NA	NA	NA	---	86	NA
Cobalt	RASW	Jul-95	4	0.51	129.00	51.58	RADSW010	None[a]	---
	RASW	Oct-95	NA	NA	NA	NA	---	None[a]	NA
	RASW	Jan-96	7	14.70	80.40	39.07	RADSW008	None[a]	---
	RASW	Apr/May-96	4	5.10	40.40	23.88	RADSW008	None[a]	---
	RASW	Jun-98	NA	NA	NA	NA	---	None[a]	NA

TABLE 6-5

R AREA DISPOSAL SITE, SUMMARY OF CHEMICALS IN SURFACE WATER COMPARED TO SCREENING VALUES
TIDAL AREA QEA, NWS SBD CONCORD

Analyte	Unit	Quarter Sampled	Total Number of Samples	Minimum Concentration Detected	Maximum Concentration Detected	Mean Concentration Detected	Location of Maximum Detection	Concord Tidal Area QEA Screening Value	Number of Samples that Exceed the Screening Value
Inorganic Chemicals (all values in µg/L) (Continued)									
Copper	RASW	Jul-95	4	10.60	32.00	21.30	RADSW010	3.2	2/4
	RASW	Oct-95	NA	NA	NA	NA	---	3.2	NA
	RASW	Jan-96	7	8.20	17.00	11.95	RADSW008	3.2	6/7
	RASW	Apr/May-96	4	17.90	17.90	17.90	RADSW010	3.2	1/4
	RASW	Jun-98	NA	NA	NA	NA	---	3.2	NA
Iron	RASW	Jul-95	4	601	239,000	84,600	RADSW010	None[a]	---
	RASW	Oct-95	NA	NA	NA	NA	---	None[a]	NA
	RASW	Jan-96	7	755	10,900	5,191	RADSW008	None[a]	---
	RASW	Apr/May-96	4	6,770	221,000	77,568	RADSW010	None[a]	---
	RASW	Jun-98	NA	NA	NA	NA	---	None[a]	NA
Lead	RASW	Jul-95	4	3.90	41.50	17.60	RADSW010	3.1	3/4
	RASW	Oct-95	NA	NA	NA	NA	---	3.1	NA
	RASW	Jan-96	7	2.30	2.30	2.30	RADSW007	3.1	0/7
	RASW	Apr/May-96	4	ND	ND	ND	---	3.1	0/4
	RASW	Jun-98	NA	NA	NA	NA	---	3.1	NA
Manganese	RASW	Jul-95	4	312	11,300	5,793	RADSW010	None[a]	---
	RASW	Oct-95	NA	NA	NA	NA	---	None[a]	NA
	RASW	Jan-96	7	403	5,360	2,946	RADSW008	None[a]	---
	RASW	Apr/May-96	4	2,140	9,030	5,685	RADSW008	None[a]	---
	RASW	Jun-98	NA	NA	NA	NA	---	None[a]	NA
Mercury	RASW	Jul-95	4	0.35	0.35	0.35	RADSW010	0.025	1/4
	RASW	Oct-95	NA	NA	NA	NA	---	0.025	NA
	RASW	Jan-96	7	ND	ND	ND	---	0.025	0/7
	RASW	Apr/May-96	4	0.26	0.30	0.28	RADSW010	0.025	2/4
	RASW	Jun-98	NA	NA	NA	NA	---	0.025	NA
Molybdenum	RASW	Jul-95	4	6.30	6.30	6.30	RADSW011	None[a]	---
	RASW	Oct-95	NA	NA	NA	NA	---	None[a]	NA
	RASW	Jan-96	7	ND	ND	ND	---	None[a]	---
	RASW	Apr/May-96	4	2.20	12.80	6.10	RADSW009	None[a]	---
	RASW	Jun-98	NA	NA	NA	NA	---	None[a]	NA

TABLE 6-5

R AREA DISPOSAL SITE, SUMMARY OF CHEMICALS IN SURFACE WATER COMPARED TO SCREENING VALUES
TIDAL AREA QEA, NWS SBD CONCORD

Analyte	Unit	Quarter Sampled	Total Number of Samples	Minimum Concentration Detected	Maximum Concentration Detected	Mean Concentration Detected	Location of Maximum Detection	Concord Tidal Area QEA Screening Value	Number of Samples that Exceed the Screening Value
Inorganic Chemicals (all values in µg/L) (Continued)									
Nickel	RASW	Jul-95	4	211.00	211.00	211.00	RADSW010	8.2	1/4
	RASW	Oct-95	NA	NA	NA	NA	---	8.2	NA
	RASW	Jan-96	7	12.80	171.00	81.97	RADSW008	8.2	7/7
	RASW	Apr/May-96	4	20.70	40.00	30.50	RADSW010	8.2	3/4
	RASW	Jun-98	NA	NA	NA	NA	---	8.2	NA
Selenium	RASW	Jul-95	4	ND	ND	ND	---	5	0/4
	RASW	Oct-95	NA	NA	NA	NA	---	5	NA
	RASW	Jan-96	7	2.40	2.40	2.40	RADSW007	5	0/7
	RASW	Apr/May-96	4	3.90	4.10	4.00	RADSW010	5	0/4
	RASW	Jun-98	NA	NA	NA	NA	---	5	NA
Thallium	RASW	Jul-95	4	8.10	8.10	8.10	RADSW013	None[a]	---
	RASW	Oct-95	NA	NA	NA	NA	---	None[a]	NA
	RASW	Jan-96	7	4.40	4.40	4.40	RADSW013	None[a]	---
	RASW	Apr/May-96	4	ND	ND	ND	---	None[a]	---
	RASW	Jun-98	NA	NA	NA	NA	---	None[a]	NA
Vanadium	RASW	Jul-95	4	18.50	33.70	26.10	RADSW010	None[a]	---
	RASW	Oct-95	NA	NA	NA	NA	---	None[a]	NA
	RASW	Jan-96	7	3.80	3.80	3.80	RADSW007	None[a]	---
	RASW	Apr/May-96	4	2.30	26.10	8.78	RADSW010	None[a]	---
	RASW	Jun-98	NA	NA	NA	NA	---	None[a]	NA
Zinc	RASW	Jul-95	4	57.60	265.00	121.68	RADSW010	58	3/4
	RASW	Oct-95	NA	NA	NA	NA	---	58	NA
	RASW	Jan-96	7	29.40	234.00	101.84	RADSW008	58	4/7
	RASW	Apr/May-96	NA	ND	ND	ND	NA	58	NA
	RASW	Jun-98	NA	NA	NA	NA	---	58	NA
CLP Pesticides (all values in µg/L)									
Aldrin	RASW	Jul-95	4	ND	ND	ND	---	0.13	0/4
	RASW	Oct-95	NA	NA	NA	NA	---	0.13	NA
	RASW	Jan-96	7	ND	ND	ND	---	0.13	0/7
	RASW	Apr/May-96	4	0.029	0.029	0.029	RADSW011	0.13	0/4
	RASW	Jun-98	NA	NA	NA	NA	---	0.13	NA

TABLE 6-5

R AREA DISPOSAL SITE, SUMMARY OF CHEMICALS IN SURFACE WATER COMPARED TO SCREENING VALUES
TIDAL AREA QEA, NWS SBD CONCORD

Analyte	Unit	Quarter Sampled	Total Number of Samples	Minimum Concentration Detected	Maximum Concentration Detected	Mean Concentration Detected	Location of Maximum Detection	Concord Tidal Area QEA Screening Value	Number of Samples that Exceed the Screening Value
CLP Pesticides (all values in μg/L) (Continued)									
alpha-BHC	RASW	Jul-95	4	ND	ND	ND	—	None[a]	---
	RASW	Oct-95	NA	NA	NA	NA	—	None[a]	NA
	RASW	Jan-96	7	ND	ND	ND	—	None[a]	---
	RASW	Apr/May-96	4	0.029	0.067	0.045	RADSW010	None[a]	---
	RASW	Jun-98	NA	NA	NA	NA	—	None[a]	NA
beta-BHC	RASW	Jul-95	4	ND	ND	ND	—	None[a]	---
	RASW	Oct-95	NA	NA	NA	NA	—	None[a]	NA
	RASW	Jan-96	7	ND	ND	ND	---	None[a]	---
	RASW	Apr/May-96	4	0.027	0.027	0.027	RADSW008	None[a]	---
	RASW	Jun-98	NA	NA	NA	NA	---	None[a]	NA
Heptachlor epoxide	RASW	Jul-95	4	ND	ND	ND	---	0.0036	0/4
	RASW	Oct-95	NA	NA	NA	NA		0.0036	NA
	RASW	Jan-96	7	ND	ND	ND	---	0.0036	0/7
	RASW	Apr/May-96	4	0.013	0.037	0.025	RADSW008	0.0036	2/4
	RASW	Jun-98	NA	NA	NA	NA	—	0.0036	NA
Total BHC	RASW	Jul-95	4	0.10	0.50	0.20	RADSW010	None[a]	---
	RASW	Oct-95	NA	NA	NA	NA	---	None[a]	NA
	RASW	Jan-96	7	0.10	0.10	0.10	RADSW007	None[a]	---
	RASW	Apr/May-96	4	0.10	0.14	0.12	RADSW010	None[a]	---
	RASW	Jun-98	NA	NA	NA	NA	---	None[a]	NA
Total Chlordanes	RASW	Jul-95	4	0.05	0.25	0.10	RADSW010	0.004	4/4
	RASW	Oct-95	NA	NA	NA	NA	---	0.004	NA
	RASW	Jan-96	7	0.05	0.05	0.05	RADSW007	0.004	7/7
	RASW	Apr/May-96	4	0.05	0.05	0.05	RADSW008	0.004	4/4
	RASW	Jun-98	NA	NA	NA	NA	---	0.004	NA
Total DDTs	RASW	Jul-95	4	0.15	0.75	0.30	RADSW010	None[a]	---
	RASW	Oct-95	NA	NA	NA	NA	---	None[a]	NA
	RASW	Jan-96	7	0.15	0.15	0.15	RADSW007	None[a]	---
	RASW	Apr/May-96	NA	0.15	0.15	0.15	RADSW008	None[a]	NA
	RASW	Jun-98	NA	NA	NA	NA	---	None[a]	NA

TABLE 6-5

R AREA DISPOSAL SITE, SUMMARY OF CHEMICALS IN SURFACE WATER COMPARED TO SCREENING VALUES
TIDAL AREA QEA, NWS SBD CONCORD

Analyte	Unit	Quarter Sampled	Total Number of Samples	Minimum Concentration Detected	Maximum Concentration Detected	Mean Concentration Detected	Location of Maximum Detection	Concord Tidal Area QEA Screening Value	Number of Samples that Exceed the Screening Value
CLP Pesticides (all values in µg/L) (Continued)									
Total PCBs	RASW	Jul-95	4	1.75	8.75	3.50	RADSW010	None[a]	---
	RASW	Oct-95	NA	NA	NA	NA	---	None[a]	NA
	RASW	Jan-96	7	1.75	1.75	1.75	RADSW007	None[a]	---
	RASW	Apr/May-96	4	1.75	1.75	1.75	RADSW008	None[a]	---
	RASW	Jun-98	NA	NA	NA	NA	---	None[a]	NA
CLP SVOAs (all values in µg/L)									
Total HMW PAHs	RASW	Jul-95	4	50	50	50	RADSW007	None[a]	---
	RASW	Oct-95	NA	NA	NA	NA	---	None[a]	NA
	RASW	Jan-96	7	50	50	50	RADSW007	None[a]	---
	RASW	Apr/May-96	4	50	50	50	RADSW008	None[a]	---
	RASW	Jun-98	NA	NA	NA	NA	---	None[a]	NA
Total LMW PAHs	RASW	Jul-95	4	35	35	35	RADSW007	None[a]	---
	RASW	Oct-95	NA	NA	NA	NA	---	None[a]	NA
	RASW	Jan-96	7	35	35	35	RADSW007	None[a]	---
	RASW	Apr/May-96	4	35	35	35	RADSW008	None[a]	---
	RASW	Jun-98	NA	NA	NA	NA	---	None[a]	NA
Total PAHs	RASW	Jul-95	4	85	85	85	RADSW007	15	4/4
	RASW	Oct-95	NA	NA	NA	NA	---	15	NA
	RASW	Jan-96	7	85	85	85	RADSW007	15	7/7
	RASW	Apr/May-96	4	85	85	85	RADSW008	15	4/4
	RASW	Jun-98	NA	NA	NA	NA	---	15	NA

Notes: For all surface water screening values please refer to Table 5-2.

BHC Hexachlorocyclohexane
CLP Contract laboratory program
DDT Dichlorodiphenyltrichloroethane
HMW High molecular weight
LMW Low molecular weight
NA Not analyzed
a No screening value is available
--- Not applicable

ND Not detected
PAH Polynuclear aromatic hydrocarbon
PCB Polychlorinated biphenyl
SVOA Semivolatile organic analyte
VOA Volatile organic analyte
µg/L Microgram per liter

TABLE 6-6

FROID AND TAYLOR ROADS - TERRESTRIAL UNIT
SUMMARY OF CHEMICALS IN SOIL AND SEDIMENT COMPARED TO SCREENING VALUES
TIDAL AREA QEA, NWS SBD CONCORD

Analyte	Depth[a]	Number of Samples Collected[b]	Number of Nondetect Results	Maximum Detected Conc.[b]	Location of Maximum Detection	Top Depth of Sample (ft. bgs)	Tidal Area Ambient Value (99UCL)[c]	SF Bay Ambient Value[d]	ER-L[e]	ER-M[e]	Number of Samples that Exceed Tidal Area Ambient Value[f]	Number of Samples that Exceed SF Bay Ambient Value[f]	Number of Samples that Exceed ER-L[f]	Number of Samples that Exceed ER-M[f]
Inorganic Chemicals (mg/kg)[h]														
Aluminum	Surface	1	0	14900	FTSSB001	0.0	27,300	NA	NA	NA	0/1	NA	NA	NA
Arsenic	Surface	1	0	4.5	FTSSB001	0.0	27	15.3	8.2	70	0/1	0/1	0/1	0/1
Barium	Surface	1	0	165	FTSSB001	0.0	530	NA	NA	NA	0/1	NA	NA	NA
Beryllium	Surface	1	1	ND	ND	ND	0.18	NA	NA	NA	ND	ND	ND	ND
Cadmium	Surface	1	0	0.38	FTSSB001	0.0	1.9	0.33	1.2	9.6	0/1	1/1	0/1	0/1
Chromium	Surface	1	0	34.2	FTSSB001	0.0	82.1	112	81	370	0/1	0/1	0/1	0/1
Cobalt	Surface	1	0	12.9	FTSSB001	0.0	36	NA	NA	NA	0/1	NA	NA	NA
Copper	Surface	1	0	30.3	FTSSB001	0.0	81	68.1	34	270	0/1	0/1	0/1	0/1
Lead	Surface	1	0	72	FTSSB001	0.0	95	43.2	46.7	218	0/1	1/1	1/1	0/1
Manganese	Surface	1	0	608	FTSSB001	0.0	1,500	NA	NA	NA	0/1	NA	NA	NA
Mercury	Surface	1	0	0.25	FTSSB001	0.4	0.32	0.43	0.15	0.71	0/1	0/1	1/1	0/1
Molybdenum	Surface	1	1	ND	ND	ND	6.6	NA	NA	NA	ND	ND	ND	ND
Nickel	Surface	1	0	38	FTSSB001	0.0	120	112	20.9	51.6	0/1	0/1	1/1	0/1
Selenium[g]	Surface	1	1	ND	ND	ND	NA	0.64	0.70	1.40	ND	ND	ND	ND
Silver	Surface	1	1	ND	ND	ND	NA	0.58	1.0	3.7	ND	ND	ND	ND
Thallium	Surface	1	0	0.64	FTSSB001	0.4	2.2	NA	NA	NA	0/1	NA	NA	NA
Vanadium	Surface	1	0	54.7	FTSSB001	0.0	96	NA	NA	NA	0/1	NA	NA	NA
Zinc	Surface	1	0	106	FTSSB001	0.0	264	158	150	410	0/1	0/1	0/1	0/1
Low Detection Limit PCBs (µg/kg)														
PCB-128 (2,2',3,3',4,4')	Surface	1	0	2	FTSSB001	0.0	NA	NA	NA	NA	NA	NA	NA	NA
Total PCBs	Surface	1	0	5.8	FTSSB001	0.0	NA	14.8	22.7	180	NA	0/1	0/1	0/1
CLP PCBs (µg/kg)														
Total PCBs	Surface	1	0	2,940	FTSSB001	0.4	NA	14.8	22.7	180	NA	1/1	1/1	1/1
Low Detection Limit Pesticides (µg/kg)														
2,4'-DDD	Surface	1	0	0.3	FTSSB001	0.0	NA	NA	NA	NA	NA	NA	NA	NA
2,4'-DDE	Surface	1	0	0.5	FTSSB001	0.0	NA	NA	NA	NA	NA	NA	NA	NA
2,4'-DDT	Surface	1	0	2.0	FTSSB001	0.0	NA	NA	NA	NA	NA	NA	NA	NA
4,4'-DDD	Surface	1	0	4.0	FTSSB001	0.0	NA	NA	2.0	20	NA	NA	1/1	0/1
4,4'-DDE	Surface	1	0	15	FTSSB001	0.0	NA	NA	2.2	27	NA	NA	1/1	0/1
4,4'-DDT	Surface	1	0	19	FTSSB001	0.0	NA	NA	1.0	7.0	NA	NA	1/1	1/1
Total DDTs	Surface	1	0	40.8	FTSSB001	0.0	NA	7.0	1.58	46.1	NA	1/1	1/1	0/1
Total BHCs	Surface	1	0	0.2	FTSSB001	0.0	NA	0.78	NA	NA	NA	0/1	NA	NA
alpha-Chlordane	Surface	1	0	3.0	FTSSB001	0.0	NA	NA	NA	NA	NA	NA	NA	NA
Total Chlordane	Surface	3	0	190	FTSSB101	0.0	NA	1.1	0.5	6.0	NA	3/3	3/3	2/3
trans-Nonachlor	Surface	1	0	4.0	FTSSB001	0.0	NA	NA	NA	NA	NA	NA	NA	NA
CLP Pesticides (µg/kg)														
4,4'-DDE	Surface	1	0	9.6	FTSSB001	0.4	NA	NA	2.2	27	NA	NA	1/1	0/1
4,4'-DDT	Surface	1	0	8.9	FTSSB001	0.4	NA	NA	1.0	7.0	NA	NA	1/1	1/1
Total DDTs	Surface	1	0	55	FTSSB001	0.4	NA	7.0	1.58	46.1	NA	1/1	1/1	1/1
Total BHCs	Surface	1	0	72	FTSSB001	0.4	NA	0.78	NA	NA	NA	1/1	NA	NA
alpha-Chlordane	Surface	1	0	35	FTSSB001	0.4	NA	NA	NA	NA	NA	NA	NA	NA
gamma-Chlordane	Surface	1	0	25	FTSSB001	0.4	NA	NA	NA	NA	NA	NA	NA	NA
Total Chlordanes	Surface	1	0	60	FTSSB001	0.4	NA	1.1	0.5	6.0	NA	1/1	1/1	1/1

TABLE 6-6

FROID AND TAYLOR ROADS - TERRESTRIAL UNIT
SUMMARY OF CHEMICALS IN SOIL AND SEDIMENT COMPARED TO SCREENING VALUES
TIDAL AREA QEA, NWS SBD CONCORD

Analyte	Depth[a]	Number of Samples Collected[b]	Number of Nondetect Results	Maximum Detected Conc.[b]	Location of Maximum Detection	Top Depth of Sample (ft. bgs)	Tidal Area Ambient Value (99UCL)[c]	SF Bay Ambient Value[d]	ER-L[e]	ER-M[e]	Number of Samples that Exceed Tidal Area Ambient Value[f]	Number of Samples that Exceed SF Bay Ambient Value[f]	Number of Samples that Exceed ER-L[f]	Number of Samples that Exceed ER-M[f]
Low Detection Level SVOAs (µg/kg)														
1-Methylnaphthalene	Surface	1	0	5.0	FTSSB001	0.0	NA	12.1	NA	NA	NA	0/1	NA	NA
2,4-Dimethylphenol	Surface	1	0	5.0	FTSSB001	0.0	NA	NA	NA	NA	NA	NA	NA	NA
2,6-Dimethylnaphthalene	Surface	1	0	5.0	FTSSB001	0.0	NA	12.1	NA	NA	NA	0/1	NA	NA
2-Methylnaphthalene	Surface	1	0	9.0	FTSSB001	0.0	NA	19.4	70	670	NA	0/1	0/1	0/1
Benzoic acid	Surface	1	0	24	FTSSB001	0.0	NA	NA	NA	NA	NA	NA	NA	NA
Total HMW PAHs	Surface	1	0	246	FTSSB001	0.0	NA	3,060	1,700	9,600	NA	0/1	0/1	0/1
Total LMW PAHs	Surface	1	0	157.5	FTSSB001	0.0	NA	434	552	3,160	NA	0/1	0/1	0/1
Total PAHs	Surface	1	0	403.5	FTSSB001	0.0	NA	3,390	4,022	44,792	NA	0/1	0/1	0/1
CLP SVOAs (µg/kg)														
Total HMW PAHs	Surface	1	0	3,600	FTSSB001	0.4	NA	3,060	1,700	9,600	NA	1/1	1/1	0/1
Total LMW PAHs	Surface	1	0	2,520	FTSSB001	0.4	NA	434	552	3,160	NA	1/1	1/1	0/1
Total PAHs	Surface	1	0	6,120	FTSSB001	0.4	NA	3,390	4,022	44,792	NA	1/1	1/1	0/1
TPH-Extractable (mg/kg)														
Motor Oil	Surface	1	0	9,200	FTSSB001	0.4	NA	NA	NA	NA	NA	NA	NA	NA

Notes:
Where total values were calculated (for example, total PCBs, total DDTs, etc.) 1/2 of the standard quantitation limit (SQL) was used for Nondetected analytes.

bgs	Below ground surface	LMW	Low molecular weight
BHC	Hexachlorocyclohexane	mg/kg	Milligrams per kilogram
CLP	Contract Laboratory Program	NA	Screening value not available
Conc.	Concentration	ND	Nondetected
DDD	Dichlorodiphenyldichloroethane	PAH	Polycyclic aromatic hydrocarbon
DDE	Dichlorodiphenyldichloroethene	PCB	Polychlorinated biphenyl
DDT	Dichlorodiphenyltrichloroethane	SVOA	Semivolatile organic analyte
ER-L	Effects range-low	UCL	Upper confidence limit
ER-M	Effects range-median	µg/kg	Micrograms per kilogram
ft.	feet	VOA	Volatile organic analyte
HMW	High molecular weight		

a Surface samples are those collected between 0 and 3 feet bgs; subsurface samples are those collected greater than 3 feet bgs.
b If more than one sample was analyzed in the surface and subsurface depth ranges, only the highest result from the interval is reported and used in the data set.
c PRC Environmental Management, Inc (PRC). 1996a. "Estimation of Ambient Metals Concentrations in the Tidal Area Soils. Technical Memorandum. Naval Weapons Station, Concord, California." March.
d San Francisco Bay Regional Water Quality Control Board (RWQCB). 1998. "Ambient Concentrations of Toxic Chemicals in Sediments." April.
e National Oceanic and Atmospheric Administration (NOAA). 1991. "The Potential for Biological Effects of Sediment-Sorbed Contaminants Tested in the National Status and Trends Program." Technical Memorandum NOS OMA 52. NOAA, Office of Oceanography and Marine Assessment. Seattle, Washington.
Long, E.R., D. D. MacDonald, S.L. Smith, F.D. Calder. 1995. "Incidence of Adverse Biological Effects Within Ranges of Chemical Concentrations in Marine and Estuarine Sediments." *Environmental Management*. Volume 19. Number 1. Pages 81 through 97.
f Number of samples that exceeded screening value / number of samples
g Detection limits were below screening values for all chemicals except selenium. The median detection limit for selenium exceeded the ER-L value.

TABLE 6-7

FROID AND TAYLOR ROADS - AQUATIC UNIT
SUMMARY OF CHEMICALS IN SOIL AND SEDIMENT COMPARED TO SCREENING VALUES
TIDAL AREA QEA, NWS SBD CONCORD

	Depth[a]	Number of Samples Collected[b]	Number of Nondetect Results	Maximum Detected Conc.[b]	Location of Maximum Detection	Top Depth of Sample (ft. bgs)	Tidal Area Ambient Value (99UCL)[c]	SF Bay Ambient Value[d]	ER-L[e]	ER-M[e]	Number of Samples that Exceed Tidal Area Ambient Value[f]	Number of Samples that Exceed SF Bay Ambient Value[f]	Number of Samples that Exceed ER-L[f]	Number of Samples that Exceed ER-M[f]
Inorganic Chemicals (mg/kg)														
Aluminum	Surface	11	0	37,500	FTSSB005	0.0	27,300	NA	NA	NA	1/11	NA	NA	NA
Antimony	Surface	6	3	2.2	FTSSL102	0.0	2.2	NA	2.0	25	0/6	NA	1/6	0/6
Arsenic	Surface	11	0	26.6	FTSSB008	1.2	27	15.3	8.2	70	0/11	5/11	8/11	0/11
Barium	Surface	11	0	234	FTSSB005	0.0	530	NA	NA	NA	0/11	NA	NA	NA
Beryllium	Surface	11	10	0.35	FTSSL103	0.0	0.18	NA	NA	NA	1/11	NA	NA	NA
Cadmium	Surface	11	4	1.9	FTSSL104	0.0	1.9	0.33	1.2	9.6	0/11	6/11	1/11	0/11
Chromium	Surface	11	0	106	FTSSB005	0.0	82.1	112	81	370	1/11	0/11	2/11	0/11
Cobalt	Surface	11	0	20.6	FTSSL104	0.0	36	NA	NA	NA	0/11	NA	NA	NA
Copper	Surface	11	0	92	FTSSL102	0.0	81	68.1	34	270	2/11	2/11	9/11	0/11
Lead	Surface	11	0	515	FTSSB002	0.0	95	43.2	46.7	218	5/11	9/11	9/11	1/11
Manganese	Surface	11	0	3,530	FTSSL104	0.0	1,500	NA	NA	NA	1/11	NA	NA	NA
Mercury	Surface	11	3	0.49	FTSSB006	0.0	0.32	0.43	0.15	0.71	4/11	1/11	6/11	0/11
Molybdenum	Surface	11	5	4.3	FTSSL102	0.0	6.6	NA	NA	NA	0/11	NA	NA	NA
Nickel	Surface	11	0	90.9	FTSSB005	0.0	120	112	20.9	51.6	0/11	0/11	11/11	9/11
Selenium[g]	Surface	11	9	1.5	FTSSL104	0.0	NA	0.64	0.70	1.40	NA	2/11	2/11	1/11
Silver	Surface	11	4	0.63	FTSSL104	0.0	NA	0.58	1.0	3.7	NA	1/11	0/11	0/11
Thallium	Surface	11	8	3.8	FTSSL104	0.0	2.2	NA	NA	NA	1/11	NA	NA	NA
Vanadium	Surface	11	0	136	FTSSB008	1.2	96	NA	NA	NA	2/11	NA	NA	NA
Zinc	Surface	11	0	436	FTSSB002	0.0	264	158	150	410	1/11	4/11	5/11	1/11
Low Detection Limit PCBs (µg/kg)														
PCB-77 (3,3',4,4')	Surface	11	10	0.3	FTSSB003	0.0	NA	NA	NA	NA	NA	NA	NA	NA
PCB-101 (2,2',3,5,5')	Surface	11	9	0.4	FTSSB003	0.0	NA	NA	NA	NA	NA	NA	NA	NA
PCB-105 (2,3,3',4,4')	Surface	11	9	0.3	FTSSL104	0.0	NA	NA	NA	NA	NA	NA	NA	NA
PCB-118 (2,3',4,4',5)	Surface	11	8	0.7	FTSSL104	0.0	NA	NA	NA	NA	NA	NA	NA	NA
PCB-126 (3,3',4,4',5)	Surface	11	9	0.1	FTSSB003	0.0	NA	NA	NA	NA	NA	NA	NA	NA
PCB-128 (2,2',3,3',4,4')	Surface	11	9	0.3	FTSSB003	0.0	NA	NA	NA	NA	NA	NA	NA	NA
PCB-138 (2,2',3,4,4',5')	Surface	11	6	2.0	FTSSB003	0.0	NA	NA	NA	NA	NA	NA	NA	NA
PCB-153 (2,2',4,4',5,5')	Surface	11	7	0.9	FTSSL104	0.0	NA	NA	NA	NA	NA	NA	NA	NA
PCB-180 (2,2',3,4,4',5,5')	Surface	11	8	0.4	FTSSB003	0.0	NA	NA	NA	NA	NA	NA	NA	NA
PCB-187 (2,2',3,4',5,5',6)	Surface	11	8	0.4	FTSSL104	0.0	NA	NA	NA	NA	NA	NA	NA	NA
PCB-206 (2,2',3,3',4,4',5,5',6)	Surface	3	2	2.0	FTSSL104	0.0	NA	NA	NA	NA	NA	NA	NA	NA
PCB-206 (2,2',3,3',4,4',5,5',	Surface	8	4	0.8	FTSSB003	0.0	NA	NA	NA	NA	NA	NA	NA	NA
PCB-209 (2,2',3,3',4,4',5,5',6)	Surface	11	8	0.8	FTSSL104	0.0	NA	NA	NA	NA	NA	NA	NA	NA
Total PCBs	Surface	11	0	9.1	FTSSL104	0.0	NA	14.8	22.7	180	NA	0/11	0/11	0/11
CLP PCBs (µg/kg)														
Total PCBs	Surface	8	0	760	FTSSB006	1.1	NA	14.8	22.7	180	NA	8/8	8/8	6/8
Low Detection Limit Pesticides (µg/kg)														
2,4'-DDD	Surface	11	6	7.0	FTSSL103	0.0	NA	NA	NA	NA	NA	NA	NA	NA
2,4'-DDE	Surface	11	8	0.6	FTSSB003	0.0	NA	NA	NA	NA	NA	NA	NA	NA
2,4'-DDT	Surface	11	8	3.0	FTSSL102	0.0	NA	NA	NA	NA	NA	NA	NA	NA
4,4'-DDD	Surface	11	3	14	FTSSL102	0.0	NA	NA	2.0	20	NA	NA	6/11	0/11
4,4'-DDE	Surface	11	3	7.00	FTSSL102	0.0	NA	NA	2.2	27	NA	NA	4/11	0/11
4,4'-DDT	Surface	11	7	15	FTSSL102	0.0	NA	NA	1.0	7.0	NA	NA	3/11	2/11
Total DDTs	Surface	11	0	43.2	FTSSL102	0.0	NA	7.0	1.58	46.1	NA	6/11	7/11	0/11
Aldrin	Surface	11	10	0.4	FTSSB003	0.0	NA	NA	NA	NA	NA	NA	NA	NA

TABLE 6-7

FROID AND TAYLOR ROADS - AQUATIC UNIT
SUMMARY OF CHEMICALS IN SOIL AND SEDIMENT COMPARED TO SCREENING VALUES
TIDAL AREA QEA, NWS SBD CONCORD

	Depth[a]	Number of Samples Collected[b]	Number of Nondetect Results	Maximum Detected Conc.[b]	Location of Maximum Detection	Top Depth of Sample (ft. bgs)	Tidal Area Ambient Value (99UCL)[c]	SF Bay Ambient Value[d]	ER-L[e]	ER-M[e]	Number of Samples that Exceed Tidal Area Ambient Value[f]	Number of Samples that Exceed SF Bay Ambient Value[f]	Number of Samples that Exceed ER-L[f]	Number of Samples that Exceed ER-M[f]
Low Detection Limit Pesticides (µg/kg) (Continued)														
alpha-BHC	Surface	3	2	0.7	FTSSL102	0.0	NA	NA	NA	NA	NA	NA	NA	NA
gamma-BHC (Lindane)	Surface	11	10	0.4	FTSSB003	0.0	NA	NA	NA	NA	NA	NA	NA	NA
Total BHCs	Surface	11	0	1.3	FTSSL102	0.0	NA	0.78	NA	NA	NA	1/11	NA	NA
alpha-Chlordane	Surface	11	3	11	FTSSL102	0.0	NA	NA	NA	NA	NA	NA	NA	NA
gamma-Chlordane	Surface	3	0	12	FTSSL102	0.0	NA	NA	NA	NA	NA	NA	NA	NA
Total Chlordanes	Surface	11	0	23	FTSSL102	0.0	NA	1.1	0.5	6.0	NA	3/11	6/11	1/11
Dieldrin	Surface	11	9	0.8	FTSSB003	0.0	NA	0.44	0.02	8.0	NA	1/11	2/11	0/11
Hexachlorobenzene	Surface	11	8	0.5	FTSSB002	0.0	NA	0.48	NA	NA	NA	1/11	NA	NA
trans-Nonachlor	Surface	11	5	2.0	FTSSB003	0.0	NA	NA	NA	NA	NA	NA	NA	NA
CLP Pesticides (µg/kg)														
4,4'-DDD	Surface	8	7	8.2	FTSSB008	1.2	NA	NA	2.0	20	NA	NA	1/8	0/8
Total DDTs	Surface	8	0	28.5	FTSSB006	1.1	NA	7.0	1.58	46.1	NA	6/8	8/8	0/8
Total BHCs	Surface	8	0	19	FTSSB006	1.1	NA	0.78	NA	NA	NA	8/8	NA	NA
Total Chlordanes	Surface	8	0	9.5	FTSSB006	1.1	NA	1.1	0.5	6.0	NA	8/8	8/8	3/8
Low Detection Level SVOAs (µg/kg)														
1,1'-Biphenyl	Surface	8	7	9.0	FTSSB002	0.0	NA	NA	NA	NA	NA	NA	NA	NA
1-Methylnaphthalene	Surface	8	7	30	FTSSB002	0.0	NA	12.1	NA	NA	NA	1/8	NA	NA
2,4-Dimethylphenol	Surface	8	7	12	FTSSB002	0.0	NA	NA	NA	NA	NA	NA	NA	NA
2,6-Dimethylnaphthalene	Surface	8	6	41	FTSSB005	0.0	NA	12.1	NA	NA	NA	2/8	NA	NA
2-Methylnaphthalene	Surface	8	7	46	FTSSB002	0.0	NA	19.4	70	670	NA	1/8	0/8	0/8
4-Methylphenol	Surface	8	7	5.0	FTSSB002	0.0	NA	NA	NA	NA	NA	NA	NA	NA
Acenaphthylene	Surface	8	7	29	FTSSB009	0.0	NA	31.7	44	640	NA	0/8	0/8	0/8
Anthracene	Surface	8	7	37	FTSSB009	0.0	NA	88	85.3	1,100	NA	0/8	0/8	0/8
Benzo(a)anthracene	Surface	8	5	91	FTSSB009	0.0	NA	244	261	1,600	NA	0/8	0/8	0/8
Benzo(a)pyrene	Surface	8	6	130	FTSSB005	0.0	NA	412	430	1,600	NA	0/8	0/8	0/8
Benzo(b)fluoranthene	Surface	8	6	240	FTSSB009	0.0	NA	371	NA	NA	NA	0/8	NA	NA
Benzo(e)pyrene	Surface	8	7	280	FTSSB009	0.0	NA	294	NA	NA	NA	0/8	NA	NA
Benzo(g,h,i)perylene	Surface	8	6	210	FTSSB005	0.0	NA	310	NA	NA	NA	0/8	NA	NA
Benzo(k)fluoranthene	Surface	8	6	120	FTSSB009	0.0	NA	258	NA	NA	NA	0/8	NA	NA
Benzoic Acid	Surface	8	5	530	FTSSB006	0.0	NA	NA	NA	NA	NA	NA	NA	NA
Bis(2-ethylhexyl)phthalate	Surface	8	7	2500	FTSSB008	0.0	NA	NA	NA	NA	NA	NA	NA	NA
Carbazole	Surface	8	7	24	FTSSB009	0.0	NA	NA	NA	NA	NA	NA	NA	NA
Chrysene	Surface	8	5	240	FTSSB009	0.0	NA	289	384	2,800	NA	0/8	0/8	0/8
Low Detection Level SVOAs (µg/kg) (Continued)														
Dibenzofuran	Surface	8	7	7.0	FTSSB002	0.0	NA	NA	NA	NA	NA	NA	NA	NA
Fluoranthene	Surface	8	4	190	FTSSB005	0.0	NA	514	600	5,100	NA	0/8	0/8	0/8
Fluorene	Surface	8	7	6.0	FTSSB002	0.0	NA	25.3	19	540	NA	0/8	0/8	0/8
Indeno(1,2,3-cd)pyrene	Surface	8	7	140	FTSSB009	0.0	NA	382	NA	NA	NA	0/8	NA	NA
Naphthalene	Surface	8	7	14	FTSSB002	0.0	NA	55.8	160	2,100	NA	0/8	0/8	0/8
Phenanthrene	Surface	8	5	49	FTSSB005	0.0	NA	237	240	1,500	NA	0/8	0/8	0/8
Pyrene	Surface	8	5	200	FTSSB005	0.0	NA	665	665	2,600	NA	0/8	0/8	0/8
Total HMW PAHs	Surface	8	0	3960	FTSSB006	0.0	NA	3,060	1,700	9,600	NA	1/8	3/8	0/8
Total LMW PAHs	Surface	8	0	2970	FTSSB006	0.0	NA	434	552	3,160	NA	5/8	5/8	0/8
Total PAHs	Surface	8	0	6930	FTSSB006	0.0	NA	3,390	4,022	44,792	NA	1/8	1/8	0/8

TABLE 6-7

FROID AND TAYLOR ROADS - AQUATIC UNIT
SUMMARY OF CHEMICALS IN SOIL AND SEDIMENT COMPARED TO SCREENING VALUES
TIDAL AREA QEA, NWS SBD CONCORD

	Depth[a]	Number of Samples Collected[b]	Number of Nondetect Results	Maximum Detected Conc.[b]	Location of Maximum Detection	Top Depth of Sample (ft. bgs)	Tidal Area Ambient Value (99UCL)[c]	SF Bay Ambient Value[d]	ER-L[e]	ER-M[e]	Number of Samples that Exceed Tidal Area Ambient Value[f]	Number of Samples that Exceed SF Bay Ambient Value[f]	Number of Samples that Exceed ER-L[f]	Number of Samples that Exceed ER-M[f]
CLP SVOAs (µg/kg)														
4-Methylphenol	Surface	11	10	300	FTSSL102	0.0	NA	NA	NA	NA	NA	NA	NA	NA
Chrysene	Surface	10	8	76	FTSSL102	0.0	NA	289	384	2,800	NA	0/10	0/10	0/10
Fluoranthene	Surface	10	8	140	FTSSL102	0.0	NA	514	600	5,100	NA	0/10	0/10	0/10
Phenol	Surface	11	8	500	FTSSB002	0.8	NA	NA	NA	NA	NA	NA	NA	NA
Pyrene	Surface	10	9	110	FTSSL102	0.0	NA	665	665	2,600	NA	0/10	0/10	0/10
Total HMW PAHs	Surface	10	0	8,000	FTSSB005	2.0	NA	3,060	1,700	9,600	NA	6/10	10/10	0/10
Total LMW PAHs	Surface	10	0	5,600	FTSSB005	2.0	NA	434	552	3,160	NA	10/10	10/10	3/10
Total PAHs	Surface	10	0	13,600	FTSSB005	2.0	NA	3,390	4,022	44,792	NA	10/10	8/10	0/10
CLP VOAs (µg/kg)														
4-Methyl-2-pentanone	Surface	8	7	27	FTSSB005	2.0	NA	NA	NA	NA	NA	NA	NA	NA
TPH-Extractables (mg/kg)														
Motor Oil	Surface	8	0	23,000	FTSSB003	0.0	NA	NA	NA	NA	NA	NA	NA	NA

Notes:
Where total values were calculated (for example, total PCBs, total DDTs, etc.) 1/2 of the standard quantitation limit (SQL) was used for Nondetected analytes.

bgs Below ground surface
BHC Hexachlorocyclohexane
CLP Contract Laboratory Program
Conc. Concentration
DDD Dichlorodiphenyldichloroethane
DDE Dichlorodiphenyldichloroethene
DDT Dichlorodiphenyltrichloroethane
ER-L Effects range-low
ER-M Effects range-median
ft. feet
HMW High molecular weight
LMW Low molecular weight
mg/kg Milligrams per kilogram
NA Screening value not available
ND Nondetected
PAH Polycyclic aromatic hydrocarbon
PCB Polychlorinated biphenyl
SVOA Semivolatile organic analyte
UCL Upper confidence limit
µg/kg Micrograms per kilogram
VOA Volatile organic analyte

a Surface samples are those collected between 0 and 3 feet bgs; subsurface samples are those collected greater than 3 feet bgs.
b If more than one sample was analyzed in the surface and subsurface depth ranges, only the highest result from the interval is reported and used in the data set.
c PRC Environmental Management, Inc (PRC). 1996a. "Estimation of Ambient Metals Concentrations in the Tidal Area Soils. Technical Memorandum. Naval Weapons Station, Concord, California." March.
d San Francisco Bay Regional Water Quality Control Board (RWQCB). 1998. "Ambient Concentrations of Toxic Chemicals in Sediments." April.

TABLE 6-8

FROID AND TAYLOR ROADS, SUMMARY OF CHEMICALS IN SURFACE WATER COMPARED TO SCREENING VALUES
TIDAL AREA QEA, NWS SBD CONCORD

Analyte	Unit	Quarter Sampled	Total Number of Samples	Minimum Concentration Detected	Maximum Concentration Detected	Mean Concentration Detected	Location of Maximum Detection	Concord Tidal Area QEA Screening Value	Number of Samples that Exceed the Screening Value
Inorganic Chemicals (all values in μg/L)									
Aluminum	FTSW	Jul-95	2	304	343	324	FTSSW001	87	2/2
	FTSW	Oct-95	1	1,610	1,610	1,610	FTSSW001	87	1/1
	FTSW	Jan-96	2	ND	ND	ND	---	87	0/2
	FTSW	Apr/May-96	1	116	116	116	FTSSW001	87	1/1
	FTSW	Jun-98	3	446	461	454	FTSSL104	87	2/3
Antimony	FTSW	Jul-95	2	ND	ND	ND	---	None[a]	---
	FTSW	Oct-95	1	9.90	9.90	9.90	FTSSW001	None[a]	---
	FTSW	Jan-96	2	ND	ND	ND	---	None[a]	---
	FTSW	Apr/May-96	1	ND	ND	ND	---	None[a]	---
	FTSW	Jun-98	3	1.00	1.00	1.00	FTSSL102	None[a]	---
Arsenic	FTSW	Jul-95	2	20.90	29.70	25.30	FTSSW002	36	0/2
	FTSW	Oct-95	1	275.00	275.00	275.00	FTSSW001	36	1/1
	FTSW	Jan-96	2	2.20	3.00	2.60	FTSSW001	36	0/2
	FTSW	Apr/May-96	1	10.00	10.00	10.00	FTSSW001	36	0/1
	FTSW	Jun-98	3	12.20	12.50	12.37	FTSSL104	36	0/3
Barium	FTSW	Jul-95	2	220	221	221	FTSSW001	None[a]	---
	FTSW	Oct-95	1	809	809	809	FTSSW001	None[a]	---
	FTSW	Jan-96	2	106	115	111	FTSSW002	None[a]	---
	FTSW	Apr/May-96	1	159	159	159	FTSSW001	None[a]	---
	FTSW	Jun-98	3	220	253	238	FTSSL102	None[a]	---
Cadmium	FTSW	Jul-95	2	ND	ND	ND	---	1.1	0/2
	FTSW	Oct-95	1	ND	ND	ND	---	1.1	0/1
	FTSW	Jan-96	2	ND	ND	ND	---	1.1	0/2
	FTSW	Apr/May-96	1	1.10	1.10	1.10	FTSSW001	1.1	0/1
	FTSW	Jun-98	3	ND	ND	ND	---	1.1	0/3
Chromium	FTSW	Jul-95	2	ND	ND	ND	---	86	0/2
	FTSW	Oct-95	1	6.90	6.90	6.90	FTSSW001	86	0/1
	FTSW	Jan-96	2	ND	ND	ND	---	86	0/2
	FTSW	Apr/May-96	1	1.70	1.70	1.70	FTSSW001	86	0/1
	FTSW	Jun-98	3	ND	ND	ND	---	86	0/3

TABLE 6-8

FROID AND TAYLOR ROADS, SUMMARY OF CHEMICALS IN SURFACE WATER COMPARED TO SCREENING VALUES
TIDAL AREA QEA, NWS SBD CONCORD

Analyte	Unit	Quarter Sampled	Total Number of Samples	Minimum Concentration Detected	Maximum Concentration Detected	Mean Concentration Detected	Location of Maximum Detection	Concord Tidal Area QEA Screening Value	Number of Samples that Exceed the Screening Value
Inorganic Chemicals (all values in μg/L) (Continued)									
Cobalt	FTSW	Jul-95	2	3.90	4.00	3.95	FTSSW002	None[a]	---
	FTSW	Oct-95	1	5.10	5.10	5.10	FTSSW001	None[a]	---
	FTSW	Jan-96	2	ND	ND	ND	---	None[a]	---
	FTSW	Apr/May-96	1	2.30	2.30	2.30	FTSSW001	None[a]	---
	FTSW	Jun-98	3	1.20	1.80	1.57	FTSSL104	None[a]	---
Copper	FTSW	Jul-95	2	9.60	12.70	11.15	FTSSW001	3.2	2/2
	FTSW	Oct-95	1	10.80	10.80	10.80	FTSSW001	3.2	1/1
	FTSW	Jan-96	2	7.80	13.40	10.60	FTSSW001	3.2	2/2
	FTSW	Apr/May-96	1	ND	ND	ND	---	3.2	0/1
	FTSW	Jun-98	3	2.90	3.80	3.40	FTSSL102	3.2	2/3
Iron	FTSW	Jul-95	2	785	8,480	4,633	FTSSW002	None[a]	---
	FTSW	Oct-95	1	3,230	3,230	3,230	FTSSW001	None[a]	---
	FTSW	Jan-96	2	186	477	332	FTSSW001	None[a]	---
	FTSW	Apr/May-96	1	1,830	1,830	1,830	FTSSW001	None[a]	---
	FTSW	Jun-98	3	2,350	3,060	2,797	FTSSL102	None[a]	---
Lead	FTSW	Jul-95	2	4.00	4.00	4.00	FTSSW002	3.1	1/2
	FTSW	Oct-95	1	ND	ND	ND	---	3.1	0/1
	FTSW	Jan-96	2	ND	ND	ND	---	3.1	0/2
	FTSW	Apr/May-96	1	ND	ND	ND	---	3.1	0/1
	FTSW	Jun-98	3	ND	ND	ND	---	3.1	0/3
Manganese	FTSW	Jul-95	2	532	1,060	796	FTSSW002	None[a]	---
	FTSW	Oct-95	1	4,480	4,480	4,480	FTSSW001	None[a]	---
	FTSW	Jan-96	2	207	310	259	FTSSW002	None[a]	---
	FTSW	Apr/May-96	1	585	585	585	FTSSW001	None[a]	---
	FTSW	Jun-98	3	452	1,740	948	FTSSL102	None[a]	---
Mercury	FTSW	Jul-95	2	0.13	0.17	0.15	FTSSW002	0.025	2/2
	FTSW	Oct-95	1	ND	ND	ND	---	0.025	0/1
	FTSW	Jan-96	2	ND	ND	ND	---	0.025	0/2
	FTSW	Apr/May-96	1	ND	ND	ND	---	0.025	0/1
	FTSW	Jun-98	3	ND	ND	ND	---	0.025	0/3

TABLE 6-8

FROID AND TAYLOR ROADS, SUMMARY OF CHEMICALS IN SURFACE WATER COMPARED TO SCREENING VALUES
TIDAL AREA QEA, NWS SBD CONCORD

Analyte	Unit	Quarter Sampled	Total Number of Samples	Minimum Concentration Detected	Maximum Concentration Detected	Mean Concentration Detected	Location of Maximum Detection	Concord Tidal Area QEA Screening Value	Number of Samples that Exceed the Screening Value
Inorganic Chemicals (all values in µg/L) (Continued)									
Molybdenum	FTSW	Jul-95	2	ND	ND	ND	---	None[a]	---
	FTSW	Oct-95	1	1.30	1.30	1.30	FTSSW001	None[a]	---
	FTSW	Jan-96	2	4.60	4.60	4.60	FTSSW001	None[a]	---
	FTSW	Apr/May-96	1	2.30	2.30	2.30	FTSSW001	None[a]	---
	FTSW	Jun-98	3	0.92	1.10	0.99	FTSSL102	None[a]	---
Nickel	FTSW	Jul-95	2	ND	ND	ND	---	8.2	0/2
	FTSW	Oct-95	1	44.70	44.70	44.70	FTSSW001	8.2	1/1
	FTSW	Jan-96	2	3.80	9.10	6.45	FTSSW001	8.2	1/2
	FTSW	Apr/May-96	1	ND	ND	ND	---	8.2	0/1
	FTSW	Jun-98	3	5.30	11.90	9.47	FTSSL104	8.2	2/3
Selenium	FTSW	Jul-95	2	ND	ND	ND	---	5.0	0/2
	FTSW	Oct-95	1	ND	ND	ND	---	5.0	0/1
	FTSW	Jan-96	2	2.40	2.40	2.40	FTSSW001	5.0	0/2
	FTSW	Apr/May-96	1	ND	ND	ND	---	5.0	0/1
	FTSW	Jun-98	3	1.00	2.30	1.50	FTSSL102	5.0	0/3
Silver	FTSW	Jul-95	2	ND	ND	ND	---	0.22	0/2
	FTSW	Oct-95	1	ND	ND	ND	---	0.22	0/1
	FTSW	Jan-96	2	ND	ND	ND	---	0.22	0/2
	FTSW	Apr/May-96	1	ND	ND	ND	---	0.22	0/1
	FTSW	Jun-98	3	0.27	0.30	0.29	FTSSL102	0.22	2/3
Thallium	FTSW	Jul-95	2	ND	ND	ND	---	None[a]	---
	FTSW	Oct-95	1	8.40	8.40	8.40	FTSSW001	None[a]	---
	FTSW	Jan-96	2	ND	ND	ND	---	None[a]	---
	FTSW	Apr/May-96	1	ND	ND	ND	---	None[a]	---
	FTSW	Jun-98	3	ND	ND	ND	---	None[a]	---
Vanadium	FTSW	Jul-95	2	10.00	15.70	12.85	FTSSW002	None[a]	---
	FTSW	Oct-95	1	29.80	29.80	29.80	FTSSW001	None[a]	---
	FTSW	Jan-96	2	ND	ND	ND	---	None[a]	---
	FTSW	Apr/May-96	1	4.10	4.10	4.10	FTSSW001	None[a]	---
	FTSW	Jun-98	3	5.50	7.00	6.30	FTSSL104	None[a]	---

TABLE 6-8

FROID AND TAYLOR ROADS, SUMMARY OF CHEMICALS IN SURFACE WATER COMPARED TO SCREENING VALUES
TIDAL AREA QEA, NWS SBD CONCORD

Analyte	Unit	Quarter Sampled	Total Number of Samples	Minimum Concentration Detected	Maximum Concentration Detected	Mean Concentration Detected	Location of Maximum Detection	Concord Tidal Area QEA Screening Value	Number of Samples that Exceed the Screening Value
Inorganic Chemicals (all values in µg/L) (Continued)									
Zinc	FTSW	Jul-95	2	95.20	95.20	95.20	FTSSW002	58	1/2
	FTSW	Oct-95	1	ND	ND	ND	—	58	0/1
	FTSW	Jan-96	2	ND	ND	ND	---	58	0/2
	FTSW	Apr/May-96	1	ND	ND	ND	---	58	0/1
	FTSW	Jun-98	3	21.90	21.90	21.90	FTSSL102	58	0/3
CLP Pesticides (all values in µg/L)									
Total BHC	FTSW	Jul-95	2	0.10	0.10	0.10	FTSSW001	None[a]	---
	FTSW	Oct-95	1	0.10	0.10	0.10	FTSSW001	None[a]	---
	FTSW	Jan-96	2	0.10	0.10	0.10	FTSSW001	None[a]	---
	FTSW	Apr/May-96	1	0.10	0.10	0.10	FTSSW001	None[a]	---
	FTSW	Jun-98	3	0.10	0.12	0.11	FTSSL104	None[a]	---
Total Chlordanes	FTSW	Jul-95	2	0.05	0.05	0.05	FTSSW001	0.004	2/2
	FTSW	Oct-95	1	0.05	0.05	0.05	FTSSW001	0.004	1/1
	FTSW	Jan-96	2	0.05	0.05	0.05	FTSSW001	0.004	2/2
	FTSW	Apr/May-96	1	0.05	0.05	0.05	FTSSW001	0.004	1/1
	FTSW	Jun-98	3	0.05	0.06	0.05	FTSSL104	0.004	3/3
Total DDTs	FTSW	Jul-95	2	0.15	0.15	0.15	FTSSW001	None[a]	---
	FTSW	Oct-95	1	0.15	0.15	0.15	FTSSW001	None[a]	---
	FTSW	Jan-96	2	0.15	0.15	0.15	FTSSW001	None[a]	---
	FTSW	Apr/May-96	1	0.15	0.15	0.15	FTSSW001	None[a]	---
	FTSW	Jun-98	3	0.15	0.15	0.15	FTSSL102	None[a]	---
Total PCBs	FTSW	Jul-95	2	1.75	1.75	1.75	FTSSW001	None[a]	---
	FTSW	Oct-95	1	1.75	1.75	1.75	FTSSW001	None[a]	---
	FTSW	Jan-96	2	1.75	1.75	1.75	FTSSW001	None[a]	---
	FTSW	Apr/May-96	1	1.75	1.75	1.75	FTSSW001	None[a]	---
	FTSW	Jun-98	3	2.00	2.30	2.10	FTSSL104	None[a]	---

TABLE 6-8

FROID AND TAYLOR ROADS, SUMMARY OF CHEMICALS IN SURFACE WATER COMPARED TO SCREENING VALUES
TIDAL AREA QEA, NWS SBD CONCORD

Analyte	Unit	Quarter Sampled	Total Number of Samples	Minimum Concentration Detected	Maximum Concentration Detected	Mean Concentration Detected	Location of Maximum Detection	Concord Tidal Area QEA Screening Value	Number of Samples that Exceed the Screening Value
CLP SVOAs (all values in μg/L)									
Total HMW PAHs	FTSW	Jul-95	2	50	50	50	FTSSW001	None[a]	---
	FTSW	Oct-95	1	250	250	250	FTSSW001	None[a]	---
	FTSW	Jan-96	2	50	50	50	FTSSW001	None[a]	---
	FTSW	Apr/May-96	1	50	50	50	FTSSW001	None[a]	---
	FTSW	Jun-98	3	50	50	50	FTSSL104	None[a]	---
Total LMW PAHs	FTSW	Jul-95	2	35	35	35	FTSSW001	None[a]	---
	FTSW	Oct-95	1	175	175	175	FTSSW001	None[a]	---
	FTSW	Jan-96	2	35	35	35	FTSSW001	None[a]	---
	FTSW	Apr/May-96	1	35	35	35	FTSSW001	None[a]	---
	FTSW	Jun-98	3	35	39	36	FTSSL104	None[a]	---
Total PAHs	FTSW	Jul-95	2	85	85	85	FTSSW001	15	2/2
	FTSW	Oct-95	1	425	425	425	FTSSW001	15	1/1
	FTSW	Jan-96	2	85	85	85	FTSSW001	15	2/2
	FTSW	Apr/May-96	1	85	85	85	FTSSW001	15	1/1
	FTSW	Jun-98	3	85	89	86	FTSSL104	15	3/3
CLP VOAs (all values in μg/L)									
Carbon Disulfide	FTSW	Jul-95	2	ND	ND	ND	---	None[a]	---
	FTSW	Oct-95	1	20.00	20.00	20.00	FTSSW001	None[a]	---
	FTSW	Jan-96	2	ND	ND	ND	---	None[a]	---
	FTSW	Apr/May-96	1	ND	ND	ND	---	None[a]	---
	FTSW	Jun-98	NA	NA	NA	NA	---	None[a]	---
CLP SVOAs (all values in μg/L)									
4-Methylphenol	FTSW	Jul-95	2	ND	ND	ND	---	None[a]	---
	FTSW	Oct-95	1	ND	ND	ND	---	None[a]	---
	FTSW	Jan-96	2	ND	ND	ND	---	None[a]	---
	FTSW	Apr/May-96	1	ND	ND	ND	---	None[a]	---
	FTSW	Jun-98	3	3.00	3.00	3.00	FTSSL102	None[a]	---

TABLE 6-8

FROID AND TAYLOR ROADS, SUMMARY OF CHEMICALS IN SURFACE WATER COMPARED TO SCREENING VALUES
TIDAL AREA QEA, NWS SBD CONCORD

Analyte	Unit	Quarter Sampled	Total Number of Samples	Minimum Concentration Detected	Maximum Concentration Detected	Mean Concentration Detected	Location of Maximum Detection	Concord Tidal Area QEA Screening Value	Number of Samples that Exceed the Screening Value
CLP SVOAs (all values in μg/L) (Continued)									
Chrysene	FTSW	Jul-95	2	ND	ND	ND	---	None[a]	---
	FTSW	Oct-95	1	ND	ND	ND	---	None[a]	---
	FTSW	Jan-96	2	ND	ND	ND	---	None[a]	---
	FTSW	Apr/May-96	1	ND	ND	ND	---	None[a]	---
	FTSW	Jun-98	3	0.60	0.60	0.60	FTSSL104	None[a]	---
Phenol	FTSW	Jul-95	2	ND	ND	ND	---	None[a]	---
	FTSW	Oct-95	1	ND	ND	ND	---	None[a]	---
	FTSW	Jan-96	2	ND	ND	ND	---	None[a]	---
	FTSW	Apr/May-96	1	ND	ND	ND	---	None[a]	---
	FTSW	Jun-98	3	0.90	0.90	0.90	FTSSL102	None[a]	---
TPH-Extractables (all values in mg/L)									
Diesel range organics	FTSW	Jul-95	2	0.25	0.29	0.27	FTSSW001	None[a]	---
	FTSW	Oct-95	1	2.00	2.00	2.00	FTSSW001	None[a]	---
	FTSW	Jan-96	2	0.084	0.120	0.102	FTSSW001	None[a]	---
	FTSW	Apr/May-96	1	ND	ND	ND	---	None[a]	---
	FTSW	Jun-98	NA	NA	NA	NA	---	None[a]	---
TPH-Extractables (all values in mg/L) (Continued)									
Motor oil range organics	FTSW	Jul-95	2	0.60	0.75	0.68	FTSSW002	None[a]	---
	FTSW	Oct-95	1	2.30	2.30	2.30	FTSSW001	None[a]	---
	FTSW	Jan-96	2	0.11	0.16	0.14	FTSSW001	None[a]	---
	FTSW	Apr/May-96	1	0.57	0.57	0.57	FTSSW001	None[a]	---
	FTSW	Jun-98	NA	NA	NA	NA	---	None[a]	---

Notes: For all surface water screening values please refer to Table 5-2.

BHC Hexachlorocyclohexane
CLP Contract laboratory program
DDT Dichlorodiphenyltrichloroethane
HMW High molecular weight
LMW Low molecular weight
NA Not analyzed
ND Not detected
PAH Polynuclear aromatic hydrocarbon
PCB Polychlorinated biphenyl
SVOA Semivolatile organic analyte
TPH Total petroleum hydrocarbons
VOA Volatile organic analyte
μg/L Microgram per liter
a No screening value is available
--- Not applicable

TABLE 6-9

WOOD HOGGER SITE
SUMMARY OF CHEMICALS IN SOIL AND SEDIMENT COMPARED TO SCREENING VALUES
TIDAL AREA QEA, NWS SBD CONCORD

Analyte	Depth[a]	Number of Samples Collected[b]	Number of Nondetect Results	Maximum Detected Conc.[b]	Location of Maximum Detection	Top Depth of Sample (ft. bgs)	Tidal Area Ambient Value (99UCL)[c]	SF Bay Ambient Value[d]	ER-L[e]	ER-M[e]	Number of Samples that Exceed Tidal Area Ambient Value[f]	Number of Samples that Exceed SF Bay Ambient Value[f]	Number of Samples that Exceed ER-L[f]	Number of Samples that Exceed ER-M[f]
Inorganic Chemicals (mg/kg)														
Aluminum	Surface	63	0	32,500.0	WHSSB024	0.0	27,300	NA	NA	NA	2/63	NA	NA	NA
	Subsurface	20	0	27,300.0	WHSSBF03	9.5	27,300	NA	NA	NA	0/20	NA	NA	NA
Antimony	Surface	63	19	7.1	WHSSB014	0.0	2.2	NA	2.0	25	12/63	NA	15/63	0/63
	Subsurface	20	14	5.7	WHSSBK06	4.5	2.2	NA	2.0	25	1/20	NA	1/20	0/20
Arsenic	Surface	63	4	27.1	WHSSBG02	0.0	27	15.3	8.2	70	1/63	8/63	21/63	0/63
	Subsurface	20	1	37	WHSSBK06	4.5	27	15.3	8.2	70	1/20	4/20	7/20	0/20
Barium	Surface	63	0	546	WHSSBE08	2.5	530	NA	NA	NA	1/63	NA	NA	NA
	Subsurface	20	0	415	WHSSBA06	13.0	530	NA	NA	NA	0/20	NA	NA	NA
Beryllium	Surface	63	43	0.52	WHSSB011	0.0	0.18	NA	NA	NA	8/63	NA	NA	NA
	Subsurface	20	14	0.25	S37-08	5.0	0.18	NA	NA	NA	1/20	NA	NA	NA
Cadmium	Surface	63	39	20.8	WHSSBI02	0.0	1.9	0.33	1.2	9.6	9/63	18/63	13/63	3/63
	Subsurface	20	18	1.9	WHSSBF03	4.5	1.9	0.33	1.2	9.6	0/20	1/20	1/20	0/20
Chromium	Surface	63	0	122	WHSSB014	0.0	82.1	112	81	370	2/63	1/63	2/63	0/63
	Subsurface	20	0	95.2	WHSSBF03	9.5	82.1	112	81	370	1/20	0/20	2/20	0/20
Chromium VI	Surface	2	1	60	WHSSBE08	0.0	NA	NA	NA	NA	NA	NA	NA	NA
Cobalt	Surface	63	0	30.2	WHSSB024	0.0	36	NA	NA	NA	0/63	NA	NA	NA
	Subsurface	20	0	35.6	WHSSBE08	9.0	36	NA	NA	NA	0/20	NA	NA	NA
Copper	Surface	63	3	607	WHSSBH03	0.0	81	68.1	34	270	9/63	14/63	28/63	1/63
	Subsurface	20	0	74.1	WHSSBE08	5.5	81	68.1	34	270	0/20	1/20	7/20	0/20
Lead	Surface	63	0	598	WHSSB014	0.0	95	43.2	46.7	218	14/63	20/63	20/63	4/63
	Subsurface	20	0	728	WHSSBF03	4.5	95	43.2	46.7	218	1/20	3/20	3/20	1/20
Manganese	Surface	63	0	1,300	WHSSB051	2.0	1,500	NA	NA	NA	0/63	NA	NA	NA
	Subsurface	20	0	1,470	WHSSBA06	4.5	1,500	NA	NA	NA	0/20	NA	NA	NA
Mercury	Surface	63	20	7.1	WHSSB024	0.0	0.32	0.43	0.15	0.71	13/63	9/63	27/63	5/63
	Subsurface	20	16	0.2	WHSSBK06	4.5	0.32	0.43	0.15	0.71	0/20	0/20	1/20	0/20
Molybdenum	Surface	63	44	5.6	WHSSBI08	0.0	6.6	NA	NA	NA	0/63	NA	NA	NA
	Subsurface	20	12	12.9	WHSSBH07	4.0	6.6	NA	NA	NA	1/20	NA	NA	NA
Nickel	Surface	63	1	103	WHSSBE08	2.5	120	112	20.9	51.6	0/63	0/63	53/63	20/63
	Subsurface	20	0	119	WHSSBE08	5.5	120	112	20.9	51.6	0/20	2/20	19/20	8/20
Selenium[g]	Surface	63	59	4.8	WHSSBC02	1.3	NA	0.64	0.70	1.40	NA	4/63	3/63	1/63
	Subsurface	20	20	ND	ND	ND	NA	0.64	0.70	1.40	ND	ND	ND	ND
Silver	Surface	63	53	4.4	WHSSB013	0.0	NA	0.58	1.0	3.7	NA	5/63	5/63	1/63
	Subsurface	20	20	ND	ND	ND	NA	0.58	1.0	3.7	ND	ND	ND	ND
Thallium	Surface	63	53	2.4	WHSSBD03	0.0	2.2	NA	NA	NA	1/63	NA	NA	NA
	Subsurface	20	19	1.8	WHSSBA06	4.5	2.2	NA	NA	NA	0/20	NA	NA	NA
Vanadium	Surface	63	0	163	WHSSBE08	2.5	96	NA	NA	NA	5/63	NA	NA	NA
	Subsurface	20	0	95.8	WHSSBE08	9.0	96	NA	NA	NA	0/20	NA	NA	NA
Zinc	Surface	63	6	3,010	WHSSBI02	0.0	264	158	150	410	15/63	21/63	24/63	10/63
	Subsurface	20	1	1,440	WHSSBF03	4.5	264	158	150	410	1/20	2/20	2/20	1/20

TABLE 6-9

WOOD HOGGER SITE
SUMMARY OF CHEMICALS IN SOIL AND SEDIMENT COMPARED TO SCREENING VALUES
TIDAL AREA QEA, NWS SBD CONCORD

Analyte	Depth[a]	Number of Samples Collected[b]	Number of Nondetect Results	Maximum Detected Conc.[b]	Location of Maximum Detection	Top Depth of Sample (ft. bgs)	Tidal Area Ambient Value (99UCL)[c]	SF Bay Ambient Value[d]	ER-L[e]	ER-M[e]	Number of Samples that Exceed Tidal Area Ambient Value[f]	Number of Samples that Exceed SF Bay Ambient Value[f]	Number of Samples that Exceed ER-L[f]	Number of Samples that Exceed ER-M[f]
Low Detection Limit PCBs (µg/kg)														
PCB-8 (2,4')	Surface	37	34	5.9	WHSSBI02	0.0	NA	NA	NA	NA	NA	NA	NA	NA
PCB-18 (2,2',5)	Surface	37	32	0.81	WHSSBI08	0.0	NA	NA	NA	NA	NA	NA	NA	NA
PCB-28 (2,4,4')	Surface	37	33	2.1	WHSSBI02	0.0	NA	NA	NA	NA	NA	NA	NA	NA
PCB-44 (2,2',3,5')	Surface	37	29	1.7	WHSSBI02	0.0	NA	NA	NA	NA	NA	NA	NA	NA
PCB-52 (2,2',5,5')	Surface	37	23	2.0	WHSSB013	0.0	NA	NA	NA	NA	NA	NA	NA	NA
PCB-66 (2,3',4,4')	Surface	37	32	1.0	WHSSB007	0.0	NA	NA	NA	NA	NA	NA	NA	NA
Low Detection Limit PCBs (µg/kg) (Continued)														
PCB-77 (3,3',4,4')	Surface	37	35	0.87	WHSSBB07	0.0	NA	NA	NA	NA	NA	NA	NA	NA
PCB-101 (2,2',3,5,5')	Surface	37	15	7.0	WHSSB014	0.0	NA	NA	NA	NA	NA	NA	NA	NA
PCB-105 (2,3,3',4,4')	Surface	37	19	3.0	WHSSB014	0.0	NA	NA	NA	NA	NA	NA	NA	NA
PCB-118 (2,3',4,4',5)	Surface	37	20	5.0	WHSSB014	0.0	NA	NA	NA	NA	NA	NA	NA	NA
PCB-126 (3,3',4,4',5)	Surface	37	33	0.56	WHSSBB07	0.0	NA	NA	NA	NA	NA	NA	NA	NA
PCB-128 (2,2',3,3',4,4')	Surface	37	32	3.0	WHSSB014	0.0	NA	NA	NA	NA	NA	NA	NA	NA
PCB-138 (2,2',3,4,4',5')	Surface	37	14	12	WHSSB014	0.0	NA	NA	NA	NA	NA	NA	NA	NA
PCB-153 (2,2',4,4',5,5')	Surface	37	20	9.6	WHSSBI02	0.0	NA	NA	NA	NA	NA	NA	NA	NA
PCB-170 (2,2',3,3',4,4',5)	Surface	37	28	6.6	WHSSBI02	0.0	NA	NA	NA	NA	NA	NA	NA	NA
PCB-180 (2,2',3,4,4',5,5')	Surface	37	18	15	WHSSBI02	0.0	NA	NA	NA	NA	NA	NA	NA	NA
PCB-187 (2,2',3,4',5,5',6)	Surface	37	22	6.7	WHSSBI02	0.0	NA	NA	NA	NA	NA	NA	NA	NA
PCB-195 (2,2',3,3',4,4',5,6)	Surface	37	33	1.3	WHSSBI02	0.0	NA	NA	NA	NA	NA	NA	NA	NA
PCB-206 (2,2',3,3',4,4',5,5',	Surface	37	26	0.86	WHSSBC02	0.0	NA	NA	NA	NA	NA	NA	NA	NA
PCB-209 (2,2',3,3',4,4',5,5',6	Surface	37	34	0.25	WHSSBC06	0.0	NA	NA	NA	NA	NA	NA	NA	NA
Total PCBs	Surface	37	0	73.5	WHSSB009	0.0	NA	14.8	22.7	180	NA	8/37	8/37	0/37
CLP PCBs (µg/kg)														
Total PCBs	Surface	22	0	1,595	S37-10	3.0	NA	14.8	22.7	180	NA	22/22	22/22	7/22
	Subsurface	20	0	1,035	WHSSBD03	18.5	NA	14.8	22.7	180	NA	20/20	20/20	8/20
Low Detection Limit Pesticides (µg/kg)														
2,4'-DDD	Surface	37	16	8.0	WHSSB014	0.0	NA	NA	NA	NA	NA	NA	NA	NA
2,4'-DDE	Surface	37	31	3.0	WHSSB014	0.0	NA	NA	NA	NA	NA	NA	NA	NA
2,4'-DDT	Surface	37	21	34	WHSSB016	0.0	NA	NA	NA	NA	NA	NA	NA	NA
4,4'-DDD	Surface	37	10	280	WHSSB009	0.0	NA	NA	2.0	20	NA	NA	13/37	3/37
4,4'-DDE	Surface	37	6	32	WHSSB016	0.0	NA	NA	2.2	27	NA	NA	10/37	2/37
4,4'-DDT	Surface	37	8	230	WHSSB016	0.0	NA	NA	1.0	7.0	NA	NA	15/37	8/37
Total DDTs	Surface	37	0	334.5	WHSSB009	0.0	NA	7.0	1.58	46.1	NA	14/37	26/37	6/37
Aldrin	Surface	37	32	0.48	WHSSBE08	0.0	NA	NA	NA	NA	NA	NA	NA	NA
gamma-BHC (Lindane)	Surface	37	34	2.0	WHSSB017	0.0	NA	NA	NA	NA	NA	NA	NA	NA
Total BHCs	Surface	37	0	3.5	WHSSB009	0.0	NA	0.78	NA	NA	NA	8/37	NA	NA
alpha-Chlordane	Surface	37	5	78	WHSSB015	0.0	NA	NA	NA	NA	NA	NA	NA	NA
Total Chlordanes	Surface	37	0	78	WHSSB015	0.0	NA	1.1	0.5	6.0	NA	14/37	23/37	7/37
Dieldrin	Surface	37	23	6.0	WHSSB015	0.0	NA	0.44	0.02	8.0	NA	12/37	14/37	0/37
Heptachlor	Surface	37	36	0.66	WHSSB007	0.0	NA	NA	NA	NA	NA	NA	NA	NA

TABLE 6-9

WOOD HOGGER SITE
SUMMARY OF CHEMICALS IN SOIL AND SEDIMENT COMPARED TO SCREENING VALUES
TIDAL AREA QEA, NWS SBD CONCORD

Analyte	Depth[a]	Number of Samples Collected[b]	Number of Nondetect Results	Maximum Detected Conc.[b]	Location of Maximum Detection	Top Depth of Sample (ft. bgs)	Tidal Area Ambient Value (99UCL)[c]	SF Bay Ambient Value[d]	ER-L[e]	ER-M[e]	Number of Samples that Exceed Tidal Area Ambient Value[f]	Number of Samples that Exceed SF Bay Ambient Value[f]	Number of Samples that Exceed ER-L[f]	Number of Samples that Exceed ER-M[f]
Low Detection Limit Pesticides (µg/kg) (Continued)														
Heptachlor Epoxide	Surface	37	33	6.0	WHSSB015	0.0	NA	NA	NA	NA	NA	NA	NA	NA
Hexachlorobenzene	Surface	37	33	0.37	WHSSBB07	0.0	NA	0.48	NA	NA	NA	0/37	NA	NA
Mirex	Surface	37	27	5.0	WHSSB014	0.0	NA	NA	NA	NA	NA	NA	NA	NA
trans-Nonachlor	Surface	37	7	65	WHSSB015	0.0	NA	NA	NA	NA	NA	NA	NA	NA
CLP Pesticides (µg/kg)														
4,4'-DDD	Surface	22	20	7.4	WHSSBD07	1.5	NA	NA	2.0	20	NA	NA	2/22	0/22
	Subsurface	20	18	8.8	WHSSBF03	4.5	NA	NA	2.0	20	NA	NA	2/20	0/20
4,4'-DDE	Surface	22	21	1.5	WHSSBD07	1.5	NA	NA	2.2	27	NA	NA	0/22	0/22
4,4'-DDT	Surface	22	21	3.5	WHSSBD07	1.5	NA	NA	1.0	7.0	NA	NA	1/22	0/22
	Subsurface	20	18	11	WHSSBF03	4.5	NA	NA	1.0	7.0	NA	NA	2/20	1/20
Total DDTs	Surface	22	0	60	S37-10	3.0	NA	7.0	1.58	46.1	NA	8/22	22/22	1/22
	Subsurface	20	0	39	WHSSBD03	18.5	NA	7.0	1.58	46.1	NA	9/20	20/20	0/20
CLP Pesticides (µg/kg) (Continued)														
Total BHCs	Surface	22	0	40	S37-10	3.0	NA	0.78	NA	NA	NA	22/22	NA	NA
	Subsurface	20	0	26	WHSSBD03	18.5	NA	0.78	NA	NA	NA	20/20	NA	NA
alpha-Chlordane	Surface	22	21	1.5	WHSSBD07	1.5	NA	NA	NA	NA	NA	NA	NA	NA
Total Chlordanes	Surface	22	0	20	S37-10	3.0	NA	1.1	0.5	6.0	NA	22/22	22/22	3/22
	Subsurface	20	0	13	WHSSBD03	18.5	NA	1.1	0.5	6.0	NA	20/20	20/20	4/20
Endrin Ketone	Subsurface	20	19	3.7	S37-08	5.0	NA	NA	NA	NA	NA	NA	NA	NA
Dioxins (µg/kg)														
1,2,3,4,6,7,8,9-OCDD	Surface	7	2	140	WHSSB016	0.0	NA	NA	NA	NA	NA	NA	NA	NA
1,2,3,4,6,7,8,9-OCDF	Surface	7	5	13	WHSSB016	0.0	NA	NA	NA	NA	NA	NA	NA	NA
1,2,3,4,6,7,8-HPCDD	Surface	8	5	16	WHSSB016	0.0	NA	NA	NA	NA	NA	NA	NA	NA
1,2,3,4,6,7,8-HPCDF	Surface	8	5	3.0	WHSSB016	0.0	NA	NA	NA	NA	NA	NA	NA	NA
Total HPCDDs	Surface	2	1	0.8	WHSSB019	0.0	NA	NA	NA	NA	NA	NA	NA	NA
	Surface	7	3	41	WHSSB007	0.0	NA	NA	NA	NA	NA	NA	NA	NA
Total HPCDFs	Surface	2	1	0.29	WHSSB019	0.0	NA	NA	NA	NA	NA	NA	NA	NA
	Surface	7	4	13	WHSSB016	0.0	NA	NA	NA	NA	NA	NA	NA	NA
Total HXCDF	Surface	7	5	4.0	WHSSB016	0.0	NA	NA	NA	NA	NA	NA	NA	NA
Total OCDD	Surface	2	0	3.8	WHSSB019	0.0	NA	NA	NA	NA	NA	NA	NA	NA
Total TCDD	Surface	7	0	6.0	WHSSB007	0.0	NA	NA	NA	NA	NA	NA	NA	NA
Low Detection Limit SVOAs (µg/kg)														
1-Methylphenanthrene	Surface	37	35	350	WHSSBC06	0.0	NA	31.7	NA	NA	NA	1/37	NA	NA
Acenaphthene	Surface	37	33	280	WHSSBC06	0.0	NA	26.6	16	500	NA	4/37	4/37	0/37
Acenaphthylene	Surface	37	36	270	WHSSBC06	0.0	NA	31.7	44	640	NA	1/37	1/37	0/37
Anthracene	Surface	37	27	2,100	WHSSBC06	0.0	NA	88	85.3	1,100	NA	7/37	7/37	1/37
Benzo(a)anthracene	Surface	37	26	3,800	WHSSBC06	0.0	NA	244	261	1,600	NA	4/37	4/37	1/37
Benzo(a)pyrene	Surface	37	26	2,700	WHSSBC06	0.0	NA	412	430	1,600	NA	2/37	2/37	1/37
Benzo(b)fluoranthene	Surface	37	25	3,100	WHSSBC06	0.0	NA	371	NA	NA	NA	4/37	NA	NA
Benzo(e)pyrene	Surface	37	16	2,400	WHSSB016	0.0	NA	294	NA	NA	NA	9/37	NA	NA

TABLE 6-9

WOOD HOGGER SITE
SUMMARY OF CHEMICALS IN SOIL AND SEDIMENT COMPARED TO SCREENING VALUES
TIDAL AREA QEA, NWS SBD CONCORD

Analyte	Depth[a]	Number of Samples Collected[b]	Number of Nondetect Results	Maximum Detected Conc.[b]	Location of Maximum Detection	Top Depth of Sample (ft. bgs)	Tidal Area Ambient Value (99UCL)[c]	SF Bay Ambient Value[d]	ER-L[e]	ER-M[e]	Number of Samples that Exceed Tidal Area Ambient Value[f]	Number of Samples that Exceed SF Bay Ambient Value[f]	Number of Samples that Exceed ER-L[f]	Number of Samples that Exceed ER-M[f]
Low Detection Limit SVOAs (µg/kg) (Continued)														
Benzo(g,h,i)perylene	Surface	37	28	1,100	WHSSBC06	0.0	NA	310	NA	NA	NA	2/37	NA	NA
Benzo(k)fluoranthene	Surface	37	27	3,400	WHSSBC06	0.0	NA	258	NA	NA	NA	2/37	NA	NA
Benzoic Acid	Surface	37	30	2,300	WHSSBC02	0.0	NA	NA	NA	NA	NA	NA	NA	NA
Butylbenzylphthalate	Surface	37	36	78	WHSSB012	0.0	NA	NA	NA	NA	NA	NA	NA	NA
Carbazole	Surface	37	25	880	WHSSBC06	0.0	NA	NA	NA	NA	NA	NA	NA	NA
Chrysene	Surface	37	22	6,400	WHSSBC06	0.0	NA	289	384	2,800	NA	8/37	5/37	2/37
Dibenz(a,h)anthracene	Surface	37	33	600	WHSSBC06	0.0	NA	32.7	63.4	260	NA	3/37	3/37	1/37
Dibenzofuran	Surface	37	35	170	WHSSBC06	0.0	NA	NA	NA	NA	NA	NA	NA	NA
Dibenzothiophene	Surface	37	34	170	WHSSBC06	0.0	NA	NA	NA	NA	NA	NA	NA	NA
Fluoranthene	Surface	37	10	14,000	WHSSBC06	0.0	NA	514	600	5,100	NA	12/37	11/37	2/37
Fluorene	Surface	37	33	350	WHSSBC06	0.0	NA	25.3	19	540	NA	3/37	4/37	0/37
Indeno(1,2,3-cd)pyrene	Surface	37	29	1,200	WHSSBC06	0.0	NA	382	NA	NA	NA	2/37	NA	NA
Naphthalene	Surface	37	36	110	WHSSB013	0.0	NA	55.8	160	2,100	NA	1/37	0/37	0/37
Pentachlorophenol	Surface	32	28	780	WHSSBC06	0.0	NA	NA	NA	NA	NA	NA	NA	NA
Perylene	Surface	37	33	840	WHSSBC06	0.0	NA	145	NA	NA	NA	2/37	NA	NA
Phenanthrene	Surface	37	19	4,000	WHSSB016	0.0	NA	237	240	1,500	NA	12/37	10/37	2/37
Pyrene	Surface	37	11	13,000	WHSSBC06	0.0	NA	665	665	2,600	NA	9/37	9/37	2/37
Total HMW PAHs	Surface	37	0	132,000	WHSSBI02	0.0	NA	3,060	1,700	9,600	NA	22/37	28/37	8/37
Total LMW PAHs	Surface	37	0	99,000	WHSSBI02	0.0	NA	434	552	3,160	NA	30/37	30/37	18/37
Total PAHs	Surface	37	0	231,000	WHSSBI02	0.0	NA	3,390	4,022	44,792	NA	26/37	24/37	3/37
CLP SVOAs (µg/kg)														
Benzo(b)fluoranthene	Subsurface	21	20	440	WHSSBF03	4.5	NA	371	NA	NA	NA	1/21	NA	NA
Carbazole	Subsurface	21	20	350	WHSSBF03	4.5	NA	NA	NA	NA	NA	NA	NA	NA
Chrysene	Subsurface	21	20	330	WHSSBF03	4.5	NA	289	384	2,800	NA	1/21	0/21	0/21
Fluoranthene	Subsurface	21	20	780	WHSSBF03	4.5	NA	514	600	5,100	NA	1/21	1/21	0/21
Phenanthrene	Subsurface	21	20	490	WHSSBF03	4.5	NA	237	240	1,500	NA	1/21	1/21	0/21
Phenol	Surface	24	17	2,600	WHSSBK06	1.5	NA	NA	NA	NA	NA	NA	NA	NA
	Subsurface	21	15	4,600	WHSSBG06	9.0	NA	NA	NA	NA	NA	NA	NA	NA
Pyrene	Subsurface	21	20	640	WHSSBF03	4.5	NA	665	665	2,600	NA	0/21	0/21	0/21
Total HMW PAHs	Surface	24	0	9,500	WHSSBD03	1.5	NA	3,060	1,700	9,600	NA	5/24	23/24	0/24
	Subsurface	21	0	100,000	WHSSB030	3.2	NA	3,060	1,700	9,600	NA	9/21	21/21	4/21
Total LMW PAHs	Surface	24	0	6,650	WHSSBD03	1.5	NA	434	552	3,160	NA	24/24	24/24	3/24
	Subsurface	21	0	70,000	WHSSB030	3.2	NA	434	552	3,160	NA	21/21	21/21	8/21
Total PAHs	Surface	24	0	16,150	WHSSBD03	1.5	NA	3,390	4,022	44,792	NA	13/24	5/24	0/24
	Subsurface	21	0	170,000	WHSSB030	3.2	NA	3,390	4,022	44,792	NA	20/21	9/21	1/21
CLP VOAs (µg/kg)														
2-Butanone	Subsurface	20	18	720	WHSSBK06	4.5	NA	NA	NA	NA	NA	NA	NA	NA
Acetone	Surface	21	20	300	WHSSBF03	1.5	NA	NA	NA	NA	NA	NA	NA	NA
Carbon Disulfide	Surface	21	20	81	WHSSBD03	1.5	NA	NA	NA	NA	NA	NA	NA	NA
	Subsurface	20	16	290	WHSSBD03	4.5	NA	NA	NA	NA	NA	NA	NA	NA
Xylene (Total)	Surface	21	20	26	WHSSBC02	1.3	NA	NA	NA	NA	NA	NA	NA	NA
	Subsurface	20	19	54	WHSSBC02	4.0	NA	NA	NA	NA	NA	NA	NA	NA

TABLE 6-9

WOOD HOGGER SITE
SUMMARY OF CHEMICALS IN SOIL AND SEDIMENT COMPARED TO SCREENING VALUES
TIDAL AREA QEA, NWS SBD CONCORD

Analyte	Depth[a]	Number of Samples Collected[b]	Number of Nondetect Results	Maximum Detected Conc.[b]	Location of Maximum Detection	Top Depth of Sample (ft. bgs)	Tidal Area Ambient Value (99UCL)[c]	SF Bay Ambient Value[d]	ER-L[e]	ER-M[e]	Number of Samples that Exceed Tidal Area Ambient Value[f]	Number of Samples that Exceed SF Bay Ambient Value[f]	Number of Samples that Exceed ER-L[f]	Number of Samples that Exceed ER-M[f]
Aromatic Volatiles (µg/kg)														
Ethylbenzene	Subsurface	1	0	160	WHSSB030	3.2	NA	NA	NA	NA	NA	NA	NA	NA
Xylene (total)	Subsurface	1	0	220	WHSSB030	3.2	NA	NA	NA	NA	NA	NA	NA	NA
TPH-Extractables (mg/kg)														
Diesel	Subsurface	3	2	2,300	WHSSB030	3.2	NA	NA	NA	NA	NA	NA	NA	NA
Motor Oil	Surface	2	1	640	WHSSBD07	1.5	NA	NA	NA	NA	NA	NA	NA	NA
	Subsurface	3	2	8,900	WHSSB030	3.2	NA	NA	NA	NA	NA	NA	NA	NA
TPH-Purgeables (mg/kg)														
Gasoline	Surface	2	1	0.47	WHSSBD07	1.5	NA	NA	NA	NA	NA	NA	NA	NA
	Subsurface	3	2	26	WHSSB030	3.2	NA	NA	NA	NA	NA	NA	NA	NA
Explosives (µg/kg)														
1,3-Dinitrobenzene	Surface	19	18	130	S37-03	0.0	NA	NA	NA	NA	NA	NA	NA	NA
HMX	Surface	19	18	357	WHSSBH07	1.3	NA	NA	NA	NA	NA	NA	NA	NA

Notes:
Where total values were calculated (for example, total PCBs, total DDTs, etc.) 1/2 of the standard quantitation limit (SQL) was used for nondetected analytes.

bgs	Below ground surface	HXCDF	Hexachlorodibenzofuran
BHC	Hexachlorocyclohexane	LMW	Low molecular weight
CLP	Contract Laboratory Program	mg/kg	Milligrams per kilogram
Conc.	Concentration	NA	Screening value not available
DDD	Dichlorodiphenyldichloroethane	ND	Nondetected
DDE	Dichlorodiphenyldichloroethene	OCDD	Octachlorodibenzo-p-dioxin
DDT	Dichlorodiphenyltrichloroethane	OCDF	Octachlorodibenzofuran
ER-L	Effects range-low	PAH	Polycyclic aromatic hydrocarbon
ER-M	Effects range-median	PCB	Polychlorinated biphenyl
ft.	feet	SVOA	Semivolatile organic analyte
HMW	High molecular weight	TCDD	Tetrachlorodibenzo-p-dioxin
HMX	Cyclotetramethylene tetranitramine	UCL	Upper confidence limit
HPCDD	Heptachlorodibenzo-p-dioxin	µg/kg	Micrograms per kilogram
HPCDF	Heptachlorodibenzofuran	VOA	Volatile organic analyte

a Surface samples are those collected between 0 and 3 feet bgs; subsurface samples are those collected greater than 3 feet bgs.
b If more than one sample was analyzed in the surface and subsurface depth ranges, only the highest result from the interval is reported and used in the data set.
c FRC Environmental Management, Inc (FRC). 1996a. "Estimation of Ambient Metals Concentrations in the Tidal Area Soils. Technical Memorandum. Naval Weapons Station, Concord, California." March.
d San Francisco Bay Regional Water Quality Control Board (RWQCB). 1998. "Ambient Concentrations of Toxic Chemicals in Sediments." April.
e National Oceanic and Atmospheric Administration (NOAA). 1991. "The Potential for Biological Effects of Sediment-Sorbed Contaminants Tested in the National Status and Trends Program." Technical Memorandum NOS OMA 52. NOAA, Office of Oceanography and Marine Assessment. Seattle, Washington.
Long, E.R., D. D. MacDonald, S.L. Smith, F.D. Calder. 1995. "Incidence of Adverse Biological Effects Within Ranges of Chemical Concentrations in Marine and Estuarine Sediments." *Environmental Management* Volume 19. Number 1. Pages 81 through 97.
f Number of samples that exceeded screening value / number of samples
g Detection limits were below screening values for all chemicals except selenium. The median detection limit for selenium exceeded the ER-L value.

TABLE 6-10

WOOD HOGGER SITE, SUMMARY OF CHEMICALS IN SURFACE WATER COMPARED TO SCREENING VALUES
TIDAL AREA QEA, NWS SBD CONCORD

Analyte	Unit	Quarter Sampled	Total Number of Samples	Minimum Concentration Detected	Maximum Concentration Detected	Mean Concentration Detected	Location of Maximum Detection	Concord Tidal Area QEA Screening Value	Number of Samples that Exceed the Screening Value
Inorganic Chemicals (all values in µg/L)									
Aluminum	WHSSW	Jul-95	2	ND	ND	ND	---	87	0/2
	WHSSW	Oct-95	2	428	428	428	WHSSW006	87	1/2
	WHSSW	Jan-96	2	166	206	186	WHSSW005	87	2/2
	WHSSW	Apr/May-96	2	332	748	540	WHSSW005	87	2/2
	WHSSW	Jun-98	NA	NA	NA	NA	---	87	NA
Antimony	WHSSW	Jul-95	2	ND	ND	ND	---	None[a]	---
	WHSSW	Oct-95	2	3.60	3.60	3.60	WHSSW005	None[a]	---
	WHSSW	Jan-96	2	ND	ND	ND	---	None[a]	---
	WHSSW	Apr/May-96	2	2.60	2.60	2.60	WHSSW005	None[a]	---
	WHSSW	Jun-98	NA	NA	NA	NA	---	None[a]	NA
Arsenic	WHSSW	Jul-95	2	ND	ND	ND	---	36	0/2
	WHSSW	Oct-95	2	ND	ND	ND	---	36	0/2
	WHSSW	Jan-96	2	2.40	2.40	2.40	WHSSW005	36	0/2
	WHSSW	Apr/May-96	2	11.80	11.80	11.80	WHSSW006	36	0/2
	WHSSW	Jun-98	NA	NA	NA	NA	---	36	NA
Barium	WHSSW	Jul-95	2	85.20	94.50	89.85	WHSSW005	None[a]	---
	WHSSW	Oct-95	2	110.00	173.00	141.50	WHSSW005	None[a]	---
	WHSSW	Jan-96	2	36.50	130.00	83.25	WHSSW006	None[a]	---
	WHSSW	Apr/May-96	2	106.00	119.00	112.50	WHSSW006	None[a]	---
	WHSSW	Jun-98	NA	NA	NA	NA	---	None[a]	NA
Cadmium	WHSSW	Jul-95	2	ND	ND	ND	---	1.1	0/2
	WHSSW	Oct-95	2	ND	ND	ND	---	1.1	0/2
	WHSSW	Jan-96	2	ND	ND	ND	---	1.1	0/2
	WHSSW	Apr/May-96	2	0.54	2.50	1.52	WHSSW005	1.1	1/2
	WHSSW	Jun-98	NA	NA	NA	NA	---	1.1	NA
Chromium	WHSSW	Jul-95	2	ND	ND	ND	---	86	0/2
	WHSSW	Oct-95	2	1.10	1.10	1.10	WHSSW006	86	0/2
	WHSSW	Jan-96	2	ND	ND	ND	---	86	0/2
	WHSSW	Apr/May-96	2	1.50	1.90	1.70	WHSSW006	86	0/2
	WHSSW	Jun-98	NA	NA	NA	NA	---	86	NA

TABLE 6-10

WOOD HOGGER SITE, SUMMARY OF CHEMICALS IN SURFACE WATER COMPARED TO SCREENING VALUES
TIDAL AREA QEA, NWS SBD CONCORD

Analyte	Unit	Quarter Sampled	Total Number of Samples	Minimum Concentration Detected	Maximum Concentration Detected	Mean Concentration Detected	Location of Maximum Detection	Concord Tidal Area QEA Screening Value	Number of Samples that Exceed the Screening Value
Inorganic Chemicals (all values in μg/L) (Continued)									
Cobalt	WHSSW	Jul-95	2	0.52	1.00	0.76	WHSSW005	None[a]	---
	WHSSW	Oct-95	2	0.59	0.78	0.69	WHSSW006	None[a]	---
	WHSSW	Jan-96	2	0.56	0.56	0.56	WHSSW006	None[a]	---
	WHSSW	Apr/May-96	2	ND	ND	ND	---	None[a]	---
	WHSSW	Jun-98	NA	NA	NA	NA	---	None[a]	NA
Copper	WHSSW	Jul-95	2	9.50	11.60	10.55	WHSSW005	3.2	2/2
	WHSSW	Oct-95	2	5.70	6.10	5.90	WHSSW006	3.2	2/2
	WHSSW	Jan-96	2	11.60	11.60	11.60	WHSSW005	3.2	1/2
	WHSSW	Apr/May-96	2	3.00	13.70	8.35	WHSSW005	3.2	1/2
	WHSSW	Jun-98	NA	NA	NA	NA	---	3.2	NA
Iron	WHSSW	Jul-95	2	782	1,500	1,141	WHSSW005	None[a]	---
	WHSSW	Oct-95	2	537	693	615	WHSSW006	None[a]	---
	WHSSW	Jan-96	2	583	720	652	WHSSW005	None[a]	---
	WHSSW	Apr/May-96	2	1,530	2,500	2,015	WHSSW005	None[a]	---
	WHSSW	Jun-98	NA	NA	NA	NA	---	None[a]	NA
Lead	WHSSW	Jul-95	2	2.80	2.80	2.80	WHSSW005	3.1	0/2
	WHSSW	Oct-95	2	ND	ND	ND	---	3.1	0/2
	WHSSW	Jan-96	2	ND	ND	ND	---	3.1	0/2
	WHSSW	Apr/May-96	2	3.70	3.70	3.70	WHSSW005	3.1	1/2
	WHSSW	Jun-98	NA	NA	NA	NA	---	3.1	NA
Manganese	WHSSW	Jul-95	2	311	330	321	WHSSW006	None[a]	---
	WHSSW	Oct-95	2	107	122	115	WHSSW005	None[a]	---
	WHSSW	Jan-96	2	144	469	307	WHSSW006	None[a]	---
	WHSSW	Apr/May-96	2	170	1,950	1,060	WHSSW006	None[a]	---
	WHSSW	Jun-98	NA	NA	NA	NA	---	None[a]	NA
Mercury	WHSSW	Jul-95	2	ND	ND	ND	---	0.025	0/2
	WHSSW	Oct-95	2	ND	ND	ND	---	0.025	0/2
	WHSSW	Jan-96	2	ND	ND	ND	---	0.025	0/2
	WHSSW	Apr/May-96	2	0.20	0.20	0.20	WHSSW005	0.025	1/2
	WHSSW	Jun-98	NA	NA	NA	NA	---	0.025	NA

TABLE 6-10

WOOD HOGGER SITE, SUMMARY OF CHEMICALS IN SURFACE WATER COMPARED TO SCREENING VALUES
TIDAL AREA QEA, NWS SBD CONCORD

Analyte	Unit	Quarter Sampled	Total Number of Samples	Minimum Concentration Detected	Maximum Concentration Detected	Mean Concentration Detected	Location of Maximum Detection	Concord Tidal Area QEA Screening Value	Number of Samples that Exceed the Screening Value
Inorganic Chemicals (all values in µg/L) (Continued)									
Molybdenum	WHSSW	Jul-95	2	ND	ND	ND	---	None[a]	---
	WHSSW	Oct-95	2	1.80	3.00	2.40	WHSSW005	None[a]	---
	WHSSW	Jan-96	2	ND	ND	ND	---	None[a]	---
	WHSSW	Apr/May-96	2	7.30	7.30	7.30	WHSSW005	None[a]	---
	WHSSW	Jun-98	NA	NA	NA	NA	---	None[a]	NA
Nickel	WHSSW	Jul-95	2	ND	ND	ND	---	8.2	0/2
	WHSSW	Oct-95	2	3.60	4.90	4.25	WHSSW005	8.2	0/2
	WHSSW	Jan-96	2	2.60	3.20	2.90	WHSSW005	8.2	0/2
	WHSSW	Apr/May-96	2	5.90	6.20	6.05	WHSSW006	8.2	0/2
	WHSSW	Jun-98	NA	NA	NA	NA	---	8.2	NA
Vanadium	WHSSW	Jul-95	2	ND	ND	ND	---	None[a]	---
	WHSSW	Oct-95	2	ND	ND	ND	---	None[a]	---
	WHSSW	Jan-96	2	ND	ND	ND	---	None[a]	---
	WHSSW	Apr/May-96	2	5.10	10.40	7.75	WHSSW006	None[a]	---
	WHSSW	Jun-98	NA	NA	NA	NA	---	None[a]	NA
Zinc	WHSSW	Jul-95	2	69.80	329.00	199.40	WHSSW005	58	2/2
	WHSSW	Oct-95	2	160.00	160.00	160.00	WHSSW005	58	1/2
	WHSSW	Jan-96	2	110.00	110.00	110.00	WHSSW005	58	1/2
	WHSSW	Apr/May-96	2	24.30	318.00	171.15	WHSSW005	58	1/2
	WHSSW	Jun-98	NA	NA	NA	NA	---	58	NA
CLP Pesticides (all values in µg/L)									
Total BHC	WHSSW	Jul-95	2	0.10	0.10	0.10	WHSSW005	None[a]	---
	WHSSW	Oct-95	2	0.10	0.10	0.10	WHSSW005	None[a]	---
	WHSSW	Jan-96	2	0.10	0.10	0.10	WHSSW005	None[a]	---
	WHSSW	Apr/May-96	2	0.10	0.104	0.102	WHSSW006	None[a]	---
	WHSSW	Jun-98	NA	NA	NA	NA	---	None[a]	NA
Total Chlordanes	WHSSW	Jul-95	2	0.05	0.05	0.05	WHSSW005	0.004	2/2
	WHSSW	Oct-95	2	0.05	0.05	0.05	WHSSW005	0.004	2/2
	WHSSW	Jan-96	2	0.05	0.05	0.05	WHSSW005	0.004	2/2
	WHSSW	Apr/May-96	2	0.05	0.052	0.051	WHSSW006	0.004	2/2
	WHSSW	Jun-98	NA	NA	NA	NA	---	0.004	NA

TABLE 6-10

WOOD HOGGER SITE, SUMMARY OF CHEMICALS IN SURFACE WATER COMPARED TO SCREENING VALUES
TIDAL AREA QEA, NWS SBD CONCORD

Analyte	Unit	Quarter Sampled	Total Number of Samples	Minimum Concentration Detected	Maximum Concentration Detected	Mean Concentration Detected	Location of Maximum Detection	Concord Tidal Area QEA Screening Value	Number of Samples that Exceed the Screening Value
CLP Pesticides (all values in µg/L) (Continued)									
Total DDTs	WHSSW	Jul-95	2	0.15	0.15	0.15	WHSSW005	None[a]	---
	WHSSW	Oct-95	2	0.15	0.15	0.15	WHSSW005	None[a]	---
	WHSSW	Jan-96	2	0.15	0.15	0.15	WHSSW005	None[a]	---
	WHSSW	Apr/May-96	2	0.15	0.15	0.15	WHSSW005	None[a]	---
	WHSSW	Jun-98	NA	NA	NA	NA	---	None[a]	NA
Total PCBs	WHSSW	Jul-95	2	1.75	1.75	1.75	WHSSW005	None[a]	---
	WHSSW	Oct-95	2	1.75	1.75	1.75	WHSSW005	None[a]	---
	WHSSW	Jan-96	2	1.75	1.75	1.75	WHSSW005	None[a]	---
	WHSSW	Apr/May-96	2	1.75	1.82	1.79	WHSSW006	None[a]	---
	WHSSW	Jun-98	NA	NA	NA	NA	---	None[a]	NA
CLP SVOAs (all values in µg/L)									
Total HMW PAHs	WHSSW	Jul-95	2	50	50	50	WHSSW005	None[a]	---
	WHSSW	Oct-95	2	50	50	50	WHSSW005	None[a]	---
	WHSSW	Jan-96	2	50	250	150	WHSSW005	None[a]	---
	WHSSW	Apr/May-96	2	50	50	50	WHSSW005	None[a]	---
	WHSSW	Jun-98	NA	NA	NA	NA	---	None[a]	NA
Total LMW PAHs	WHSSW	Jul-95	2	35	35	35	WHSSW005	None[a]	---
	WHSSW	Oct-95	2	35	35	35	WHSSW005	None[a]	---
	WHSSW	Jan-96	2	35	175	105	WHSSW005	None[a]	---
	WHSSW	Apr/May-96	2	35	35	35	WHSSW005	None[a]	---
	WHSSW	Jun-98	NA	NA	NA	NA	---	None[a]	NA
Total PAHs	WHSSW	Jul-95	2	85	85	85	WHSSW005	15	2/2
	WHSSW	Oct-95	2	85	85	85	WHSSW005	15	2/2
	WHSSW	Jan-96	2	85	425	255	WHSSW005	15	2/2
	WHSSW	Apr/May-96	2	85	85	85	WHSSW005	15	2/2
	WHSSW	Jun-98	NA	NA	NA	NA	---	15	NA

TABLE 6-10

WOOD HOGGER SITE, SUMMARY OF CHEMICALS IN SURFACE WATER COMPARED TO SCREENING VALUES
TIDAL AREA QEA, NWS SBD CONCORD

Analyte	Unit	Quarter Sampled	Total Number of Samples	Minimum Concentration Detected	Maximum Concentration Detected	Mean Concentration Detected	Location of Maximum Detection	Concord Tidal Area QEA Screening Value	Number of Samples that Exceed the Screening Value
CLP VOAs (all values in μg/L)									
Xylene (total)	WHSSW	Jul-95	2	8.00	8.00	8.00	WHSSW006	None[a]	---
	WHSSW	Oct-95	2	ND	ND	ND	---	None[a]	---
	WHSSW	Jan-96	2	ND	ND	ND	---	None[a]	---
	WHSSW	Apr/May-96	2	ND	ND	ND	---	None[a]	---
	WHSSW	Jun-98	NA	NA	NA	NA	---	None[a]	NA

Notes: For all surface water screening values please refer to Table 5-2.

BHC Hexachlorocyclohexane
CLP Contract laboratory program
DDT Dichlorodiphenyltrichloroethane
HMW High molecular weight
LMW Low molecular weight
NA Not analyzed
ND Not detected
PAH Polynuclear aromatic hydrocarbon
PCB Polychlorinated biphenyl
SVOA Semivolatile organic analyte
VOA Volatile organic analyte
μg/L Microgram per liter

a No screening value is available
--- Not applicable

TABLE 6-11

NORTH OTTER SLUICE UNIT
SUMMARY OF CHEMICALS IN SOIL AND SEDIMENT COMPARED TO SCREENING VALUES
TIDAL AREA QEA, NWS SBD CONCORD

Analyte	Depth[a]	Number of Samples Collected[b]	Number of Nondetect Results	Maximum Detected Conc.[b]	Location of Maximum Detection	Top Depth of Sample (ft. bgs)	Tidal Area Ambient Value (99UCL)[c]	SF Bay Ambient Value[d]	ER-L[e]	ER-M[e]	Number of Samples that Exceed Tidal Area Ambient Value[f]	Number of Samples that Exceed SF Bay Ambient Value[f]	Number of Samples that Exceed ER-L[f]	Number of Samples that Exceed ER-M[f]
Inorganic Chemicals (mg/kg)														
Aluminum	Surface	19	0	30,300	RADSB004	0.0	27,300	NA	NA	NA	4/19	NA	NA	NA
Antimony	Surface	18	10	7.1	RADSBA07	0.0	2.2	NA	2.0	25	3/18	NA	3/18	0/18
Arsenic	Surface	19	0	47.2	RADSBA07	0.0	27	15.3	8.2	70	3/19	8/19	16/19	0/19
Barium	Surface	19	0	196	RADSBA02	0.0	530	NA	NA	NA	0/19	NA	NA	NA
Beryllium	Surface	19	16	0.22	OSLSL002	0.0	0.18	NA	NA	NA	3/19	NA	NA	NA
Cadmium	Surface	19	14	0.77	OSLSL002	0.0	1.9	0.33	1.2	9.6	0/19	5/19	0/19	0/19
Chromium	Surface	19	0	319	RADSBA07	0.0	82.1	112	81	370	4/19	1/19	8/19	0/19
Cobalt	Surface	19	0	31.5	RADSB003	0.0	36	NA	NA	NA	0/19	NA	NA	NA
Copper	Surface	19	0	272	RADSBA07	0.0	81	68.1	34	270	3/19	6/19	19/19	1/19
Lead	Surface	19	0	182	RADSBA02	0.0	95	43.2	46.7	218	3/19	9/19	8/19	0/19
Manganese	Surface	19	0	897	RADSB006	0.0	1,500	NA	NA	NA	0/19	NA	NA	NA
Mercury	Surface	19	5	1.6	RADSL001	0.0	0.32	0.43	0.15	0.71	13/19	9/19	14/19	3/19
Molybdenum	Surface	19	17	53.7	RADSBA07	0.0	6.6	NA	NA	NA	1/19	NA	NA	NA
Nickel	Surface	19	0	140	RADSBA07	0.0	120	112	20.9	51.6	1/19	2/19	19/19	18/19
Selenium[g]	Surface	19	18	1.2	OSLSL001	0.0	NA	0.64	0.70	1.40	NA	1/19	1/19	0/19
Silver	Surface	19	16	0.62	RADSB006	0.0	NA	0.58	1.0	3.7	NA	1/19	0/19	0/19
Thallium	Surface	19	16	1.8	OSLSL001	0.0	2.2	NA	NA	NA	0/19	NA	NA	NA
Vanadium	Surface	19	0	105	RADSL002	0.0	96	NA	NA	NA	6/19	NA	NA	NA
Zinc	Surface	19	0	496	RADSBA07	0.0	264	158	150	410	5/19	14/19	15/19	2/19
Low Detection Limit PCBs (µg/kg)														
PCB-8 (2,4')	Surface	15	9	1.4	RADSB003	0.0	NA	NA	NA	NA	NA	NA	NA	NA
PCB-18 (2,2',5)	Surface	15	10	0.26	RADSBA05	0.0	NA	NA	NA	NA	NA	NA	NA	NA
PCB-52 (2,2',5,5')	Surface	15	7	1.4	RADSB006	0.0	NA	NA	NA	NA	NA	NA	NA	NA
PCB-66 (2,3',4,4')	Surface	15	14	0.22	RADSL001	0.0	NA	NA	NA	NA	NA	NA	NA	NA
PCB-77 (3,3',4,4')	Surface	15	14	1.0	RADSB006	0.0	NA	NA	NA	NA	NA	NA	NA	NA
PCB-101 (2,2',3,5,5')	Surface	15	8	1.0	RADSBA07	0.0	NA	NA	NA	NA	NA	NA	NA	NA
PCB-105 (2,3,3',4,4')	Surface	15	12	0.65	RADSBA07	0.0	NA	NA	NA	NA	NA	NA	NA	NA
PCB-118 (2,3',4,4',5)	Surface	15	9	1.2	RADSBA07	0.0	NA	NA	NA	NA	NA	NA	NA	NA
PCB-138 (2,2',3,4,4',5')	Surface	15	7	1.6	RADSBA07	0.0	NA	NA	NA	NA	NA	NA	NA	NA
PCB-153 (2,2',4,4',5,5')	Surface	15	6	1.4	RADSBA07	0.0	NA	NA	NA	NA	NA	NA	NA	NA
PCB-170 (2,2',3,3',4,4',5)	Surface	15	14	0.37	RADSBA07	0.0	NA	NA	NA	NA	NA	NA	NA	NA
PCB-180 (2,2',3,4,4',5,5')	Surface	15	12	0.84	RADSBA07	0.0	NA	NA	NA	NA	NA	NA	NA	NA
PCB-187 (2,2',3,4',5,5',6)	Surface	15	13	0.49	RADSBA07	0.0	NA	NA	NA	NA	NA	NA	NA	NA
PCB-206 (2,2',3,3',4,4',5,5',	Surface	12	11	0.21	RADSBA07	0.0	NA	NA	NA	NA	NA	NA	NA	NA
Total PCBs	Surface	15	0	10.34	RADSBA07	0.0	NA	14.8	22.7	180	NA	0/15	0/15	0/15

TABLE 6-11

NORTH OTTER SLUICE UNIT
SUMMARY OF CHEMICALS IN SOIL AND SEDIMENT COMPARED TO SCREENING VALUES
TIDAL AREA QEA, NWS SBD CONCORD

Analyte	Depth[a]	Number of Samples Collected[b]	Number of Nondetect Results	Maximum Detected Conc.[b]	Location of Maximum Detection	Top Depth of Sample (ft. bgs)	Tidal Area Ambient Value (99UCL)[c]	SF Bay Ambient Value[d]	ER-L[e]	ER-M[e]	Number of Samples that Exceed Tidal Area Ambient Value[f]	Number of Samples that Exceed SF Bay Ambient Value[f]	Number of Samples that Exceed ER-L[f]	Number of Samples that Exceed ER-M[f]
Low Detection Limit Pesticides (µg/kg)														
2,4'-DDD	Surface	15	8	1.0	RADSBA07	0.0	NA	NA	NA	NA	NA	NA	NA	NA
2,4'-DDT	Surface	15	13	0.36	RADSBA05	0.0	NA	NA	NA	NA	NA	NA	NA	NA
4,4'-DDD	Surface	15	4	2.3	RADSB002	0.0	NA	NA	2.0	20	NA	NA	1/15	0/15
4,4'-DDE	Surface	15	1	2.8	RADSB002	0.0	NA	NA	2.2	27	NA	NA	3/15	0/15
4,4'-DDT	Surface	15	10	0.95	RADSBA05	0.0	NA	NA	1.0	7.0	NA	NA	0/15	0/15
Total DDTs	Surface	15	0	7.11	RADSB002	0.0	NA	7.0	1.58	46.1	NA	1/15	14/15	0/15
Total BHCs	Surface	15	0	0.8	OSLSL002	0.0	NA	0.78	NA	NA	NA	2/15	NA	NA
alpha-Chlordane	Surface	15	11	1.2	RADSBA07	0.0	NA	NA	NA	NA	NA	NA	NA	NA
Total Chlordanes	Surface	15	0	1.2	RADSBA07	0.0	NA	1.1	0.5	6.0	NA	1/15	3/15	0/15
Dieldrin	Surface	15	13	0.6	RADSBA07	0.0	NA	0.44	0.02	8.0	NA	2/15	2/15	0/15
Hexachlorobenzene	Surface	15	14	0.4	OSLSL001	0.0	NA	0.48	NA	NA	NA	0/15	NA	NA
Mirex	Surface	15	13	0.13	RADSBA07	0.0	NA	NA	NA	NA	NA	NA	NA	NA
trans-Nonachlor	Surface	15	12	1.3	RADSBA07	0.0	NA	NA	NA	NA	NA	NA	NA	NA
Low Detection Level SVOAs (µg/kg)														
2,6-Dimethylnaphthalene	Surface	12	7	130	RADSB004	0.0	NA	12.1	NA	NA	NA	5/12	NA	NA
2-Methylnaphthalene	Surface	12	11	42	RADSB001	0.0	NA	19.4	70	670	NA	1/12	0/12	0/12
4-Methylphenol	Surface	12	9	740	RADSB006	0.0	NA	NA	NA	NA	NA	NA	NA	NA
Acenaphthene	Surface	12	11	30	RADSB002	0.0	NA	26.6	16	500	NA	1/12	1/12	0/12
Anthracene	Surface	12	9	38	RADSB001	0.0	NA	88	85.3	1,100	NA	0/12	0/12	0/12
Benzo(a)anthracene	Surface	12	6	110	RADSL001	0.0	NA	244	261	1,600	NA	0/12	0/12	0/12
Benzo(a)pyrene	Surface	12	5	140	RADSL001	0.0	NA	412	430	1,600	NA	0/12	0/12	0/12
Benzo(b)fluoranthene	Surface	12	6	130	RADSL001	0.0	NA	371	NA	NA	NA	0/12	NA	NA
Benzo(e)pyrene	Surface	12	7	99	RADSL001	0.0	NA	294	NA	NA	NA	0/12	NA	NA
Benzo(g,h,i)perylene	Surface	12	8	110	RADSL001	0.0	NA	310	NA	NA	NA	0/12	NA	NA
Benzo(k)fluoranthene	Surface	12	6	130	RADSL001	0.0	NA	258	NA	NA	NA	0/12	NA	NA
Benzoic Acid	Surface	12	4	270	RADSBA05	0.0	NA	NA	NA	NA	NA	NA	NA	NA
Chrysene	Surface	12	6	140	RADSL001	0.0	NA	289	384	2,800	NA	0/12	0/12	0/12
Fluoranthene	Surface	12	4	310	RADSB002	0.0	NA	514	600	5,100	NA	0/12	0/12	0/12
Fluorene	Surface	12	11	25	RADSB002	0.0	NA	25.3	19	540	NA	0/12	1/12	0/12
Indeno(1,2,3-cd)pyrene	Surface	12	8	76	RADSBA04	0.0	NA	382	NA	NA	NA	0/12	NA	NA
Naphthalene	Surface	12	10	210	RADSB001	0.0	NA	55.8	160	2,100	NA	2/12	1/12	0/12
Perylene	Surface	12	7	160	RADSL002	0.0	NA	145	NA	NA	NA	1/12	NA	NA
Phenanthrene	Surface	12	8	120	RADSB001	0.0	NA	237	240	1,500	NA	0/12	0/12	0/12
Pyrene	Surface	12	3	410	RADSL001	0.0	NA	665	665	2,600	NA	0/12	0/12	0/12
Total HMW PAHs	Surface	12	0	4,740	RADSB006	0.0	NA	3,060	1,700	9,600	NA	3/12	6/12	0/12
Total LMW PAHs	Surface	12	0	3,555	RADSB005	0.0	NA	434	552	3,160	NA	12/12	11/12	4/12
Total PAHs	Surface	12	0	8,295	RADSB006	0.0	NA	3,390	4,022	44,792	NA	6/12	4/12	0/12

TABLE 6-11

NORTH OTTER SLUICE UNIT
SUMMARY OF CHEMICALS IN SOIL AND SEDIMENT COMPARED TO SCREENING VALUES
TIDAL AREA QEA, NWS SBD CONCORD

Analyte	Depth[a]	Number of Samples Collected[b]	Number of Nondetect Results	Maximum Detected Conc.[b]	Location of Maximum Detection	Top Depth of Sample (ft. bgs)	Tidal Area Ambient Value (99UCL)[c]	SF Bay Ambient Value[d]	ER-L[e]	ER-M[e]	Number of Samples that Exceed Tidal Area Ambient Value[f]	Number of Samples that Exceed SF Bay Ambient Value[f]	Number of Samples that Exceed ER-L[f]	Number of Samples that Exceed ER-M[f]
CLP SVOAs (µg/kg)														
4-Methylphenol	Surface	3	2	64	OSLSL002	0.0	NA	NA	NA	NA	NA	NA	NA	NA
Benzo(a)pyrene	Surface	3	2	56	OSLSL001	0.0	NA	412	430	1,600	NA	0/3	0/3	0/3
Chrysene	Surface	3	2	70	OSLSL001	0.0	NA	289	384	2,800	NA	0/3	0/3	0/3
Fluoranthene	Surface	3	2	120	OSLSL001	0.0	NA	514	600	5,100	NA	0/3	0/3	0/3
Phenanthrene	Surface	3	2	48	OSLSL001	0.0	NA	237	240	1,500	NA	0/3	0/3	0/3
Total HMW PAHs	Surface	3	0	6,500	OSLSL003	0.0	NA	3,060	1,700	9,600	NA	3/3	3/3	0/3
Total LMW PAHs	Surface	3	0	4,550	OSLSL003	0.0	NA	434	552	3,160	NA	3/3	3/3	2/3
Total PAHs	Surface	3	0	11,050	OSLSL003	0.0	NA	3,390	4,022	44,792	NA	3/3	3/3	0/3

Notes:
Where total values were calculated (for example, total PCBs, total DDTs, etc.) 1/2 of the standard quantitation limit (SQL) was used for Nondetected analytes.

bgs Below ground surface
BHC Hexachlorocyclohexane
CLP Contract Laboratory Program
Conc. Concentration
DDD Dichlorodiphenyldichloroethane
DDE Dichlorodiphenyldichloroethene
DDT Dichlorodiphenyltrichloroethane
ER-L Effects range-low
ER-M Effects range-median
ft. feet
HMW High molecular weight
LMW Low molecular weight
mg/kg Milligrams per kilogram
NA Screening value not available
ND Nondetected
PAH Polycyclic aromatic hydrocarbon
PCB Polychlorinated biphenyl
SVOA Semivolatile organic analyte
UCL Upper confidence limit
µg/kg Micrograms per kilogram
VOA Volatile organic analyte

a Surface samples are those collected between 0 and 3 feet bgs; subsurface samples are those collected greater than 3 feet bgs.
b If more than one sample was analyzed in the surface and subsurface depth ranges, only the highest result from the interval is reported and used in the data set
c PRC Environmental Management, Inc (PRC). 1996a. "Estimation of Ambient Metals Concentrations in the Tidal Area Soils. Technical Memorandum. Naval Weapons Station, Concord, California." March.
d San Francisco Bay Regional Water Quality Control Board (RWQCB). 1998. "Ambient Concentrations of Toxic Chemicals in Sediments." April.
e National Oceanic and Atmospheric Administration (NOAA). 1991. "The Potential for Biological Effects of Sediment-Sorbed Contaminants Tested in the National Status and Trends Program." Technical Memorandum NOS OMA 52. NOAA, Office of Oceanography and Marine Assessment. Seattle, Washington.
Long, E.R., D. D. MacDonald, S L. Smith, F.D. Calder. 1995 "Incidence of Adverse Biological Effects Within Ranges of Chemical Concentrations in Marine and Estuarine Sediments." *Environmental Management.* Volume 19. Number 1. Pages 81 through 97
f Number of samples that exceeded screening value / number of samples
g Detection limits were below screening values for all chemicals except selenium. The median detection limit for selenium exceeded the ER-L value.

TABLE 6-12

NORTH OTTER SLUICE, SUMMARY OF CHEMICALS IN SURFACE WATER COMPARED TO SCREENING VALUES
TIDAL AREA QEA, NWS SBD CONCORD

Analyte	Unit	Quarter Sampled	Total Number of Samples	Minimum Concentration Detected	Maximum Concentration Detected	Mean Concentration Detected	Location of Maximum Detection	Concord Tidal Area QEA Screening Value	Number of Samples that Exceed the Screening Value
Inorganic Chemicals (all values in µg/L)									
Aluminum	NOSSW	Jul-95	6	205	393	321	RADSW003	87	6/6
	NOSSW	Oct-95	6	641	37,700	7,048	RADSW005	87	6/6
	NOSSW	Jan-96	6	619	1,450	1,096	RADSW002	87	6/6
	NOSSW	Apr/May-96	6	424	3,460	1,255	RADSW004	87	6/6
	NOSSW	Jun-98	3	623	1,020	806	OSLSL003	87	3/3
Antimony	NOSSW	Jul-95	6	ND	ND	ND	---	None[a]	---
	NOSSW	Oct-95	6	3.50	3.50	3.50	RADSW005	None[a]	---
	NOSSW	Jan-96	6	ND	ND	ND	---	None[a]	---
	NOSSW	Apr/May-96	6	ND	ND	ND	---	None[a]	---
	NOSSW	Jun-98	3	ND	ND	ND	---	None[a]	---
Arsenic	NOSSW	Jul-95	6	ND	ND	ND	---	36	0/6
	NOSSW	Oct-95	6	9.70	9.70	9.70	RADSW005	36	0/6
	NOSSW	Jan-96	6	1.80	2.60	2.18	RADSW005	36	0/6
	NOSSW	Apr/May-96	6	5.00	8.50	6.37	RADSW004	36	0/6
	NOSSW	Jun-98	3	2.40	2.70	2.50	OSLSL002	36	0/3
Barium	NOSSW	Jul-95	6	39.20	71.60	50.88	RADSW004	None[a]	---
	NOSSW	Oct-95	6	28.70	211.00	65.68	RADSW005	None[a]	---
	NOSSW	Jan-96	6	26.20	30.50	28.27	RADSW005	None[a]	---
	NOSSW	Apr/May-96	6	18.60	58.70	45.65	RADSW004	None[a]	---
	NOSSW	Jun-98	3	17.70	22.60	20.20	OSLSL003	None[a]	---
Cadmium	NOSSW	Jul-95	6	ND	ND	ND	---	1.1	0/6
	NOSSW	Oct-95	6	ND	ND	ND	---	1.1	0/6
	NOSSW	Jan-96	6	ND	ND	ND	---	1.1	0/6
	NOSSW	Apr/May-96	6	0.47	0.95	0.71	RADSW004	1.1	0/6
	NOSSW	Jun-98	3	ND	ND	ND	---	1.1	0/3
Chromium	NOSSW	Jul-95	6	ND	ND	ND	---	86	0/6
	NOSSW	Oct-95	6	2.00	102.00	19.20	RADSW005	86	1/6
	NOSSW	Jan-96	6	2.40	4.20	3.50	RADSW004	86	0/6
	NOSSW	Apr/May-96	6	1.60	8.00	3.27	RADSW004	86	0/6
	NOSSW	Jun-98	3	ND	ND	ND	---	86	0/3

TABLE 6-12

NORTH OTTER SLUICE, SUMMARY OF CHEMICALS IN SURFACE WATER COMPARED TO SCREENING VALUES
TIDAL AREA QEA, NWS SBD CONCORD

Analyte	Unit	Quarter Sampled	Total Number of Samples	Minimum Concentration Detected	Maximum Concentration Detected	Mean Concentration Detected	Location of Maximum Detection	Concord Tidal Area QEA Screening Value	Number of Samples that Exceed the Screening Value
Inorganic Chemicals (all values in μg/L) (Continued)									
Cobalt	NOSSW	Jul-95	6	0.51	0.98	0.71	RADSW004	None[a]	---
	NOSSW	Oct-95	6	0.64	27.60	5.45	RADSW005	None[a]	---
	NOSSW	Jan-96	6	ND	ND	ND	---	None[a]	---
	NOSSW	Apr/May-96	6	2.20	2.20	2.20	RADSW004	None[a]	---
	NOSSW	Jun-98	3	0.35	0.35	0.35	OSLSL002	None[a]	---
Copper	NOSSW	Jul-95	6	8.30	9.70	9.13	RADSW005	3.2	3/6
	NOSSW	Oct-95	6	5.00	82.00	19.23	RADSW005	3.2	6/6
	NOSSW	Jan-96	6	6.50	9.50	8.10	RADSW003	3.2	5/6
	NOSSW	Apr/May-96	6	3.40	9.00	5.87	RADSW004	3.2	3/6
	NOSSW	Jun-98	3	3.00	3.50	3.23	OSLSL003	3.2	1/3
Iron	NOSSW	Jul-95	6	384	777	664	RADSW003	None[a]	---
	NOSSW	Oct-95	6	1,070	62,800	11,735	RADSW005	None[a]	---
	NOSSW	Jan-96	6	1,030	2,020	1,670	RADSW002	None[a]	---
	NOSSW	Apr/May-96	6	1,090	4,590	1,965	RADSW004	None[a]	---
	NOSSW	Jun-98	3	973	1,570	1,301	OSLSL003	None[a]	---
Lead	NOSSW	Jul-95	6	1.50	1.50	1.50	RADSW005	3.1	0/6
	NOSSW	Oct-95	6	57.30	57.30	57.30	RADSW005	3.1	1/6
	NOSSW	Jan-96	6	2.10	2.10	2.10	RADSW003	3.1	0/6
	NOSSW	Apr/May-96	6	21.20	21.20	21.20	RADSW004	3.1	1/6
	NOSSW	Jun-98	3	ND	ND	ND	---	3.1	0/3
Manganese	NOSSW	Jul-95	6	103	691	215	RADSW005	None[a]	---
	NOSSW	Oct-95	6	31	582	160	RADSW005	None[a]	---
	NOSSW	Jan-96	6	29	108	68	RADSW005	None[a]	---
	NOSSW	Apr/May-96	6	64	128	108	RADSW004	None[a]	---
	NOSSW	Jun-98	3	37	69	57	OSLSL002	None[a]	---
Mercury	NOSSW	Jul-95	6	ND	ND	ND	---	0.025	0/6
	NOSSW	Oct-95	6	0.66	0.66	0.66	RADSW005	0.025	1/6
	NOSSW	Jan-96	6	ND	ND	ND	---	0.025	0/6
	NOSSW	Apr/May-96	5	ND	ND	ND	---	0.025	0/5
	NOSSW	Jun-98	3	ND	ND	ND	---	0.025	0/3

TABLE 6-12

NORTH OTTER SLUICE, SUMMARY OF CHEMICALS IN SURFACE WATER COMPARED TO SCREENING VALUES
TIDAL AREA QEA, NWS SBD CONCORD

Analyte	Unit	Quarter Sampled	Total Number of Samples	Minimum Concentration Detected	Maximum Concentration Detected	Mean Concentration Detected	Location of Maximum Detection	Concord Tidal Area QEA Screening Value	Number of Samples that Exceed the Screening Value
Inorganic Chemicals (all values in μg/L) (Continued)									
Molybdenum	NOSSW	Jul-95	6	ND	ND	ND	---	None[a]	---
	NOSSW	Oct-95	6	1.40	2.50	2.00	RADSW005	None[a]	---
	NOSSW	Jan-96	6	ND	ND	ND	---	None[a]	---
	NOSSW	Apr/May-96	6	1.70	4.20	2.70	RADSW004	None[a]	---
	NOSSW	Jun-98	3	0.45	0.47	0.46	OSLSL002	None[a]	---
Nickel	NOSSW	Jul-95	6	ND	ND	ND	---	8.2	0/6
	NOSSW	Oct-95	6	4.50	118.00	24.60	RADSW005	8.2	1/6
	NOSSW	Jan-96	6	3.90	7.20	5.72	RADSW006	8.2	0/6
	NOSSW	Apr/May-96	6	8.60	8.60	8.60	RADSW006	8.2	1/6
	NOSSW	Jun-98	3	2.60	3.60	3.03	OSLSL003	8.2	0/3
Thallium	NOSSW	Jul-95	6	ND	ND	ND	---	None[a]	---
	NOSSW	Oct-95	6	2.40	2.40	2.40	RADSW002	None[a]	---
	NOSSW	Jan-96	6	ND	ND	ND	---	None[a]	---
	NOSSW	Apr/May-96	6	ND	ND	ND	---	None[a]	---
	NOSSW	Jun-98	3	ND	ND	ND	---	None[a]	---
Vanadium	NOSSW	Jul-95	6	ND	ND	ND	---	None[a]	---
	NOSSW	Oct-95	6	5.20	139.00	28.72	RADSW005	None[a]	---
	NOSSW	Jan-96	6	4.70	7.50	6.43	RADSW002	None[a]	---
	NOSSW	Apr/May-96	6	6.00	19.60	9.00	RADSW004	None[a]	---
	NOSSW	Jun-98	3	4.70	6.10	5.27	OSLSL003	None[a]	---
Zinc	NOSSW	Jul-95	6	67.90	67.90	67.90	RADSW005	58	1/6
	NOSSW	Oct-95	6	346.00	346.00	346.00	RADSW005	58	1/6
	NOSSW	Jan-96	6	19.60	19.80	19.70	RADSW002	58	0/6
	NOSSW	Apr/May-96	6	9.00	58.50	22.33	RADSW004	58	1/6
	NOSSW	Jun-98	3	ND	ND	ND	---	58	0/3
CLP Pesticides (all values in μg/L)									
4,4'-DDT	NOSSW	Jul-95	6	ND	ND	ND	---	0.001	0/6
	NOSSW	Oct-95	6	0.03	0.03	0.03	RADSW004	0.001	1/6
	NOSSW	Jan-96	6	ND	ND	ND	---	0.001	0/6
	NOSSW	Apr/May-96	5	ND	ND	ND	---	0.001	0/5
	NOSSW	Jun-98	3	ND	ND	ND	---	0.001	0/3

TABLE 6-12

NORTH OTTER SLUICE, SUMMARY OF CHEMICALS IN SURFACE WATER COMPARED TO SCREENING VALUES
TIDAL AREA QEA, NWS SBD CONCORD

Analyte	Unit	Quarter Sampled	Total Number of Samples	Minimum Concentration Detected	Maximum Concentration Detected	Mean Concentration Detected	Location of Maximum Detection	Concord Tidal Area QEA Screening Value	Number of Samples that Exceed the Screening Value
CLP Pesticides (all values in μg/L) (Continued)									
Aldrin	NOSSW	Jul-95	6	ND	ND	ND	—	0.13	0/6
	NOSSW	Oct-95	6	0.01	0.01	0.01	RADSW004	0.13	0/6
	NOSSW	Jan-96	6	ND	ND	ND	—	0.13	0/6
	NOSSW	Apr/May-96	5	ND	ND	ND	---	0.13	0/5
	NOSSW	Jun-98	3	ND	ND	ND	—	0.13	0/3
alpha-Chlordane	NOSSW	Jul-95	6	ND	ND	ND	---	None[a]	---
	NOSSW	Oct-95	6	ND	ND	ND	---	None[a]	---
	NOSSW	Jan-96	6	ND	ND	ND	---	None[a]	---
	NOSSW	Apr/May-96	5	0.042	0.042	0.042	RADSW002	None[a]	---
	NOSSW	Jun-98	3	ND	ND	ND	---	None[a]	---
Dieldrin	NOSSW	Jul-95	6	ND	ND	ND	---	0.0019	0/6
	NOSSW	Oct-95	6	0.03	0.03	0.03	RADSW004	0.0019	1/6
	NOSSW	Jan-96	6	ND	ND	ND	---	0.0019	0/6
	NOSSW	Apr/May-96	5	ND	ND	ND	---	0.0019	0/5
	NOSSW	Jun-98	3	ND	ND	ND	---	0.0019	0/3
Endrin	NOSSW	Jul-95	6	ND	ND	ND	---	0.0023	0/6
	NOSSW	Oct-95	6	0.03	0.03	0.03	RADSW004	0.0023	1/6
	NOSSW	Jan-96	6	ND	ND	ND	---	0.0023	0/6
	NOSSW	Apr/May-96	5	ND	ND	ND	---	0.0023	0/5
	NOSSW	Jun-98	3	ND	ND	ND	---	0.0023	0/3
gamma-BHC (lindane)	NOSSW	Jul-95	6	ND	ND	ND	---	0.016	0/6
	NOSSW	Oct-95	6	0.01	0.01	0.01	RADSW004	0.016	0/6
	NOSSW	Jan-96	6	ND	ND	ND	---	0.016	0/6
	NOSSW	Apr/May-96	5	ND	ND	ND	---	0.016	0/5
	NOSSW	Jun-98	3	ND	ND	ND	---	0.016	0/3
Heptachlor	NOSSW	Jul-95	6	ND	ND	ND	---	0.0036	0/6
	NOSSW	Oct-95	6	0.01	0.01	0.01	RADSW004	0.0036	1/6
	NOSSW	Jan-96	6	ND	ND	ND	---	0.0036	0/6
	NOSSW	Apr/May-96	5	0.11	0.11	0.11	RADSW002	0.0036	1/5
	NOSSW	Jun-98	3	ND	ND	ND	---	0.0036	0/3

TABLE 6-12

NORTH OTTER SLUICE, SUMMARY OF CHEMICALS IN SURFACE WATER COMPARED TO SCREENING VALUES
TIDAL AREA QEA, NWS SBD CONCORD

Analyte	Unit	Quarter Sampled	Total Number of Samples	Minimum Concentration Detected	Maximum Concentration Detected	Mean Concentration Detected	Location of Maximum Detection	Concord Tidal Area QEA Screening Value	Number of Samples that Exceed the Screening Value
CLP Pesticides (all values in µg/L) (Continued)									
Total BHC	NOSSW	Jul-95	6	0.100	0.100	0.100	RADSW001	None[a]	---
	NOSSW	Oct-95	6	0.087	0.100	0.097	RADSW001	None[a]	---
	NOSSW	Jan-96	6	0.100	0.100	0.100	RADSW001	None[a]	---
	NOSSW	Apr/May-96	5	0.100	0.104	0.101	RADSW003	None[a]	---
	NOSSW	Jun-98	3	0.100	0.100	0.100	OSLSL001	None[a]	---
Total Chlordanes	NOSSW	Jul-95	6	0.050	0.050	0.050	RADSW001	0.004	6/6
	NOSSW	Oct-95	6	0.050	0.050	0.050	RADSW001	0.004	6/6
	NOSSW	Jan-96	6	0.050	0.050	0.050	RADSW001	0.004	6/6
	NOSSW	Apr/May-96	5	0.050	0.068	0.054	RADSW002	0.004	5/5
	NOSSW	Jun-98	3	0.050	0.050	0.050	OSLSL001	0.004	3/3
Total DDTs	NOSSW	Jul-95	6	0.15	0.15	0.15	RADSW001	None[a]	---
	NOSSW	Oct-95	6	0.13	0.15	0.15	RADSW001	None[a]	---
	NOSSW	Jan-96	6	0.15	0.15	0.15	RADSW001	None[a]	---
	NOSSW	Apr/May-96	5	0.15	0.15	0.15	RADSW01	None[a]	---
	NOSSW	Jun-98	3	0.15	0.15	0.15	OSLSL001	None[a]	---
Total PCBs	NOSSW	Jul-95	6	1.75	1.75	1.75	RADSW001	None[a]	---
	NOSSW	Oct-95	6	1.75	1.75	1.75	RADSW001	None[a]	---
	NOSSW	Jan-96	6	1.75	1.75	1.75	RADSW001	None[a]	---
	NOSSW	Apr/May-96	5	1.75	1.82	1.77	RADSW003	None[a]	---
	NOSSW	Jun-98	3	2.00	2.00	2.00	OSLSL001	None[a]	---
CLP SVOAs (all values in µg/L)									
Total HMW PAHs	NOSSW	Jul-95	6	50	50	50	RADSW001	None[a]	---
	NOSSW	Oct-95	6	50	50	50	RADSW001	None[a]	---
	NOSSW	Jan-96	6	50	50	50	RADSW001	None[a]	---
	NOSSW	Apr/May-96	5	50	50	50	RADSW001	None[a]	---
	NOSSW	Jun-98	3	50	50	50	OSLSL001	None[a]	---

TABLE 6-12

NORTH OTTER SLUICE, SUMMARY OF CHEMICALS IN SURFACE WATER COMPARED TO SCREENING VALUES
TIDAL AREA QEA, NWS SBD CONCORD

Analyte	Unit	Quarter Sampled	Total Number of Samples	Minimum Concentration Detected	Maximum Concentration Detected	Mean Concentration Detected	Location of Maximum Detection	Concord Tidal Area QEA Screening Value	Number of Samples that Exceed the Screening Value
CLP SVOAs (all values in μg/L) (Continued)									
Total LMW PAHs	NOSSW	Jul-95	6	35	35	35	RADSW001	None[a]	---
	NOSSW	Oct-95	6	35	35	35	RADSW001	None[a]	---
	NOSSW	Jan-96	6	35	35	35	RADSW001	None[a]	---
	NOSSW	Apr/May-96	5	35	35	35	RADSW001	None[a]	---
	NOSSW	Jun-98	3	35	35	35	OSLSL001	None[a]	---
Total PAHs	NOSSW	Jul-95	6	85	85	85	RADSW001	15	6/6
	NOSSW	Oct-95	6	85	85	85	RADSW001	15	6/6
	NOSSW	Jan-96	6	85	85	85	RADSW001	15	6/6
	NOSSW	Apr/May-96	5	85	85	85	RADSW001	15	5/5
	NOSSW	Jun-98	3	85	85	85	OSLSL001	15	3/3
CLP VOAs (all values in μg/L)									
Chloromethane	NOSSW	Jul-95	6	11	11	11	RADSW001	None[a]	---
	NOSSW	Oct-95	6	ND	ND	ND	---	None[a]	---
	NOSSW	Jan-96	6	ND	ND	ND	---	None[a]	---
	NOSSW	Apr/May-96	6	ND	ND	ND	---	None[a]	---
	NOSSW	Jun-98	NA	NA	NA	NA	---	None[a]	NA

Notes: For all surface water screening values please refer to Table 5-2.

BHC Hexachlorocyclohexane
CLP Contract laboratory program
DDT Dichlorodiphenyltrichloroethane
HMW High molecular weight
LMW Low molecular weight
NA Not analyzed
ND Not detected
PAH Polynuclear aromatic hydrocarbon
PCB Polychlorinated biphenyl
SVOA Semivolatile organic analyte
VOA Volatile organic analyte
μg/L Microgram per liter
a No screening value is available
--- Not applicable

TABLE 6-13

SOUTH OTTER SLUICE UNIT
SUMMARY OF CHEMICALS IN SOIL AND SEDIMENT COMPARED TO SCREENING VALUES
TIDAL AREA QEA, NWS SBD CONCORD

Analyte	Depth[a]	Number of Samples Collected[b]	Number of Nondetect Results	Maximum Detected Conc.[b]	Location of Maximum Detection	Top Depth of Sample (ft. bgs)	Tidal Area Ambient Value (99UCL)[c]	SF Bay Ambient Value[d]	ER-L[e]	ER-M[e]	Number of Samples that Exceed Tidal Area Ambient Value[f]	Number of Samples that Exceed SF Bay Ambient Value[f]	Number of Samples that Exceed ER-L[f]	Number of Samples that Exceed ER-M[f]
Inorganic Chemicals (mg/kg)														
Aluminum	Surface	26	0	42,700	WHSSB001	0.00	27,300	NA	NA	NA	8/26	NA	NA	NA
Antimony	Surface	26	8	9.3	OSLSL008	0.00	2.2	NA	2.0	25	4/26	NA	7/26	0/26
Arsenic	Surface	26	0	25.9	WHSSL003	0.00	27	15.3	8.2	70	0/26	8/26	20/26	0/26
Barium	Surface	26	0	353	WHSSBD01	0.00	530	NA	NA	NA	0/26	NA	NA	NA
Beryllium	Surface	26	6	0.94	OSLSL008	0.00	0.18	NA	NA	NA	18/26	NA	NA	NA
Cadmium	Surface	26	13	4.2	WHSSB002	0.00	1.9	0.33	1.2	9.6	2/26	12/26	4/26	0/26
Chromium	Surface	26	0	122	WHSSB001	0.00	82.1	112	81	370	5/26	1/26	6/26	0/26
Cobalt	Surface	26	0	39.3	WHSSB022	0.00	36	NA	NA	NA	1/26	NA	NA	NA
Copper	Surface	26	0	105	WHSSBA02	0.00	81	68.1	34	270	7/26	12/26	20/26	0/26
Lead	Surface	26	0	99.5	WHSSB002	0.00	95	43.2	46.7	218	1/26	9/26	8/26	0/26
Manganese	Surface	26	0	1270	WHSSB022	0.00	1,500	NA	NA	NA	0/26	NA	NA	NA
Mercury	Surface	26	7	18.5	WHSSB022	0.00	0.32	0.43	0.15	0.71	9/26	5/26	14/26	3/26
Molybdenum	Surface	26	8	5.2	WHSSBA02	0.00	6.6	NA	NA	NA	0/26	NA	NA	NA
Nickel	Surface	26	0	123	WHSSB001	0.00	120	112	20.9	51.6	1/26	1/26	26/26	20/26
Selenium[g]	Surface	26	21	3.5	WHSSB001	0.00	NA	0.64	0.70	1.40	NA	5/26	5/26	2/26
Silver	Surface	26	22	0.6	OSLSL006	0.00	NA	0.58	1.0	3.7	NA	1/26	0/26	0/26
Thallium	Surface	26	22	2.8	OSLSL007	0.00	2.2	NA	NA	NA	1/26	NA	NA	NA
Vanadium	Surface	26	0	139	WHSSB001	0.00	96	NA	NA	NA	9/26	NA	NA	NA
Zinc	Surface	26	0	605	WHSSB002	0.00	264	158	150	410	6/26	15/26	16/26	2/26
Low Detection Limit PCBs (µg/kg)														
PCB-8 (2,4')	Surface	19	15	1.1	WHSSB003	0.00	NA	NA	NA	NA	NA	NA	NA	NA
PCB-18 (2,2',5)	Surface	19	17	0.31	WHSSB002	0.00	NA	NA	NA	NA	NA	NA	NA	NA
PCB-44 (2,2',3,5')	Surface	19	17	0.57	WHSSL003	0.00	NA	NA	NA	NA	NA	NA	NA	NA
PCB-52 (2,2',5,5')	Surface	19	15	1.3	WHSSB001	0.00	NA	NA	NA	NA	NA	NA	NA	NA
PCB-101 (2,2',3,5,5')	Surface	19	17	0.54	WHSSB001	0.00	NA	NA	NA	NA	NA	NA	NA	NA
PCB-118 (2,3',4,4',5)	Surface	19	17	0.96	WHSSB001	0.00	NA	NA	NA	NA	NA	NA	NA	NA
PCB-126 (3,3',4,4',5)	Surface	19	18	0.24	WHSSBA04	0.00	NA	NA	NA	NA	NA	NA	NA	NA
PCB-138 (2,2',3,4,4',5')	Surface	19	14	1.3	WHSSB001	0.00	NA	NA	NA	NA	NA	NA	NA	NA
PCB-153 (2,2',4,4',5,5')	Surface	19	16	1.1	WHSSBB05	0.00	NA	NA	NA	NA	NA	NA	NA	NA
PCB-170 (2,2',3,3',4,4',5)	Surface	19	17	1.0	OSLSL008	0.00	NA	NA	NA	NA	NA	NA	NA	NA
PCB-180 (2,2',3,4,4',5,5')	Surface	19	17	1.3	WHSSBB05	0.00	NA	NA	NA	NA	NA	NA	NA	NA
PCB-187 (2,2',3,4',5,5',6)	Surface	19	17	0.61	WHSSBB05	0.00	NA	NA	NA	NA	NA	NA	NA	NA
Total PCBs	Surface	19	0	16.85	OSLSL008	0.00	NA	14.8	22.7	180	NA	1/19	0/19	0/19
Low Detection Limit Pesticides (µg/kg)														
2,4'-DDD	Surface	19	17	0.67	WHSSL001	0.00	NA	NA	NA	NA	NA	NA	NA	NA
2,4'-DDT	Surface	19	18	0.18	WHSSBD01	0.00	NA	NA	NA	NA	NA	NA	NA	NA
4,4'-DDD	Surface	19	6	2.0	OSLSL008	0.00	NA	NA	2.0	20	NA	NA	0/19	0/19
4,4'-DDE	Surface	19	5	2.3	WHSSB001	0.00	NA	NA	2.2	27	NA	NA	1/19	0/19
4,4'-DDT	Surface	19	18	0.58	WHSSBD01	0.00	NA	NA	1.0	7.0	NA	NA	0/19	0/19
Total DDTs	Surface	19	0	5.85	OSLSL008	0.00	NA	7.0	1.58	46.1	NA	0/19	13/19	0/19

TABLE 6-13

SOUTH OTTER SLUICE UNIT
SUMMARY OF CHEMICALS IN SOIL AND SEDIMENT COMPARED TO SCREENING VALUES
TIDAL AREA QEA, NWS SBD CONCORD

Analyte	Depth[a]	Number of Samples Collected[b]	Number of Nondetect Results	Maximum Detected Conc.[b]	Location of Maximum Detection	Top Depth of Sample (ft. bgs)	Tidal Area Ambient Value (99UCL)[c]	SF Bay Ambient Value[d]	ER-L[e]	ER-M[e]	Number of Samples that Exceed Tidal Area Ambient Value[f]	Number of Samples that Exceed SF Bay Ambient Value[f]	Number of Samples that Exceed ER-L[f]	Number of Samples that Exceed ER-M[f]
Low Detection Limit Pesticides (µg/kg) (Continued)														
alpha-BHC	Surface	6	5	0.5	OSLSL007	0.00	NA	NA	NA	NA	NA	NA	NA	NA
gamma-BHC (Lindane)	Surface	19	16	1.2	WHSSB002	0.00	NA	NA	NA	NA	NA	NA	NA	NA
Total BHCs	Surface	19	0	1.8	OSLSL008	0.00	NA	0.78	NA	NA	NA	6/19	NA	NA
alpha-Chlordane	Surface	19	12	1.1	WHSSL001	0.00	NA	NA	NA	NA	NA	NA	NA	NA
gamma-Chlordane	Surface	6	5	0.7	OSLSL006	0.00	NA	NA	NA	NA	NA	NA	NA	NA
Total Chlordanes	Surface	19	0	1.45	OSLSL008	0.00	NA	1.1	0.5	6.0	NA	2/19	7/19	0/19
Heptachlor	Surface	19	16	1.8	WHSSL001	0.00	NA	NA	NA	NA	NA	NA	NA	NA
Hexachlorobenzene	Surface	19	18	0.4	OSLSL007	0.00	NA	0.48	NA	NA	NA	0/19	NA	NA
Methoxychlor	Surface	6	5	5.0	OSLSL008	0.00	NA	NA	NA	NA	NA	NA	NA	NA
trans-Nonachlor	Surface	19	13	0.93	WHSSL001	0.00	NA	NA	NA	NA	NA	NA	NA	NA
Dioxins (µg/kg)														
1,2,3,4,6,7,8,9-OCDD	Surface	2	0	9	WHSSB023	0.00	NA	NA	NA	NA	NA	NA	NA	NA
1,2,3,4,6,7,8,9-OCDF	Surface	2	1	0.5	WHSSB023	0.00	NA	NA	NA	NA	NA	NA	NA	NA
1,2,3,4,6,7,8-HPCDD	Surface	2	1	2.0	WHSSB023	0.00	NA	NA	NA	NA	NA	NA	NA	NA
1,2,3,4,6,7,8-HPCDF	Surface	2	1	0.2	WHSSB023	0.00	NA	NA	NA	NA	NA	NA	NA	NA
Total HPCDD	Surface	2	0	6.0	WHSSB023	0.00	NA	NA	NA	NA	NA	NA	NA	NA
Total HPCDF	Surface	2	1	0.8	WHSSB023	0.00	NA	NA	NA	NA	NA	NA	NA	NA
Total TCDD	Surface	2	0	13	WHSSB023	0.00	NA	NA	NA	NA	NA	NA	NA	NA
Low Detection Level SVOAs (µg/kg)														
2,6-Dimethylnaphthalene	Surface	13	12	37	WHSSBK08	0.00	NA	12.1	NA	NA	NA	1/13	NA	NA
Benzo(a)anthracene	Surface	13	12	20	WHSSBD01	0.00	NA	244	261	1,600	NA	0/13	0/13	0/13
Benzo(a)pyrene	Surface	13	10	270	WHSSBB05	0.00	NA	412	430	1,600	NA	0/13	0/13	0/13
Benzo(b)fluoranthene	Surface	13	10	300	WHSSBB05	0.00	NA	371	NA	NA	NA	0/13	NA	NA
Benzo(e)pyrene	Surface	13	10	240	WHSSBB05	0.00	NA	294	NA	NA	NA	0/13	NA	NA
Benzo(g,h,i)perylene	Surface	13	11	230	WHSSBB05	0.00	NA	310	NA	NA	NA	0/13	NA	NA
Benzo(k)fluoranthene	Surface	13	10	300	WHSSBB05	0.00	NA	258	NA	NA	NA	1/13	NA	NA
Benzoic Acid	Surface	13	12	1,000	WHSSB003	0.00	NA	NA	NA	NA	NA	NA	NA	NA
Chrysene	Surface	13	10	360	WHSSBB05	0.00	NA	289	384	2,800	NA	1/13	0/13	0/13
Fluoranthene	Surface	13	9	430	WHSSBB05	0.00	NA	514	600	5,100	NA	0/13	0/13	0/13
Indeno(1,2,3-cd)pyrene	Surface	13	12	20	WHSSBD01	0.00	NA	382	NA	NA	NA	0/13	NA	NA
Phenanthrene	Surface	13	12	22	WHSSB018	0.00	NA	237	240	1,500	NA	0/13	0/13	0/13
Pyrene	Surface	13	9	480	WHSSBB05	0.00	NA	665	665	2,600	NA	0/13	0/13	0/13
Total HMW PAHs	Surface	13	0	6,810	WHSSBB05	0.00	NA	3,060	1,700	9,600	NA	3/13	6/13	0/13
Total LMW PAHs	Surface	13	0	9,450	WHSSBB05	0.00	NA	434	552	3,160	NA	10/13	10/13	1/13
Total PAHs	Surface	13	0	16,260	WHSSBB05	0.00	NA	3,390	4,022	44,792	NA	5/13	5/13	0/13

TABLE 6-13

SOUTH OTTER SLUICE UNIT
SUMMARY OF CHEMICALS IN SOIL AND SEDIMENT COMPARED TO SCREENING VALUES
TIDAL AREA QEA, NWS SBD CONCORD

Analyte	Depth[a]	Number of Samples Collected[b]	Number of Nondetect Results	Maximum Detected Conc.[b]	Location of Maximum Detection	Top Depth of Sample (ft. bgs)	Tidal Area Ambient Value (99UCL)[c]	SF Bay Ambient Value[d]	ER-L[e]	ER-M[e]	Number of Samples that Exceed Tidal Area Ambient Value[f]	Number of Samples that Exceed SF Bay Ambient Value[f]	Number of Samples that Exceed ER-L[f]	Number of Samples that Exceed ER-M[f]
CLP SVOAs (µg/kg)														
4-Methylphenol	Surface	6	4	200	OSLSL005	0.0	NA	NA	NA	NA	NA	NA	NA	NA
Fluoranthene	Surface	6	5	72	OSLSL006	0.0	NA	514	600	5,100	NA	0/6	0/6	0/6
Pyrene	Surface	6	5	160	OSLSL008	0.0	NA	665	665	2,600	NA	0/6	0/6	0/6
Total HMW PAHs	Surface	6	0	13,660	OSLSL008	0.0	NA	3,060	1,700	9,600	NA	6/6	6/6	2/6
Total LMW PAHs	Surface	6	0	10,500	OSLSL008	0.0	NA	434	552	3,160	NA	6/6	6/6	6/6
Total PAHs	Surface	6	0	24,160	OSLSL008	0.0	NA	3,390	4,022	44,792	NA	6/6	6/6	0/6

Notes:
Where total values were calculated (for example, total PCBs, total DDTs, etc.) 1/2 of the standard quantitation limit (SQL) was used for Nondetected analytes.

bgs	Below ground surface	LMW	Low molecular weight
BHC	Hexachlorocyclohexane	mg/kg	Milligrams per kilogram
CLP	Contract Laboratory Program	NA	Screening value not available
Conc.	Concentration	ND	Nondetected
DDD	Dichlorodiphenyldichloroethane	OCDD	Octachlorodibenzo-p-dioxin
DDE	Dichlorodiphenyldichloroethene	OCDF	Octachlorodibenzofuran
DDT	Dichlorodiphenyltrichloroethane	PAH	Polycyclic aromatic hydrocarbon
ER-L	Effects range-low	PCB	Polychlorinated biphenyl
ER-M	Effects range-median	SVOA	Semivolatile organic analyte
ft.	feet	TCDD	Tetrachlorodibenzo-p-dioxin
HMW	High molecular weight	UCL	Upper confidence limit
HPCDD	Heptachlorodibenzo-p-dioxin	µg/kg	Micrograms per kilogram
HPCDF	Heptachlorodibenzofuran	VOA	Volatile organic analyte

a Surface samples are those collected between 0 and 3 feet bgs; subsurface samples are those collected greater than 3 feet bgs.
b If more than one sample was analyzed in the surface and subsurface depth ranges, only the highest result from the interval is reported and used in the data set.
c PRC Environmental Management, Inc (PRC). 1996a. "Estimation of Ambient Metals Concentrations in the Tidal Area Soils. Technical Memorandum. Naval Weapons Station, Concord, California." March.
d San Francisco Bay Regional Water Quality Control Board (RWQCB). 1998. "Ambient Concentrations of Toxic Chemicals in Sediments." April.
e National Oceanic and Atmospheric Administration (NOAA). 1991. "The Potential for Biological Effects of Sediment-Sorbed Contaminants Tested in the National Status and Trends Program." Technical Memorandum NOS OMA 52. NOAA, Office of Oceanography and Marine Assessment. Seattle, Washington.
Long, E.R., D. D. MacDonald, S.L. Smith, F.D. Calder. 1995. "Incidence of Adverse Biological Effects Within Ranges of Chemical Concentrations in Marine and Estuarine Sediments." *Environmental Management*. Volume 19. Number 1. Pages 81 through 97.
f Number of samples that exceeded screening value / number of samples
g Detection limits were below screening values for all chemicals except selenium. The median detection limit for selenium exceeded the ER-L value.

TABLE 6-14

SOUTH OTTER SLUICE, SUMMARY OF CHEMICALS IN SURFACE WATER COMPARED TO SCREENING VALUES
TIDAL AREA QEA, NWS SBD CONCORD

Analyte	Unit	Quarter Sampled	Total Number of Samples	Minimum Concentration Detected	Maximum Concentration Detected	Mean Concentration Detected	Location of Maximum Detection	Concord Tidal Area QEA Screening Value	Number of Samples that Exceed the Screening Value
Inorganic Chemicals (all values in μg/L)									
Aluminum	SOSSW	Jul-95	4	167	294	226	WHSSW002	87	4/4
	SOSSW	Oct-95	4	281	1,510	800	WHSSW004	87	4/4
	SOSSW	Jan-96	4	818	1,430	1,172	WHSSW002	87	4/4
	SOSSW	Apr/May-96	4	876	2,100	1,281	WHSSW004	87	4/4
	SOSSW	Jun-98	6	543	1,140	776	OSLSL009	87	6/6
Arsenic	SOSSW	Jul-95	4	ND	ND	ND	---	36	0/4
	SOSSW	Oct-95	4	ND	ND	ND	---	36	0/4
	SOSSW	Jan-96	4	2.10	2.70	2.48	WHSSW002	36	0/4
	SOSSW	Apr/May-96	4	4.10	4.40	4.25	WHSSW003	36	0/4
	SOSSW	Jun-98	6	2.00	3.70	2.63	OSLSL006	36	0/6
Barium	SOSSW	Jul-95	4	46.70	64.00	54.28	WHSSW004	None[a]	---
	SOSSW	Oct-95	4	33.00	64.60	51.23	WHSSW004	None[a]	---
	SOSSW	Jan-96	4	25.50	43.90	32.83	WHSSW004	None[a]	---
	SOSSW	Apr/May-96	4	56.60	77.20	64.58	WHSSW003	None[a]	---
	SOSSW	Jun-98	6	19.40	1,160.00	211.80	OSLSL009	None[a]	---
Cadmium	SOSSW	Jul-95	4	ND	ND	ND	---	1.1	0/4
	SOSSW	Oct-95	4	ND	ND	ND	---	1.1	0/4
	SOSSW	Jan-96	4	ND	ND	ND	---	1.1	0/4
	SOSSW	Apr/May-96	4	0.44	0.52	0.49	WHSSW003	1.1	0/4
	SOSSW	Jun-98	6	ND	ND	ND	---	1.1	0/6
Chromium	SOSSW	Jul-95	4	ND	ND	ND	---	86	0/4
	SOSSW	Oct-95	4	0.63	4.80	2.29	WHSSW004	86	0/4
	SOSSW	Jan-96	4	3.90	4.10	3.97	WHSSW002	86	0/4
	SOSSW	Apr/May-96	4	2.40	6.10	4.10	WHSSW004	86	0/4
	SOSSW	Jun-98	6	2.80	3.40	3.10	OSLSL009	86	0/6
Cobalt	SOSSW	Jul-95	4	0.60	0.82	0.71	WHSSW004	None[a]	---
	SOSSW	Oct-95	4	0.74	1.40	1.11	WHSSW004	None[a]	---
	SOSSW	Jan-96	4	ND	ND	ND	---	None[a]	---
	SOSSW	Apr/May-96	4	1.20	1.20	1.20	WHSSW004	None[a]	---
	SOSSW	Jun-98	6	0.30	0.80	0.48	OSLSL007	None[a]	---

TABLE 6-14

SOUTH OTTER SLUICE, SUMMARY OF CHEMICALS IN SURFACE WATER COMPARED TO SCREENING VALUES
TIDAL AREA QEA, NWS SBD CONCORD

Analyte	Unit	Quarter Sampled	Total Number of Samples	Minimum Concentration Detected	Maximum Concentration Detected	Mean Concentration Detected	Location of Maximum Detection	Concord Tidal Area QEA Screening Value	Number of Samples that Exceed the Screening Value
Inorganic Chemicals (all values in µg/L) (Continued)									
Copper	SOSSW	Jul-95	4	ND	ND	ND	---	3.2	0/4
	SOSSW	Oct-95	4	4.30	7.70	5.48	WHSSW004	3.2	4/4
	SOSSW	Jan-96	4	5.30	7.80	6.55	WHSSW004	3.2	4/4
	SOSSW	Apr/May-96	4	4.20	6.90	5.70	WHSSW004	3.2	3/4
	SOSSW	Jun-98	6	2.90	5.60	3.62	OSLSL009	3.2	2/6
Iron	SOSSW	Jul-95	4	396	849	718	WHSSW001	None[a]	---
	SOSSW	Oct-95	4	625	3,240	1,766	WHSSW004	None[a]	---
	SOSSW	Jan-96	4	1,470	2,460	2,050	WHSSW004	None[a]	---
	SOSSW	Apr/May-96	4	1,660	3,300	2,380	WHSSW004	None[a]	---
	SOSSW	Jun-98	6	1,110	2,120	1,472	OSLSL009	None[a]	---
Lead	SOSSW	Jul-95	4	ND	ND	ND	---	3.1	0/4
	SOSSW	Oct-95	4	ND	ND	ND	---	3.1	0/4
	SOSSW	Jan-96	4	1.30	3.10	1.93	WHSSW002	3.1	0/4
	SOSSW	Apr/May-96	4	ND	ND	ND	---	3.1	0/4
	SOSSW	Jun-98	6	ND	ND	ND	---	3.1	0/6
Manganese	SOSSW	Jul-95	4	44.6	224.0	150.7	WHSSW001	None[a]	---
	SOSSW	Oct-95	4	47.8	278.0	177.5	WHSSW004	None[a]	---
	SOSSW	Jan-96	4	64.3	147.0	93.6	WHSSW004	None[a]	---
	SOSSW	Apr/May-96	4	157.0	256.0	198.5	WHSSW003	None[a]	---
	SOSSW	Jun-98	6	37.9	227.0	110.3	OSLSL007	None[a]	---
Mercury	SOSSW	Jul-95	4	ND	ND	ND	---	0.025	0/4
	SOSSW	Oct-95	4	ND	ND	ND	---	0.025	0/4
	SOSSW	Jan-96	4	ND	ND	ND	---	0.025	0/4
	SOSSW	Apr/May-96	4	0.24	0.24	0.24	WHSSW002	0.025	1/4
	SOSSW	Jun-98	6	ND	ND	ND	---	0.025	0/6
Molybdenum	SOSSW	Jul-95	4	ND	ND	ND	---	None[a]	---
	SOSSW	Oct-95	4	1.30	1.90	1.53	WHSSW003	None[a]	---
	SOSSW	Jan-96	4	ND	ND	ND	---	None[a]	---
	SOSSW	Apr/May-96	4	ND	ND	ND	---	None[a]	---
	SOSSW	Jun-98	6	0.42	0.69	0.52	OSLSL006	None[a]	---

TABLE 6-14

SOUTH OTTER SLUICE, SUMMARY OF CHEMICALS IN SURFACE WATER COMPARED TO SCREENING VALUES
TIDAL AREA QEA, NWS SBD CONCORD

Analyte	Unit	Quarter Sampled	Total Number of Samples	Minimum Concentration Detected	Maximum Concentration Detected	Mean Concentration Detected	Location of Maximum Detection	Concord Tidal Area QEA Screening Value	Number of Samples that Exceed the Screening Value
Inorganic Chemicals (all values in µg/L) (Continued)									
Nickel	SOSSW	Jul-95	4	ND	ND	ND	---	8.2	0/4
	SOSSW	Oct-95	4	3.0	7.6	5.0	WHSSW004	8.2	0/4
	SOSSW	Jan-96	4	4.7	6.1	5.6	WHSSW004	8.2	0/4
	SOSSW	Apr/May-96	4	5.5	7.1	6.2	WHSSW004	8.2	0/4
	SOSSW	Jun-98	6	2.5	5.2	3.7	OSLSL009	8.2	0/6
Selenium	SOSSW	Jul-95	4	ND	ND	ND	---	5.0	0/4
	SOSSW	Oct-95	4	ND	ND	ND	---	5.0	0/4
	SOSSW	Jan-96	4	ND	ND	ND	---	5.0	0/4
	SOSSW	Apr/May-96	4	ND	ND	ND	---	5.0	0/4
	SOSSW	Jun-98	6	0.77	1.00	0.85	OSLSL007	5.0	0/6
Thallium	SOSSW	Jul-95	4	ND	ND	ND	---	None[a]	---
	SOSSW	Oct-95	4	2.40	2.40	2.40	WHSSW003	None[a]	---
	SOSSW	Jan-96	4	ND	ND	ND	---	None[a]	---
	SOSSW	Apr/May-96	4	ND	ND	ND	---	None[a]	---
	SOSSW	Jun-98	6	ND	ND	ND	---	None[a]	---
Vanadium	SOSSW	Jul-95	4	ND	ND	ND	---	None[a]	---
	SOSSW	Oct-95	4	5.1	9.7	6.6	WHSSW004	None[a]	---
	SOSSW	Jan-96	4	5.1	7.5	6.5	WHSSW004	None[a]	---
	SOSSW	Apr/May-96	4	7.1	11.3	9.3	WHSSW004	None[a]	---
	SOSSW	Jun-98	6	4.4	6.1	5.2	OSLSL007	None[a]	---
Zinc	SOSSW	Jul-95	4	53.9	67.7	60.8	WHSSW004	58	1/4
	SOSSW	Oct-95	NA	ND	ND	ND	NA	58	NA
	SOSSW	Jan-96	4	31.5	32.5	32.0	WHSSW004	58	0/4
	SOSSW	Apr/May-96	4	12.7	38.8	22.0	WHSSW004	58	0/4
	SOSSW	Jun-98	6	7.1	430.0	218.6	OSLSL009	58	1/6
Low Detection Level Pesticides (all values in µg/L)									
Total BHC	SOSSW	Jul-95	NA	NA	NA	NA	---	None[a]	NA
	SOSSW	Oct-95	NA	NA	NA	NA	---	None[a]	NA
	SOSSW	Jan-96	NA	NA	NA	NA	---	None[a]	NA
	SOSSW	Apr/May-96	NA	NA	NA	NA	---	None[a]	NA
	SOSSW	Jun-98	2	0.10	0.10	0.10	OSLSL008	None[a]	---

TABLE 6-14

SOUTH OTTER SLUICE, SUMMARY OF CHEMICALS IN SURFACE WATER COMPARED TO SCREENING VALUES
TIDAL AREA QEA, NWS SBD CONCORD

Analyte	Unit	Quarter Sampled	Total Number of Samples	Minimum Concentration Detected	Maximum Concentration Detected	Mean Concentration Detected	Location of Maximum Detection	Concord Tidal Area QEA Screening Value	Number of Samples that Exceed the Screening Value
Low Detection Level Pesticides (all values in μg/L) (Continued)									
Total Chlordanes	SOSSW	Jul-95	NA	NA	NA	NA	---	0.004	NA
	SOSSW	Oct-95	NA	NA	NA	NA	---	0.004	NA
	SOSSW	Jan-96	NA	NA	NA	NA	---	0.004	NA
	SOSSW	Apr/May-96	NA	NA	NA	NA	---	0.004	NA
	SOSSW	Jun-98	2	0.05	0.05	0.05	OSLSL008	0.004	2/2
Total DDTs	SOSSW	Jul-95	NA	NA	NA	NA	---	None[a]	NA
	SOSSW	Oct-95	NA	NA	NA	NA	---	None[a]	NA
	SOSSW	Jan-96	NA	NA	NA	NA	---	None[a]	NA
	SOSSW	Apr/May-96	NA	NA	NA	NA	---	None[a]	NA
	SOSSW	Jun-98	2	0.15	0.15	0.15	OSLSL008	None[a]	---
Total PCBs	SOSSW	Jul-95	NA	NA	NA	NA	---	None[a]	NA
	SOSSW	Oct-95	NA	NA	NA	NA	---	None[a]	NA
	SOSSW	Jan-96	NA	NA	NA	NA	---	None[a]	NA
	SOSSW	Apr/May-96	NA	NA	NA	NA	---	None[a]	NA
	SOSSW	Jun-98	2	2.00	2.00	2.00	OSLSL008	None[a]	---
CLP Pesticides (all values in μg/L)									
Total BHC	SOSSW	Jul-95	4	0.100	0.100	0.100	WHSSW001	None[a]	---
	SOSSW	Oct-95	4	0.100	0.100	0.100	WHSSW001	None[a]	---
	SOSSW	Jan-96	4	0.100	0.100	0.100	WHSSW001	None[a]	---
	SOSSW	Apr/May-96	4	0.100	0.104	0.102	WHSSW003	None[a]	---
	SOSSW	Jun-98	4	0.100	0.100	0.100	OSLSL004	None[a]	---
Total Chlordanes	SOSSW	Jul-95	4	0.050	0.050	0.050	WHSSW001	0.004	4/4
	SOSSW	Oct-95	4	0.050	0.050	0.050	WHSSW001	0.004	4/4
	SOSSW	Jan-96	4	0.050	0.050	0.050	WHSSW001	0.004	4/4
	SOSSW	Apr/May-96	4	0.050	0.052	0.051	WHSSW003	0.004	4/4
	SOSSW	Jun-98	4	0.050	0.050	0.050	OSLSL004	0.004	4/4
Total DDTs	SOSSW	Jul-95	4	0.15	0.15	0.15	WHSSW001	None[a]	---
	SOSSW	Oct-95	4	0.15	0.15	0.15	WHSSW001	None[a]	---
	SOSSW	Jan-96	4	0.15	0.15	0.15	WHSSW001	None[a]	---
	SOSSW	Apr/May-96	4	0.15	0.15	0.15	WHSSW001	None[a]	---
	SOSSW	Jun-98	4	0.15	0.15	0.15	OSLSL004	None[a]	

TABLE 6-14

SOUTH OTTER SLUICE, SUMMARY OF CHEMICALS IN SURFACE WATER COMPARED TO SCREENING VALUES
TIDAL AREA QEA, NWS SBD CONCORD

Analyte	Unit	Quarter Sampled	Total Number of Samples	Minimum Concentration Detected	Maximum Concentration Detected	Mean Concentration Detected	Location of Maximum Detection	Concord Tidal Area QEA Screening Value	Number of Samples that Exceed the Screening Value
CLP Pesticides (all values in μg/L) (Continued)									
Total PCBs	SOSSW	Jul-95	4	1.75	1.75	1.75	WHSSW001	None[a]	---
	SOSSW	Oct-95	4	1.75	1.75	1.75	WHSSW001	None[a]	---
	SOSSW	Jan-96	4	1.75	1.75	1.75	WHSSW001	None[a]	---
	SOSSW	Apr/May-96	4	1.75	1.82	1.785	WHSSW003	None[a]	---
	SOSSW	Jun-98	4	2.00	2.00	2.00	OSLSL004	None[a]	---
CLP SVOAs (all values in μg/L)									
Total HMW PAHs	SOSSW	Jul-95	4	50	50	50	WHSSW001	None[a]	---
	SOSSW	Oct-95	4	50	50	50	WHSSW001	None[a]	---
	SOSSW	Jan-96	4	50	50	50	WHSSW001	None[a]	---
	SOSSW	Apr/May-96	4	50	50	50	WHSSW001	None[a]	---
	SOSSW	Jun-98	6	50	50	50	OSLSL004	None[a]	---
Total LMW PAHs	SOSSW	Jul-95	4	35	35	35	WHSSW001	None[a]	---
	SOSSW	Oct-95	4	35	35	35	WHSSW001	None[a]	---
	SOSSW	Jan-96	4	35	35	35	WHSSW001	None[a]	---
	SOSSW	Apr/May-96	4	35	35	35	WHSSW001	None[a]	---
	SOSSW	Jun-98	6	35	35	35	OSLSL004	None[a]	---
Total PAHs	SOSSW	Jul-95	4	85	85	85	WHSSW001	15	4/4
	SOSSW	Oct-95	4	85	85	85	WHSSW001	15	4/4
	SOSSW	Jan-96	4	85	85	85	WHSSW001	15	4/4
	SOSSW	Apr/May-96	4	85	85	85	WHSSW001	15	4/4
	SOSSW	Jun-98	6	85	85	85	OSLSL004	15	6/6

TABLE 6-14

SOUTH OTTER SLUICE, SUMMARY OF CHEMICALS IN SURFACE WATER COMPARED TO SCREENING VALUES
TIDAL AREA QEA, NWS SBD CONCORD

Analyte	Unit	Quarter Sampled	Total Number of Samples	Minimum Concentration Detected	Maximum Concentration Detected	Mean Concentration Detected	Location of Maximum Detection	Concord Tidal Area QEA Screening Value	Number of Samples that Exceed the Screening Value
CLP SVOAs (all values in μg/L) (Continued)									
Bis(2-ethylhexyl)phthalate	SOSSW	Jul-95	4	ND	ND	ND	---	None[a]	---
	SOSSW	Oct-95	4	ND	ND	ND	---	None[a]	---
	SOSSW	Jan-96	4	ND	ND	ND	---	None[a]	---
	SOSSW	Apr/May-96	4	ND	ND	ND	---	None[a]	---
	SOSSW	Jun-98	6	29	29	29	OSLSL005	None[a]	---

Notes: For all surface water screening values please refer to Table 5-2.

BHC Hexachlorocyclohexane
CLP Contract laboratory program
DDT Dichlorodiphenyltrichloroethane
HMW High molecular weight
LMW Low molecular weight
NA Not analyzed
ND Not detected
PAH Polynuclear aromatic hydrocarbon
PCB Polychlorinated biphenyl
SVOA Semivolatile organic analyte
VOA Volatile organic analyte
μg/L Microgram per liter

a No screening value is available
--- Not applicable

TABLE 6-15

SUMMARY OF DETECTED INORGANIC CONSTITUENT CONCENTRATIONS IN SOIL AND SEDIMENT SAMPLES
TIDAL AREA QEA, NWS SBD CONCORD

Sample Location	Sample Depth (feet bgs)	Inorganic Constituents (mg/kg)																			
		Aluminum	Antimony	Arsenic	Barium	Beryllium	Cadmium	Chromium	Chromium VI	Cobalt	Copper	Lead	Manganese	Mercury	Molybdenum	Nickel	Selenium	Silver	Thallium	Vanadium	Zinc
Tidal Area Landfill - Terrestrial Unit																					
TLSSB001	0 - 0.5	23,700	--	10.3	114	0.16	--	82.7	NA	19	42.1	19.7	394	0.09	--	80.1	--	--	--	75.1	113
	1.3 - 2.5	12,200	--	2.9	70.3	--	--	33.3	NA	8.1	19.6	14.6	140	--	--	66.4	--	--	--	55.5	46.4
	3.9 - 4.5	9,930	--	11.8	60.7	--	--	29.3	NA	10.2	37.8	24.9	152	--	--	72.7	--	--	--	49.4	50.1
TLSSB002	0 - 0.5	14,100	--	18.1	171	--	5.8	40	NA	16.4	117	152	692	--	--	131	--	--	--	69.9	743
	1.3 - 2.5	15,900	--	8.8	76.5	--	2.6	41.9	NA	33.5	17.8	--	410	--	--	103	--	--	--	63	109
	4.3 - 5.5	4,370	--	6.6	26	--	--	--	NA	5.2	25.5	--	75.1	--	--	24.7	--	--	--	29.6	--
TLSSB003	0 - 0.5	20,100	--	10	165	0.51	--	61.5	NA	14.6	55.9	49.1	309	0.14	--	72.1	--	--	--	63.7	238
	1.5 - 2.5	23,500	--	16.8	45.5	--	2.6	55.7	NA	13.6	25.7	12.3	325	0.19	--	94	--	--	--	71.6	164
	4.5 - 5.3	29,400	--	8.4	52.6	--	--	92.5	NA	17	32.6	10.3	333	--	--	79.1	--	--	--	100	100
TLSSB004	0 - 0.5	21,300	--	20.4	436	--	--	59.9	NA	15.3	101	82.6	472	0.48	--	81.5	--	--	--	92.4	137
	1.3 - 2.4	27,400	--	27.7	68.8	0.56	0.74	75	NA	7.7	47.2	20.9	217	0.16	--	80.5	--	--	--	89.5	93.8
	4.3 - 5.5	26,500	--	5.8	47.8	--	--	82.9	NA	17.4	27	9.7	413	--	--	92.5	--	--	--	81.5	90.2
TLSSB005	0 - 0.5	21,100	NA	11.6	103	--	3.2	72.6	NA	14.5	32.2	23.9	351	--	--	67.9	--	--	--	66.6	307
	0.9 - 2	20,800	NA	12.4	65.6	--	--	68.9	NA	8.3	24.7	10.2	312	--	4.2	67.5	--	--	2.2	83.9	127
	4.5 - 5.8	11,400	NA	6.6	45.3	--	--	41	NA	29.4	20.9	5.3	301	--	2.5	81.1	--	--	--	59.1	64.1
TLSSB006	0 - 0.5	22,200	2.5	7.7	99	--	--	55.7	NA	13.5	66.8	54	332	--	3.3	36.2	--	--	--	108	163
	1.3 - 2	25,700	1.8	8.4	91.4	--	--	83.4	NA	18.4	36	11.4	1000	--	--	78.1	--	--	1.2	76	98.7
	4.5 - 6	23,100	NA	11.1	90.5	--	--	78.6	NA	24.8	33.9	10.9	843	--	--	105	--	--	1.7	72.4	92.3
TLSSB007	0 - 0.5	5,470	3.1	57.6	340	--	--	24.3	NA	5.8	264	156	109	0.38	3.7	24.8	--	1.2	--	43.6	258
	1.5 - 2.3	14,600	NA	11.2	52.3	--	--	49.2	NA	12.6	30.7	5.8	246	--	3.7	61.7	--	--	--	68.3	56.3
	4.5 - 5.3	12,600	NA	5.7	35.7	--	--	39	--	8.4	21.4	5.3	163	--	3.4	46.1	--	--	--	55	60.5
TLSSB008	0 - 0.5	9,580	NA	11.5	148	--	--	27.3	NA	5.5	31.8	31.2	129	--	1.5	30.1	--	--	--	44.8	70.6
	1.5 - 2.7	26,600	1.6	42.7	57.6	--	--	1.8	NA	29.4	41.8	15.9	280	--	--	100	--	--	--	79.2	144
	4.5 - 5.7	24,000	1.2	17.2	67.2	--	--	88	NA	26.5	39.4	12.8	342	--	--	99.7	--	--	--	80.6	102
Area Disposal Site - Terrestrial Unit																					
ADSB007	0 - 0.5	13,200	2	9.5	232	--	--	37.2	NA	17.1	62.3	275	827	0.36	--	74.3	--	--	0.92	70.3	290
RADSB008	0 - 0.5	12,800	5.6	11.1	169	--	--	33.4	NA	13.8	62.4	132	716	--	--	66.4	--	0.21	--	55.3	266
RADSB009	0 - 0.5	16,300	--	12.3	98	--	--	46.3	NA	16.2	45.8	40.9	913	0.15	--	72.9	--	--	0.66	73.1	371
RADSB010	0 - 0.5	19,400	--	17.2	50	--	--	69.6	NA	11.1	47.4	79.2	200	0.37	0.97	66.3	--	--	--	78.7	101
RADSB011	0 - 0.5	26,800	2.9	17.7	104	--	--	93.4	NA	14.1	48.5	75.4	283	0.31	0.6	77.9	--	--	--	91.2	120
RADSB012	0 - 0.5	20,900	2	28.1	65.7	--	--	72.3	NA	18.8	71	70.7	533	0.58	0.77	75.1	--	--	--	86.6	210
RADSB014	0 - 0.5	12,900	1.2	7.3	76.3	--	--	47.5	NA	16.6	20.6	7.5	1170	--	--	68.5	--	--	0.93	46.4	68.7
RADSB015	0 - 0.5	12,400	1.1	6.3	140	--	--	53.6	NA	15.5	24.1	13.7	666	0.05	--	71.7	--	--	--	59.4	78.2
RADSB017	0 - 0.5	13,600	3.1	16.3	190	--	--	41.7	NA	18.2	85.5	127	838	0.14	--	81.1	--	--	--	64	959
RADSB018	0 - 0.5	18,400	0.73	6.9	140	--	--	53.4	NA	13.8	36.3	42	228	0.08	0.42	61.9	--	--	--	59.1	178
RADSB019	0 - 0.5	17,600	--	9	112	--	--	49.7	NA	13.8	34.2	68	425	0.14	--	65.8	--	--	--	54.8	136
RADSB020	0 - 0.5	15,400	1.6	8.6	46.3	--	--	49.1	NA	16.2	60.3	300	470	0.47	--	102	--	0.51	--	61.2	166
RADSB021	0 - 0.5	22,200	0.87	10	139	0.37	--	60.3	NA	22.2	40.6	54.6	550	0.29	--	84.3	--	--	--	55.4	213
RADSB022	0 - 0.5	26,000	1.9	18.5	64.9	0.41	--	74.6	NA	13.5	69.7	53.4	309	0.41	1.6	69.3	--	--	--	89.1	108
RADSB023	0 - 0.5	26,100	1.6	9.6	101	--	--	85.9	NA	13.2	34.9	16.9	303	--	--	65.2	--	--	--	76.4	94
RADSB024	0 - 0.5	4,420	1.4	20.9	365	--	--	--	NA	31.2	27	56	626	--	--	95.5	--	--	--	41.1	132
RADSB025	0 - 0.5	12,500	0.63	5.5	111	0.57	--	32.6	NA	7.9	29.1	44.5	161	0.15	1.5	50.5	--	--	--	40.3	46.9
RADSB026	0 - 0.5	12,300	1.4	7	124	0.11	--	38.3	NA	16.5	28.6	19.8	355	0.09	--	124	--	--	--	52.1	105
RADSB028	0 - 0.5	18,800	--	11.8	83.2	--	--	65.2	NA	25.8	31.1	55.4	678	0.11	--	107	--	--	--	68.2	93.9
RADSB029	0 - 0.5	21,000	2.1	17.4	51.5	0.34	--	58.3	NA	9.2	75.2	70.1	251	0.22	3.3	78.2	1.3	0.26	--	71.8	115
RADSB030	0 - 0.5	14,500	0.77	19.5	184	--	--	37.4	NA	14.6	37.7	23	590	0.13	--	66.7	--	--	--	69	86.9
RADSBA08	0 - 0.5	11,900	--	9	499	0.21	--	29	NA	11.8	64.4	192	59	0.1	--	41.1	--	--	--	36.7	201
RADSBB01	0 - 0.5	13,900	1.1	6.2	180	--	--	32.2	NA	11.1	23.7	26.7	498	0.07	--	44.5	--	--	--	47.2	70.3
RADSBB02	0 - 0.5	11,700	0.78	3.8	177	0.18	--	20.4	NA	9.2	20.2	35.8	365	0.06	--	29.4	--	--	--	40.4	62.5
RADSBB03	0 - 0.5	15,300	--	9	205	--	--	41.9	NA	18.6	44.8	35.8	638	0.1	--	92	--	--	--	62.8	102
RADSBB04	0 - 0.5	15,200	--	8.9	127	--	--	54	NA	13.6	30.2	54.9	229	0.19	--	78.5	--	--	--	61.4	135
	0.9 - 1.5	18,000	--	12.8	57.4	--	--	60.7	NA	6.8	35.3	18	175	--	5.6	39.4	--	--	--	67.5	72.1
	4 - 5.2	17,500	--	8.6	33.1	--	--	59.5	NA	10.3	24.4	7.2	246	--	4.5	58.9	--	--	--	73	72.2
RADSBB05	0 - 0.5	20,200	--	10.7	166	--	--	56.6	NA	28.2	36.5	51.5	803	--	--	90	--	--	--	65.5	100
DSBB06	0 - 0.5	13,200	--	5.6	47.2	--	--	41.2	NA	9	34.5	53.4	257	0.11	--	54.4	--	--	--	53.3	93.8
	1.2 - 2	25,200	--	21.2	70.1	0.14	--	72.1	NA	12.6	56.1	34.2	268	0.25	2.1	78	--	--	--	72.7	108

TABLE 6-15

SUMMARY OF DETECTED INORGANIC CONSTITUENT CONCENTRATIONS IN SOIL AND SEDIMENT SAMPLES
TIDAL AREA QEA, NWS SBD CONCORD

Sample Location	Sample Depth (feet bgs)	Inorganic Constituents (mg/kg)																			
		Aluminum	Antimony	Arsenic	Barium	Beryllium	Cadmium	Chromium	Chromium VI	Cobalt	Copper	Lead	Manganese	Mercury	Molybdenum	Nickel	Selenium	Silver	Thallium	Vanadium	Zinc
R Area Disposal Site - Terrestrial Unit (Continued)																					
RADSBB07	0 - 0.5	19,800	0.72	19.7	165	--	--	61.1	NA	20.7	51.7	100	653	0.36	--	79	--	--	--	70.9	215
RADSBB08	0 - 0.5	13,500	0.89	6.1	178	--	--	31.3	NA	13	26	32.5	601	--	--	49.2	--	--	--	62	87.8
	1.5 - 2	13,700	NA	6	185	--	--	27.9	NA	18.6	23.3	9.5	789	--	--	66.1	--	--	--	56.2	62.1
RADSBC03	0 - 0.5	11,000	--	8.9	173	--	--	27.1	NA	14.6	32.8	20	719	0.08	--	61.2	--	--	0.72	52.4	71.1
RADSBC04	0 - 0.5	14,700	1	10.8	45.4	--	--	52.8	NA	16.3	41.3	71.6	349	0.25	--	78.1	--	--	--	66.1	155
RADSBC05	0 - 0.5	11,700	--	8.3	162	--	--	41.9	NA	17.7	20.7	164	793	--	--	67.1	--	--	2.4	50.7	95.8
	1.1 - 2	16,500	--	14.5	188	--	--	49.3	NA	13.4	40	176	291	0.23	--	62.7	--	--	--	60.1	204
RADSBC06	0 - 0.5	10,400	0.67	5.9	107	--	--	40.2	NA	11.7	26.8	140	487	0.15	0.37	58.9	--	--	--	47.3	148
RADSBC07	0 - 0.5	17,600	0.79	19.2	140	--	--	56.1	NA	14.4	51.7	84.1	305	0.32	1.5	65	--	--	--	74.5	173
RADSBC08	0 - 0.5	16,000	1.2	8	168	--	--	--	NA	15.9	31.5	45.5	567	0.12	--	70	--	--	--	70.8	122
RADSBD03	0 - 0.5	12,600	--	8.9	141	--	--	33.5	NA	13	40.3	67.1	504	0.25	0.95	57	--	--	--	60	120
RADSBD04	0 - 0.5	17,300	--	16.1	169	--	--	54.7	NA	21.6	48.7	120	517	0.29	--	71.5	--	--	--	67	203
RADSBD05	0 - 0.5	15,800	--	9.6	160	--	0.83	45.9	NA	18.9	37.9	68	1250	0.27	--	80.8	--	--	1.3	46.9	172
	1.2 - 2	22,200	--	--	37.7	--	--	77.8	NA	9	34.2	7.5	220	--	2	48.3	--	--	--	65.1	77.9
RADSBD06	0 - 0.5	16,400	0.74	8	149	--	--	47.4	--	15.2	39.2	79	657	0.24	--	67	--	--	--	45.8	179
	0.6 - 1	24,700	--	13.6	51.8	--	--	80.9	NA	9.3	36.8	17.2	238	--	5	52.2	--	--	--	82.4	84.1
	4.5 - 5.7	17,200	--	5.1	49.6	--	--	69.2	NA	7.5	29.1	11.2	192	--	2.7	42.5	--	--	--	69.4	65.9
RADSBD07	0 - 0.5	28,800	0.87	13.3	160	--	--	74.5	NA	17.7	49.3	83.4	784	0.3	--	106	--	--	--	74.4	235
RADSBD08	0 - 0.5	21,300	1.2	12.4	81.6	--	--	72.8	NA	14.1	29.6	43.1	376	0.15	--	71.4	--	--	--	79.1	119
RADSBE02	0 - 0.5	15,400	--	9	198	--	--	37.6	NA	16.4	33	11.2	753	0.08	--	67.6	--	--	1.4	57	74.1
RADSBE03	0 - 0.5	32,500	2.2	29.9	155	--	--	101	NA	11.6	76.9	55.8	240	--	3.1	85.4	--	--	--	130	137
	1.5 - 2.3	8,640	--	--	25.7	--	--	27.2	NA	3.7	13	4.7	105	--	2.1	25	--	--	--	37.3	40.4
RADSBE04	0 - 0.5	15,100	--	9	105	--	--	48	NA	12.4	34.7	51.3	290	0.3	0.32	52.5	--	--	--	53.2	119
RADSBE05	0 - 0.5	21,600	1.1	9.6	101	0.29	--	61.4	NA	16.9	47	113	674	0.34	--	79.6	--	--	--	59.7	201
RADSBE06	0 - 0.5	33,500	0.69	18.3	168	--	--	80	NA	18.1	46.5	76.2	351	0.2	--	84.6	--	--	--	86	229
RADSBE07	0 - 0.5	22,300	3.1	9.8	7705	--	--	66.3	NA	14.1	87.8	235	450	0.34	--	120	--	0.72	--	80.3	185
RADSBE08	0 - 0.5	9,380	--	7.6	126	--	--	--	NA	14.9	18	7.5	653	0.06	--	43.7	--	--	1.6	48.4	50.6
RADSBF02	0 - 0.5	20,400	--	15.3	127	--	--	68.6	NA	13.2	43.4	65.4	292	0.14	--	62.1	--	--	--	68.5	113
RADSBF03	0 - 0.5	10,000	--	18.3	94.2	--	--	36.8	NA	21.9	46.5	68.4	1090	0.35	2.9	64.1	--	--	--	57.7	89.9
RADSBF04	0 - 0.5	20,900	--	12.4	99.6	--	--	79.1	NA	14.9	38.9	49.2	432	0.14	--	66.6	--	--	--	74.3	105
RADSBF05	0 - 0.5	33,700	1	11.4	121	--	--	95	NA	17	49.8	44.6	330	0.15	--	83.8	--	--	--	87.8	154
RADSBF06	0 - 0.5	14,300	2.2	7.5	44	--	--	--	NA	14	63.2	208	489	0.54	--	146	--	0.62	--	55.9	143
RADSBF07	0 - 0.5	32,900	1.4	16.7	139	--	--	84.7	NA	15.6	46	117	287	0.32	--	80.8	--	--	--	91.9	236
RADSBF08	0 - 0.5	17,600	0.53	10.1	269	--	--	--	NA	14.7	42.8	26.8	588	--	--	52.9	--	--	--	71.4	78.4
RADSBG02	0 - 0.5	12,700	--	5.9	189	--	--	31.4	NA	14.9	28.4	9.5	702	0.07	--	55.9	--	--	--	55.4	62.3
RADSBG03	0 - 0.5	17,000	2.8	14.7	100	--	--	58.9	NA	15.9	49.2	46.7	478	0.23	2.1	72.7	--	--	--	69.4	101
RADSBG04	0 - 0.5	19,300	--	10.6	79.3	--	--	70.2	--	10.9	27.3	14.8	249	0.1	--	53.6	--	--	--	63.6	79.7
	1 - 2	26,700	--	12.6	47.5	--	--	95.1	NA	18	36.4	16	310	0.1	1.5	62.1	--	--	--	91.3	81.6
	4.5 - 5.8	16,600	--	13.6	54.8	--	--	61.7	NA	11.6	23	9.5	408	--	2	50.7	--	--	--	82.7	70.3
RADSBG05	0 - 0.5	13,000	0.9	22	90.7	--	--	45.2	NA	15.2	26	46.6	301	0.46	--	56.2	--	--	--	57.6	92.2
RADSBG06	0 - 0.5	32,700	1.7	16.8	58.7	--	--	93.8	NA	14.6	44.4	26.3	294	0.13	--	78.9	--	--	--	107	127
RADSBG07	0 - 0.5	28,000	2	13.5	140	--	--	76.7	NA	13.3	47.4	51.6	325	0.13	--	79.5	--	--	--	91.8	142
RADSBG08	0 - 0.5	10,600	0.97	--	140	--	--	--	--	12.1	24.6	39.2	443	0.12	--	44.6	--	--	--	47.5	115
	0.7 - 2	19,700	1.5	10.3	185	--	--	48.6	NA	12.7	80.4	1160	303	0.15	--	51	--	--	--	56.5	488
	4 - 5.3	10,200	--	25.7	40.8	--	--	--	NA	5.9	24.7	11.8	207	--	6.2	49.3	2.8	--	--	51	56.5
RADSBH02	0 - 0.5	10,400	--	5.9	132	--	--	27.6	NA	14.1	28.7	7.7	669	0.05	--	60.4	--	--	--	50.1	64.5
RADSBH03	0 - 0.5	26,200	1.1	8.6	95.1	--	--	82.8	NA	13	40.6	14.6	278	--	--	67.4	--	--	--	71.2	96.7
RADSBH04	0 - 0.5	20,100	0.87	10.2	93.9	--	--	69.5	NA	12.8	36	21.6	302	0.11	--	60.7	--	--	--	64	83.5
RADSBH05	0 - 0.5	10,400	2.6	6.3	42.5	0.39	--	35.9	NA	11	48.8	172	226	--	--	84.4	--	0.47	--	46.8	119
RADSBH06	0 - 0.5	26,400	1	8.6	44.4	--	--	92.5	--	15.2	30.1	25	320	--	1.2	78	--	--	--	86.5	138
	1.5 - 2	20,700	--	40.1	45.1	--	0.4	81	NA	108	80.6	22	266	--	17.8	242	--	--	--	85.4	61.4
RADSBH07	0 - 0.5	14,400	2.8	30.9	158	--	--	52.4	NA	12.2	77.3	101	258	0.41	10.3	71.6	--	--	--	85.6	93.5
RADSBH08	0 - 0.5	17,000	0.98	8.3	273	--	--	35.8	NA	13.5	29.6	12.3	581	0.09	--	54.2	--	--	--	61.4	67.6
RADSBI01	0 - 0.5	9,450	--	4.5	124	--	--	25.1	NA	10.2	27.5	23.5	384	0.07	--	36.1	--	--	--	36.5	94
RADSBI02	0 - 0.5	17,100	0.98	7.1	76.2	--	--	61.2	NA	11.5	20.6	7.7	285	--	--	54	--	--	--	54.6	71.3
RADSBI03	0 - 0.5	16,300	1.1	6.4	117	0.12	--	39	NA	18.1	17.3	11.4	537	--	0.51	69.4	--	--	--	49.4	67.6

TABLE 6-15

SUMMARY OF DETECTED INORGANIC CONSTITUENT CONCENTRATIONS IN SOIL AND SEDIMENT SAMPLES
TIDAL AREA QEA, NWS SBD CONCORD

Sample Location	Sample Depth (feet bgs)	Inorganic Constituents (mg/kg)																			
		Aluminum	Antimony	Arsenic	Barium	Beryllium	Cadmium	Chromium	Chromium VI	Cobalt	Copper	Lead	Manganese	Mercury	Molybdenum	Nickel	Selenium	Silver	Thallium	Vanadium	Zinc
R Area Disposal Site - Terrestrial Unit (Continued)																					
RADSBI04	0 - 0.5	25,100	1.2	10.8	98.3	--	--	81.9	--	14.2	43.8	51.7	276	--	--	72.9	--	--	--	79.1	111
	1.5 - 2	17,900	--	--	40.4	--	--	62.2	NA	9.3	28.3	--	385	--	5.1	45.1	--	--	--	65	74.8
RADSBI05	0 - 0.5	25,600	1.2	5.9	96.2	--	--	80.7	NA	13.5	33.4	18	304	--	--	69.2	--	--	--	70.3	104
RADSBI06	0 - 0.5	12,500	2.5	23.4	347	--	--	40.9	NA	12.3	74	285	317	0.4	5.7	57.6	--	0.54	--	71.1	87.3
RADSBI07	0 - 0.5	29,400	2.1	17.8	165	0.14	--	82.6	NA	16.3	59.8	63.7	293	0.28	--	82.1	--	--	--	96.3	215
RADSBI08	0 - 0.5	8,410	--	11.6	115	--	--	23.8	--	19.4	21.1	10.3	2090	--	--	54.6	--	--	--	40.3	67.6
	1.5 - 2	18,800	--	25.6	318	--	--	51.2	NA	49.1	51.7	28.3	6300	--	--	115	--	--	5.4	84.8	188
RADSBJ01	0 - 0.5	12,200	0.71	6	176	--	--	41.6	NA	20.5	31.4	25.4	658	0.07	--	73.4	--	--	--	60.6	75.7
RADSBJ02	0 - 0.5	13,000	--	5.7	63.8	--	--	51.2	--	11.5	18.5	7.8	297	0.06	--	51.8	--	--	--	47.4	61.5
	1 - 2.2	19,900	--	6.6	79.9	--	--	69.2	NA	12.6	23.5	7.7	318	0.07	--	60.9	--	--	--	62	74.3
	4.7 - 6	16,600	--	2.3	114	--	--	40.3	NA	5.7	26.2	9.6	1450	0.07	--	31.5	--	--	0.74	63.6	42
RADSBJ03	0 - 0.5	14,500	0.97	10.9	79.4	0.15	--	49.1	NA	11.1	34.5	19.3	264	0.12	4.3	54.3	--	--	--	57.1	70.1
RADSBJ04	0 - 0.5	30,400	2.7	42	82.4	0.26	--	62.9	NA	13.2	75.7	196	177	0.19	5.1	126	--	0.39	--	79.3	95.8
RADSBJ06	0 - 0.5	25,000	0.78	9.6	108	--	--	88.2	NA	13.3	39.6	14.6	395	--	--	69.8	--	--	--	75.3	115
RADSBJ07	0 - 0.5	25,900	1.4	13.5	67.9	0.34	--	74.8	NA	10.7	70.4	45.3	257	0.2	2.2	74.5	--	--	--	72.7	100
RADSBJ08	0 - 0.5	13,900	1.9	11.8	173	--	0.55	38.3	NA	22.9	47.5	86.1	908	0.17	--	76	--	--	--	61.8	249
RADSBK01	0 - 0.5	20,800	1.6	6.8	277	--	--	65.5	NA	20.4	40.3	51.7	669	0.05	--	83.4	--	--	--	99.3	112
RADSBK02	0 - 0.5	11,200	0.62	4.2	229	0.23	--	18.1	NA	15.4	18.5	12.7	650	--	--	30.6	--	--	--	32.3	70.6
RADSBK03	0 - 0.5	14,400	0.99	7.9	67.1	--	--	48.2	NA	14.3	29.4	36.2	562	0.18	--	66.3	--	--	--	51.5	92.9
RADSBK04	0 - 0.5	20,100	1.9	12.8	122	--	--	72.6	NA	18.7	46.7	35	412	0.11	--	73.8	--	--	--	70.2	205
RADSBK07	0 - 0.5	22,300	1.2	5.4	213	--	--	39.4	NA	20	51	11.7	910	0.09	--	37.3	--	--	--	75.1	100
RADSBK08	0 - 0.5	14,200	0.86	7.4	203	--	--	34.3	--	16.2	42.9	25.6	667	--	--	86.1	--	--	--	58.8	97.8
	1.3 - 2	15,200	0.94	7.1	276	--	--	38.1	NA	15.8	34.3	8.5	567	--	--	62.9	--	--	--	54.1	66.9
RADSBL03	0 - 0.5	9,650	1	7.2	91.1	--	--	33.7	NA	12.9	29.9	25.5	710	0.18	--	73.1	1	--	--	41.1	80.5
RADSBL08	0 - 0.5	13,200	0.94	6.5	177	--	--	37.2	NA	14.6	36.3	31.2	671	0.11	--	70.4	--	--	--	56.5	91.4
DSBM08	0 - 0.5	14,700	--	10.1	237	--	--	38.3	--	20.1	34.1	11	446	--	--	86.6	--	--	--	61.5	98.8
	1.3 - 2	11,100	--	--	107	--	--	26.4	NA	11.7	26.3	6.9	673	--	--	47.1	--	--	--	44.5	56.1
R Area Disposal Site - Aquatic Unit																					
RADSB013	0 - 0.5	16,300	--	25.1	159	--	--	65.5	--	21.9	55.3	41	701	--	--	89.7	--	--	--	94.7	424
RADSB027	0 - 0.5	14,300	0.64	7.9	174	--	--	29.4	NA	18	25.6	8.7	525	--	--	55.4	--	--	--	54.2	62.5
RADSBN08	0 - 0.5	16,800	0.87	4.3	174	--	--	27.7	NA	15.3	29.5	31.4	859	--	--	29	--	--	--	76.4	109
Froid and Taylor Roads Site - Aquatic Unit																					
FTSSB002	0 - 0.5	10,700	--	6.2	163	--	1.1	25.7	NA	7.1	55	515	171	0.17	--	28.8	--	0.18	--	39.8	436
	0.75 - 1.8	21,800	NA	6.4	48.3	--	--	70.5	NA	6.7	30.7	21	142	--	3.9	57.8	--	--	--	68.7	63.1
FTSSB003	0 - 0.25	14,700	--	10.6	110	--	0.61	47	NA	8.6	59.7	211	186	0.39	--	49.4	--	0.36	--	57.4	160
	0.75 - 1.75	24,800	NA	9.5	43.9	--	--	82.1	NA	8.5	30.8	9.5	182	--	2.9	53.5	--	--	--	85.1	80.7
FTSSB004	0 - 0.5	15,800	NA	10.1	95.8	--	--	48.1	--	10.1	63.1	86	179	0.36	--	62.4	--	0.22	--	56.9	173
	1.5 - 2.5	17,700	NA	12	54.1	--	--	69	NA	13.9	28	9.7	224	0.1	--	64.7	--	--	--	65.6	91.3
FTSSB005	0 - 0.5	37,500	--	18	234	--	--	106	NA	18.1	86	115	382	0.34	--	90.9	--	--	--	113	213
	2 - 3	5,630	NA	4.8	27.7	--	--	20.5	NA	3.6	13.1	3.5	104	--	--	21	--	--	--	32.6	39.1
FTSSB006	0 - 0.5	16,700	NA	15.6	130	--	0.32	50.6	NA	7.9	64.6	157	186	0.49	--	53.2	--	0.5	--	67.6	144
	1.1 - 2	8,100	NA	7.8	31.8	--	--	24.8	NA	7.7	16.8	7.5	60.7	--	3.4	38.5	--	--	--	47	47.9
FTSSB007	0 - 0.25	9,310	NA	--	195	--	--	25.2	--	12.3	25.3	14.3	706	0.07	--	65.4	--	--	--	38.4	58.5
	1.5 - 2.3	11,000	NA	7	170	--	--	24.7	NA	10.7	28.7	7.7	400	0.07	--	51.4	--	--	--	47.1	60.7
FTSSB008	0 - 0.5	9,260	NA	6.2	177	--	--	28.3	NA	11.5	26.5	20.1	182	0.07	--	41.2	--	--	--	39.6	115
	1.2 - 1.75	4,810	NA	26.6	48.3	--	0.73	25.2	NA	6.2	50.9	84.4	246	0.28	3.8	81.7	--	--	2	136	154
FTSSB009	0 - 0.12	13,100	NA	4.9	71.4	--	--	39.3	NA	11.5	34.1	143	314	0.11	--	57.5	--	--	--	50.7	118
	0.12 - 1.3	9,500	NA	--	166	--	--	19.8	NA	9	16.5	7.5	359	0.08	--	32.4	--	--	--	37.2	45.5
FTSSL102	0 - 0	10,300	2.2	9.8	230	--	0.89	33.4	NA	4.7	92	79.5	135	--	4.3	22.7	1.2	0.38	--	48.2	148
FTSSL103	0 - 0	16,900	1.1	23.2	48.7	0.35	0.41	45.7	NA	7.4	33	32.8	139	--	0.22	40	--	0.15	1.1	62.2	59.5
FTSSL104	0 - 0	7,020	1.5	17.4	199	--	1.9	25.1	NA	20.6	43.7	55.6	3530	--	--	61	1.5	0.63	3.8	45.2	149
Froid and Taylor Roads Site - Terrestrial Unit																					
FTSSB001	0 - 0.3	14,900	NA	4.5	165	--	0.38	34.2	NA	12.9	30.3	72	608	0.17	--	38	--	--	--	54.7	106
	0.35 - 1.3	9,200	NA	--	43.8	--	--	15.3	NA	7.4	21.4	8.8	227	0.25	--	15.6	--	--	0.64	34.4	27.5

TABLE 6-15

SUMMARY OF DETECTED INORGANIC CONSTITUENT CONCENTRATIONS IN SOIL AND SEDIMENT SAMPLES
TIDAL AREA QEA, NWS SBD CONCORD

Sample Location	Sample Depth (feet bgs)	Inorganic Constituents (mg/kg)																			
		Aluminum	Antimony	Arsenic	Barium	Beryllium	Cadmium	Chromium	Chromium VI	Cobalt	Copper	Lead	Manganese	Mercury	Molybdenum	Nickel	Selenium	Silver	Thallium	Vanadium	Zinc
Wood Hogger Site - Terrestrial Unit																					
S37-01	0 - 1	16,400	0.48	3.2	221	--	--	31.2	NA	17.3	32.9	6	456	--	--	34.4	--	--	--	69.9	41.7
S37-02	0 - 1	5,230	--	4.7	36.4	--	--	10.5	NA	5.5	9.2	5.2	123	--	--	8.9	--	--	--	24	--
	4 - 5	13,000	0.68	--	96	--	--	15.4	NA	14.4	32.3	5.7	458	--	--	37.6	--	--	--	51.9	38.3
S37-03	0 - 1	19,400	0.64	--	3.5	--	--	19.8	NA	17	20	2.4	244	0.35	--	11.2	--	--	--	76.1	--
	5 - 6	6,480	--	3.8	172	--	--	17.9	NA	7.9	14.8	4.8	340	--	--	26.9	--	--	--	40.2	36.7
S37-04	0 - 1	11,000	--	4.7	183	--	--	20.8	NA	10	26.7	7.6	338	--	--	35.8	--	--	--	49.8	55.7
	5 - 6	10,700	--	9.9	228	--	--	39.6	NA	15.1	39.7	8.2	590	--	--	79.3	--	--	--	65.3	62
S37-05	0.5 - 1.5	12,800	0.72	13.2	287	--	--	37.3	NA	16.3	32.7	6.5	252	--	--	65.2	--	--	--	61.1	67.2
	5 - 6	8,800	--	5.1	103	--	--	18.5	NA	7.8	13.5	6.7	270	--	--	26	--	--	--	43.1	39.3
S37-06	0.5 - 1.5	3,350	--	3.5	20.3	--	--	7	NA	3.4	4.6	3.1	75.1	--	--	--	--	--	--	14.8	--
	5 - 6	5,260	--	3.9	157	--	--	12.3	NA	10	10.8	5	452	--	--	22	--	--	--	36.9	--
S37-07	0 - 1	6,500	--	3.8	175	0.36	0.48	12.5	NA	4.4	11.4	6.3	179	--	--	14.7	--	--	--	15.8	--
	5 - 6	9,510	--	3.9	237	--	--	15	NA	6.5	14.8	7	159	--	--	20.7	--	--	--	35.1	40.1
S37-08	0 - 1	4,790	0.53	8.2	34.7	--	--	10.4	NA	4.7	9.9	5.2	98.3	--	--	7	--	--	--	25.1	--
	5 - 6	11,500	0.7	4.3	183	0.25	--	20.3	NA	13.2	27.1	7.9	538	--	--	47.5	--	--	--	48	64.1
S37-09	0 - 1	3,340	--	3.4	22.9	--	--	6.4	NA	4.8	6.1	3.3	123	--	--	6.3	--	--	--	15.3	--
	4.5 - 5.5	11,700	--	4.6	215	--	--	23.9	NA	14.5	29.3	8.4	608	--	--	51	--	--	--	49.1	68.1
S37-10	0.5 - 1	25,600	0.68	3.6	11.7	--	1.2	23.3	NA	29.2	86	5.6	462	0.51	--	18.6	--	1.3	--	86.4	46
	3 - 4	10,800	0.48	2.7	438	--	--	29	NA	14.4	33.3	5.8	759	--	--	46.5	--	--	--	60.3	56.6
S37-11	0.5 - 1.5	14,000	1.3	6.2	127	--	--	62.9	NA	18.1	60.8	25	293	0.22	--	45	--	--	--	71.7	88.7
	5 - 6	13,100	--	7.2	106	--	--	25.2	NA	9.2	22.3	8.1	247	0.06	--	38.7	--	--	--	53.5	50.2
S37-12	0.5 - 1.5	6,770	--	--	109	--	--	13.1	NA	8.7	17.9	4.9	291	--	--	26	--	--	--	28.9	37.8
	5 - 6	13,400	--	3.5	165	--	--	25.9	NA	15.3	37.3	12.2	569	--	--	50	--	--	--	53.4	58.5
WHSSB006	0 - 0.5	12,700	0.97	5.5	134	0.41	0.53	25.3	NA	9.8	22.2	26.8	408	0.08	0.48	28.7	--	--	--	42.2	109
WHSSB007	0 - 0.5	18,400	1.2	5.7	282	0.36	0.43	45.7	NA	13.7	34	17.7	417	0.07	0.84	53.2	--	--	--	71.5	124
ISSB008	0 - 0.5	6,940	--	2	83.3	0.19	0.08	17.9	NA	8.4	14	7.5	436	0.06	--	29.9	--	--	--	27	33.1
..ISSB009	0 - 0.5	11,300	2.9	11.6	75.1	--	4.7	36.1	NA	15.2	102	167	652	0.28	0.34	27.5	--	1.6	--	50.2	746
WHSSB010	0 - 0.5	5,400	0.61	9.1	32.1	--	0.05	27.2	NA	13	7.6	8	311	--	--	47.4	--	--	--	29.3	49.2
WHSSB011	0 - 0.5	22,800	0.71	5.6	163	0.52	0.46	49.2	NA	14.7	30.9	10	522	0.07	--	62.5	--	--	--	65.1	71.7
WHSSB012	0 - 0.5	9,080	0.67	4	118	0.11	0.18	24.2	NA	8.6	18.1	16	361	0.08	--	34.6	--	--	--	36.4	74.6
WHSSB013	0 - 0.5	10,200	4.9	15.2	82.9	--	3.3	30.2	NA	12.9	67.4	226	489	0.33	1.1	25.5	1.2	4.4	--	43	467
WHSSB014	0 - 0.5	6,400	7.1	13.2	301	--	2.1	122	NA	7.6	--	598	379	0.22	0.75	16.6	--	2.3	--	28.1	426
WHSSB015	0 - 0.5	7,150	2.1	6.9	87.3	--	1.6	25.8	NA	7.9	--	142	402	0.24	0.59	18.9	0.9	0.4	--	29.5	258
WHSSB016	0 - 0.5	7,010	7	8.6	139	--	2.4	34.4	NA	9.4	84.3	211	627	0.3	--	20.8	--	1.1	--	32.9	515
WHSSB017	0 - 0.5	5,920	1.2	3.4	59.2	--	0.31	21.9	NA	9.7	45.7	56.3	390	0.11	--	37.5	--	--	--	30.2	94.9
WHSSB024	0 - 0.5	32,500	2.8	5.8	45.4	--	--	73.2	NA	30.2	102	31	652	7.1	--	63.2	--	--	1.1	139	224
WHSSB025	0 - 0.5	11,400	--	4.5	73.8	--	--	28.1	NA	12.5	20.4	21.4	418	0.07	--	33.8	--	--	--	64.8	153
WHSSB027	0 - 0.5	12,500	1.7	3.4	183	0.17	--	33.5	NA	10.5	16.3	10.7	477	0.07	--	29.2	--	--	1.1	45.5	36
WHSSB028	0 - 0.5	11,100	--	6.9	124	--	--	36.3	NA	12.4	18.9	150	463	--	--	53.2	--	--	--	47.3	71.9
WHSSB029	0 - 0.5	15,400	--	--	59.2	--	--	27.1	NA	15.2	24.8	23.7	338	--	--	33.9	--	--	--	64.5	63.1
WHSSB050	0 - 0.5	16,900	1.4	4.1	115	--	19.9	34.2	NA	19.5	71.5	127	674	0.18	1	30.2	--	--	--	65.6	723
	2 - 2.5	7,590	--	4.4	138	--	--	17.3	NA	13	12.8	6.2	962	--	--	28	--	--	--	44.6	42.4
WHSSB051	0 - 0.5	19,200	0.44	--	7.9	--	--	17	NA	20.7	28.6	1.8	250	0.21	--	10.8	--	--	--	74.2	28.6
	2 - 2.5	10,500	0.64	4.5	195	--	--	34.9	NA	15.1	30.8	5.6	1300	0.14	--	68.4	--	--	--	59.2	54.2
WHSSBA06	0 - 0.5	20,600	0.69	--	19	--	--	14.9	NA	23.5	67.3	3.7	752	5.6	--	16.5	--	--	--	83	83.9
	1 - 2	16,400	0.87	3.6	460	--	--	47.3	NA	23.9	38.8	5.8	1190	0.09	--	74.5	--	--	--	80	73.7
	4.5 - 5	10,400	1.3	5.4	177	--	--	32.6	NA	13.1	24.5	6.8	1470	0.09	--	50.8	--	--	1.8	56.6	57.1
	9 - 10.9	13,900	--	5.1	116	0.13	--	28.9	NA	16.5	27.3	9.5	327	--	--	54.6	--	--	--	56.2	48.3
	13 - 14	17,800	0.84	4	415	0.13	--	34.9	NA	13.2	24.4	9.1	163	--	--	46.4	--	--	--	60	47
WHSSBA08	0 - 0.5	32,200	2.5	14.9	116	0.06	--	100	NA	23.6	70.8	40.9	943	0.44	--	95.5	--	--	--	102	281
WHSSBB03	0 - 0.5	11,800	1.8	6.8	250	0.1	--	21.6	NA	12	22.5	15.3	354	0.08	--	37.7	--	--	--	50	198
WHSSBB07	0 - 0.5	15,300	3.7	7.2	76.6	--	--	43.4	NA	16.8	82.5	68.3	234	0.18	0.57	34.8	--	--	--	69.5	194
WHSSBC02	0 - 0.5	17,600	--	22.4	62	--	--	53.4	NA	7.2	69.1	175	164	0.39	--	56.8	--	--	--	99.7	338
	1.3 - 2	9,410	--	3.7	29.9	--	--	35.9	NA	2.8	14.5	5.8	119	--	2.3	25.5	4.8	--	--	50.2	31.4
	4 - 5.5	2,750	--	--	18.5	--	--	11.2	NA	1.7	14.2	1.9	63.3	--	3.2	14.4	--	--	--	31.9	28.7
	8.8 - 10	6,300	--	9.2	20.9	--	--	23.5	NA	5.4	16.4	4.3	78.2	--	4.7	26.6	--	--	--	44.7	27.7
..HSSBC04	0 - 0.5	12,400	--	5.3	175	--	--	27.2	NA	28.4	21.6	33.5	1060	0.08	--	51.9	--	--	1	53.9	158

TABLE 6-15

SUMMARY OF DETECTED INORGANIC CONSTITUENT CONCENTRATIONS IN SOIL AND SEDIMENT SAMPLES
TIDAL AREA QEA, NWS SBD CONCORD

Sample Location	Sample Depth (feet bgs)	Inorganic Constituents (mg/kg)																			
		Aluminum	Antimony	Arsenic	Barium	Beryllium	Cadmium	Chromium	Chromium VI	Cobalt	Copper	Lead	Manganese	Mercury	Molybdenum	Nickel	Selenium	Silver	Thallium	Vanadium	Zinc
Wood Hogger Site - Terrestrial Unit (Continued)																					
WHSSBC06	0 - 0.5	14,400	0.93	16.7	50.6	0.21	0.24	24.9	NA	12.7	57.5	11	217	0.16	--	19.5	0.67	--	--	47.7	60.7
WHSSBC08	0 - 0.5	16,900	2.2	10.8	186	--	--	49.2	NA	20.7	56.3	11.3	772	0.14	--	100	--	--	1.9	90.6	89.8
WHSSBD03	0 - 0.5	18,000	--	17.9	84	--	--	55.5	NA	7	103	218	185	--	--	58.9	--	--	2.4	83.8	417
	1.5 - 2	15,500	--	9.8	57	--	--	50.8	NA	3.8	22.7	9.8	126	--	--	35.6	--	--	--	58.6	--
	4.5 - 5.8	22,400	--	15.1	52.9	--	--	71.5	NA	23.1	27.5	12.3	353	--	6.6	97.7	--	--	--	78.4	--
	9.5 - 10.4	17,400	--	7	39	--	--	58.3	NA	13.4	33.3	9.1	440	--	--	59.3	--	--	--	42.2	98.3
	18.5 - 20	2,050	--	--	28	--	--	--	NA	--	20.4	--	94	--	--	--	--	--	--	13.1	--
WHSSBD07	0 - 0.5	7,850	2.2	7.2	63.3	--	1.7	25.5	NA	9.1	43.7	90.9	319	0.22	1.1	21.2	--	0.22	--	32.2	225
	1.5 - 2.3	7,770	0.84	3.4	90.1	--	0.56	20.2	NA	13.7	55.8	49.6	255	0.08	--	31.3	--	--	--	38.2	593
	4.5 - 5.3	14,700	0.6	7.2	186	--	0.2	43.6	NA	16.7	45.4	8	508	0.11	--	114	--	--	--	82.5	76.8
	9.3 - 10	11,100	--	5	188	0.18	0.09	25.8	NA	9.5	26.5	8.8	149	0.08	0.35	46.6	--	--	--	51.4	45.9
WHSSBE02	0 - 0.5	10,200	0.72	3.3	146	0.13	--	24.8	NA	8.7	13.7	11.1	420	--	--	25.9	--	--	--	41.1	88.6
WHSSBE04	0 - 0.5	14,800	5.7	15.4	103	--	16.2	41.5	NA	18.3	173	593	731	0.82	--	43.9	--	--	--	64.3	544
WHSSBE06	0 - 0.5	11,100	1.9	6.3	145	0.08	--	38.6	NA	10.9	35	91.2	366	0.1	0.25	31.9	--	--	--	40	155
WHSSBE08	0 - 0.5	7,690	5.7	5.2	63.2	--	--	36.6	60	6.6	78.3	320	110	0.2	0.94	17.5	--	0.23	--	33.1	244
	2.5 - 4	20,900	2.2	8.4	546	--	--	63.2	NA	29.1	55.7	24.5	877	--	1.5	103	--	--	2.2	163	141
	5.5 - 6.5	14,400	1.7	8.2	189	--	--	52.3	NA	18.6	74.1	47.4	621	--	1.3	119	--	--	--	79.1	136
	9 - 10.3	26,800	1.4	19.3	58.8	--	--	81.9	NA	35.6	28.4	12.7	337	--	6.6	111	--	--	--	95.8	92.3
WHSSBF03	0 - 0.5	9,750	--	6.7	233	--	4.1	23.8	NA	11.9	42	49.1	901	--	--	35.3	--	--	0.96	41.1	285
	1.5 - 2.3	25,900	--	21.3	70.6	--	--	73.8	NA	13.2	45.2	29.9	224	--	--	53.8	--	--	--	86.8	89.1
	4.5 - 5.9	20,600	--	19.3	130	--	1.9	80.7	NA	16	59.1	728	653	--	2.3	87.4	--	--	--	68.8	1440
	9.5 - 10.8	27,300	--	10.5	57.4	--	--	95.2	NA	19.6	34.9	23	418	--	--	91.8	--	--	--	76.6	122
WHSSBF07	0 - 0.5	9,040	0.66	4.8	111	0.07	0.28	26.2	NA	8.8	--	22.3	258	--	--	39.5	--	--	--	39.1	92.8
WHSSBG02	0 - 0.5	12,900	3.2	27.1	109	--	1.7	54	NA	5.8	67.7	103	167	--	2.4	45.1	--	--	--	71.1	342
WHSSBG06	0 - 0.5	12,200	0.86	2.9	107	0.22	--	28	NA	11.3	15.4	7.2	435	--	--	40.7	--	--	--	35.6	35.7
	1.1 - 2	12,100	--	3.9	529	--	--	43	NA	10.3	37.3	6.1	374	0.07	--	35.8	--	--	--	66.2	48.8
	4.5 - 5	9,390	--	5.5	233	0.11	--	17.7	NA	8.5	20.7	7	254	--	--	30	--	--	--	47.8	50
	9 - 11	20,600	--	3.3	57.5	--	--	58.6	NA	7.4	23.9	8.1	151	--	4.5	49.1	--	--	--	64.3	59.4
WHSSBH03	0 - 0.5	6,920	1.6	4.6	72.3	--	5.4	35	NA	7.8	607	134	523	0.63	1.6	24	--	0.18	--	25.5	2540
WHSSBH07	0 - 0.5	14,100	--	--	70.8	--	--	28	NA	16.7	31.8	15.3	417	0.18	--	43.9	--	--	0.69	65.2	79
	1.3 - 2.3	82.2	--	--	1.1	--	--	--	NA	--	0.72	0.35	4.3	NA	--	--	--	--	--	0.28	--
	4 - 5	21,700	--	24.6	65.9	--	--	71.6	NA	8.4	43.7	13.9	170	--	12.9	88.5	--	--	--	92.3	81.4
	8 - 10.1	7,650	--	15.1	61.4	--	--	23.2	NA	4.5	22	4.4	275	--	5.1	33	--	--	--	44.8	40.7
WHSSBI02	0 - 0.5	23,900	6.2	21.2	179	--	20.8	69.8	NA	24.8	228	195	1080	0.79	0.83	88.2	--	--	--	99	3010
WHSSBI06	0 - 0.5	10,200	0.94	5.2	176	0.12	--	22.8	NA	10.6	22.6	40.9	424	0.09	--	25	--	--	--	38.4	116
WHSSBI08	0 - 0.5	25,500	--	15.9	120	0.46	1.8	70.9	NA	20	78.7	43.1	1000	0.34	5.6	84.4	--	--	--	94.9	339
WHSSBJ05	0 - 0.5	12,400	1.4	5.5	165	0.14	--	26.4	NA	9.8	24.4	41.5	375	0.05	0.38	26.2	--	--	--	41	120
WHSSBJ07	0 - 0.5	10,300	1.4	3.3	105	0.14	--	25.5	NA	7.5	15.4	14.6	266	--	--	34.5	--	--	--	37.2	68.8
WHSSBK04	0 - 0.5	17,600	0.94	4.2	112	--	--	24.2	NA	15.9	43.2	25.7	452	0.5	--	23	--	--	--	61.7	128
WHSSBK06	0 - 0.5	11,800	0.86	3.3	129	0.11	--	24.2	--	11.5	35.7	11.6	488	0.07	--	26.8	--	--	--	41.7	54.6
	1.5 - 2.3	14,900	4.6	15.1	134	--	--	57.7	NA	16.9	54.1	94.7	287	0.32	1.2	66.1	--	--	--	73.4	264
	4.5 - 5.3	16,400	5.7	37	80.4	--	--	64.6	NA	11.9	59.5	66.2	372	0.2	5	47.9	--	--	--	71.8	240
	9.5 - 10.4	18,500	2	15	51.2	0.11	--	70	NA	16.8	44.1	24.6	263	0.12	0.92	77.5	--	--	--	64.2	114
WHSSBL05	0 - 0.5	15,000	1.1	4.6	171	--	--	41.3	NA	14.7	27.8	32.9	781	--	--	60.6	--	--	0.93	63.3	95.1
WHSSBL07	0 - 0.5	15,200	1.4	6.7	189	0.08	--	31	NA	11.8	24.9	28.4	433	0.16	--	46.8	--	--	1.7	58.1	71.2
WHSSBM04	0 - 0.5	12,400	--	8.6	214	--	--	24.9	NA	12.3	20.8	28.1	777	0.12	--	36.8	--	--	--	40	59.2
WHSSBM06	0 - 0.5	13,000	--	8.3	142	--	--	40.2	NA	14.2	16.2	16.6	494	7	--	55.1	--	--	--	52.5	59.5
WHSSBM08	0 - 0.5	9,100	--	14.6	71.1	--	--	37	NA	11.1	45.4	27.7	295	--	1.5	52.8	--	0.16	--	42.4	70.2
	1 - 1.7	15,200	--	5.8	198	--	--	42.1	NA	18.6	32.7	25.3	626	--	--	75.3	--	--	--	77.1	73.2
	4.1 - 5.2	9,230	--	5	230	--	--	23.1	NA	11.7	12.7	6.9	194	--	--	26.1	--	--	--	45	45.6
	9 - 10.5	7,140	NA	--	31.7	--	--	--	NA	3.7	--	--	53.1	--	--	25	--	--	--	44.9	--

TABLE 6-15

SUMMARY OF DETECTED INORGANIC CONSTITUENT CONCENTRATIONS IN SOIL AND SEDIMENT SAMPLES
TIDAL AREA QEA, NWS SBD CONCORD

Sample Location	Sample Depth (feet bgs)	Inorganic Constituents (mg/kg)																			
		Aluminum	Antimony	Arsenic	Barium	Beryllium	Cadmium	Chromium	Chromium VI	Cobalt	Copper	Lead	Manganese	Mercury	Molybdenum	Nickel	Selenium	Silver	Thallium	Vanadium	Zinc
North Otter Sluice - Aquatic Unit																					
OSLSL001	0 - 0	18,700	1.7	6.8	55.6	0.2	0.71	54.5	NA	12.2	41	24.1	280	--	--	56.8	1.2	0.32	1.8	53.6	89.5
OSLSL002	0 - 0	17,300	1.3	6.9	56.4	0.22	0.77	55	NA	12.1	41.3	16.3	270	--	--	58.9	--	0.32	1.8	52.5	89.7
OSLSL003	0 - 0	16,700	1.7	6.3	53.2	0.21	0.69	52.7	NA	11.6	40.1	16.8	251	--	--	56.3	--	--	1.8	52.1	89.4
RADSB001	0 - 0.5	17,100	--	15.2	97.7	--	--	52.8	NA	19.3	64.9	89.5	429	0.27	--	67.4	--	--	--	67.5	304
RADSB002	0 - 0.5	19,900	NA	11.1	83.2	--	--	53.6	NA	18	47.8	36.1	383	--	--	56.7	--	--	--	68.2	264
RADSB003	0 - 0.5	29,300	3	28	90.9	--	0.43	92.3	NA	31.5	83.4	66.4	479	0.55	--	114	--	--	--	102	309
RADSB004	0 - 0.5	30,300	1.3	9	89.8	--	--	90.2	NA	21.9	68.7	44.8	530	0.79	--	86.4	--	--	--	96.8	193
RADSB005	0 - 0.5	26,100	--	15	93.1	--	--	80.1	NA	23.6	56.9	40.9	563	0.34	--	76.4	--	--	--	99	232
RADSB006	0 - 0.5	14,900	--	33.2	87.7	--	--	56.2	NA	27.3	57.6	33.3	897	--	--	76.4	--	0.62	--	95.6	474
RADSB016	0 - 0.5	23,700	--	14.7	85.4	--	--	81.7	NA	21.2	65.5	49.3	798	0.35	--	87.7	--	--	--	85.7	172
RADSBA01	0 - 0.5	22,200	1.1	17.8	90.8	--	--	71	NA	20	55.6	128	344	0.56	--	78.3	--	--	--	77.1	241
RADSBA02	0 - 0.5	25,800	--	15.6	196	--	--	81.7	NA	19.3	61.9	182	402	0.36	--	80.7	--	--	--	82.9	228
RADSBA03	0 - 0.5	23,500	3.1	16.7	91.2	--	0.68	81.2	NA	27	98	94	513	0.37	--	96.4	--	--	--	89.2	305
RADSBA04	0 - 0.5	27,400	--	9.1	75	--	--	82	NA	22.3	72.6	37.8	463	0.92	--	85.8	--	--	--	96.1	215
RADSBA05	0 - 0.5	23,400	--	14.6	57.3	--	--	78.9	NA	12.6	47.4	30.7	417	0.44	2.5	61	--	--	--	79.2	146
RADSBA06	0 - 0.5	13,500	--	17.5	92.9	--	--	46.3	NA	7.2	46.6	23	144	0.56	--	32	--	--	--	66.1	152
RADSBA07	0 - 0.5	23,100	7.1	47.2	77.1	--	--	319	NA	20.3	272	106	401	0.51	53.7	140	--	--	--	96.8	496
RADSL001	0 - 0.5	13,400	--	12.7	65.1	--	--	48.3	NA	17.8	63.9	89.5	293	1.6	--	61.3	--	--	--	54.9	178
RADSL002	0 - 0.5	28,700	--	18	80.6	--	--	95.5	NA	25.1	76.3	40.4	419	0.51	--	98.3	--	--	--	105	214
South Otter Sluice - Aquatic Unit																					
OSLSL004	0 - 0	15,300	1.2	13.7	53.9	0.23	0.87	50.6	NA	13.4	44.1	20.1	279	--	0.58	55.5	1.5	0.26	1.5	58.9	97
OSLSL005	0 - 0	16,900	1.8	14	56.8	0.29	1.9	53.2	NA	19.5	53.5	31.1	370	--	0.83	66.3	1.2	0.4	2	62.9	166
OSLSL006	0 - 0	15,800	1.4	12.1	61.3	0.23	1.6	53.6	NA	15.5	56.8	34.1	341	--	0.45	60.6	--	0.6	1.6	64.1	157
OSLSL007	0 - 0	16,900	1.1	12.1	71	0.11	0.8	54.5	NA	13.6	42.7	21.7	607	--	0.58	60.5	1.3	0.32	2.8	59.7	119
OSLSL008	0 - 0	27,900	9.3	21.2	157	0.94	--	95	NA	23.3	101	55.4	499	--	3.5	112	--	--	--	106	285
OSLSL009	0 - 0	18,500	--	13.8	106	0.38	--	61	NA	15.2	58.7	35.8	447	--	--	67.4	--	--	--	66.6	177
WHSSB001	0 - 0.5	42,700	--	18.6	100	0.84	--	122	NA	28.4	96	47.8	577	0.49	3.6	123	3.5	--	--	139	268
WHSSB002	0 - 0.5	30,400	2.9	24.8	280	0.81	4.2	65.8	NA	23.8	104	99.5	597	0.42	2.9	102	--	--	--	120	605
WHSSB003	0 - 0.5	30,600	2.2	19.7	139	0.78	0.66	81.1	NA	33.9	77.3	59.1	693	0.3	1.8	107	--	--	--	109	394
WHSSB004	0 - 0.5	19,600	2.4	12.2	107	0.28	0.89	50.3	NA	11.4	78.7	92.2	364	0.22	2.4	50	--	--	--	78.1	166
WHSSB005	0 - 0.5	15,500	0.95	6	160	0.49	0.25	26	--	11.7	19.7	6.8	541	0.03	--	30.3	--	--	--	50.6	48.3
WHSSB018	0 - 0.5	21,800	1.8	1.3	37	0.01	0.64	28.1	NA	28.4	58.1	5.4	928	10	--	30.9	--	--	--	112	176
WHSSB021	0 - 0.5	5,130	--	19.2	47.6	--	--	21.6	NA	2.4	29.2	39.3	55.3	--	5	27.2	--	--	--	41.4	82.1
WHSSB022	0 - 0.5	22,500	--	3.8	46.8	--	--	28.3	NA	39.3	89	8.4	1270	18.5	--	23.6	--	--	--	136	164
WHSSB023	0 - 0.5	20,700	--	11.8	70.5	--	--	54.2	NA	23.3	82.9	81.4	702	0.27	1.9	68.4	--	--	--	83.9	322
WHSSB026	0 - 0.5	21,600	2	9.6	80.2	0.37	1.1	56.2	NA	15.8	57.3	27.5	374	0.22	4.2	68.2	--	--	--	82.3	207
WHSSBA02	0 - 0.5	33,100	2.8	17.7	191	0.65	3.9	72.3	NA	22.7	105	66.4	677	0.35	5.2	94.7	--	--	--	109	568
WHSSBA04	0 - 0.5	17,000	2.1	8.7	256	0.19	--	36.6	NA	15.3	30.8	10.4	551	0.08	--	54.3	--	--	--	61.9	69.3
WHSSBB01	0 - 0.5	13,600	--	5.4	297	--	--	23.8	NA	11.9	16.7	8.8	496	0.06	--	30	--	--	--	42.2	53
WHSSBB05	0 - 0.5	28,000	--	9.8	70.1	--	--	78	NA	15.2	85.1	46.2	285	0.82	--	69.2	--	--	--	92.8	259
WHSSBD01	0 - 0.5	14,300	--	5.2	353	--	--	32.9	NA	14.3	30	5.5	622	0.14	--	56.7	--	--	--	64.5	63.9
WHSSBG08	0 - 0.5	20,600	1.6	10.3	95.5	0.36	0.51	59.1	NA	21.6	51.2	18.3	512	0.2	1.4	82.4	--	--	--	86.1	150
WHSSBK08	0 - 0.5	21,700	0.71	7.8	212	0.51	0.35	44.2	NA	16.6	33.6	10.8	656	0.08	0.57	73.4	--	--	--	70.2	87.5
WHSSL001	0 - 0.5	28,700	1.8	21.4	89.8	0.68	--	86.5	NA	24.8	76.1	41.5	490	0.35	1.3	95.5	--	--	--	103	203
WHSSL002	0 - 0.5	26,500	2.2	12.2	86.7	0.59	--	85	NA	19.6	71.9	40.2	430	0.37	1.6	90.5	--	--	--	92.3	200
WHSSL003	0 - 0.5	35,200	1.5	25.9	82.9	0.72	--	94.7	NA	13.1	73.5	52.2	205	0.51	3	75.6	1.3	--	--	119	107

Notes:

bgs Below ground surface
mg/kg Milligrams per kilogram
NA Not analyzed
-- Not detected

TABLE 6-16

SUMMARY OF DETECTED PESTICIDE CONCENTRATIONS IN SOIL AND SEDIMENT SAMPLES
TIDAL AREA QEA, NWS SBD CONCORD

		CLP Pesticides (µg/kg)						Low Detection Limit Method Pesticides (µg/kg)																			
Sample Location	Sample Depth (ft bgs)	4,4'-DDD	4,4'-DDE	4,4'-DDT	Alpha-chlordane	Endrin Ketone	Gamma-chlordane	2,4'-DDD	2,4'-DDE	2,4'-DDT	4,4'-DDD	4,4'-DDE	4,4'-DDT	Aldrin	Alpha-BHC	Alpha-chlordane	Dieldrin	Gamma-BHC (Lindane)	Gamma-Chlordane	Heptachlor	Heptachlor Epoxide	Hexachlorobenzene	Methoxychlor	Mirex	Total BHCs[a]	Total Chlordanes[a]	Total DDTs[c]
Tidal Area Landfill - Terrestrial Unit																											
TLSSB001	0 - .5	NA	NA	NA	NA	NA	NA	12	--	0.98	27	5.6	2.2	1.6	--	4.4	2.2	--	--	--	--	2	--	0.49	a	a	47.78
	3.9 - 4.5	NA	NA	NA	NA	NA	NA	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	a	a	--
TLSSB002	0 - .5	NA	NA	NA	NA	NA	NA	3.2	0.93	--	6.1	5.7	0.98	1.2	--	5.1	1.6	--	--	--	--	0.86	--	0.53	a	a	16.91
TLSSB004	1.3 - 2.4	NA	NA	NA	NA	NA	NA	--	--	--	--	--	--	--	--	--	--	--	--	0.77	--	--	--	--	a	a	--
TLSSB005	0 - .5	NA	NA	NA	NA	NA	NA	4.6	0.59	--	9.3	1.8	1	--	--	1.5	0.53	--	--	--	--	--	--	--	a	a	17.29
TLSSB006	0 - .5	NA	NA	NA	NA	NA	NA	2.1	--	--	2.6	3.1	--	--	--	1.5	--	--	--	--	--	--	--	--	a	a	7.8
TLSSB008	0 - .5	NA	NA	NA	NA	NA	NA	0.66	--	--	1.5	2	0.73	--	--	4.2	--	--	--	0.57	--	--	--	--	a	a	4.89
R Area Disposal Site - Terrestrial Unit																											
RADSB008	0 - .5	NA	NA	NA	NA	NA	NA	--	--	0.26	--	0.48	--	--	--	--	--	--	--	--	--	0.31	--	--	a	a	0.74
RADSB009	0 - .5	NA	NA	NA	NA	NA	NA	0.6	--	1.2	0.88	1.4	4.8	--	--	0.96	0.72	--	--	--	--	0.45	--	0.18	a	a	8.88
RADSB010	0 - .5	NA	NA	NA	NA	NA	NA	6.5	1.1	2.6	20	8.7	12	--	--	0.95	0.89	--	--	--	--	--	--	--	a	a	50.9
RADSB011	0 - .5	NA	NA	NA	NA	NA	NA	6.5	1.2	5	26	6.5	28	--	--	2.2	2	--	--	--	--	1.6	--	1.3	a	a	73.2
RADSB012	0 - .5	NA	NA	NA	NA	NA	NA	2	0.33	0.71	6.4	2.6	3.4	--	--	1.4	0.59	--	--	--	--	0.5	--	0.65	a	a	15.44
RADSB014	0 - .5	NA	NA	NA	NA	NA	NA	0.3	0.28	--	0.32	0.44	--	--	--	0.89	--	--	--	--	--	--	--	--	a	a	1.34
RADSB015	0 - .5	NA	NA	NA	NA	NA	NA	--	--	0.21	--	0.27	1.3	--	--	0.31	--	--	--	--	--	--	--	--	a	a	1.78
RADSBB01	0 - .5	NA	NA	NA	NA	NA	NA	--	--	--	--	0.2	0.25	--	--	--	--	--	--	--	--	--	--	--	a	a	0.45
RADSBB03	0 - .5	NA	NA	NA	NA	NA	NA	--	--	0.2	--	0.68	2	--	--	0.19	--	--	--	--	--	0.37	--	0.046	a	a	2.88
RADSBB04	0 - .5	NA	NA	NA	NA	NA	NA	0.68	--	--	0.92	1.7	0.85	--	--	0.81	--	--	--	--	--	--	--	--	a	a	4.15
RADSBB06	0 - .5	NA	NA	NA	NA	NA	NA	--	--	--	0.49	1.5	--	--	--	0.68	--	--	--	--	--	--	--	--	a	a	1.99
RADSBB07	0 - .5	NA	NA	NA	NA	NA	NA	--	--	--	--	--	--	0.4	--	--	--	--	--	--	--	0.26	--	--	a	a	--
RADSBB08	0 - .5	NA	NA	NA	NA	NA	NA	--	--	--	--	0.29	0.3	--	--	--	--	--	--	--	--	--	--	--	a	a	0.59
RADSBC05	0 - .5	NA	NA	NA	NA	NA	NA	1.4	--	2.4	2.5	4.7	7.4	--	--	1.6	0.64	--	--	0.43	--	--	--	0.15	a	a	18.4
RADSBC08	0 - .5	NA	NA	NA	NA	NA	NA	--	--	0.8	--	0.72	6	--	--	--	--	--	--	--	--	--	--	--	a	a	7.52
RADSBD03	0 - .5	NA	NA	NA	NA	NA	NA	--	--	0.31	--	0.53	0.89	--	--	--	--	--	--	--	--	--	--	0.12	a	a	1.73
RADSBD05	0 - .5	NA	NA	NA	NA	NA	NA	3.8	0.57	0.8	5.6	2.8	1.9	--	--	2.5	1.4	0.75	--	--	0.55	0.64	--	0.54	a	a	15.47
RADSBD06	0 - .5	NA	NA	NA	NA	NA	NA	0.92	--	0.64	1.4	1.1	0.99	0.43	--	1.8	0.89	0.5	--	--	0.42	0.46	--	1.3	a	a	5.05
RADSBD07	0 - .5	NA	NA	NA	NA	NA	NA	--	--	0.38	0.34	0.6	1.6	--	--	--	--	--	--	--	--	--	--	--	a	a	2.92
RADSBD08	0 - .5	NA	NA	NA	NA	NA	NA	--	--	--	--	0.48	1.6	--	--	--	0.18	--	--	--	--	--	--	--	a	a	2.08
RADSBE02	0 - .5	NA	NA	NA	NA	NA	NA	--	--	--	--	0.65	1.3	--	--	0.33	--	--	--	--	--	--	--	--	a	a	1.95
RADSBE03	0 - .5	NA	NA	NA	NA	NA	NA	--	--	0.46	--	--	0.5	0.47	--	--	--	--	--	--	0.49	0.34	--	--	a	a	0.96
RADSBE05	0 - .5	NA	NA	NA	NA	NA	NA	--	--	0.17	0.25	0.22	0.6	--	--	--	--	--	--	--	--	--	--	--	a	a	1.24
RADSBE08	0 - .5	NA	NA	NA	NA	NA	NA	--	--	--	--	--	--	--	--	--	--	--	--	0.32	--	--	--	--	a	a	--
RADSBF02	0 - .5	NA	NA	NA	NA	NA	NA	2.9	0.38	--	6	1.6	0.54	0.41	--	1.2	0.44	--	--	--	0.37	--	--	--	a	a	11.42
RADSBF03	0 - .5	NA	NA	NA	NA	NA	NA	4.1	0.27	0.65	6.6	2.5	2.8	--	--	0.24	0.24	--	--	--	--	--	--	--	a	a	16.92
RADSBF06	0 - .5	NA	NA	NA	NA	NA	NA	0.28	--	0.36	0.4	0.34	1	0.23	--	--	--	--	--	--	--	--	--	--	a	a	2.38
RADSBF08	0 - .5	NA	NA	NA	NA	NA	NA	--	--	0.44	1.2	1.5	1.5	--	--	0.55	0.31	--	--	--	--	--	--	0.13	a	a	4.64
RADSBG04	0 - .5	NA	NA	NA	NA	NA	NA	3.1	0.47	1.6	11	2.2	5.5	--	--	0.4	0.5	0.89	--	--	--	0.84	--	--	a	a	23.87
RADSBG05	0 - .5	NA	NA	NA	NA	NA	NA	--	--	--	0.37	--	--	0.38	--	--	--	--	--	--	--	0.2	--	0.24	a	a	0.37
RADSBG06	0 - .5	NA	NA	NA	NA	NA	NA	--	--	0.36	0.38	0.43	--	0.32	--	--	--	--	--	--	--	--	--	--	a	a	1.17
RADSBG08	0 - .5	NA	NA	NA	NA	NA	NA	--	--	--	--	0.21	--	--	--	--	--	--	--	--	--	--	--	--	a	a	0.21
RADSBH02	0 - .5	NA	NA	NA	NA	NA	NA	--	--	0.32	--	--	0.32	--	--	0.22	--	0.31	--	--	0.34	0.17	--	--	a	a	0.64
RADSBH03	0 - .5	NA	NA	NA	NA	NA	NA	0.8	--	0.44	2	0.44	0.25	--	--	--	--	--	--	--	0.34	0.21	--	--	a	a	3.93
RADSBH05	0 - .5	NA	NA	NA	NA	NA	NA	0.45	0.26	--	1	0.85	1.2	--	--	0.25	0.28	--	--	--	--	0.51	--	--	a	a	3.76
RADSBH06	0 - .5	NA	NA	NA	NA	NA	NA	3.3	--	--	6.1	4	--	--	--	2.3	1.1	0.68	--	--	--	--	--	0.34	a	a	13.4
RADSBH07	0 - .5	NA	NA	NA	NA	NA	NA	0.34	--	--	0.82	0.36	0.36	0.75	--	--	--	--	--	--	--	--	--	--	a	a	1.88
RADSBJ01	0 - .5	NA	NA	NA	NA	NA	NA	--	--	--	0.44	0.2	0.18	--	--	--	--	0.29	--	--	0.18	--	--	--	a	a	0.82
RADSBJ02	0 - .5	NA	NA	NA	NA	NA	NA	0.58	--	0.32	0.77	0.26	0.24	0.33	--	0.17	--	--	--	--	0.95	--	--	--	a	a	2.17
RADSBJ04	0 - .5	NA	NA	NA	NA	NA	NA	2.7	0.42	--	8.2	1.2	--	--	--	0.97	0.55	--	--	--	--	--	--	--	a	a	12.52
RADSBJ05	0 - .5	NA	NA	NA	NA	NA	NA	--	--	--	--	--	--	0.35	--	--	--	--	--	--	--	--	--	--	a	a	--
RADSBJ08	0 - .5	NA	NA	NA	NA	NA	NA	--	--	--	--	0.76	--	--	--	0.29	--	--	--	--	--	--	--	--	a	a	0.76
RADSBJ02	0 - .5	NA	NA	NA	NA	NA	NA	0.43	--	3.4	0.77	1.7	11	--	--	--	--	--	--	--	--	0.56	--	--	a	a	17.3
RADSBJ03	0 - .5	NA	NA	NA	NA	NA	NA	0.61	--	0.22	1.3	0.59	0.56	--	--	0.23	--	0.61	--	--	--	0.55	--	--	a	a	3.28
RADSBJ07	0 - .5	NA	NA	NA	NA	NA	NA	0.49	0.3	0.44	0.86	0.68	1.5	--	--	0.24	0.41	--	--	--	--	0.45	--	0.3	a	a	4.27
RADSBK03	0 - .5	NA	NA	NA	NA	NA	NA	--	0.27	0.27	0.3	0.59	0.56	--	--	--	--	--	--	--	--	0.25	--	--	a	a	1.99
RADSBK07	0 - .5	NA	NA	NA	NA	NA	NA	1.9	0.56	3.5	3.6	2.2	14	--	--	0.67	--	--	--	--	--	--	--	0.37	a	a	25.76
RADSBK08	0 - .5	NA	NA	NA	NA	NA	NA	--	--	0.31	--	1.1	--	--	--	--	--	--	--	--	--	--	--	--	a	a	1.41
RADSBL03	0 - .5	NA	NA	NA	NA	NA	NA	--	0.57	0.95	0.53	4.7	7.5	--	--	0.56	--	--	--	--	--	--	--	--	a	a	14.25
RADSBL08	0 - .5	NA	NA	NA	NA	NA	NA	--	--	0.5	--	1.8	2.5	--	--	--	--	--	--	--	--	--	--	--	a	a	4.8
RADSBM08	0 - .5	NA	NA	NA	NA	NA	NA	0.42	--	--	--	0.62	1.6	--	--	0.49	--	--	--	--	--	--	--	--	a	a	2.64

TABLE 6-16

SUMMARY OF DETECTED PESTICIDE CONCENTRATIONS IN SOIL AND SEDIMENT SAMPLES
TIDAL AREA QEA, NWS SBD CONCORD

		CLP Pesticides (µg/kg)						Low Detection Limit Method Pesticides (µg/kg)																			
Sample Location	Sample Depth (ft bgs)	4,4'-DDD	4,4'-DDE	4,4'-DDT	Alpha-chlordane	Endrin Ketone	Gamma-chlordane	2,4'-DDD	2,4'-DDE	2,4'-DDT	4,4'-DDD	4,4'-DDE	4,4'-DDT	Aldrin	Alpha-BHC	Alpha-chlordane	Dieldrin	Gamma-BHC (Lindane)	Gamma-Chlordane	Heptachlor	Heptachlor Epoxide	Hexachlorobenzene	Methoxychlor	Mirex	Total BHCs[a]	Total Chlordanes[a]	Total DDTs[c]
R Area Disposal Site - Aquatic Unit																											
RADSB013	0 - .5	NA	NA	NA	NA	NA	NA	0.72	--	--	--	0.72	--	0.32	--	2.3	0.37	--	--	--	--	0.21	--	0.33	a	a	1.44
Froid and Taylor Roads Site - Aquatic Unit																											
FTSSB002	0 - .5	NA	NA	NA	NA	NA	NA	--	--	1	2	0.6	4	--	--	0.9	0.4	--	--	--	--	0.5	--	--	a	a	7.6
FTSSB003	0 - .25	NA	NA	NA	NA	NA	NA	5	0.6	2	9	2	8	0.4	--	2	0.8	0.4	--	--	--	--	--	--	a	a	26.6
FTSSB004	0 - .5	NA	NA	NA	NA	NA	NA	--	--	--	--	--	--	--	--	0.3	--	--	--	--	--	--	--	--	a	a	--
FTSSB005	0 - .5	NA	NA	NA	NA	NA	NA	0.8	--	--	3	0.6	0.6	--	--	0.7	--	--	--	--	--	--	--	--	a	a	5
FTSSB008	0 - .5	NA	NA	NA	NA	NA	NA	--	0.5	--	10	3	--	--	--	--	--	--	--	--	--	--	--	--	a	a	13.5
	1.2 - 1.75	8.2	--	--	--	--	--	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	a	a	8.2
FTSSB009	0 - .12	NA	NA	NA	NA	NA	NA	--	--	--	0.3	0.3	--	--	--	0.3	--	--	--	--	--	--	--	--	a	a	0.6
FTSSL102	0 - .5	NA	NA	NA	NA	NA	NA	4	--	3	14	7	15	--	0.7	11	--	--	12	--	--	--	--	--	1.3	23	43.2*
FTSSL103	0 - .5	NA	NA	NA	NA	NA	NA	7	0.4	--	7	3	--	--	--	0.3	--	--	0.4	--	--	0.4	--	--	0.4	0.7	17.65*
FTSSL104	0 - .5	NA	NA	NA	NA	NA	NA	7	--	--	11	6	--	--	--	2	--	--	2	--	--	0.4	--	--	0.4	4	24.35*
Froid and Taylor Roads Site - Terrestrial Unit																											
FTSSB001	0 - .3	NA	NA	NA	NA	NA	NA	0.3	0.5	2	4	15	19	--	--	3	--	--	--	--	--	--	--	--	a	a	40.8
	.35 - 1.3	--	9.6	8.9	35	--	25	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	a	a	18.5
FTSSB100	0 - .5	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	21[d]	NA
FTSSB101	0 - .5	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	190[d]	NA
Wood Hogger Site - Terrestrial Unit																											
S37-08	5 - 6	--	--	--	--	3.7	--	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	a	a	--
S37-11	.5 - 1.5	2.4	--	--	--	--	--	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	a	a	2.4
S37-12	5 - 6	3.7	--	2.6	--	--	--	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	a	a	6.3
WHSSB006	0 - .5	NA	NA	NA	NA	NA	NA	0.35	--	0.46	0.42	0.94	1.7	--	--	1	0.6	--	--	--	0.21	--	--	0.14	a	a	3.87
WHSSB007	0 - .5	NA	NA	NA	NA	NA	NA	0.57	--	--	1.6	3	8.9	--	--	0.99	0.54	--	--	0.66	--	--	--	--	a	a	14.07
WHSSB008	0 - .5	NA	NA	NA	NA	NA	NA	1	--	0.3	0.8	0.4	0.9	--	--	0.4	--	--	--	--	--	--	--	0.2	a	a	3.4
WHSSB009	0 - .5	NA	NA	NA	NA	NA	NA	--	--	--	280	30	14	--	--	50	--	--	--	--	--	--	--	--	a	a	324
WHSSB010	0 - .5	NA	NA	NA	NA	NA	NA	--	--	--	0.4	--	0.3	--	--	0.9	--	--	--	--	--	--	--	--	a	a	0.7
WHSSB011	0 - .5	NA	NA	NA	NA	NA	NA	--	--	0.26	--	0.42	0.58	--	--	0.37	--	--	--	--	--	--	--	--	a	a	1.26
WHSSB012	0 - .5	NA	NA	NA	NA	NA	NA	0.3	--	--	0.2	0.3	0.6	--	--	0.3	--	--	--	--	--	--	--	--	a	a	1.4
WHSSB013	0 - .5	NA	NA	NA	NA	NA	NA	4	--	--	50	6	3	--	--	8	--	--	--	--	--	--	--	2	a	a	63
WHSSB014	0 - .5	NA	NA	NA	NA	NA	NA	8	3	11	30	12	69	--	--	17	4	--	--	--	--	--	--	5	a	a	133
WHSSB015	0 - .5	NA	NA	NA	NA	NA	NA	7	--	--	9	6	14	--	--	78	6	--	--	--	6	--	--	0.4	a	a	36
WHSSB016	0 - .5	NA	NA	NA	NA	NA	NA	4	--	34	7	32	230	--	--	17	--	--	--	--	--	--	--	--	a	a	307
WHSSB017	0 - .5	NA	NA	NA	NA	NA	NA	--	0.5	5	1	2	30	--	--	1	2	2	--	--	--	--	--	--	a	a	38.5
WHSSBA06	0 - .5	NA	NA	NA	NA	NA	NA	--	--	--	--	--	--	--	--	--	--	0.42	--	--	0.66	--	--	--	a	a	--
WHSSBB03	0 - .5	NA	NA	NA	NA	NA	NA	0.54	--	--	1.3	1.3	--	--	--	0.74	--	--	--	--	--	--	--	--	a	a	3.14
WHSSBB07	0 - .5	NA	NA	NA	NA	NA	NA	1.4	0.36	0.52	2.6	0.81	0.84	0.39	--	2.9	0.65	--	--	--	--	0.37	--	0.47	a	a	6.53
WHSSBC06	0 - .5	NA	NA	NA	NA	NA	NA	0.99	--	0.32	0.49	0.27	0.32	--	--	0.24	--	--	--	--	--	--	--	--	a	a	2.39
WHSSBC08	0 - .5	NA	NA	NA	NA	NA	NA	0.74	--	0.46	1.3	1.3	1.7	0.38	--	0.65	--	--	--	--	--	--	--	--	a	a	5.5
WHSSBD03	0 - .5	NA	NA	NA	NA	NA	NA	5.2	--	--	5.6	2.8	--	--	--	2.2	--	--	--	--	--	--	--	--	a	a	13.6
WHSSBD07	0 - .5	NA	NA	NA	NA	NA	NA	--	--	11	15	9	51	--	--	23	--	--	--	--	--	--	--	--	a	a	86
	1.5 - 2.3	7.4	1.5	3.5	1.5	--	--	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	a	a	12.4
WHSSBE02	0 - .5	NA	NA	NA	NA	NA	NA	--	--	0.21	--	0.31	0.54	--	--	1.3	--	--	--	--	--	--	--	--	a	a	1.06
WHSSBE06	0 - .5	NA	NA	NA	NA	NA	NA	--	--	--	16	17	110	--	--	19	--	--	--	--	--	--	--	--	a	a	143
WHSSBE08	0 - .5	NA	NA	NA	NA	NA	NA	1.5	0.61	--	4	1.3	0.58	0.48	--	2.1	0.82	--	--	--	--	--	--	0.15	a	a	7.99
WHSSBF03	0 - .5	NA	NA	NA	NA	NA	NA	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.21	--	--	a	a	--
WHSSBF03	4.5 - 5.9	8.8	--	11	--	--	--	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	a	a	19.8
WHSSBF07	0 - .5	NA	NA	NA	NA	NA	NA	--	--	--	--	--	0.3	--	--	--	--	--	--	--	--	--	--	--	a	a	0.3
WHSSBG02	0 - .5	NA	NA	NA	NA	NA	NA	0.89	1	--	18	3.8	1.1	--	--	2.2	1.1	--	--	--	--	--	--	--	a	a	24.79
WHSSBG06	0 - .5	NA	NA	NA	NA	NA	NA	1.4	0.46	--	4.5	0.94	0.45	0.34	--	1.2	0.48	--	--	--	--	0.22	--	0.65	a	a	7.75
WHSSBH03	0 - .5	NA	NA	NA	NA	NA	NA	0.7	--	0.1	1	0.8	0.6	0.2	--	0.6	0.5	--	--	--	--	0.2	--	0.2	a	a	3.2
WHSSBH07	0 - .5	NA	NA	NA	NA	NA	NA	--	--	0.22	0.72	0.97	1.4	--	--	0.99	0.36	0.8	--	--	0.5	--	--	--	a	a	3.31
WHSSBI02	0 - .5	NA	NA	NA	NA	NA	NA	1.2	--	--	2.8	2.1	2.1	--	--	3.3	1.2	--	--	--	--	--	--	--	a	a	8.2
WHSSBI08	0 - .5	NA	NA	NA	NA	NA	NA	--	--	--	1.7	1.6	--	--	--	--	--	--	--	--	--	--	--	--	a	a	3.3
WHSSBK04	0 - .5	NA	NA	NA	NA	NA	NA	--	--	0.16	0.42	0.32	0.85	--	--	0.53	2	--	--	--	--	--	--	--	a	a	1.75
WHSSBK06	0 - .5	NA	NA	NA	NA	NA	NA	--	--	--	--	--	0.44	--	--	0.18	--	--	--	--	--	--	--	--	a	a	0.44
WHSSBL05	0 - .5	NA	NA	NA	NA	NA	NA	0.39	--	--	0.44	0.47	--	--	--	0.31	--	--	--	--	--	--	--	--	a	a	1.3
WHSSBL07	0 - .5	NA	NA	NA	NA	NA	NA	--	--	0.5	--	0.72	1.5	--	--	0.42	0.24	--	--	--	--	--	--	--	a	a	2.72
WHSSBM06	0 - .5	NA	NA	NA	NA	NA	NA	0.47	--	--	--	0.24	0.49	--	--	0.2	--	--	--	--	--	--	--	0.63	a	a	1.2
WHSSBM08	0 - .5	NA	NA	NA	NA	NA	NA	0.47	--	0.17	--	0.37	--	--	--	0.23	--	--	--	--	--	--	--	--	a	a	1.01

TABLE 6-16

SUMMARY OF DETECTED PESTICIDE CONCENTRATIONS IN SOIL AND SEDIMENT SAMPLES
TIDAL AREA QEA, NWS SBD CONCORD

Sample Location	Sample Depth (ft bgs)	CLP Pesticides (µg/kg)						Low Detection Limit Method Pesticides (µg/kg)																			
		4,4'-DDD	4,4'-DDE	4,4'-DDT	Alpha-chlordane	Endrin Ketone	Gamma-chlordane	2,4'-DDD	2,4'-DDE	2,4'-DDT	4,4'-DDD	4,4'-DDE	4,4'-DDT	Aldrin	Alpha-BHC	Alpha-chlordane	Dieldrin	Gamma-BHC (Lindane)	Gamma-Chlordane	Heptachlor	Heptachlor Epoxide	Hexachlorobenzene	Methoxychlor	Mirex	Total BHCs[a]	Total Chlordanes[a]	Total DDTs[c]
North Otter Sluice - Aquatic Unit																											
OSLSL001	0 - .5	NA	NA	NA	NA	NA	NA	--	--	--	--	2	--	--	--	0.3	--	--	--	--	--	0.4	--	--	0.6[b]	0.45[b]	2.85[b]
OSLSL002	0 - .5	NA	NA	NA	NA	NA	NA	--	--	--	0.4	1	--	--	--	--	--	--	--	--	--	--	--	--	0.8[b]	0.4[b]	2.3[b]
OSLSL003	0 - .5	NA	NA	NA	NA	NA	NA	--	--	--	--	2	--	--	--	--	--	--	--	--	--	--	--	--	0.8[b]	0.4[b]	3.1[b]
RADSB001	0 - .5	NA	NA	NA	NA	NA	NA	--	--	--	0.52	--	--	--	--	--	--	--	--	--	--	--	--	--	a	a	0.52
RADSB002	0 - .5	NA	NA	NA	NA	NA	NA	0.72	--	--	2.3	2.8	0.93	--	--	--	--	--	--	--	--	--	--	--	a	a	6.75
RADSB003	0 - .5	NA	NA	NA	NA	NA	NA	--	--	--	1.2	2	--	--	--	--	--	--	--	--	--	--	--	--	a	a	3.2
RADSB004	0 - .5	NA	NA	NA	NA	NA	NA	--	--	--	1.3	1.7	--	--	--	--	--	--	--	--	--	--	--	--	a	a	3
RADSB005	0 - .5	NA	NA	NA	NA	NA	NA	0.4	--	--	1.1	1.5	0.57	--	--	--	--	--	--	--	--	--	--	--	a	a	3.57
RADSB006	0 - .5	NA	NA	NA	NA	NA	NA	--	--	--	--	2.3	--	--	--	--	--	--	--	--	--	--	--	--	a	a	2.3
RADSBA01	0 - .5	NA	NA	NA	NA	NA	NA	0.49	--	--	1.5	1.3	--	--	--	--	--	--	--	--	--	--	--	--	a	a	3.29
RADSBA04	0 - .5	NA	NA	NA	NA	NA	NA	0.7	--	--	--	1.2	--	--	--	--	--	--	--	--	--	--	--	--	a	a	1.9
RADSBA05	0 - .5	NA	NA	NA	NA	NA	NA	0.31	--	0.36	0.55	1.2	0.95	--	--	0.62	0.5	--	--	--	--	--	--	0.085	a	a	3.37
RADSBA07	0 - .5	NA	NA	NA	NA	NA	NA	1	--	--	1.4	2.6	0.67	--	--	1.2	0.6	--	--	--	--	--	--	0.13	a	a	5.67
RADSL001	0 - .5	NA	NA	NA	NA	NA	NA	0.56	--	0.32	0.78	1.2	0.36	--	--	0.64	--	--	--	--	--	--	--	--	a	a	3.22
RADSL002	0 - .5	NA	NA	NA	NA	NA	NA	--	--	--	0.79	1.2	--	--	--	--	--	--	--	--	--	--	--	--	a	a	1.99
South Otter Sluice - Aquatic Unit																											
OSLSL004	0 - .5	NA	NA	NA	NA	NA	NA	--	--	--	--	1	--	--	--	--	--	--	--	--	--	--	--	--	0.6[b]	0.3[b]	1.9[b]
OSLSL005	0 - .5	NA	NA	NA	NA	NA	NA	--	--	--	0.7	--	--	--	--	--	--	--	--	--	--	--	--	--	0.8[b]	0.4[b]	1.8[b]
OSLSL006	0 - .5	NA	NA	NA	NA	NA	NA	--	--	--	0.8	2	--	--	--	0.7	--	0.6	0.7	--	--	--	--	--	1.2[b]	1.4[b]	3.75[b]
OSLSL007	0 - .5	NA	NA	NA	NA	NA	NA	--	--	--	0.6	1	--	--	0.5	0.5	--	--	--	--	--	0.4	--	--	1.1[b]	0.7[b]	2.5[b]
OSLSL008	0 - .5	NA	NA	NA	NA	NA	NA	--	--	--	2	2	--	--	--	1	--	--	--	--	--	--	5	--	1.8[b]	1.45[b]	5.85[b]
OSLSL009	0 - .5	NA	NA	NA	NA	NA	NA	--	--	--	1	1	--	--	--	--	--	--	--	--	--	--	--	--	1.4[b]	0.7[b]	3.55[b]
WHSSB001	0 - .5	NA	NA	NA	NA	NA	NA	--	--	--	2	2.3	--	--	--	--	--	--	--	--	--	--	--	--	a	a	4.3
WHSSB002	0 - .5	NA	NA	NA	NA	NA	NA	--	--	--	--	0.78	--	--	--	--	--	1.2	--	0.74	--	--	--	--	a	a	0.78
WHSSB003	0 - .5	NA	NA	NA	NA	NA	NA	--	--	--	1.6	1.5	--	--	--	--	--	--	--	--	--	--	--	--	a	a	3.1
WHSSB004	0 - .5	NA	NA	NA	NA	NA	NA	0.43	--	--	0.83	0.75	--	--	--	--	--	--	--	--	--	--	--	--	a	a	2.01
WHSSB018	0 - .5	NA	NA	NA	NA	NA	NA	--	--	--	--	--	--	--	--	--	--	0.47	--	--	--	--	--	--	a	a	--
WHSSBA04	0 - .5	NA	NA	NA	NA	NA	NA	--	--	--	--	--	--	--	--	--	--	--	--	0.29	--	--	--	--	a	a	--
WHSSBB05	0 - .5	NA	NA	NA	NA	NA	NA	--	--	--	0.92	0.93	--	--	--	0.98	--	--	--	--	--	--	--	--	a	a	1.85
WHSSBD01	0 - .5	NA	NA	NA	NA	NA	NA	--	--	0.18	0.23	0.26	0.58	--	--	0.32	--	--	--	--	--	--	--	--	a	a	1.25
WHSSL001	0 - .5	NA	NA	NA	NA	NA	NA	0.67	--	--	1.4	1.6	--	--	--	1.1	--	--	--	1.8	--	--	--	--	a	a	3.67
WHSSL002	0 - .5	NA	NA	NA	NA	NA	NA	--	--	--	1.4	1.7	--	--	--	--	--	--	--	--	--	--	--	--	a	a	3.1
WHSSL003	0 - .5	NA	NA	NA	NA	NA	NA	--	--	--	1.1	1.3	--	--	--	0.63	--	--	--	--	--	--	--	--	a	a	2.4

Notes:

bgs Below ground surface
BHC Hexachlorocyclohexane
DDD Dichlorodiphenyldichloroethane
DDE Dichlorodiphenyldichloroethene
DDT Dichlorodiphenyltrichloroethane
NA Not analyzed
µg/kg Micrograms per kilogram

a Calculated for 1998 samples only.
b Total includes 1/2 sample quantitation limit for non-detects.
c Total DDTs = sum of DDT, DDE, and DDD congeners
d Total chlordane was measured by the laboratory for this sample.
-- Not detected

TABLE 6-17

SUMMARY OF DETECTED PCB CONCENTRATIONS IN SOIL AND SEDIMENT SAMPLES
TIDAL AREA QEA, NWS SBD CONCORD

Sample Location	Sample Depth (ft bgs)	Low Detection Limit PCBs (mg/kg)																					Total PCBs
		PCB-8 (2,4')	PCB-18 (2,2',5)	PCB-28 (2,4,4')	PCB-44 (2,2',3,5')	PCB-52 (2,2',5,5')	PCB-66 (2,3',4,4')	PCB-77 (3,3',4,4')	PCB-101 (2,2',3,5,5')	PCB-105 (2,3,3',4,4')	PCB-118 (2,3',4,4',5)	PCB-126 (3,3',4,4',5)	PCB-128 (2,2',3,3', 4,4')	PCB-138 (2,2',3,4, 4',5')	PCB-153 (2,2',4,4',5 ,5')	PCB-170 (2,2',3,3', 4,4',5)	PCB-180 (2,2',3,4, 4',5,5')	PCB-187 (2,2',3,4', 5,5',6)	PCB-195 (2,2',3,3',4, 4',5,6)	PCB-206 (2,2',3,3', 4,4',5,5',	PCB-209 (2,2',3,3',4, 4',5,5',6	trans-Nonachlor	
Tidal Area Landfill - Terrestrial Unit																							
TLSSB001	0 - 0.5	--	--	--	--	0.68	2.6	1	1.4	1.2	2.1	--	0.77	2.9	2	--	1.5	0.62	--	--	--	3.7	16.77
TLSSB002	0 - 0.5	--	2.4	2.3	2.9	2.3	3.5	1.2	2.2	1.6	4.2	--	0.82	3.1	2.2	0.54	1.2	0.71	0.68	0.31	--	3.9	32.16
TLSSB004*	1.3 - 2.4	--	0.21	--	0.34	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.55
TLSSB005	0 - 0.5	--	0.32	--	--	0.21	--	--	0.64	0.38	0.57	--	--	0.89	0.62	--	0.64	0.22	--	0.53	--	0.83	5.02
TLSSB006	0 - 0.5	--	0.44	--	--	0.53	--	--	0.74	0.52	0.92	--	--	1.6	0.85	--	0.58	0.2	--	--	--	1.3	6.38
TLSSB008	0 - 0.5	--	--	--	--	--	--	0.24	0.33	0.36	0.42	--	--	0.67	1.2	--	0.96	0.5	--	0.54	--	3.4	5.22
R Area Disposal Site - Terrestrial Unit																							
RADSB007	0 - 0.5	--	--	--	--	--	--	--	--	--	--	--	--	0.16	--	--	--	--	--	--	--	--	0.16
RADSB009	0 - 0.5	--	--	--	--	0.079	--	--	0.39	0.36	0.56	--	--	0.55	0.38	--	0.3	0.23	--	--	--	1	2.849
RADSB010	0 - 0.5	--	--	--	--	--	--	--	--	--	--	3	--	--	--	--	--	--	--	0.36	--	0.67	3.36
RADSB011	0 - 0.5	1.8	--	--	--	--	0.86	--	0.51	0.95	0.94	--	--	1.1	1.3	--	1.1	--	--	--	--	1.9	8.56
RADSB012	0 - 0.5	--	--	--	--	--	0.24	--	0.35	0.38	0.44	--	0.16	0.8	0.58	0.28	0.53	0.33	--	0.54	--	1.2	4.63
RADSB014	0 - 0.5	--	--	--	--	--	--	--	0.07	--	--	--	--	--	--	--	--	--	--	--	--	0.68	0.07
RADSB015	0 - 0.5	0.44	--	--	--	--	--	--	0.24	--	0.15	--	--	0.16	0.12	--	--	--	--	0.11	--	0.34	1.22
RADSBB03	0 - 0.5	0.27	--	--	--	0.056	--	--	0.56	0.16	0.12	0.16	--	0.27	0.091	--	0.13	0.065	--	0.22	0.16	0.24	2.262
RADSBB04	0 - 0.5	0.68	--	--	--	--	--	--	0.54	--	0.73	--	--	0.81	0.6	--	0.47	--	--	--	--	1.1	3.83
RADSBB06	0 - 0.5	0.36	0.17	--	--	0.16	--	0.17	0.9	0.41	0.79	--	--	1.3	1	--	0.55	0.32	--	0.14	--	1.8	6.27
RADSBB07	0 - 0.5	--	--	--	0.25	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.25
RADSBC05	0 - 0.5	--	--	--	--	0.25	0.77	0.46	0.89	0.78	1.2	--	0.58	1.7	1.1	0.51	0.91	0.52	--	0.44	--	1.7	10.11
RADSBD03	0 - 0.5	--	--	--	--	--	--	--	--	--	--	--	--	0.29	--	--	--	--	--	--	--	--	0.29
RADSBD05	0 - 0.5	--	--	--	--	--	0.64	0.82	1	0.69	0.99	--	0.58	1.6	1.1	--	0.74	0.46	--	0.48	--	2.3	9.1
RADSBD06	0 - 0.5	--	--	--	0.28	--	0.44	--	0.81	0.56	0.83	--	0.38	1.3	0.77	0.3	0.54	0.4	--	0.52	--	2.3	7.13
RADSBE02	0 - 0.5	0.86	--	--	--	--	0.09	--	0.15	0.14	0.094	--	--	--	0.065	--	--	--	--	0.088	--	0.46	1.487
RADSBE03	0 - 0.5	2	0.26	0.37	--	0.25	--	1.3	--	--	--	0.37	--	0.22	--	--	--	--	0.3	--	--	--	5.07
RADSBE08	0 - 0.5	--	--	--	--	--	--	--	--	--	--	0.28	--	--	--	--	--	0.44	--	--	--	--	0.72
RADSBF02	0 - 0.5	3.7	--	--	--	--	0.16	--	--	0.26	0.32	--	--	0.53	0.17	--	0.14	--	--	--	--	1	5.28
RADSBF03	0 - 0.5	--	--	--	--	--	--	0.35	--	--	--	3.7	--	--	--	--	--	--	--	--	--	--	4.05
RADSBF06	0 - 0.5	0.55	--	--	0.23	--	--	0.66	--	--	--	--	--	--	--	--	--	--	--	0.32	--	--	1.76
RADSBF08	0 - 0.5	--	--	--	--	--	--	--	--	0.32	0.55	--	0.28	0.42	--	0.28	0.28	--	0.39	--	--	0.7	2.52
RADSBG04	0 - 0.5	0.89	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.89
RADSBG06	0 - 0.5	--	--	--	--	0.33	--	0.9	--	--	--	2	--	--	0.19	--	--	--	--	--	--	--	3.42
RADSBG08	0 - 0.5	--	--	--	--	--	--	--	--	--	--	--	--	0.27	--	--	--	--	--	--	--	--	0.27
RADSBH02	0 - 0.5	0.64	0.39	--	--	--	--	--	0.13	--	--	--	--	--	--	--	--	--	--	--	--	0.3	1.16
RADSBH03	0 - 0.5	--	--	--	--	--	--	0.46	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.46
RADSBH05	0 - 0.5	--	--	--	--	0.15	0.15	0.36	0.14	--	--	0.73	--	--	--	--	--	--	--	--	--	0.15	1.53
RADSBH06	0 - 0.5	--	0.29	--	--	--	0.78	--	0.81	0.48	0.87	1.7	--	1.2	1	--	--	0.2	--	--	--	2.4	7.33
RADSBH07	0 - 0.5	2.2	--	--	--	0.27	--	0.71	--	--	--	0.62	--	--	--	--	--	--	--	--	--	--	3.8
RADSBI01	0 - 0.5	--	--	0.48	--	0.2	--	--	--	--	--	0.4	--	0.2	--	--	--	0.62	--	--	--	--	1.9
RADSBI02	0 - 0.5	--	--	--	--	--	--	0.41	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.41
RADSBI04	0 - 0.5	--	--	--	--	0.24	0.53	--	0.63	0.31	0.61	--	0.19	0.84	0.61	--	0.46	0.094	--	0.15	--	0.64	4.664
RADSBI05	0 - 0.5	--	--	--	--	--	--	--	--	--	--	0.19	--	--	--	--	--	--	--	--	--	--	0.19
RADSBI08	0 - 0.5	--	0.19	--	--	--	--	--	--	--	0.1	--	--	0.17	0.13	--	--	--	--	0.09	--	0.38	0.68
RADSBJ02	0 - 0.5	0.76	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.76
RADSBJ03	0 - 0.5	0.92	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.92
RADSBJ07	0 - 0.5	0.97	--	--	--	--	0.16	0.97	0.26	0.17	--	2.1	--	--	0.12	--	--	--	--	0.21	--	0.16	4.96
RADSBK02	0 - 0.5	--	--	--	--	--	--	0.094	--	--	--	--	--	--	--	--	--	--	--	--	--	0.15	0.094
RADSBK03	0 - 0.5	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.14	--	--	--	0.14
RADSBK07	0 - 0.5	--	--	--	--	--	--	--	--	--	--	0.38	--	0.54	0.25	--	--	--	--	0.48	--	0.63	1.65
RADSBK08	0 - 0.5	--	--	--	--	--	--	--	--	--	--	--	--	--	0.13	--	0.19	0.085	--	0.05	--	0.19	0.455
RADSBL03	0 - 0.5	--	--	--	--	--	1	0.37	0.65	1.2	1.3	--	0.45	1.5	1.8	0.9	1.9	0.77	--	1.1	0.38	0.97	13.32
RADSBM08	0 - 0.5	--	0.21	--	--	0.12	0.28	--	0.25	0.16	0.36	--	--	0.49	0.33	--	0.22	--	--	0.21	--	0.62	2.63

TABLE 6-17

SUMMARY OF DETECTED PCB CONCENTRATIONS IN SOIL AND SEDIMENT SAMPLES
TIDAL AREA QEA, NWS SBD CONCORD

Sample Location	Sample Depth (ft bgs)	Low Detection Limit PCBs (mg/kg)																					Total PCBs
		PCB-8 (2,4')	PCB-18 (2,2',5)	PCB-28 (2,4,4')	PCB-44 (2,2',3,5')	PCB-52 (2,2',5,5')	PCB-66 (2,3',4,4')	PCB-77 (3,3',4,4')	PCB-101 (2,2',3,5,5')	PCB-105 (2,3,3',4,4')	PCB-118 (2,3',4,4',5)	PCB-126 (3,3',4,4',5)	PCB-128 (2,2',3,3', 4,4')	PCB-138 (2,2',3,4, 4',5')	PCB-153 (2,2',4,4',5 ,5')	PCB-170 (2,2',3,3', 4,4',5)	PCB-180 (2,2',3,4, 4',5,5')	PCB-187 (2,2',3,4', 5,5',6)	PCB-195 (2,2',3,3',4, 4',5,6)	PCB-206 (2,2,',3,3', 4,4',5,5',	PCB-209 (2,2',3,3',4, 4',5,5',6	trans-Nonachlor	
R Area Disposal Site - Aquatic Unit																							
RADSB013	0 - 0.5	--	0.13	--	--	0.18	0.24	--	0.23	0.27	0.32	--	--	0.58	0.45	--	0.41	--	--	0.22	--	1.9	3.03
Froid and Taylor Roads Site - Aquatic Unit																							
FTSSB001	0 - .3	--	--	--	--	--	--	--	--	--	--	--	2	--	--	--	--	--	--	--	--	4	2
FTSSB002	0 - 0.5	--	--	--	--	--	--	--	0.1	0.2	0.2	--	--	0.3	0.1	--	0.1	0.07	--	0.2	--	0.6	1.27
FTSSB003	0 - 0.25	--	--	--	--	--	--	0.3	0.4	--	--	0.1	0.3	2	0.5	--	0.4	0.2	--	0.8	0.3	2	5.3
FTSSB004	0 - 0.5	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.2	--
FTSSB005	0 - 0.5	--	--	--	--	--	--	--	--	--	0.1	0.1	--	0.4	0.2	--	0.2	--	--	0.5	0.08	0.5	1.58
FTSSB009	0 - .12	--	--	--	--	--	--	--	--	--	--	--	0.1	--	--	--	--	--	--	0.2	--	0.3	0.3
FTSSL102	0 - 0.5	--	--	--	--	--	--	--	--	--	--	--	--	0.5	--	--	--	--	--	--	--	--	7.15[b]
FTSSL103	0 - 0.5	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.3	3.65[b]
FTSSL104	0 - 0.5	--	--	--	--	--	--	--	--	0.3	0.7	--	--	1	0.9	--	--	0.4	--	2	0.8	--	9.1[b]
Wood Hogger Site - Terrestrial Unit																							
WHSSB006	0 - 0.5	--	--	--	--	--	0.24	--	0.48	0.46	0.67	0.22	--	0.63	0.3	--	0.28	0.17	--	0.19	0.18	1.5	3.82
WHSSB007	0 - 0.5	--	--	--	0.25	0.62	1	--	1.3	0.62	1.2	--	--	1.2	0.92	--	0.39	--	--	--	--	0.94	7.5
WHSSB008	0 - 0.5	--	--	--	--	--	--	--	0.2	0.1	--	--	--	--	--	--	--	--	--	--	--	0.4	0.3
WHSSB009	0 - 0.5	--	--	--	--	--	--	--	--	--	--	--	--	7	--	--	--	--	--	--	--	34	7
WHSSB010	0 - 0.5	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.9	--
WHSSB011	0 - 0.5	--	--	--	--	--	--	--	0.12	0.22	0.32	--	--	0.24	--	--	--	--	--	--	--	0.61	0.9
WHSSB012	0 - 0.5	--	--	--	--	--	--	--	--	--	0.1	--	--	--	--	--	--	--	--	--	--	0.6	0.1
WHSSB013	0 - 0.5	--	--	--	--	2	--	--	5	1	3	--	--	7	5	--	4	0.4	--	--	--	6	27.4
WHSSB014	0 - 0.5	--	--	--	--	--	--	--	7	3	5	--	3	12	9	--	6	2	--	--	--	15	47
WHSSB015	0 - 0.5	--	--	--	--	--	--	--	3	--	--	--	--	6	5	--	6	4	--	--	--	65	24
WHSSB016	0 - 0.5	--	--	--	--	--	--	--	3	--	--	--	--	--	--	--	4	--	--	--	--	29	7
WHSSBA06	0 - 0.5	--	0.13	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.13
WHSSBB03	0 - 0.5	--	--	--	0.73	0.3	--	--	--	--	--	--	--	0.25	--	--	--	--	--	--	--	0.54	1.28
WHSSBB07	0 - 0.5	--	--	--	0.24	0.22	--	0.87	0.73	0.54	0.33	0.56	0.29	1.6	1.1	0.54	1.2	0.65	0.16	0.32	--	2	9.35
WHSSBC02	0 - 0.5	--	--	--	--	--	--	--	--	1.1	--	--	--	--	--	--	--	--	1.2	0.86	--	--	3.16
WHSSBC06	0 - 0.5	--	--	--	0.37	--	0.16	--	--	--	--	--	--	0.34	--	0.63	--	--	--	--	0.25	0.25	1.75
WHSSBC08	0 - 0.5	--	0.21	0.24	0.33	0.16	--	0.33	0.2	0.29	--	--	--	0.5	0.36	--	0.31	0.14	--	0.21	--	1.1	3.28
WHSSBD03	0 - 0.5	--	--	--	--	--	--	--	0.82	--	1.4	--	--	1.8	--	--	1.9	0.46	--	--	--	2.2	6.38
WHSSBD07	0 - 0.5	--	--	--	--	--	--	--	1	--	4	--	--	--	4	1	4	2	--	--	--	16	16
WHSSBE02	0 - 0.5	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1.8	--
WHSSBE06	0 - 0.5	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	16	--
WHSSBE08	0 - 0.5	--	--	--	--	0.22	--	--	0.75	0.42	0.82	--	0.32	1.3	1.2	0.26	0.74	0.41	--	0.24	--	1.1	6.68
WHSSBG02	0 - 0.5	--	--	--	--	--	--	--	0.53	0.82	1.1	--	--	1.5	1.2	--	1.3	0.85	--	0.66	--	1.5	7.96
WHSSBG06	0 - 0.5	--	--	--	--	0.26	0.53	--	0.42	0.32	0.37	--	0.23	0.54	0.45	0.15	--	0.18	--	--	--	0.61	3.45
WHSSBH03	0 - 0.5	0.5	0.3	0.5	0.6	1	--	--	1	0.4	0.4	--	--	1	0.9	--	0.5	0.2	0.6	--	--	0.4	7.9
WHSSBH07	0 - 0.5	0.99	--	0.19	1	0.19	0.42	--	0.39	0.36	0.91	--	0.22	0.45	0.45	0.16	0.29	--	--	0.36	0.25	1.2	6.63
WHSSBI02	0 - 0.5	5.9	--	2.1	1.7	1.1	--	--	2.7	2.9	2.1	--	--	12	9.6	6.6	15	6.7	1.3	0.66	--	2.8	70.36
WHSSBI08	0 - 0.5	--	0.81	--	--	1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1.81
WHSSBK04	0 - 0.5	--	--	--	--	--	--	--	0.33	0.2	0.26	--	--	0.59	0.4	0.14	0.27	0.14	--	--	--	0.49	2.33
WHSSBK06	0 - 0.5	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.21	--
WHSSBL05	0 - 0.5	--	0.35	--	--	0.13	--	--	0.4	--	--	--	--	0.22	0.13	--	0.19	--	--	0.18	--	0.25	1.6
WHSSBL07	0 - 0.5	--	--	--	--	0.077	--	--	0.26	0.22	0.33	--	--	0.45	0.34	--	0.2	0.092	--	0.39	--	0.57	2.359
WHSSBM06	0 - 0.5	--	--	--	--	--	--	--	0.07	0.41	--	0.12	--	0.8	--	0.87	0.13	--	--	--	--	0.31	2.4
WHSSBM08	0 - 0.5	--	--	--	--	0.28	--	--	--	--	--	0.1	--	0.16	--	--	--	--	--	0.3	--	--	0.84

TABLE 6-17

SUMMARY OF DETECTED PCB CONCENTRATIONS IN SOIL AND SEDIMENT SAMPLES
TIDAL AREA QEA, NWS SBD CONCORD

Sample Location	Sample Depth (ft bgs)	Low Detection Limit PCBs (mg/kg)																					Total PCBs
		PCB-8 (2,4')	PCB-18 (2,2',5)	PCB-28 (2,4,4')	PCB-44 (2,2',3,5')	PCB-52 (2,2',5,5')	PCB-66 (2,3',4,4')	PCB-77 (3,3',4,4')	PCB-101 (2,2',3,5,5')	PCB-105 (2,3,3',4,4')	PCB-118 (2,3',4,4',5)	PCB-126 (3,3',4,4',5)	PCB-128 (2,2',3,3', 4,4')	PCB-138 (2,2',3,4, 4',5')	PCB-153 (2,2',4,4',5 ,5')	PCB-170 (2,2',3,3', 4,4',5)	PCB-180 (2,2',3,4, 4',5,5')	PCB-187 (2,2',3,4', 5,5',6)	PCB-195 (2,2',3,3',4, 4',5,6)	PCB-206 (2,2,',3,3', 4,4',5,5',	PCB-209 (2,2',3,3',4, 4',5,5',6	trans-Nonachlor	
North Otter Sluice - Aquatic Unit																							
OSLSL001	0 - 0.5	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	5[b]
OSLSL002	0 - 0.5	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	6.8[b]
OSLSL003	0 - 0.5	--	--	--	--	--	--	--	--	--	--	--	--	--	0.5	--	--	--	--	--	--	--	7.1[b]
RADSB002	0 - 0.5	0.46	--	--	--	0.36	--	--	0.37	0.6	0.5	--	--	0.77	0.72	--	0.64	0.36	--	--	--	--	4.78
RADSB003	0 - 0.5	1.4	0.22	--	--	1.1	--	--	0.33	--	0.27	--	--	0.32	0.49	--	--	--	--	--	--	--	4.13
RADSB004	0 - 0.5	0.73	--	--	--	0.92	--	--	0.58	--	0.66	--	--	0.99	0.64	--	0.75	--	--	--	--	--	5.27
RADSB005	0 - 0.5	--	0.15	--	--	0.96	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1.11
RADSB006	0 - 0.5	--	0.24	--	--	1.4	--	1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	2.64
RADSBA01	0 - 0.5	0.4	--	--	--	0.097	--	--	0.15	--	0.3	--	--	0.33	0.34	--	--	--	--	--	--	--	1.617
RADSBA04	0 - 0.5	--	--	--	--	1.3	--	--	--	--	--	--	--	0.3	--	--	--	--	--	--	--	--	1.6
RADSBA05	0 - 0.5	--	0.26	--	--	--	--	--	0.2	--	0.22	--	--	0.3	0.2	--	--	--	--	--	--	0.6	1.18
RADSBA07	0 - 0.5	0.78	0.2	--	--	0.4	--	--	1	0.65	1.2	--	--	1.6	1.4	0.37	0.84	0.49	--	0.21	--	1.3	9.14
RADSL001	0 - 0.5	0.57	--	--	--	--	0.22	--	0.087	0.19	--	--	--	0.2	0.24	--	--	--	--	--	--	0.4	1.507
RADSL002	0 - 0.5	--	--	--	--	--	--	--	--	--	--	--	--	--	0.17	--	--	--	--	--	--	--	0.17
South Otter Sluice - Aquatic Unit																							
OSLSL004	0 - 0.5	--	--	--	--	--	--	--	--	--	--	--	--	0.6	0.8	--	0.7	--	--	--	--	--	7.2[b]
OSLSL005	0 - 0.5	--	--	--	--	--	--	--	--	--	--	--	--	--	0.5	--	--	--	--	--	--	--	7.15[b]
OSLSL006	0 - 0.5	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.6	6.9[b]
OSLSL007	0 - 0.5	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.5	6.8[b]
OSLSL008	0 - 0.5	--	--	--	--	--	--	--	--	--	--	--	--	1	--	1	--	--	--	--	--	--	16.85[b]
OSLSL009	0 - 0.5	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	11.75[b]
WHSSB001	0 - 0.5	--	--	--	--	1.3	--	--	0.54	--	0.96	--	--	1.3	--	--	--	--	--	--	--	--	4.1
WHSSB002	0 - 0.5	0.44	0.31	--	--	--	--	--	--	--	--	--	--	0.57	--	--	--	--	--	--	--	--	1.32
WHSSB003	0 - 0.5	1.1	0.28	--	--	0.61	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1.99
WHSSB005	0 - 0.5	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.32	--
WHSSB018	0 - 0.5	0.16	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.16
WHSSBA04	0 - 0.5	--	--	--	--	--	--	--	--	--	--	0.24	--	--	--	--	--	0.56	--	--	--	--	0.8
WHSSBB05	0 - 0.5	--	--	--	--	--	--	--	0.22	--	0.22	--	--	0.97	1.1	0.71	1.3	0.61	--	--	--	0.91	5.13
WHSSBD01	0 - 0.5	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.24	--
WHSSL001	0 - 0.5	--	--	--	0.47	0.75	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.93	1.22
WHSSL002	0 - 0.5	--	--	--	--	0.89	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.89
WHSSL003	0 - 0.5	0.74	--	--	0.57	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1.31

Notes:

bgs Below ground surface
mg/kg Milligrams per kilogram
PCB Polychlorinated biphenyl

a PCBs were not detected in CLP samples; this subsurface sample was analyzed using the low detection limit method.
b 1/2 of the sample quantitation limit was included for non-detect results
c Total PCBs = sum of all aroclors and PCBs; samples marked with a "b" include 1/2 of the sample quantitation limit for non-detect results.
-- Not detected

TABLE 6-18

SUMMARY OF DETECTED DIOXIN CONCENTRATIONS IN SOIL AND SEDIMENT SAMPLES
TIDAL AREA QEA, NWS SBD CONCORD

Sample Location	Sample Depth (ft bgs)	Dioxins (µg/kg)							
		1,2,3,4,6,7,8,9-OCDD	1,2,3,4,6,7,8,9-OCDF	1,2,3,4,6,7,8-HPCDD	1,2,3,4,6,7,8-HPCDF	Total HPCDD[b]	Total HPCDF[b]	Total HXCDF[b]	Total TCDD[b]
South Otter Sluice - Aquatic Unit									
WHSSB018	0 - .5	4	--	--	--	2	--	--	7
WHSSB023	0 - .5	9	0.5	2	0.2	6	0.8	--	13
Wood Hogger Site - Terrestrial Unit									
WHSSB007	0 - .5	--	--	--	--	41	--	--	6
WHSSB008	0 - .5	2	--	--	--	--	--	--	4
WHSSB009	0 - .5	100	5	8	2	15	6	1	6
WHSSB010	0 - .5	--	--	--	--	--	--	--	2
WHSSB016	0 - .5	140	13	16	3	33	13	4	4
WHSSB017	0 - .5	7	--	--	--	--	0.9	--	3
WHSSB019	0 - .5	10	--	--	--	8	--	--	4
WHSSB019	0 - .5	3.8	--	0.47	0.13	0.8	0.29	--	--
WHSSB020	0 - .5	0.36	--	--	--	--	--	--	--

Notes:

bgs Below ground surface
HPCDD Heptachlorodibenzo-p-dioxin
HPCDF Heptachlorodibenzofuran
HXCDF Hexachlorodibenzofuran
OCDD Octachlorodibenzo-p-dioxin
OCDF Octachlorodibenzofuran
TCDD Tetrachlorodibenzo-p-dioxin
µg/kg Micrograms per kilogram

a 1/2 of the sample quantitation limit was included for nondetect results
b Totals = sum of congeners, including 1/2 of the sample quantitation limit for nondetect results.
-- Not Detected

TABLE 6-19

SUMMARY OF DETECTED SVOC CONCENTRATIONS IN SOIL AND SEDIMENT SAMPLES
TIDAL AREA QEA, NWS SBD CONCORD

Low Detection Limit SVOCs (µg/kg)

Sample Location	Sample Depth (ft bgs)	1,1'-Biphenyl	1-Methylnaphthalene	1-Methylphenanthrene	2,4-Dimethylphenol	2,6-Dimethylnaphthalene	2-Methylnaphthalene	4-Methylphenol	Acenaphthene	Acenaphthylene	Anthracene	Benzo(a)anthracene	Benzo(a)pyrene	Benzo(b)fluoranthene	Benzo(c)pyrene	Benzo(g,h,i)perylene	Benzo(k)fluoranthene	Benzoic Acid	Bis(2-ethylhexyl)phthalate	Butylbenzylphthalate	Carbazole	Chrysene	Dibenz(a,h)anthracene	Dibenzofuran	Dibenzothiophene	Diethylphthalate	Fluoranthene	Fluorene	Indeno(1,2,3-cd)pyrene	Isophorone	Naphthalene	Pentachlorophenol	Perylene	Phenanthrene	Phenol	Pyrene
Tidal Area Landfill - Terrestrial Unit																																				
TLSSB001	0 - 0.5	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	49	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	3.9 - 4.5	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
TLSSB002	0 - 0.5	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	150	--	--	--	--	--	--	--	--	--
	1.3 - 2.5	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	4.3 - 5.5	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
TLSSB003	4.5 - 5.3	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
TLSSB004	0 - 0.5	--	--	--	--	30	--	--	--	--	--	68	68	61	46	66	75	47	--	--	--	59	--	--	--	--	100	--	47	--	--	--	39	32	--	280
	1.3 - 2.4	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1,100	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	19,000	1,300
	4.3 - 5.5	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
TLSSB005	0 - 0.5	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	14	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
TLSSB006	0 - 0.5	--	--	--	--	--	--	--	--	--	--	38	--	50	47	--	41	100	--	45	--	72	--	--	--	--	99	--	--	--	--	--	--	40	--	78
	1.3 - 2	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
TLSSB007	1.5 - 2.3	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
TLSSB008	0 - 0.5	--	--	--	--	--	--	--	--	--	--	41	--	85	47	--	53	43	--	--	--	110	--	--	--	--	110	--	--	--	--	--	--	41	--	92
R Area Disposal Site - Terrestrial Unit																																				
RADSB007	0 - 0.5	--	--	37	--	--	--	--	15	--	100	440	320	360	230	220	320	--	--	--	40	440	94	--	23	--	1,100	--	190	--	--	--	87	660	--	680
RADSB008	0 - 0.5	--	--	--	--	--	--	--	18	--	67	340	280	390	230	220	260	--	--	--	24	400	87	--	--	--	650	--	180	--	18	--	95	310	--	580
RADSB009	0 - 0.5	--	--	--	--	--	--	95	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
RADSB011	0 - 0.5	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	180	--	--	--	--	--	--	160	--	--	--	--	--	--	--	--	--	--
RADSB012	0 - 0.5	--	--	--	--	--	--	--	--	--	--	97	140	210	110	190	96	--	--	--	--	230	58	--	--	--	280	--	140	--	--	--	68	120	--	290
RADSB014	0 - 0.5	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	140	--	--	--	--	170	--	--	--	--	--	--	--	--	130
RADSBB03	0 - 0.5	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	18	--	--	--	8	--	--	--	--	10	--	--	--	--	--	--	8	--	8
RADSBB04	0 - 0.5	--	--	--	--	--	--	280	--	--	--	--	--	--	--	--	--	280	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
RADSBB05	0 - 0.5	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	200	--	--	--	--	--	--	--	--	47	--	--	--	--	--	--	--	--	44
RADSBB07	0 - 0.5	--	--	--	--	--	--	--	--	--	--	--	13	15	11	21	--	--	--	--	--	--	--	--	--	--	12	--	15	--	--	--	--	--	--	16
RADSBB08	1.5 - 2	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
RADSBE03	0 - 0.5	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	920	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
RADSBF02	0 - 0.5	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	220	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
RADSBG04	0 - 0.5	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	120	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
RADSBG05	0 - 0.5	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	280	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
RADSBG06	0 - 0.5	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	83	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
RADSBG08	.7 - 2	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
RADSBH06	0 - 0.5	--	--	--	--	--	--	--	--	--	--	61	59	84	62	61	--	--	--	--	--	96	--	--	--	--	140	--	--	--	--	--	--	52	--	110
	1.5 - 2	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
RADSBJ04	0 - 0.5	--	--	--	24	--	--	--	--	--	--	--	--	6	--	--	--	59	--	--	--	6	--	--	--	--	17	--	--	38	--	--	9	7	--	6
RADSBJ08	0 - 0.5	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	53	--	--	--	23	--	--	--	--	11	--	--	--	--	--	--	--	--	--
RADSBJ02	0 - 0.5	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	68	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	1 - 2.2	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
RADSBJ03	0 - 0.5	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	410	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
RADSBK07	0 - 0.5	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	87	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
RADSBK08	0 - 0.5	--	--	--	--	--	--	--	--	--	--	12	13	17	--	15	11	--	--	--	--	13	10	--	--	--	--	--	12	--	--	--	--	--	--	--
RADSBL03	0 - 0.5	--	--	--	--	--	--	--	--	--	--	26	26	41	30	27	33	--	--	--	--	48	--	--	--	--	34	--	22	--	--	--	--	--	--	30
RADSBM08	0 - 0.5	--	--	--	--	--	--	--	--	--	--	49	83	120	64	--	43	--	--	--	--	77	34	--	--	--	67	--	67	--	--	--	--	44	--	68
R Area Disposal Site - Aquatic Unit																																				
RADSB013	0 - 0.5	--	--	--	--	--	--	--	--	--	--	89	97	200	110	110	84	--	--	--	--	180	--	--	--	--	220	--	92	--	--	--	--	120	--	190
Froid and Taylor Roads Site - Terrestrial Unit																																				
FTSSB001	0 - .3	--	5	--	5	5	9	--	--	--	--	--	--	--	--	--	--	24	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Froid and Taylor Roads Site - Aquatic Unit																																				
FTSSB002	.75 - 1.8	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	0 - 0.5	9	30	--	12	24	46	5	--	--	--	--	--	--	--	--	--	91	--	--	--	--	--	7	--	--	--	6	--	--	14	--	--	--	--	--
FTSSB004	0 - 0.5	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	61	--	--	--	--	--	--	--	--	--
	1.5 - 2.5	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
FTSSB005	0 - 0.5	--	--	--	--	41	--	--	--	--	--	54	130	110	--	210	83	100	--	--	--	88	--	--	--	--	190	--	--	--	--	--	--	49	--	200
FTSSB006	0 - 0.5	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	530	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
FTSSB007	1.5 - 2.3	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
FTSSB008	0 - 0.5	--	--	--	--	--	--	--	--	--	--	53	--	--	--	--	--	--	2,500	--	--	110	--	--	--	--	150	--	--	--	--	--	--	47	--	110
FTSSB009	0 - .12	--	--	--	--	--	--	--	--	29	37	91	120	240	280	170	120	--	--	--	24	240	--	--	--	--	170	--	140	--	--	--	--	31	--	120
FTSSL102	0 - 0.5	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
FTSSL103	0 - 0.5	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
FTSSL104	0 - 0.5	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

CLP SVOCs (µg/kg)

Sample Location	Sample Depth (ft bgs)	4-Methylphenol	Acenaphthene	Anthracene	Benzo(a)anthracene	Benzo(a)pyrene	Benzo(b)fluoranthene	Benzo(g,h,i)perylene	Benzo(k)fluoranthene	Carbazole	Chrysene	Dibenzofuran	Fluoranthene	Fluorene	Indeno(1,2,3-cd)pyrene	Naphthalene	Phenanthrene	Phenol	Pyrene	HMW PAH*	LMW PAH*	Total PAHs*
Tidal Area Landfill - Terrestrial Unit																						
TLSSB001	0 - 0.5	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	--	--	--
	3.9 - 4.5	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	11,000	--	--	--	--
TLSSB002	0 - 0.5	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	150	--	150
	1.3 - 2.5	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	3,700	--	--	--	--
	4.3 - 5.5	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1,100	--	--	--	--
TLSSB003	4.5 - 5.3	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	720	--	--	--	--
TLSSB004	0 - 0.5	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	824	32	767
	1.3 - 2.4	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	3,200	--	1,300	--	1,300
	4.3 - 5.5	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1,300	--	--	--	--
TLSSB005	0 - 0.5	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	--	--	--
TLSSB006	0 - 0.5	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	378	40	355
	1.3 - 2	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	450	--	--	--	--
TLSSB007	1.5 - 2.3	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	3,100	--	--	--	--
TLSSB008	0 - 0.5	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	491	41	428
R Area Disposal Site - Terrestrial Unit																						
RADSB007	0 - 0.5	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	4,164	775	4,092
RADSB008	0 - 0.5	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	3,387	413	3,118
RADSB009	0 - 0.5	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
RADSB011	0 - 0.5	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	--	--	--
RADSB012	0 - 0.5	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	1,731	120	1,504
RADSB014	0 - 0.5	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	440	--	300
RADSBB03	0 - 0.5	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	26	8	26
RADSBB04	0 - 0.5	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	--	--	--
RADSBB05	0 - 0.5	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	91	--	91
RADSBB07	0 - 0.5	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	92	--	88
RADSBB08	1.5 - 2	--	--	--	320	--	290	--	--	--	300	--	640	--	--	--	440	--	630	2,180	440	2,000
RADSBE03	0 - 0.5	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	--	--	--
RADSBF02	0 - 0.5	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	--	--	--
RADSBG04	0 - 0.5	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	--	--	--
RADSBG05	0 - 0.5	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	--	--	--
RADSBG06	0 - 0.5	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	--	--	--
RADSBG08	.7 - 2	--	660	1,200	2,000	1,500	2,300	520	820	1,100	1,800	500	5,000	600	530	300	5,900	--	4,300	18,770	8,660	23,100
RADSBH06	0 - 0.5	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	611	52	568
	1.5 - 2	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	600	--	--	--	--
RADSBJ04	0 - 0.5	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	35	7	45
RADSBJ08	0 - 0.5	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	34	--	11
RADSBJ02	0 - 0.5	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	--	--	--
	1 - 2.2	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	470	--	--	--	--
RADSBJ03	0 - 0.5	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	--	--	--
RADSBK07	0 - 0.5	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	--	--	--
RADSBK08	0 - 0.5	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	103	--	56
RADSBL03	0 - 0.5	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	287	--	221
RADSBM08	0 - 0.5	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	608	44	489
R Area Disposal Site - Aquatic Unit																						
RADSB013	0 - 0.5	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	1,262	120	1,131
Froid and Taylor Roads Site - Terrestrial Unit																						
FTSSB001	0 - .3	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	--	9	--
Froid and Taylor Roads Site - Aquatic Unit																						
FTSSB002	.75 - 1.8	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	500	--	--	--	--
	0 - 0.5	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	--	66	20
FTSSB004	0 - 0.5	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	61	--	61
	1.5 - 2.5	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	290	--	--	--	--
FTSSB005	0 - 0.5	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	1,065	49	972
FTSSB006	0 - 0.5	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
FTSSB007	1.5 - 2.3	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	423	47	307
FTSSB008	0 - 0.5	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	160	--	--	--	--
FTSSB009	0 - .12	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	1,411	68	1,288
FTSSL102	0 - 0.5	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	--	110	5226[a]	4900[a]	10126[a]
FTSSL103	0 - 0.5	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	--	--	3250[a]	2275[a]	5525[a]
FTSSL104	0 - 0.5	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	--	--	2799[a]	2380[a]	5179[a]

TABLE 6-19

SUMMARY OF DETECTED SVOC CONCENTRATIONS IN SOIL AND SEDIMENT SAMPLES
TIDAL AREA QEA, NWS SBD CONCORD

Sample Location	Sample Depth (ft bgs)	Low Detection Limit SVOCs (µg/kg)																
		1,1'-Biphenyl	1-Methylnaphthalene	1-Methylphenanthrene	2,4-Dimethylphenol	2,6-Dimethylnaphthalene	2-Methylnaphthalene	4-Methylphenol	Acenaphthene	Acenaphthylene	Anthracene	Benzo(a)anthracene	Benzo(a)pyrene	Benzo(b)fluoranthene	Benzo(e)pyrene	Benzo(g,h,i)perylene	Benzo(k)fluoranthene	Benzoic Acid
Wood Hopper Site - Terrestrial Unit																		
S37-01	0 - 1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
S37-10	.5 - 1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	3 - 4	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
WHSSB006	0 - 0.5	--	--	--	--	--	--	--	--	--	--	110	68	170	110	46	130	--
WHSSB008	0 - 0.5	--	--	--	--	--	--	--	--	--	390	--	--	--	1,800	--	--	--
WHSSB009	0 - 0.5	--	--	--	--	--	--	--	57	--	140	--	--	--	420	--	--	78
WHSSB010	0 - 0.5	--	--	--	--	--	--	--	27	--	70	--	--	--	120	--	--	--
WHSSB011	0 - 0.5	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
WHSSB012	0 - 0.5	--	--	--	--	--	--	--	--	--	--	--	--	--	51	--	--	--
WHSSB013	0 - 0.5	--	--	--	--	--	--	--	210	--	360	--	--	--	510	--	--	--
WHSSB014	0 - 0.5	--	--	--	--	--	--	--	--	--	--	--	--	--	630	--	--	--
WHSSB015	0 - 0.5	--	--	--	--	--	--	--	--	--	--	--	--	--	150	--	--	--
WHSSB016	0 - 0.5	--	--	--	--	--	--	--	--	--	--	--	--	--	2,400	--	--	--
WHSSB017	0 - 0.5	--	--	--	--	--	--	--	--	--	--	--	--	--	150	--	--	--
WHSSB050	0 - 0.5	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	2 - 2.5	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
WHSSB051	0 - 0.5	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	2 - 2.5	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
WHSSBB02	0 - 0.5		--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
WHSSBB07	0 - 0.5	--	--	--	--	--	--	--	--	--	--	150	190	290	170	180	210	--
WHSSBC02	0 - 0.5	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	2,300
	4 - 5.5	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
WHSSBC06	0 - 0.5	--	--	350	--	--	--	--	280	270	2,100	3,800	2,700	3,100	2,400	1,100	3,400	--
WHSSBC08	0 - 0.5	--	--	--	--	--	--	--	--	--	--	31	37	50	--	--	45	--
WHSSBD03	0 - 0.5	--	--	--	--	--	--	--	--	--	--	62	79	99	75	77	72	350
	18.5 - 20	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
WHSSBD07	0 - 0.5	--	--	--	--	--	--	--	--	--	360	--	--	--	840	--	--	--
	1.5 - 2.3	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
WHSSBE06	0 - 0.5	--	--	--	--	--	--	--	--	--	180	500	570	1,200	540	520	850	--
WHSSBE08	0 - 0.5	--	--	--	--	--	--	--	--	--	170	310	350	570	330	300	190	830
WHSSBF03	0 - 0.5	--	--	--	--	--	--	--	--	--	14	68	77	130	88	86	68	40
	4.5 - 5.9	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	9.5 - 10.8	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
WHSSBG02	0 - 0.5	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1,100
WHSSBG06	9 - 11	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
WHSSBH03	0 - 0.5	--	--	--	--	--	--	--	--	--	--	--	--	--	160	--	--	--
WHSSBH07	0 - 0.5	--	--	--	--	--	--	--	--	--	--	--	--	27	--	--	--	76
	1.3 - 2.3	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	4 - 5	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	8 - 10.1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
WHSSBK04	0 - 0.5	--	--	--	--	--	--	--	--	--	--	12	19	25	19	21	20	--
WHSSBK06	1.5 - 2.3	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
WHSSBL05	0 - 0.5	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
WHSSBL07	0 - 0.5	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
WHSSBM06	0 - 0.5	--	--	--	--	--	--	--	--	--	--	310	120	590	230	--	--	--
WHSSBM08	0 - 0.5	--	--	30	--	--	--	--	--	--	26	50	47	130	78	41	130	--
	9 - 10.5	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
North Otter Sluice - Aquatic Unit																		
OSLSL001	0 - 0.5	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
OSLSL002	0 - 0.5	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
OSLSL003	0 - 0.5	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
RADSB001	0 - 0.5	--	--	--	--	--	42	45	--	--	38	68	68	70	45	65	56	260
RADSB002	0 - 0.5	--	--	--	--	97	--	34	30	--	30	44	43	49	43	51	43	150
RADSB003	0 - 0.5	--	--	--	--	53	--	--	--	--	--	32	45	45	31	51	34	71
RADSB004	0 - 0.5	--	--	--	--	130	--	--	--	--	--	--	--	--	--	--	--	95
RADSB005	0 - 0.5	--	--	--	--	98	--	--	--	--	--	--	--	--	--	--	--	--
RADSB006	0 - 0.5	--	--	--	--	--	--	740	--	--	--	--	--	--	--	--	--	230
RADSBA01	0 - 0.5	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	110
RADSBA04	0 - 0.5	--	--	--	--	--	--	--	--	--	--	75	80	83	--	--	72	--
RADSBA05	0 - 0.5	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	270
RADSBA07	0 - 0.5	--	--	--	--	--	--	--	--	--	--	22	35	39	39	--	24	250
RADSL001	0 - 0.5	--	--	--	--	13	--	--	--	--	24	110	140	130	99	110	130	--
RADSL002	0 - 0.5	--	--	--	--	--	--	--	--	--	--	--	39	--	--	--	--	--

Sample Location	Sample Depth (ft bgs)	Low Detection Limit SVOCs (µg/kg)																	
		Bis(2-ethylhexyl)phthalate	Butylbenzylphthalate	Carbazole	Chrysene	Dibenz(a,h)anthracene	Dibenzofuran	Dibenzothiophene	Diethylphthalate	Fluoranthene	Fluorene	Indeno(1,2,3-cd)pyrene	Isophorone	Naphthalene	Pentachlorophenol	Perylene	Phenanthrene	Phenol	Pyrene
Wood Hopper Site - Terrestrial Unit																			
S37-01	0 - 1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
S37-10	.5 - 1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	3 - 4	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
WHSSB006	0 - 0.5	--	--	49	360	--	--	--	--	260	--	44	--	--	--	--	56	--	240
WHSSB008	0 - 0.5	--	--	200	2,900	--	--	--	--	1,200	--	--	--	--	--	--	240	--	1,600
WHSSB009	0 - 0.5	--	--	120	--	--	--	25	--	1,300	40	--	--	--	120	--	650	--	950
WHSSB010	0 - 0.5	--	--	50	--	--	--	--	--	530	20	--	--	--	--	--	300	--	400
WHSSB011	0 - 0.5	--	--	--	47	--	--	--	--	54	--	--	--	--	--	--	--	--	48
WHSSB012	0 - 0.5	--	78	--	--	--	--	--	--	95	--	--	--	--	--	--	49	--	88
WHSSB013	0 - 0.5	--	--	190	--	--	84	53	--	1,700	160	--	--	110	120	--	1,200	--	1,200
WHSSB014	0 - 0.5	--	--	--	--	--	--	--	--	930	--	--	--	--	--	--	450	--	1,000
WHSSB015	0 - 0.5	--	--	--	--	--	--	--	--	150	--	--	--	--	--	--	72	--	120
WHSSB016	0 - 0.5	--	--	--	--	--	--	--	--	5,400	--	--	--	--	--	--	4,000	--	3,900
WHSSB017	0 - 0.5	--	--	--	--	--	--	--	--	96	--	--	--	--	--	--	--	--	--
WHSSB050	0 - 0.5	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	2 - 2.5	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
WHSSB051	0 - 0.5	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	2 - 2.5	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
WHSSBB02	0 - 0.5	--	--	--	--	--	--	--	--	200	--	--	--	--	--	--	--	--	200
WHSSBB07	0 - 0.5	--	--	--	300	--	--	--	--	310	--	140	--	--	--	--	200	--	290
WHSSBC02	0 - 0.5	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	4 - 5.5	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
WHSSBC06	0 - 0.5	--	--	880	6,400	600	170	170	--	14,000	350	1,200	--	--	780	840	3,000	--	13,000
WHSSBC08	0 - 0.5	--	--	--	64	--	--	--	--	89	--	--	--	--	--	--	45	--	80
WHSSBD03	0 - 0.5	--	--	--	130	--	--	--	--	140	--	--	--	--	--	--	--	--	130
	18.5 - 20	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
WHSSBD07	0 - 0.5	--	--	150	--	--	--	--	--	770	--	--	--	--	--	--	240	--	590
	1.5 - 2.3	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
WHSSBE06	0 - 0.5	--	--	200	1,200	130	--	--	--	1,200	--	470	--	--	--	150	470	--	970
WHSSBE08	0 - 0.5	--	--	130	390	110	--	--	--	910	--	250	--	--	250	130	400	--	410
WHSSBF03	0 - 0.5	--	--	18	97	32	--	--	--	130	--	70	--	--	--	26	49	--	110
	4.5 - 5.9	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	9.5 - 10.8	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
WHSSBG02	0 - 0.5	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
WHSSBG06	9 - 11	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
WHSSBH03	0 - 0.5	--	--	--	--	--	--	--	--	150	--	--	--	--	--	--	--	--	140
WHSSBH07	0 - 0.5	--	--	--	25	--	--	--	--	39	--	--	--	--	--	--	--	--	25
	1.3 - 2.3	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	4 - 5	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	8 - 10.1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
WHSSBK04	0 - 0.5	--	--	--	23	--	--	--	--	14	--	17	--	--	--	--	--	--	19
WHSSBK06	1.5 - 2.3	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
WHSSBL05	0 - 0.5	--	--	--	--	--	--	--	--	180	--	--	--	--	--	--	--	--	140
WHSSBL07	0 - 0.5	--	--	--	150	--	--	--	--	200	--	--	--	--	--	--	--	--	150
WHSSBM06	0 - 0.5	--	--	140	720	--	--	--	--	1,100	--	--	--	--	--	--	440	--	910
WHSSBM08	0 - 0.5	--	--	89	290	--	--	--	--	860	--	38	--	--	--	--	630	--	740
	9 - 10.5	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
North Otter Sluice - Aquatic Unit																			
OSLSL001	0 - 0.5	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
OSLSL002	0 - 0.5	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
OSLSL003	0 - 0.5	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
RADSB001	0 - 0.5	--	--	--	86	--	--	--	--	150	--	--	--	210	--	--	120	--	98
RADSB002	0 - 0.5	--	--	--	53	--	--	--	--	110	25	37	--	160	--	46	43	--	270
RADSB003	0 - 0.5	--	--	--	38	--	--	--	--	72	--	37	--	--	--	66	--	--	89
RADSB004	0 - 0.5	--	--	--	--	--	--	--	--	110	--	--	--	--	--	--	--	--	120
RADSB005	0 - 0.5	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	86
RADSB006	0 - 0.5	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
RADSBA01	0 - 0.5	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
RADSBA04	0 - 0.5	--	--	--	86	--	--	--	--	170	--	76	--	--	--	110	--	--	150
RADSBA05	0 - 0.5	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
RADSBA07	0 - 0.5	--	--	--	39	--	--	--	--	45	--	--	--	--	--	--	25	--	55
RADSL001	0 - 0.5	--	--	--	140	--	--	--	--	220	--	76	--	--	--	59	59	--	410
RADSL002	0 - 0.5	--	--	--	--	--	--	--	--	53	--	--	--	--	--	160	--	--	68

Sample Location	Sample Depth (ft bgs)	CLP SVOCs (µg/kg)																				
		4-Methylphenol	Acenaphthene	Anthracene	Benzo(a)anthracene	Benzo(a)pyrene	Benzo(b)fluoranthene	Benzo(g,h,i)perylene	Benzo(k)fluoranthene	Carbazole	Chrysene	Dibenzofuran	Fluoranthene	Fluorene	Indeno(1,2,3-cd)pyrene	Naphthalene	Phenanthrene	Phenol	Pyrene	HMW PAH[a]	LMW PAH[a]	Total PAHs[a]
Wood Hopper Site - Terrestrial Unit																						
S37-01	0 - 1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	280	--	--	--	--
S37-10	.5 - 1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	200	--	--	--	--
	3 - 4	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	230	--	--	--	--
WHSSB006	0 - 0.5	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	1,428	56	1,080
WHSSB008	0 - 0.5	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	5,700	630	5,230
WHSSB009	0 - 0.5	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	2,250	887	3,557
WHSSB010	0 - 0.5	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	930	417	1,467
WHSSB011	0 - 0.5	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	149	--	102
WHSSB012	0 - 0.5	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	183	49	283
WHSSB013	0 - 0.5	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	2,900	2,040	5,450
WHSSB014	0 - 0.5	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	1,930	450	3,010
WHSSB015	0 - 0.5	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	270	72	492
WHSSB016	0 - 0.5	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	9,300	4,000	15,700
WHSSB017	0 - 0.5	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	96	--	246
WHSSB050	0 - 0.5	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	450	--	--	--	--
	2 - 2.5	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	560	--	--	--	--
WHSSB051	0 - 0.5	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	900	--	--	--	--
	2 - 2.5	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	980	--	--	--	--
WHSSBB02	0 - 0.5	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	400	--	400
WHSSBB07	0 - 0.5	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	2,060	200	1,840
WHSSBC02	0 - 0.5	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	--	--	--
	4 - 5.5	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1,500	--	--	--	--
WHSSBC06	0 - 0.5	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	49,300	5,730	46,270
WHSSBC08	0 - 0.5	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	396	45	346
WHSSBD03	0 - 0.5	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	789	--	672
	18.5 - 20	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	4,200	--	--	--	--
WHSSBD07	0 - 0.5	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	--	1,360	600	2,800
	1.5 - 2.3	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1,500	--	--	--	--
WHSSBE06	0 - 0.5	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	7,610	650	6,650
WHSSBE08	0 - 0.5	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	3,790	570	3,760
WHSSBF03	0 - 0.5	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	868	63	778
	4.5 - 5.9	--	--	--	--	--	440	--	--	350	330	--	780	--	--	--	490	--	640	2,190	490	2,350
	9.5 - 10.8	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	680	--	--	--	--
WHSSBG02	0 - 0.5	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	--	--	--
WHSSBG06	9 - 11	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	4,600	--	--	--	--
WHSSBH03	0 - 0.5	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	290	--	450
WHSSBH07	0 - 0.5	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	116	--	91
	1.3 - 2.3	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	370	--	--	--	--
	4 - 5	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1,400	--	--	--	--
	8 - 10.1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	2,000	--	--	--	--
WHSSBK04	0 - 0.5	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	170	--	137
WHSSBK06	1.5 - 2.3	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	2,600	--	--	--	--
WHSSBL05	0 - 0.5	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	320	--	320
WHSSBL07	0 - 0.5	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	500	--	350
WHSSBM06	0 - 0.5	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	3,750	440	3,390
WHSSBM08	0 - 0.5	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	2,326	656	2,682
	9 - 10.5	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1,600	--	--	--	--
North Otter Sluice - Aquatic Unit																						
OSLSL001	0 - 0.5	--	--	--	--	56	--	--	--	--	70	--	120	--	--	--	48	--	--	3746[d]	3048[d]	6794[d]
OSLSL002	0 - 0.5	64	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	6000[d]	4200[d]	10200[d]
OSLSL003	0 - 0.5	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	6500[d]	4550[d]	11050[d]
RADSB001	0 - 0.5	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	661	410	920
RADSB002	0 - 0.5	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	900	288	1,143
RADSB003	0 - 0.5	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	443	--	433
RADSB004	0 - 0.5	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	230	--	230
RADSB005	0 - 0.5	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	86	--	86
RADSB006	0 - 0.5	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	--	--	--
RADSBA01	0 - 0.5	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	--	--	--
RADSBA04	0 - 0.5	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	792	--	665
RADSBA05	0 - 0.5	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	--	--	--
RADSBA07	0 - 0.5	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	259	25	262
RADSL001	0 - 0.5	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	1,466	83	1,381
RADSL002	0 - 0.5	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	160	--	320

TABLE 6-19

SUMMARY OF DETECTED SVOC CONCENTRATIONS IN SOIL AND SEDIMENT SAMPLES
TIDAL AREA QEA, NWS SBD CONCORD

Low Detection Limit SVOCs (µg/kg)

Sample Location	Sample Depth (ft bgs)	1,1'-Biphenyl	1-Methylnaphthalene	1-Methylphenanthrene	2,4-Dimethylphenol	2,6-Dimethylnaphthalene	2-Methylnaphthalene	4-Methylphenol	Acenaphthene	Acenaphthylene	Anthracene	Benzo(a)anthracene	Benzo(a)pyrene	Benzo(b)fluoranthene	Benzo(e)pyrene	Benzo(g,h,i)perylene	Benzo(k)fluoranthene	Benzoic Acid	Bis(2-ethylhexyl)phthalate	Butylbenzylphthalate	Carbazole	Chrysene	Dibenz(a,h)anthracene	Dibenzofuran	Dibenzothiophene	Diethylphthalate	Fluoranthene	Fluorene	Indeno(1,2,3-cd)pyrene	Isophorone	Naphthalene	Pentachlorophenol	Perylene	Phenanthrene	Phenol	Pyrene
South Otter Sluice - Aquatic Unit																																				
OSLSL004	0 - 0.5	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
OSLSL005	0 - 0.5	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
OSLSL006	0 - 0.5	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
OSLSL007	0 - 0.5	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
OSLSL008	0 - 0.5	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
OSLSL009	0 - 0.5	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
WHSSB003	0 - 0.5	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1,000	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
WHSSB018	0 - 0.5	--	--	--	--	--	--	--	--	--	--	--	20	27	21	--	20	--	--	--	--	28	--	--	--	--	50	--	--	--	--	--	--	22	--	37
WHSSBB05	0 - 0.5	--	--	--	--	--	--	--	--	--	--	--	270	300	240	230	300	--	--	--	--	360	--	--	--	--	430	--	--	--	--	--	--	--	--	480
WHSSBD01	0 - 0.5	--	--	--	--	--	--	--	--	--	--	20	20	33	33	29	22	--	--	--	--	37	--	--	--	--	39	--	20	--	--	--	--	--	--	34
WHSSBK08	0 - 0.5	--	--	--	--	37	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	91	--	--	--	--	--	--	--	--	72

CLP SVOCs (µg/kg)

Sample Location	Sample Depth (ft bgs)	4-Methylphenol	Acenaphthene	Anthracene	Benzo(a)anthracene	Benzo(a)pyrene	Benzo(b)fluoranthene	Benzo(g,h,i)perylene	Benzo(k)fluoranthene	Carbazole	Chrysene	Dibenzofuran	Fluoranthene	Fluorene	Indeno(1,2,3-cd)pyrene	Naphthalene	Phenanthrene	Phenol	Pyrene	HMW PAH[a]	LMW PAH[b]	Total PAHs[c]
South Otter Sluice - Aquatic Unit																						
OSLSL004	0 - 0.5	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	5500[d]	3850[d]	9350[d]
OSLSL005	0 - 0.5	200	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	6500[d]	4550[d]	11050[d]
OSLSL006	0 - 0.5	--	--	--	--	--	--	--	--	--	--	--	72	--	--	--	--	--	--	6822[d]	5250[d]	12072[d]
OSLSL007	0 - 0.5	92	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	6000[d]	4200[d]	10200[d]
OSLSL008	0 - 0.5	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	160	13660[d]	10500[d]	24160[d]
OSLSL009	0 - 0.5	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	11000[d]	7700[d]	18700[d]
WHSSB003	0 - 0.5	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	--	--	--
WHSSB018	0 - 0.5	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	182	22	197
WHSSBB05	0 - 0.5	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	2,370	--	2,250
WHSSBD01	0 - 0.5	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	254	--	210
WHSSBK08	0 - 0.5	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	163	--	163

Notes:

bgs Below ground surface
HMW High molecular weight
LMW Low molecular weight
NA Not analyzed
PAH Polycyclic aromatic hydrocarbon
SVOC Semivolatile organic compound
µg/kg Micrograms per kilogram

a HMW PAHs = sum of benzo(a)fluorene, benzo(b)fluorene, fluoranthene, pyrene, benzo(k)fluoranthene, benzo(g,h,i)perylene, chrysene, benzo(a)anthracene, indeno(1,2,3-cd)pyrene, benzo(b)fluoranthene, benzo(a)pyrene, and dibenz(a,h)anthracene.
b LMW PAHs = sum of naphthalene, fluorene, anthracene, phenanthrene, acenaphthene, and 2-methylnaphthalene.
c Total PAHs = sum of naphthalene, fluorene, anthracene, phenanthrene, acenapthene, benzo(a)fluorene, benzo(b)fluorene, fluoranthene, pyrene, benzo(k)fluoranthene, benzo(g,h,i)fluoranthene, perylene, benzo(e)pyrene, benzo(h,g,i)perylene, benzo(b)fluoranthene, and benzo(a)pyrene\
d Total includes 1/2 sample quantitation limit for nondetects.
-- Not detected

TABLE 6-20

SUMMARY OF DETECTED VOA AND AROMATIC CONCENTRATIONS IN SOIL AND SEDIMENT SAMPLES
TIDAL AREA QEA, NWS SBD CONCORD

Sample Location	Sample Depth (ft bgs)	Aromatic and C21Volatile Organic Analytes (µg/kg)						
		2-Butanone	4-Methyl-2-Pentanone	Acetone	Carbon Disulfide	Chloromethane	Ethylbenzene	Xylene (Total)
Tidal Area Landfill - Terrestrial Unit								
TLSSB001	3.9 - 4.5	--	--	--	--	48	--	--
TLSSB002	4.3 - 5.5	--	--	--	44	--	--	--
TLSSB003	4.5 - 5.3	--	--	--	85	27	--	--
TLSSB004	1.3 - 2.4	390	--	--	--	--	--	--
	4.3 - 5.5	--	--	--	120	37	--	--
TLSSB005	4.5 - 5.8	--	--	--	23	--	--	--
TLSSB007	1.5 - 2.3	--	--	580	97	--	--	--
	4.5 - 5.3	--	--	--	33	--	--	--
TLSSB008	1.5 - 2.7	--	--	240	--	--	--	--
	4.5 - 5.7	--	--	--	10	--	--	--
R Area Disposal Site - Terrestrial Unit								
RADSBB04	4 - 5.2	--	--	--	160	--	--	--
RADSBB06	1.2 - 2	43	--	--	--	--	--	--
RADSBD06	4.5 - 5.7	73	--	--	--	--	--	--
RADSBG04	4.5 - 5.8	--	--	--	21	--	--	--
RADSBH06	1.5 - 2	--	--	--	--	14	--	--
RADSBI08	1.5 - 2	--	--	--	45	--	--	--
RADSBJ02	4.7 - 6	--	--	--	7	--	--	--
Froid and Taylor Roads Site - Aquatic Unit								
FTSSB005	2 - 3	--	27	--	--	--	--	--
Wood Hogger Site - Terrestrial Unit								
WHSSB030	3.2 - 3.5	--	--	--	--	--	160	220
WHSSBC02	1.3 - 2	--	--	--	--	--	--	26
	4 - 5.5	--	--	--	--	--	--	54
WHSSBD03	1.5 - 2	--	--	--	81	--	--	--
	4.5 - 5.8	--	--	--	290	--	--	--
	9.5 - 10.4	--	--	--	48	--	--	--
	18.5 - 20	--	--	--	70	--	--	--
WHSSBE08	9 - 10.3	290	--	--	--	--	--	--

TABLE 6-20

SUMMARY OF DETECTED VOA AND AROMATIC CONCENTRATIONS IN SOIL AND SEDIMENT SAMPLES
TIDAL AREA QEA, NWS SBD CONCORD

Sample Location	Sample Depth (ft bgs)	Aromatic and C21Volatile Organic Analytes (µg/kg)						
		2-Butanone	4-Methyl-2-Pentanone	Acetone	Carbon Disulfide	Chloromethane	Ethylbenzene	Xylene (Total)
Wood Hogger Site - Terrestrial Unit (Continued)								
WHSSBF03	1.5 - 2.3	--	--	300	--	--	--	--
	9.5 - 10.8	--	--	--	23	--	--	--
WHSSBK06	4.5 - 5.3	720	--	--	28	--	--	--
	9.5 - 10.4	20	--	--	27	--	--	--
WHSSBM08	9 - 10.5	--	--	--	110	--	--	--

Notes:

bgs Below ground surface
VOA Volatile organic analyte
µg/kg Micrograms per kilogram
-- Not detected

TABLE 6-21

SUMMARY OF DETECTED TPH CONCENTRATIONS IN SOIL AND SEDIMENT TIDAL AREA QEA, NWS SBD CONCORD

Sample Location	Sample Depth (ft bgs)	TPH-g (mg/kg)	TPH-d (mg/kg)	TPH-mo (mg/kg)	Total PAHs (µg/kg)
Froid and Taylor Roads Site - Terrestrial Unit					
FTSSB001	0 - 0.3	--	--	54	--
	0.35 -1.3	--	--	9,200	--
Froid and Taylor Roads Site - Aquatic Unit					
FTSSB002	0 - 0.5	--	--	7,800	20
	0.75 - 1.8	--	--	160	--
FTSSB003	0 - 0.25	--	--	23,000	--
	0.75 - 1.75	--	--	45	--
FTSSB004	0 - 0.5	--	--	240	61
FTSSB005	0 - 0.5	--	--	180	972
	2 - 3	--	--	340	--
FTSSB006	0 - 0.5	--	--	47	--
	1.1 - 2	--	--	800	--
FTSSB007	1.5 - 2.3	--	--	9	--
FTSSB008	0 - 0.5	--	--	18	307
	1.2 - 1.75	--	--	50	--
FTSSB009	0 - 0.12	--	--	88	1,288
Wood Hogger Site - Terrestrial Unit					
WHSSB030	3.2 - 3.5	26	2,300	8,900	--
WHSSBD07	1.5 - 2.3	0.47	--	640	2,800

Notes:

bgs	Below ground surface
mg/kg	Milligrams per kilogram
PAH	Polycyclic aromatic hydrocarbon
TPH-d	Total petroleum hydrocarbons as diesel
TPH-g	Total petroleum hydrocarbons as gasoline
TPH-mo	Total petroleum hydrocarbons as motor oil
µg/kg	Micrograms per kilogram
--	Not detected

TABLE 6-22

COMPARISON OF WET-ACID AND WET-DI RESULTS TO QEA WATER SCREENING VALUES TIDAL AREA QEA, NWS SBD CONCORD

Analyte	Location of Maximum Detection	Maximum Detected Concentration (µg/L)	QEA Screening Value[a] (µg/L)	Number of Samples	Number of Detections	Number of Samples that Exceed QEA Screening Value	Percent of Samples that Exceed QEA Screening Value
WET-Acid							
Aluminum	WHSSBC08	388,000	87	20	20	20	100.0
Antimony	WHSSL003	11.7	NA	20	8	NA	NA
Arsenic	RADSBE03	445	36	20	18	14	70.0
Barium	WHSSBG06	12,900	NA	20	20	NA	NA
Beryllium	RADSBD06	14.4	NA	20	15	NA	NA
Cadmium	WHSSL002	41.5	1.1	20	14	14	70.0
Chromium	WHSSBC08	928	86	20	20	20	100.0
Cobalt	WHSSBC08	903	NA	20	20	NA	NA
Copper	WHSSBB07	2420	3.2	20	20	20	100.0
Lead	FTSSB002	11,000	3.1	20	20	20	100.0
Manganese	FTSSB007	45,300	NA	20	20	NA	NA
Mercury	WHSSBF03	3.6	0.025	20	14	14	70.0
Molybdenum	ND	ND	NA	20	0	ND	ND
Nickel	WHSSBC08	3,140	8.2	20	20	20	100.0
Selenium	ND	ND	5	17	0	ND	ND
Silver	RADSBB06	2	0.22	20	3	3	15.0
Thallium	FTSSB007	73.1	NA	20	8	NA	NA
Vanadium	RADSBE03	2,850	NA	20	20	NA	NA
Zinc	WHSSBB03	15,800	58	20	20	20	100.0
WET-DI							
Aluminum	WHSSBB07	350,000	87	52	47	45	86.5
Antimony	WHSSBE08	11.2	NA	52	16	NA	NA
Arsenic	WHSSBC02	63.7	36	52	36	4	7.7
Barium	WHSSBB07	3,340	NA	52	52	NA	NA
Beryllium	ND	ND	NA	52	0	ND	ND
Cadmium	WHSSL001	3.1	1.1	52	4	2	3.8
Chromium	WHSSBB07	525	86	52	14	1	1.9
Cobalt	WHSSBB07	220	NA	52	37	NA	NA
Copper	WHSSBB07	2,320	3.2	52	48	48	92.3
Lead	WHSSBB07	3,630	3.1	52	36	31	59.6
Manganese	WHSSBI02	4,440	NA	52	49	NA	NA
Mercury	WHSSBA06	1.2	0.025	52	13	13	25.0
Molybdenum	WHSSBF03	20.2	NA	52	24	NA	NA
Nickel	WHSSBB07	579	8.2	52	39	29	55.8
Selenium	RADSBK08	4.2	5	52	3	0	0.0
Silver	FTSSB003	2.8	0.22	52	8	8	15.4
Thallium	WHSSBI02	4.4	NA	52	1	NA	NA
Vanadium	WHSSBB07	1,090	NA	52	49	NA	NA
Zinc	WHSSBB07	8,500	58	52	41	19	36.5

Notes:

DI Deionized water

NA Screening value not available

ND Not detected

WET Waste Extraction Test

µg/L Micrograms per liter

a See Table 5-3 for selection of QEA water screening values.

TABLE 6-23
INORGANIC COPECs
TIDAL AREA QEA, NWS SBD CONCORD

Analyte	Tidal Area Ambient Value (99 UCL)[a]	SF Bay Ambient Value[b]	ER-L[c]	ER-M[d]	Maximum Concentration	Median Concentration	95% UCL	No. of Outliers	No. of Extreme Values	Remarks	COPEC
Aluminum	27,300	NA	NA	NA	42,700	16,900	18,801	2	0	COPEC in South Otter Sluice. Potential problem at one sample location only (WHSSB001).	Y
Antimony	2.2	NA	2.0	25	9.3	1.4	2.07	5	5		Y
Arsenic	27	15.3	8.2	70	57.6	10.1	13.35	5	2	Maximum concentration less than ER-M.	Y
Barium	530	NA	NA	NA	7,705	122	242.87	7	5	COPEC in R Area only. Potential problem at one sample location (RADSBE07). Concentrations at other locations close to ambient.	Y
Beryllium	0.18	NA	NA	NA	0.94	0.23	0.37	2	0		Y
Cadmium	1.9	0.33	1.2	9.6	20.8	0.8	3.43	5	2		Y
Chromium	82.1	112	81	370	319	49.2	56.93	0	1	Only one extreme value; concentration less than ER-M. Concentrations at other locations close to ambient. One hexavalent chromium detected; concentration less than ambient value and ER-L. Thus, chromium not of high concern	N
Cobalt	36	NA	NA	NA	108	14.7	17.43	8	3	COPEC in R Area only. Potential problem at one sample location (RADSBH06). Concentrations at other locations close to ambient.	Y
Copper	81	68.1	34	270	607	44.6	60.26	1	5		Y
Lead	95	43.2	46.7	218	1,160	40.9	85.91	24	8		Y
Manganese	1,500	NA	NA	NA	6,300	433	591.81	4	2	COPEC in R Area only. Potential problem at sample location (RADSB108). With exception of sample location FTSSL104, concentrations at other locations less than ambient	Y
Mercury	0.32	0.43	0.15	0.71	18.5	0.22	0.83	5	6		Y
Molybdenum	6.6	NA	NA	NA	53.7	1.7	4.62	1	2		Y
Nickel	120	112	20.9	51.6	242	65.3	68.09	3	1	COPEC in R Area only. Potential problem at one sample location (RADSHI06). Concentrations at other locations less than ambient.	Y
Selenium	NA	0.64	0.70	1.40	4.8	1.25	2.26	0	2		Y
Silver	NA	0.58	1.0	3.7	4.4	0.44	0.96	3	2	One sample location greater than ER-M.	N
Thallium	2.2	NA	NA	NA	5.4	1.5	2.03	1	1	Only one sample exceeded ambient value; concentration less than three times ambient. No toxicity benchmarks available.	N

TABLE 6-23
INORGANIC COPECs
TIDAL AREA QEA, NWS SBD CONCORD

Analyte	Tidal Area Ambient Value (99 UCL)[a]	SF Bay Ambient Value[b]	ER-L[c]	ER-M[d]	Maximum Concentration	Median Concentration	95% UCL	No. of Outliers	No. of Extreme Values	Remarks	COPEC
Vanadium	96	NA	NA	NA	163	66.1	71.4	5	0	Four outliers, no extreme values. Maximum concentration less than two times ambient value. No toxicity benchmarks available.	N
Zinc	264	158	150	410	3,010	127	236	12	7		Y

Notes: If more than one sample was analyzed in the surface and subsurface depth ranges, only the highest result from the interval is reported and used in the data set.

COPEC Chemical of potential ecological concern
ER-L Effects range-low
ER-M Effects range-median
NA Not available
SF San Francisco
UCL Upper confidence limit

a PRC Environmental Management, Inc (PRC). 1996a. "Estimation of Ambient Metals Concentrations in the Tidal Area Soils. Technical Memorandum. Naval Weapons Station, Concord, California." March.
b San Francisco Bay Regional Water Quality Control Board (RWQCB). 1998. "Ambient Concentrations of Toxic Chemicals in Sediments." April.
c National Oceanic and Atmospheric Administration (NOAA). 1991. "The Potential for Biological Effects of Sediment-Sorbed Contaminants Tested in the National Status and Trends Program." Technical Memorandum NOS OMA 52. NOAA, Office of Oceanography and Marine Assessment. Seattle, Washington.
d Long, E.R., D. D. MacDonald, S.L. Smith, F.D. Calder. 1995. "Incidence of Adverse Biological Effects Within Ranges of Chemical Concentrations in Marine and Estuarine Sediments." *Environmental Management*. Volume 19. Number 1. Pages 81 through 97.

TABLE 7-1

ASSESSMENT AND MEASUREMENT ENDPOINTS AND RATIONALE FOR THEIR SELECTION
TIDAL AREA QEA, NWS SBD CONCORD

Assessment Endpoints	Rationale	Measurement Endpoints
Protection of populations of upland plants	-- Potential food-chain transfer to terrestrial herbivores -- Exposure via soil and surface water	• Chemical characterization of soil and comparison to CDFG and ORNL benchmarks at which effects to individual plants are expected
Protection of populations of wetland plants	-- Provides habitat structure and cover for wetland community -- Food and habitat for salt marsh harvest mouse and other special status species -- Exposure via sediment and surface water	• Chemical characterization of pickleweed tissue as measure of bioavailability of site contaminants • Chemical characterization of soil and comparison to CDFG and ORNL benchmarks at which effects to individual plants are expected
Protection of soil biota and terrestrial invertebrates	-- Potential food transfer to terrestrial vertebrates -- Exposure via soil	• Chemical characterization of soil and comparison to CDFG and ORNL benchmarks at which effects to soil biota are expected • Biological testing: soil tested by Microtox and cytochrome P450 tests (endpoints of statistically significant difference in response indicating potential effects)
Protection of the benthic invertebrate community	-- Important in food-chain and nutrient dynamics -- Prey of shorebirds -- Sensitive to contaminated sediments -- Exposure via sediment and water	• Chemical characterization of sediment and comparison to ER-Ls at which effects on populations are expected • Chemical characterization of clam and amphipod tissues as a measure of bioavailability • Biological testing - whole sediment bioassay using the amphipod *Eohaustorius estuarius* (statistically significant reduction in survival and reburial

TABLE 7-1 (Continued)

ASSESSMENT AND MEASUREMENT ENDPOINTS AND RATIONALE FOR THEIR SELECTION
TIDAL AREA QEA, NWS SBD CONCORD

Assessment Endpoints	Rationale	Measurement Endpoints
Protection of fish community in Otter Sluice	-- Exposure via sediment and water -- Sensitive to contaminated water or sediments -- Prey of shorebirds and river otter	• Chemical characterization of sediment and surface water and comparison to guidance values • Chemical characterization of fish tissues and comparison to regional levels reported in the literature • Biological testing: sediment-water interface test using topsmelt, *Atherinops affinis*, embryos (statistically significant reduction in hatchability)
Protection of populations of piscivorous birds	-- Exposure via prey, sediment, and surface water -- High societal value -- Top predator of fish and invertebrates	• Food-chain modeling to Great Blue Heron as representative receptor, using measured concentrations of chemicals in prey and incidentally ingested sediment; comparison to toxicity reference values at which effects on populations expected
Protection of individual California Black Rails	-- Predator of benthic invertebrates in wetland -- Special status species -- Year-round resident	• Food-chain modeling to California Black Rail using measured concentrations of chemicals in prey and incidentally ingested sediment; comparison to toxicity reference values at which effects on individual rails expected
Protection of populations of shorebirds	-- Exposure via prey, sediment, and surface water -- High societal value -- Predator of invertebrates in wetland	• Food-chain modeling to Black-necked Stilt as representative receptor, using measured concentrations of chemicals in prey and incidentally ingested sediment; comparison to toxicity reference values at which effects on populations expected

TABLE 7-1 (Continued)

ASSESSMENT AND MEASUREMENT ENDPOINTS AND RATIONALE FOR THEIR SELECTION
TIDAL AREA QEA, NWS SBD CONCORD

Assessment Endpoints	Rationale	Measurement Endpoints
Protection of populations of raptors	-- Exposure via prey, surface water, and soil -- Top predator of rodents -- High societal value	• Food-chain modeling to Northern Harrier as representative receptor, using measured concentrations of chemicals in prey and incidentally ingested soil; comparisons to toxicity reference values at which effects on populations expected
Protection of populations of carnivorous mammals	-- Exposure via prey, surface water, soil -- Top predator of rodents -- High societal value	• Food-chain modeling to gray fox and river otter as representative receptors, using measured concentrations of chemicals in prey and soil or incidentally ingested sediment; comparisons to toxicity reference values at which effects on populations expected
Protection of individual salt marsh harvest mouse	-- Exposure via plants, prey, soil, and surface water -- Special status species -- Prey of top predators	• Food-chain modeling to salt marsh harvest mouse, using measured concentrations of chemicals in pickleweed tissues and incidentally ingested soil; comparisons to toxicity reference values at which effects on individuals expected

Notes:

CDFG California Department of Fish and Game
ORNL Oak Ridge National Laboratory

TABLE 7-2

RISK CHARACTERIZATION METHODOLOGY
TIDAL AREA QEA, NWS SBD CONCORD

Assessment Endpoint	Primary Method for Risk Characterization	Sources of Data or Primary Method	Other Data Used in Weight-of-Evidence Approach to Risk Assessment	Linkage to Assessment Endpoint
Protection of populations of upland plants	• Use of toxicity derived screening guidelines	• Chemistry of soil	• Literature review	Evaluate potential effects
Protection of populations of wetland plants	• Use of toxicity derived screening guidelines	• Chemistry of soil • Pickleweed tissue	• Bioavailability data • Literature review	Evaluate bioaccumulation and potential effects
Protection of soil biota	• Direct toxicity testing • Use of toxicity derived screening guidelines	• Chemistry of soil • Microtox bioassay • P450 bioassay	• Literature review	Direct effects of chemicals on bacteria (Microtox); potential effects (enzyme induction) on higher organisms (P450)
Protection of benthic invertebrate community	• Direct toxicity testing • Use of toxicity derived screening guidelines	• Chemistry of soil • Amphipod, clam tissues • Amphipod whole sediment bioassay	• Bioavailability data • Literature review	Evaluate bioaccumulation; Direct measure of effects of chemicals on amphipods
Protection of fish community in Otter Sluice	• Direct toxicity testing • Use of toxicity derived screening guidelines	• Chemistry of sediment • Topsmelt sediment-water interface bioassay • Fish tissues	• Bioavailability data • Literature review	Evaluate bioaccumulation; Direct measure of effects of chemicals on fish embryos
Protection of populations of piscivorous birds	• Chemical exposure and effects modeling	• Chemistry of sediment and soil • Fish and invertebrate tissues	• Literature review	Evaluate potential for food chain transfer and potential effects on representative receptor

TABLE 7-2 (Continued)

RISK CHARACTERIZATION METHODOLOGY
TIDAL AREA QEA, NWS SBD CONCORD

Assessment Endpoint	Primary Method for Risk Characterization	Sources of Data or Primary Method	Other Data Used in Weight-of-Evidence Approach to Risk Assessment	Linkage to Assessment Endpoint
Protection of populations of California Black Rail	• Chemical exposure and effects modeling	• Chemistry of sediment and soil • Invertebrate tissues	• Literature review	Evaluate potential for food chain transfer and potential effects on representative receptor
Protection of populations of shore birds	• Chemical exposure and effects modeling	• Chemistry of sediment and soil • Fish and invertebrate tissues	• Literature review	Evaluate potential for food chain transfer and potential effects on representative receptor
Protection of populations of raptors	• Chemical exposure and effects modeling	• Chemistry of soil • Rodent tissues	• Literature review	Evaluate potential for food chain transfer and potential effects on representative receptor
Protection of populations of carnivorous mammals	• Chemical exposure and effects modeling	• Chemistry of sediment and soil • Rodent, fish, clam tissues	• Literature review	Evaluate potential for food chain transfer and potential effects on representative receptor
Protection of individual salt marsh harvest mouse	• Chemical exposure and effects modeling	• Chemistry of sediment and soil • pickleweed tissue	• Literature review	Evaluate potential for food chain transfer and potential effects on representative receptor

TABLE 8-1

MICROTOX AND CYTOCHROME P450 SOIL BIOASSAY RESULTS
TIDAL AREA QEA, NWS SBD CONCORD

Sample Location	Top Depth (feet bgs)	Bottom Depth (feet bgs)	P450 (Fold Induction)[a]	Microtox Organic Extract (Percent)[b]	Microtox Solid Phase (Percent)[b]
R Area Disposal Site					
RADSBA01	0	0.50	103	0.082	0.11
RADSBA07	0	0.50	26	0.31	1.12
RADSBB04	0	0.50	28	0.72	0.59
RADSBB06	0	0.50	16	1.35	0.55
RADSBB08	0	0.50	49	1.91	3.00
RADSBC05	0	0.50	21	1.18	0.76
RADSBD05	0	0.50	14	1.39	0.34
RADSBD06	0	0.50	20	1.32	0.31
RADSBE03	0	0.50	21	1.14	0.44
RADSBF06	0	0.50	14	1.66	0.23
RADSBG04	0	0.50	35	1.70	1.27
RADSBG08	0	0.50	17	1.48	0.77
RADSBH06	0	0.50	42	1.16	0.72
RADSBI02	0	0.50	39	1.49	1.56
RADSBI04	0	0.50	154	1.35	1.97
RADSBJ08	0	0.50	9	0.025	0.14
RADSBJ02	0	0.50	13	1.77	5.78
RADSBJ07	0	0.50	49	1.78	1.16
RADSBK08	0	0.50	21	0.045	0.36
RADSBM08	0	0.50	134	0.065	0.76
Froid and Taylor Roads Site					
FTSSB001	0	0.30	93	NA	0.52
FTSSB002	0	0.50	67	NA	1.13
FTSSB003	0	0.25	51	NA	0.64
FTSSB004	0	0.50	43	0.51	0.69
FTSSB005	0	0.50	18	0.045	0.57
FTSSB006	0	0.50	17	0.11	0.14
FTSSB007	0	0.25	9	0.19	0.57

TABLE 8-1 (Continued)

MICROTOX AND CYTOCHROME P450 SOIL BIOASSAY RESULTS
TIDAL AREA QEA, NWS SBD CONCORD

Sample Location	Top Depth (feet bgs)	Bottom Depth (feet bgs)	P450 (Fold Induction)[a]	Microtox Organic Extract (Percent)[b]	Microtox Solid Phase (Percent)[b]
Froid and Taylor Roads Site (Continued)					
FTSSB008	0	0.5	29	0.049	0.014
FTSSB009	0	0.12	44	0.31	0.59
Wood Hogger Site					
WHSSBA04	0	0.50	60	0.09	0.01
WHSSBA06	0	0.50	37	NA	1.34
WHSSBB03	0	0.50	51	0.22	0.48
WHSSBB07	0	0.50	10	1.5	0.33
WHSSBC02	0	0.50	26	1.16	0.22
WHSSBC08	0	0.50	103	0.05	0.19
WHSSBD03	0	0.50	77	0.25	0.37
WHSSBE02	0	0.50	50	2.00	0.95
WHSSBE06	0	0.50	119	2.00	1.04
WHSSBE08	0	0.50	169.24	NA	3.47
WHSSBE08A	0	0.50	17	0.09	0.025
WHSSBF03	0	0.50	135	NA	1.01
WHSSBG06	0	0.50	24.1	NA	0.27
WHSSBG06A	0	0.50	150	NA	1.09
WHSSBH07	0	0.50	67	1.84	0.42
WHSSBI02	0	0.50	92	0.02	0.15
WHSSBK06	0	0.50	136	NA	0.88
WHSSBK08	0	0.50	28	1.67	0.69
WHSSBL05	0	0.50	78	0.05	0.08
WHSSBM08	0	0.50	13	0.046	0.34

Notes:

bgs Below ground surface

NA Not analyzed

a Fold induction is a measure of biochemical response. A higher number indicates greater enzyme activity; numbers have been normalized and are expressed as equivalents of benzo(a)pyrene.

b Percent of site soil that was associated with a 50 percent reduction in light output in the Microtox text.

TABLE 8-2

AMPHIPOD (*Eohaustorius estuarius*) SEDIMENT BIOASSAY RESULTS, SURVIVAL AND REBURIAL TIDAL AREA QEA, NWS SBD CONCORD

Unit	Sample ID	Mean Survival (%)	Mean Reburial (%)
North Otter Sluice	OSLSL001	95[a]	94[a]
	OSLSL002	92[a]	92[a]
	OSLSL003	97	96[a]
	OSLSL004	97[a]	97[a]
South Otter Sluice	OSLSL005	97	96
	OSLSL006	97	97
	OSLSL007	96[a]	96[a]
Laboratory	Control Sediment	100	100

Note:

a Significantly different ($p < 0.05$) as compared to laboratory control sediment.

TABLE 8-3

HATCHABILITY OF TOPSMELT EMBRYOS IN THE
SEDIMENT-WATER INTERFACE BIOASSAY
TIDAL AREA QEA, NWS SBD CONCORD

Sample Station	Percent Hatchability (Day 12)				
Otter Sluice Station	Rep A	Rep B	Rep C	Rep D	Mean
OSLSL001	0	40	10	30	20[a]
OSLSL002	0	30	0	60	22.5[a]
OSLSL003	10	0	0	0	2.5[a]
OSLSL004	40	40	50	40	42.5[a]
OSLSL005	60	80	70	90	75
OSLSL006	70	90	60	80	75
OSLSL007	50	70	30	40	47.5[a]
Control 1 (with pH adjust)[b]	*80*	*80*	*90*	*70*	*80*
Control 2	*80*	*90*	*80*	*90*	*85*

Notes:

a Significantly different than control

b Control 1 not significantly different ($p > 0.05$) than Control 2

TABLE 8-4

CORRELATIONS BETWEEN TOPSMELT HATCHABILITY AND TEST CONDITIONS[a]
TIDAL AREA QEA, NWS SBD CONCORD

		% Sediment Fines[b]	Maximum Salinity	Minimum Salinity	Maximum Ammonia	Minimum Ammonia	Maximum Dissolved Oxygen	Minimum Dissolved Oxygen
Pearson Correlations								
Mean Hatchability	Correlation	-.596**	-.488**	-.468**	.073	.306*	.269	0.18
	Sample size	(28)	(48)	(48)	(48)	(48)	(48)	(48)
	Probability	.001	< .001	.001	.621	.034	.064	.904
Normalized Mean Hatchability	Correlation	-.228	-.092	-.124	-.017	.063	-.078	.193
	Sample size	(28)	(48)	(48)	(48)	(48)	(48)	(48)
	Probability	.242	.533	.399	.910	.688	.600	.189
Spearman Rank Correlations								
Mean Hatchability	Correlation	-.732**	-.527**	-.452**	.136	.367*	.273	.292*
	Sample size	(28)	(48)	(48)	(48)	(48)	(48)	(48)
	Probability	< .001	< .001	.001	.357	.010	.061	.044
Normalized Mean Hatchability	Correlation	-.289	-.218	-.221	.014	.106	-.042	.243
	Sample size	(28)	(48)	(48)	(48)	(48)	(48)	(48)
	Probability	.136	.137	.131	.923	.475	.779	.097

Notes:

a Data compiled from NWS SBD Concord Tidal Area, NWS SBD Concord Litigation Area, Point Molate Naval Facility, and Alameda.

b Percent composition of clay in test sediments. Alameda data not available.

c Percent hatchability normalized by site.

** Correlation is significant at the 0.01 level (2-tailed).

* Correlation is significant at the 0.05 level (2-tailed).

TABLE 8-5A

CONCENTRATIONS OF CHEMICALS IN PICKLEWEED TISSUE: R AREA
TIDAL AREA QEA, NWS SBD CONCORD

Analyte	Location		
	RADSB007	RADSB017	RADSBI06
Inorganic Chemicals (mg/kg)			
Aluminum	14.3	ND	ND
Barium	ND	1.3	ND
Cadmium	ND	0.02	ND
Chromium	0.06	ND	ND
Cobalt	0.11	ND	0.13
Copper	1.0	0.8	0.36
Iron	86.6	5.8	36.3
Manganese	14.4	2.0	12.4
Nickel	ND	0.17	ND
Vanadium	0.39	0.25	0.38
Zinc	2.9	3.6	1.6

Notes:

mg/kg Milligrams per kilogram
ND Nondetected

TABLE 8-5B

CONCENTRATIONS OF CHEMICALS IN RODENT TISSUE: R AREA
TIDAL AREA QEA, NWS SBD CONCORD

Analyte	Location		
	RADC001	RADC002	RADC003
Inorganic Chemicals (mg/kg)			
Aluminum	17.7	46.2	17.7
Barium	2.4	3.8	1.9
Copper	2.2	2.2	2.6
Iron	114	71.7	108
Lead	0.39	1.2	0.25
Manganese	1.6	2.2	2.1
Molybdenum	0.21	0.16	0.21
Nickel	0.10	0.15	0.87
Selenium	0.37	0.49	0.60
Vanadium	0.22	0.24	0.18
Zinc	34.5	41.9	35.6
PCBs (μg/kg)[a]			
PCB-4 (2,4')	ND	ND	1.0
PCB-114 (2,3,4,4',5)	1.0	0.8	ND
PCB-128 (2,2',3,3',4,4')	0.5	ND	ND
PCB-138 (2,2',3,4,4',5')	5.0	ND	ND
PCB-156 (2,3,3',4,4',5)	0.6	ND	ND
PCB-170 (2,2',3,3',4,4',5)	10	ND	ND
PCB-180 (2,2',3,4,4',5,5')	7.0	ND	ND
PCB-187 (2,2',3,4',5,5',6)	4.0	ND	ND
PCB-195 (2,2',3,3',4,4',5,6)	1.0	ND	ND
PCB-206 (2,2',3,3',4,4',5,5',6	1.0	ND	ND
Total PCBs	37.7	22.3	11.6
Pesticides (μg/kg)[a]			
4,4'-DDT	0.9	ND	ND
Total DDTs	4.9	8.75	4.15
alpha-BHC	ND	1.0	0.8

TABLE 8-5B (Continued)

CONCENTRATIONS OF CHEMICALS IN RODENT TISSUE: R AREA
TIDAL AREA QEA, NWS SBD CONCORD

Analyte	Location		
	RADC001	RADC002	RADC003
Pesticides (μg/kg)[a] (Continued)			
Methoxychlor	ND	16	2.0

Notes:

BHC Hexachlorocyclohexane
DDT Dichlorodiphenyltrichloroethane
mg/kg Milligrams per kilogram
ND Nondetected
PCB Polychlorinated biphenyl
μg/kg Micrograms per kilogram

a Where total values were calculated (for example, total PCBs, total DDTs, etc.) 1/2 of the standard quantitation limit (SQL) was used for nondetected analytes.

TABLE 8-6A

CONCENTRATIONS OF CHEMICALS IN AMPHIPOD TISSUE:
FROID AND TAYLOR ROADS SITE, LOCATION FTSTI105
TIDAL AREA QEA, NWS SBD CONCORD

Analyte	Concentration
Inorganic Chemicals (mg/kg)	
Aluminum	495
Arsenic	0.77
Barium	35.8
Chromium	1.2
Cobalt	0.66
Copper	5.1
Iron	750
Lead	1.9
Manganese	72
Mercury	0.03
Nickel	1.3
Selenium	0.28
Thallium	0.33
Vanadium	4.1
Zinc	11
PCBs (μg/kg)[a]	
PCB-180 (2,2',3,4,4',5,5')	1.0
PCB-187 (2,2',3,4',5,5',6)	0.5
PCB-195 (2,2',3,3',4,4',5,6)	0.3
Total PCBs	11.95
Pesticides (μg/kg)[a]	
2,4'-DDD	3.0
4,4'-DDD	4.0
Total DDTs	10.2
gamma-BHC (lindane)	0.50
gamma-Chlordane	0.20

TABLE 8-6A (Continued)

CONCENTRATIONS OF CHEMICALS IN AMPHIPOD TISSUE: FROID AND TAYLOR ROADS SITE, LOCATION FTSTI105 TIDAL AREA QEA, NWS SBD CONCORD

Analyte	Concentration
Pesticides (μg/kg)[a] (Continued)	
Dieldrin	0.30
trans-Nonachlor	0.70

Notes:

BHC Hexachlorocyclohexane
DDD Dichlorodiphenyldichloroethane
DDT Dichlorodiphenyltrichloroethane
mg/kg Milligrams per kilogram
PCB Polychlorinated biphenyl
μg/kg Micrograms per kilogram

a Where total values were calculated (for example, total PCBs, total DDTs, etc.) 1/2 of the standard quantitation limit (SQL) was used for nondetected analytes.

TABLE 8-6B

**CONCENTRATIONS OF CHEMICALS IN FISH TISSUE:
FROID AND TAYLOR ROADS SITE, LOCATION FTSTI103
TIDAL AREA QEA, NWS SBD CONCORD**

Analyte	Concentration
Inorganic Chemicals (mg/kg)	
Aluminum	74.6
Barium	4.3
Chromium	0.29
Copper	1.5
Iron	106
Lead	0.22
Manganese	13.9
Mercury	0.09
Nickel	0.19
Selenium	0.45
Vanadium	0.58
Zinc	21.2
PCBs (μg/kg)[a]	
PCB-138 (2,2',3,4,4',5')	2.0
PCB-153 (2,2',4,4',5,5')	2.0
PCB-156 (2,3,3',4,4',5)	0.4
PCB-180 (2,2',3,4,4',5,5')	1.0
PCB-187 (2,2',3,4',5,5',6)	0.80
PCB-206 (2,2',3,3',4,4',5,5'	2.0
Total PCBs	15.2
Pesticides (μg/kg)[a]	
2,4'-DDD	4.0
4,4'-DDD	15
4,4'-DDE	6.0
Total DDTs	25.7
Dieldrin	2.0

TABLE 8-6B (Continued)

CONCENTRATIONS OF CHEMICALS IN FISH TISSUE: FROID AND TAYLOR ROADS SITE, LOCATION FTSTI103 TIDAL AREA QEA, NWS SBD CONCORD

Analyte	Concentration
Pesticides (μg/kg)[a] (Continued)	
Hexachlorobenzene	0.70
Methoxychlor	1.0

Notes:

DDD Dichlorodiphenyldichloroethane
DDE Dichlorodiphenyldichloroethene
DDT Dichlorodiphenyltrichloroethane
mg/kg Milligrams per kilogram
PCB Polychlorinated biphenyl
μg/kg Micrograms per kilogram

a Where total values were calculated (for example, total PCBs, total DDTs, etc.) 1/2 of the standard quantitation limit (SQL) was used for nondetected analytes.

TABLE 8-7A

CONCENTRATIONS OF CHEMICALS IN PICKLEWEED TISSUE:
WOOD HOGGER SITE, LOCATION WHSB021
TIDAL AREA QEA, NWS SBD CONCORD

Analyte	Concentration
Inorganic Chemicals (mg/kg)	
Aluminum	5.6
Barium	0.62
Copper	0.54
Iron	25.2
Lead	0.14
Manganese	4.5
Vanadium	0.32
Zinc	8.0

Note:

mg/kg Milligrams per kilogram

TABLE 8-7B

CONCENTRATIONS OF CHEMICALS IN RODENT TISSUE: WOOD HOGGER SITE
TIDAL AREA QEA, NWS SBD CONCORD

Analyte	Location		
	WHSC001	WHSC002	WHSC003
Inorganic Chemicals (mg/kg)			
Aluminum	21	25.7	ND
Barium	0.88	2.3	3.2
Copper	2.0	2.4	2.3
Iron	64.3	73.1	64.8
Lead	0.45	0.66	0.55
Manganese	1.5	1.5	1.6
Molybdenum	0.17	0.17	0.17
Nickel	0.15	0.10	0.16
Selenium	0.36	0.51	0.44
Vanadium	ND	0.23	ND
Zinc	36.3	48.4	27.2
PCBs (μg/kg)[a]			
PCB-8 (2,4')	ND	2.0	3.9
PCB-114 (2,3,4,4',5)	ND	ND	0.7
PCB-156 (2,3,3',4,4',5)	ND	ND	0.2
PCB-170 (2,2',3,3',4,4',5)	ND	1.0	0.7
PCB-180 (2,2',3,4,4',5,5')	ND	ND	0.8
Total PCBs	11.05	13.3	13.8
Pesticides (μg/kg)[a]			
Total DDTs	4.2	4.2	3.5
Aldrin	ND	0.2	0.3
alpha-BHC	0.7	0.6	ND
Endosulfan I	ND	0.3	ND
Endrin	0.8	1.0	ND
Methoxychlor	4.0	ND	ND
Mirex	ND	ND	0.4

TABLE 8-7B (Continued)

CONCENTRATIONS OF CHEMICALS IN RODENT TISSUE: WOOD HOGGER SITE
TIDAL AREA QEA, NWS SBD CONCORD

Analyte	Location		
	WHSC001	WHSC002	WHSC003
Dioxins (μg/kg)			
1,2,3,4,6,7,8,9-OCDD	0.088	0.09	NA
1,2,3,4,6,7,8,9-OCDF	0.004	0.003	NA
1,2,3,4,6,7,8-HPCDD	0.042	0.035	NA
1,2,3,4,6,7,8-HPCDF	0.012	0.008	NA
1,2,3,4,7,8,9-HPCDF	0.001	0.0008	NA
1,2,3,4,7,8-HXCDD	0.0008	0.0007	NA
1,2,3,4,7,8-HXCDF	0.002	0.002	NA
1,2,3,6,7,8-HXCDD	0.003	0.003	NA
1,2,3,6,7,8-HXCDF	0.002	0.001	NA
1,2,3,7,8,9-HXCDD	0.0009	0.001	NA
1,2,3,7,8-PECDD	0.0006	0.0008	NA
2,3,4,6,7,8-HXCDF	0.002	0.001	NA
2,3,4,7,8-PECDF	0.001	0.001	NA
Total HPCDD	0.044	0.044	NA
Total HPCDF	0.015	0.011	NA
Total HXCDD	0.005	0.008	NA
Total HXCDF	0.007	0.005	NA
Total PECDD	0.0006	0.0008	NA
Total PECDF	0.001	0.001	NA

Notes:

BHC	Hexachlorocyclohexane	mg/kg	Milligrams per kilogram
DDD	Dichlorodiphenyldichloroethane	NA	Not analyzed
DDT	Dichlorodiphenyltrichloroethane	ND	Nondetected
HPCDD	Heptachlorodibenzodioxin	PCB	Polychlorinated biphenyl
HPCDF	Heptachlorodibenzofuran	PECDD	Polychlorinated dibenzo-p-dioxin
HXCDD	Hexachlorodibenzodioxin	PECDF	Polychlorinatedibenzofuran
HXCDF	Hexachlorodibenzofuran	μg/kg	Micrograms per kilogram

a Where total values were calculated (for example, total PCBs, total DDTs, etc.) 1/2 of the standard quantitation limit (SQL) was used for nondetected analytes.

TABLE 8-8A

CONCENTRATIONS OF CHEMICALS IN CLAM TISSUE:
NORTH OTTER SLUICE, LOCATION OSLSL002
TIDAL AREA QEA, NWS SBD CONCORD

Analyte	Concentration
Inorganic Chemicals (mg/kg)	
Aluminum	138
Arsenic	0.61
Barium	2.1
Cadmium	0.10
Chromium	0.50
Cobalt	0.16
Copper	5.0
Iron	270
Lead	0.66
Manganese	5.1
Mercury	0.04
Molybdenum	0.12
Nickel	0.48
Selenium	0.58
Vanadium	0.49
Zinc	16.4
PCBs (μg/kg)[a]	
PCB-118 (2,3',4,4',5)	1.0
PCB-138 (2,2',3,4,4',5')	2.0
PCB-153 (2,2',4,4',5,5')	3.0
PCB-180 (2,2',3,4,4',5,5')	0.50
PCB-187 (2,2',3,4',5,5',6)	0.50
Total PCBs	13.25
Pesticides (μg/kg)[a]	
2,4'-DDD	0.70
4,4'-DDD	2.0
4,4'-DDE	5.0
Total DDTs	8.4

TABLE 8-8A (Continued)

CONCENTRATIONS OF CHEMICALS IN CLAM TISSUE:
NORTH OTTER SLUICE, LOCATION OSLSL002
TIDAL AREA QEA, NWS SBD CONCORD

Analyte	Concentration
Pesticides (μg/kg)[a] (Continued)	
alpha-Chlordane	1.0
gamma-Chlordane	0.30
Methoxychlor	2.0
trans-Nonachlor	0.80

Notes:

DDD Dichlorodiphenyldichloroethane
DDE Dichlorodiphenyldichloroethene
DDT Dichlorodiphenyltrichloroethane
mg/kg Milligrams per kilogram
PCB Polychlorinated biphenyl
μg/kg Micrograms per kilogram

a Where total values were calculated (for example, total PCBs, total DDTs, etc.) 1/2 of the standard quantitation limit (SQL) was used for nondetected analytes.

TABLE 8-8B

CONCENTRATIONS OF CHEMICALS IN FISH TISSUE: NORTH OTTER SLUICE, LOCATION OSLSL002 TIDAL AREA QEA, NWS SBD CONCORD

Analyte	Concentration
Inorganic Chemicals (mg/kg)	
Aluminum	20.3
Barium	2.0
Chromium	0.17
Copper	1.2
Iron	43.3
Manganese	3.5
Mercury	0.07
Selenium	0.49
Vanadium	0.30
Zinc	20.4
PCBs (μg/kg)[a]	
PCB-138 (2,2',3,4,4',5')	3.0
PCB-180 (2,2',3,4,4',5,5')	1.0
PCB-187 (2,2',3,4',5,5',6)	1.0
Total PCBs	22.55
Pesticides (μg/kg)[a]	
4,4'-DDD	3.0
4,4'-DDE	13
Total DDTs	18.25
Methoxychlor	2.0
trans-Nonachlor	4.0

Notes:

DDD	Dichlorodiphenyldichloroethane	mg/kg	Milligrams per kilogram
DDE	Dichlorodiphenyldichloroethene	PCB	Polychlorinated biphenyl
DDT	Dichlorodiphenyltrichloroethane	μg/kg	Micrograms per kilogram

a Where total values were calculated (for example, total PCBs, total DDTs, etc.) 1/2 of the standard quantitation limit (SQL) was used for nondetected analytes.

TABLE 8-9A

CONCENTRATIONS OF CHEMICALS IN CLAM TISSUE: SOUTH OTTER SLUICE TIDAL AREA QEA, NWS SBD CONCORD

Analyte	Location			
	OSLSL004	OSLSL005	OSLSL006	OSLSL007
Inorganic Chemicals (mg/kg)				
Aluminum	147	43.4	109	73.4
Arsenic	0.62	0.45	0.52	0.32
Barium	2.2	1.6	1.8	2.0
Cadmium	0.11	0.09	0.08	0.09
Chromium	0.51	0.19	0.38	0.29
Cobalt	0.18	0.14	0.15	0.13
Copper	5.0	4.0	4.4	4.4
Iron	275	150	239	176
Lead	0.20	ND	0.21	0.23
Manganese	4.3	2.5	4.3	5.6
Mercury	0.03	0.03	0.03	0.04
Molybdenum	0.17	0.15	ND	0.14
Nickel	0.55	0.36	0.42	0.33
Selenium	0.49	0.43	0.51	0.49
Vanadium	0.46	0.29	0.39	0.27
Zinc	15.8	17.7	14.3	15.9
PCBs (μg/kg)[a]				
PCB-28 (2,4,4')	0.30	ND	ND	ND
PCB-138 (2,2',3,4,4',5')	2.0	ND	ND	ND
PCB-153 (2,2',4,4',5,5')	30	2.0	2.0	ND
PCB-180 (2,2',3,4,4',5,5')	0.50	0.40	ND	0.50
PCB-187 (2,2',3,4',5,5',6)	0.50	ND	ND	ND
Total PCBs	13.45	11.65	11.55	11.25
Pesticides (μg/kg)[a]				
2,4'-DDD	0.70	ND	ND	0.60
4,4'-DDD	1.0	ND	ND	ND
4,4'-DDE	5.0	3.0	ND	ND
4,4'-DDT	0.60	ND	ND	ND
Total DDTs	7.8	4.7	4.2	4.3

TABLE 8-9A (Continued)

CONCENTRATIONS OF CHEMICALS IN CLAM TISSUE: SOUTH OTTER SLUICE TIDAL AREA QEA, NWS SBD CONCORD

Analyte	Location			
	OSLSL004	OSLSL005	OSLSL006	OSLSL007
Pesticides (μg/kg)[a] (Continued)				
gamma-BHC (lindane)	0.60	ND	ND	ND
alpha-Chlordane	1.0	0.70	ND	ND
Dieldrin	0.80	ND	ND	ND
Methoxychlor	1.0	ND	3.0	2.0
trans-Nonachlor	ND	0.60	ND	ND
Dioxins (μg/kg)				
1,2,3,4,6,7,8,9-OCDD	NA	NA	0.019	0.014
1,2,3,4,6,7,8,9-OCDF	NA	NA	0.002	0.001
1,2,3,4,6,7,8-HPCDD	NA	NA	0.003	0.003
1,2,3,4,6,7,8-HPCDF	NA	NA	0.001	0.0006
2,3,7,8-TCDF	NA	NA	ND	0.0003
Total HPCDD	NA	NA	0.006	0.005
Total HPCDF	NA	NA	0.004	0.002
Total HXCDD	NA	NA	ND	0.002
Total HXCDF	NA	NA	0.002	0.002
Total PECDF	NA	NA	ND	0.001
Total TCDD	NA	NA	ND	0.0001
Total TCDF	NA	NA	ND	0.003

Notes:

BHC Hexachlorocyclohexane
DDD Dichlorodiphenyldichloroethane
DDE Dichlorodiphenyldichloroethene
DDT Dichlorodiphenyltrichloroethane
HPCDD Heptachlorodibenzodioxin
HPCDF Heptachlorodibenzofuran
HXCDD Hexachlorodibenzodioxin
HXCDF Hexachlorodibenzofuran

mg/kg Milligrams per kilogram
NA Not analyzed
ND Nondetected
PCB Polychlorinated biphenyl
PECDD Polychlorinated dibenzo-p-dioxin
TCDD Tetrachlorodibenzo-p-dioxin
TCDF Tetrachlorodibenzofuran
μg/kg Micrograms per kilogram

a Where total values were calculated (for example, total PCBs, total DDTs, etc.) 1/2 of the standard quantitation limit (SQL) was used for nondetected analytes.

TABLE 8-9B

CONCENTRATIONS OF CHEMICALS IN FISH TISSUE: SOUTH OTTER SLUICE TIDAL AREA QEA, NWS SBD CONCORD

Analyte	Location			
	OSLSL004	OSLSL005	OSLSL006	OSLSL007
Inorganic Chemicals (mg/kg)				
Aluminum	20.8	14.2	53.8	26.6
Antimony	ND	0.25	ND	ND
Barium	2.3	2.3	4.0	3.4
Chromium	0.14	0.17	0.26	0.21
Copper	0.77	2.2	1.1	1.9
Iron	36.7	38.2	82.6	57.8
Manganese	1.7	5.9	7.1	14.2
Mercury	0.04	0.10	0.04	0.03
Selenium	0.52	0.46	0.35	0.37
Vanadium	0.20	ND	0.29	0.19
Zinc	12.1	25.6	24.6	26.4
PCBs (μg/kg)[a]				
PCB-44 (2,2',3,5')	0.40	ND	ND	ND
PCB-105 (2,3,3',4,4')	0.80	ND	ND	ND
PCB-138 (2,2',3,4,4',5')	3.0	ND	ND	ND
PCB-153 (2,2',4,4',5,5')	3.0	2.0	ND	ND
PCB-180 (2,2',3,4,4',5,5')	1.0	0.30	ND	0.60
PCB-187 (2,2',3,4',5,5',6)	0.90	ND	ND	0.70
Total PCBs	15.7	11.55	55.5	11.55
Pesticides (μg/kg)[a]				
2,4'-DDD	ND	ND	0.60	ND
4,4'-DDD	ND	2.0	2.0	ND
4,4'-DDE	8.0	7.0	6.0	6.0
Total DDTs	9.7	10.2	9.6	7.7
alpha-BHC	ND	36	ND	ND
beta-BHC	ND	3.0	ND	ND
delta-BHC	ND	0.9	ND	ND
gamma-BHC (lindane)	ND	2.0	ND	ND
Dieldrin	2.0	1.0	1.0	1.0

TABLE 8-9B (Continued)

CONCENTRATIONS OF CHEMICALS IN FISH TISSUE: SOUTH OTTER SLUICE TIDAL AREA QEA, NWS SBD CONCORD

Analyte	Location			
	OSLSL004	OSLSL005	OSLSL006	OSLSL007
Pesticides (μg/kg)[a] (Continued)				
Endrin aldehyde	0.30	ND	ND	0.40
Hexachlorobenzene	ND	ND	ND	0.70
Methoxychlor	2.0	1.0	1.0	ND
trans-Nonachlor	3.0	2.0	2.0	2.0
Oxychlordane	ND	ND	0.4	ND
Dioxins (μg/kg)				
1,2,3,4,6,7,8,9-OCDD	NA	NA	0.003	0.006
1,2,3,4,6,7,8,9-OCDF	NA	NA	ND	0.0005
1,2,3,4,6,7,8-HPCDD	NA	NA	0.0007	0.002
1,2,3,4,6,7,8-HPCDF	NA	NA	ND	0.0002
1,2,3,4,7,8-HXCDF	NA	NA	ND	0.0001
1,2,3,6,7,8-HXCDD	NA	NA	ND	0.0003
1,2,3,7,8-PECDD	NA	NA	ND	0.0003
1,2,3,7,8-PECDF	NA	NA	ND	0.0001
2,3,4,7,8-PECDF	NA	NA	ND	0.0002
2,3,7,8-TCDD	NA	NA	0.0001	0.0001
2,3,7,8-TCDF	NA	NA	0.0002	0.0003
Total HPCDD	NA	NA	0.001	0.002
Total HPCDF	NA	NA	ND	0.0007
Total HXCDD	NA	NA	ND	0.0003
Total HXCDF	NA	NA	ND	0.0005
Total PECDD	NA	NA	ND	0.0003
Total PECDF	NA	NA	ND	0.0005
Total TCDD	NA	NA	0.0001	0.0001
Total TCDF	NA	NA	0.0002	0.0003

Notes:

BHC Hexachlorocyclohexane
DDD Dichlorodiphenyldichloroethane
DDE Dichlorodiphenyldichloroethene
DDT Dichlorodiphenyltrichloroethane

TABLE 8-9B (Continued)

CONCENTRATIONS OF CHEMICALS IN FISH TISSUE: SOUTH OTTER SLUICE TIDAL AREA QEA, NWS SBD CONCORD

Notes (Continued):

HPCDD	Heptachlorodibenzodioxin
HPCDF	Heptachlorodibenzofuran
HXCDD	Hexachlorodibenzodioxin
HXCDF	Hexachlorodibenzofuran
mg/kg	Milligrams per kilogram
NA	Not analyzed
ND	Nondetected
PCB	Polychlorinated biphenyl
PECDD	Polychlorinated dibenzo-p-dioxin
TCDD	Tetrachlorodibenzo-p-dioxin
TCDF	Tetrachlorodibenzofuran
μg/kg	Micrograms per kilogram
a	Where total values were calculated (for example, total PCBs, total DDTs, etc.) 1/2 of the standard quantitation limit (SQL) was used for nondetected analytes.

TABLE 8-10

SUMMARY RESULTS: MICROTOX* AND CYTOCHROME P450†
TIDAL AREA QEA, NWS SBD CONCORD

SUMMARY RESULTS: MICROTOX ORGANIC PHASE (PERCENT)

Site	N[a]	Min.	Max.	Mean	S.D.[b]	1st Q[c]	2nd Q	3rd Q	4th Q
R Area Disposal	20	0.03	1.91	1.10	0.65	0-0.41	0.42-1.34	1.35-1.62	1.63-1.91
Froid and Taylor Roads	9	0.05	2.00	0.80	0.91	0-0.11	0.12-0.31	0.32-2.00	---
Wood Hogger	21	0.01	2.00	1.06	0.85	0-0.17	0.18-1.04	1.05-2.00	---

SUMMARY RESULTS: MICROTOX SOLID PHASE (PERCENT)

Site	N[a]	Min.	Max.	Mean	S.D.[b]	1st Q[c]	2nd Q	3rd Q	4th Q
R Area Disposal	20	0.11	5.78	1.10	1.31	0-0.35	0.36-0.74	0.75-1.24	1.25-5.78
Froid and Taylor Roads	9	0.01	1.13	0.51	0.32	0-0.52	0.53-0.57	0.58-0.61	0.62-1.13
Wood Hogger	21	0.02	3.47	0.83	0.88	0-0.16	0.17-0.42	0.43-1.34	1.35-3.47

TABLE 8-10 (Continued)

SUMMARY RESULTS: MICROTOX® AND CYTOCHROME P450†
TIDAL AREA QEA, NWS SBD CONCORD

SUMMARY RESULTS: CYTOCHROME P450 (RLU)

Site	N[a]	Min.	Max.	Mean	S.D.[b]	1st Q[c]	2nd Q	3rd Q	4th Q
R Area Disposal	20	9	154	41	41	0-16	17-24	25-47	48-154
Froid and Taylor Roads	9	9	93	39	29	0-17	18-43	44-51	52-93
Wood Hogger[e]	21	10	169	71	48	0-27	28-60	61-111	112-169
All Sites	50[d]	9	169	54	44	0-18	18-41	41-77	77-169

Notes:

1 Sample size

2 Standard deviation

3 Q = Quartile

4 49 samples were collected from the Tidal Area sites; one duplicate sample result from the Wood Hogger Site is included in the calculations in this table.

5 Samples from the Wood Hogger Site were statistically greater than the other two sites.

TABLE 8-11

SUMMARY MATRICES OF PEARSON CORRELATIONS AMONG SELECTED VARIABLES
TIDAL AREA QEA, NWS SBD CONCORD

		Microtox Organic Phase	Microtox Solid Phase	Percent Solids	Total PCBs	Total DDTs	Total PAHs	TOC
R Area Disposal Site								
Cytochrome P450	Correlation	0.2289	0.0411	-0.3528	-0.0419	0.0380	0.3565	-0.0298
	Sample size	(20)	(20)	(20)	(20)	(20)	(20)	(20)
	Probability	0.3318	0.8635	0.1272	0.8608	0.8735	0.1229	0.0990
Microtox organic phase	Correlation		0.4575	0.7679	-0.0375	0.3182	-0.3825	-0.1342
	Sample size		(20)	(20)	(20)	(20)	(20)	(20)
	Probability		0.0425	7E-005	0.8753	0.1715	0.0960	0.5727
Microtox solid phase	Correlation			0.3190	-0.2865	0.3732	-0.1115	-0.2311
	Sample size			(20)	(20)	(20)	(20)	(20)
	Probability			0.1703	0.2208	0.1050	0.6397	0.3269
Percent solid	Correlation				-0.2129	0.1092	-0.5426	-0.4160
	Sample size				(20)	(20)	(20)	(20)
	Probability				0.3674	0.6467	0.0134	0.0681
Total PCBs	Correlation					0.2649	0.2905	0.3531
	Sample size					(20)	(20)	(20)
	Probability					0.2590	0.2140	0.1267

TABLE 8-11 (Continued)

SUMMARY MATRICES OF PEARSON CORRELATIONS AMONG SELECTED VARIABLES
TIDAL AREA QEA, NWS SBD CONCORD

		Microtox Organic Phase	Microtox Solid Phase	Percent Solids	Total PCBs	Total DDTs	Total PAHs	TOC
R Area Disposal Site (Continued)								
Total DDTs	Correlation						0.0402	0.1619
	Sample size						(20)	(20)
	Probability						0.8665	0.4953
Total PAHs	Correlation							0.6803
	Sample size							(20)
	Probability							0.0010
Froid And Taylor Roads Site								
Cytochrome P450	Correlation	0.8651	0.5500	0.5576	-0.0113	0.6349	-0.3687	-0.2207
	Sample size	(9)	(9)	(9)	(9)	(9)	(9)	(9)
	Probability	0.0026	0.1250	0.1188	0.9769	0.0662	0.3289	0.5683
Microtox organic phase	Correlation		0.5853	0.5924	0.0369	0.6450	-0.4755	-0.0549
	Sample size		(9)	(9)	(9)	(9)	(9)	(9)
	Probability		0.0978	0.0928	0.9249	0.0607	0.1958	0.8885
Microtox solid phase	Correlation			0.5388	-0.1259	-0.1197	-0.1390	-0.3158
	Sample size			(9)	(9)	(9)	(9)	(9)
	Probability			0.1344	0.7469	0.7591	0.7214	0.4077

TABLE 8-11 (Continued)

SUMMARY MATRICES OF PEARSON CORRELATIONS AMONG SELECTED VARIABLES
TIDAL AREA QEA, NWS SBD CONCORD

		Microtox Organic Phase	Microtox Solid Phase	Percent Solids	Total PCBs	Total DDTs	Total PAHs	TOC
Froid And Taylor Roads Site (Continued)								
Percent solid	Correlation				-0.4609	0.2918	-0.6489	-0.5412
	Sample size				(9)	(9)	(9)	(9)
	Probability				0.2119	0.4461	0.0586	0.1324
Total PCBs	Correlation					-0.0453	-0.0968	0.8734
	Sample size					(9)	(9)	(9)
	Probability					0.9079	0.8044	0.0021
Total DDTs	Correlation						-0.1922	-0.1032
	Sample size						(9)	(9)
	Probability						0.6202	0.7917
Total PAHs	Correlation							-0.1374
	Sample size							(9)
	Probability							0.7245
Wood Hogger Site								
Cytochrome P450	Correlation	0.3507	0.4282	0.2048	0.0610	0.1167	0.1818	-0.1056
	Sample size	(21)	(21)	(21)	(21)	(21)	(21)	(21)
	Probability	0.1191	0.0528	0.3732	0.7929	0.6145	0.4304	0.6487

TABLE 8-11 (Continued)

SUMMARY MATRICES OF PEARSON CORRELATIONS AMONG SELECTED VARIABLES
TIDAL AREA QEA, NWS SBD CONCORD

		Microtox Organic Phase	Microtox Solid Phase	Percent Solids	Total PCBs	Total DDTs	Total PAHs	TOC
Wood Hogger Site (Continued)								
Microtox organic phase	Correlation		0.4843	0.6590	-0.3037	-0.2478	-0.2159	-0.2271
	Sample size		(21)	(21)	(21)	(21)	(21)	(21)
	Probability		0.0261	0.0012	0.1807	0.2788	0.3473	0.3222
Microtox solid phase	Correlation			0.3406	-0.1583	-0.0717	0.3903	-0.1203
	Sample size			(21)	(21)	(21)	(21)	(21)
	Probability			0.1308	0.4932	0.7574	0.0802	0.6035
Percent solids	Correlation				-0.1384	-0.4260	-0.0207	-0.6286
	Sample size				(21)	(21)	(21)	(21)
	Probability				0.5496	0.0541	0.9290	0.0023
Total PCBs	Correlation					0.3096	-0.0865	0.2947
	Sample size					(21)	(21)	(21)
	Probability					0.1720	0.7092	0.1946
Total DDTs	Correlation						0.0210	0.3944
	Sample size						(21)	(21)
	Probability						0.9178	0.0769

TABLE 8-11 (Continued)

SUMMARY MATRICES OF PEARSON CORRELATIONS AMONG SELECTED VARIABLES
TIDAL AREA QEA, NWS SBD CONCORD

		Microtox Organic Phase	Microtox Solid Phase	Percent Solids	Total PCBs	Total DDTs	Total PAHs	TOC
Wood Hogger Site (Continued)								
Total PAHs	Correlation							0.0522
	Sample size							(21)
	Probability							0.8222

Notes:

DDT Dichlorodiphenyltrichloroethane
PAH Polynuclear aromatic hydrocarbon
PCB Polychlorinated biphenyl
TOC Total organic carbon

TABLE 8-12

SUMMARY MATRICES OF SPEARMAN RANK CORRELATIONS AMONG SELECTED VARIABLES
TIDAL AREA QEA, NWS SBD CONCORD

		Cytochrome P450	Microtox Organic Phase	Microtox Solid Phase	Percent Solids	Total PCBs	Total DDTs	Total PAHs	TOC
R Area Disposal Site									
Cytochrome P450	Correlation		-0.0188	0.3724	-0.2540	-0.0173	0.1583	0.1963	0.1409
	Sample size		(9)	(9)	(9)	(9)	(9)	(9)	(9)
	Probability		0.9371	0.1059	0.2799	0.9422	0.5052	0.4068	0.5534
Microtox organic phase	Correlation			0.5869	0.7161	-0.2144	0.1534	-0.5604	-0.4844
	Sample size			(9)	(9)	(9)	(9)	(9)	(9)
	Probability			0.0065	0.0004	0.3641	0.5184	0.0102	0.0304
Microtox solid phase	Correlation				0.3768	-0.2144	0.2813	-0.0406	-0.3031
	Sample size				(9)	(9)	(9)	(9)	(9)
	Probability				0.1015	0.3641	0.2296	0.8651	0.1939
Percent solids	Correlation					-0.2466	-0.0496	-0.5911	-0.6241
	Sample size					(9)	(9)	(9)	(9)
	Probability					0.2946	0.8354	0.0061	0.0033
Total PCBs	Correlation						0.5489	0.2347	0.5383
	Sample size						(9)	(9)	(9)
	Probability						0.122	0.3193	0.0143
Total DDTs	Correlation							0.0018	0.2947
	Sample size							(9)	(9)
	Probability							0.9941	0.2071

TABLE 8-12 (Continued)

SUMMARY MATRICES OF SPEARMAN RANK CORRELATIONS AMONG SELECTED VARIABLES
TIDAL AREA QEA, NWS SBD CONCORD

		Cytochrome P450	Microtox Organic Phase	Microtox Solid Phase	Percent Solids	Total PCBs	Total DDTs	Total PAHs	TOC
R Area Disposal Site (Continued)									
Total PAHs	Correlation								0.4076
	Sample size								(9)
	Probability								0.0744
Froid And Taylor Roads Site									
Cytochrome P450	Correlation		0.8341	0.5252	0.3682	0.1688	0.4622	0.0656	0.0502
	Sample size		(9)	(9)	(9)	(9)	(9)	(9)	(9)
	Probability		0.0052	0.1465	0.3296	0.6642	0.2104	0.8669	0.8979
Microtox organic phase	Correlation			0.6043	0.7120	0.0256	0.2468	-0.3807	-0.0509
	Sample size			(9)	(9)	(9)	(9)	(9)	(9)
	Probability			0.0848	0.0314	0.9478	0.5220	0.3122	0.8966
Microtox solid phase	Correlation				0.3347	0.2279	-0.2605	-0.1180	0.0753
	Sample size				(9)	(9)	(9)	(9)	(9)
	Probability				0.3786	0.5554	0.4984	0.7624	0.8473
Percent Solids	Correlation					-0.5042	-0.0586	-0.4526	-0.5333
	Sample size					(9)	(9)	(9)	(9)
	Probability					0.1663	0.8810	0.2212	0.1392

TABLE 8-12 (Continued)

SUMMARY MATRICES OF SPEARMAN RANK CORRELATIONS AMONG SELECTED VARIABLES
TIDAL AREA QEA, NWS SBD CONCORD

		Cytochrome P450	Microtox Organic Phase	Microtox Solid Phase	Percent Solids	Total PCBs	Total DDTs	Total PAHs	TOC
Froid And Taylor Roads Site									
Total PCBs	Correlation						0.0295	-0.2545	0.7227
	Sample size						(9)	(9)	(9)
	Probability						0.9399	0.5086	0.0278
Total DDTs	Correlation							0.2054	0.2929
	Sample size							(9)	(9)
	Probability							0.5960	0.4444
Total PAHs	Correlation								-0.0870
	Sample size								(9)
	Probability								0.8238
Wood Hogger Site									
Cytochrome P450 P450	Correlation		0.3096	0.1834	0.2163	-0.1304	0.1605	0.0014	-0.0513
	Sample size		(9)	(9)	(9)	(9)	(9)	(9)	(9)
	Probability		0.1721	0.4263	0.3463	0.5732	0.4871	0.9954	0.8251
Microtox organic phase	Correlation			0.6206	0.6194	-0.2444	-0.2151	-0.3694	-0.2450
	Sample size			(9)	(9)	(9)	(9)	(9)	(9)
	Probability			0.0027	0.0028	0.2857	0.3491	0.0994	0.2845

TABLE 8-12 (Continued)

SUMMARY MATRICES OF SPEARMAN RANK CORRELATIONS AMONG SELECTED VARIABLES
TIDAL AREA QEA, NWS SBD CONCORD

	Cytochrome P450	Microtox Organic Phase	Microtox Solid Phase	Percent Solids	Total PCBs	Total DDTs	Total PAHs	TOC
Wood Hogger Site								
Microtox solid phase	Correlation			0.5704	-0.2425	-0.1656	0.1057	-0.1979
	Sample size			(9)	(9)	(9)	(9)	(9)
	Probability			0.0069	0.2895	0.4730	0.6485	0.3900
Percent solids	Correlation				-0.4793	-0.2921	-0.2578	-0.5423
	Sample size				(9)	(9)	(9)	(9)
	Probability				0.0279	0.1988	0.2592	0.0111
Total PCBs	Correlation					0.7643	0.0537	0.7021
	Sample size					(9)	(9)	(9)
	Probability					5E-005	0.8173	0.0004
Total DDTs	Correlation						0.3131	0.6314
	Sample size						(9)	(9)
	Probability						0.1669	0.0021
Total PAHs	Correlation							0.2065
	Sample size							(9)
	Probability							0.3691

Notes:

DDT Dichlorodiphenyltrichloroethane
PAH Polynuclear aromatic hydrocarbon
PCB Polychlorinated biphenyl
TOC Total organic carbon

TABLE 9-1

PHYSICAL CHARACTERISTICS OF TIDAL AREA SOILS
TIDAL AREA QEA, NWS SBD CONCORD

Sample Location	Depth (feet bgs)	Grain Size Distribution[a]					Other Soil Parameters		
		Percent Clay	Percent Silt	Percent Sand	Percent Gravel	Percent Cobbles	Percent Moisture	pH	TOC (mg/kg)
Tidal Area Landfill Terrestrial Unit									
TLSSB001	0 - 0.5	36.4	33.9	25.0	4.8	0.0	68.60	5.00	43,700
	1.3 - 2.5	48.7	36.0	15.3	0.0	0.0	306.50	5.00	325,000
	3.9 - 4.5	NA	NA	NA	NA	NA	NA	5.10	97,100
TLSSB002	0 - 0.5	27.9	40.6	31.4	0.0	0.0	251.50	6.30	221,000
	1.3 - 2.5	52.5	36.2	11.3	0.0	0.0	281.50	7.50	412,000
	4.3 - 5.5	36.6	47.2	16.2	0.0	0.0	262.50	7.70	320,000
TLSSB003	0 - 0.5	49.6	42.5	8.0	0.0	0.0	59.70	6.10	12,200
	1.5 - 2.5	NA	NA	NA	NA	NA	NA	6.40	95,000
	4.5 - 5.3	NA	NA	NA	NA	NA	NA	8.00	58,500
TLSSB004	0 - 0.5	40.7	45.8	13.5	0.0	0.0	63.30	5.60	14,400
	1.3 - 2.4	48.2	45.0	6.8	0.0	0.0	205.70	5.90	92,600
	4.3 - 5.5	34.9	26.4	38.8	0.0	0.0	193.00	7.50	57,900
TLSSB005	0 - 0.5	44.5	49.4	6.2	0.0	0.0	57.70	7.60	26,300
	0.9 - 2	26.6	22.1	51.3	0.0	0.0	209.10	6.80	135,000
	4.5 - 5.8	29.8	29.6	40.7	0.0	0.0	232.40	7.00	96,200
TLSSB006	0 - 0.5	NA	NA	NA	NA	NA	NA	7.80	60,900
	1.3 - 2	NA	NA	NA	NA	NA	NA	7.00	28,400
	4.5 - 6	61.1	33.4	5.5	0.0	0.0	95.60	7.00	19,500
TLSSB007	0 - 0.5	73.8	25.3	0.9	0.0	0.0	117.60	4.60	92,000
	1.5 - 2.3	NA	NA	NA	NA	NA	NA	5.40	132,000
	4.5 - 5.3	NA	NA	NA	NA	NA	NA	6.95	122,000
TLSSB008	0 - 0.5	34.8	32.8	32.0	0.4	0.0	55.70	7.30	46,700
	1.5 - 2.7	70.5	27.7	1.9	0.0	0.0	72.40	5.90	14,800
	4.5 - 5.7	65.6	32.8	1.6	0.0	0.0	94.00	6.60	21,400
R Area Terrestrial Unit									
RADSB007	0 - 0.5	NA	NA	NA	NA	NA	NA	8.40	15,500
RADSB008	0 - 0.5	NA	NA	NA	NA	NA	NA	7.20	94,100
RADSB009	0 - 0.5	NA	NA	NA	NA	NA	NA	6.60	163,000
RADSB010	0 - 0.5	NA	NA	NA	NA	NA	NA	4.50	25,600
RADSB011	0 - 0.5	NA	NA	NA	NA	NA	NA	5.30	43,000
RADSB012	0 - 0.5	NA	NA	NA	NA	NA	NA	6.90	23,400
RADSB014	0 - 0.5	NA	NA	NA	NA	NA	NA	8.10	3,960

TABLE 9-1

PHYSICAL CHARACTERISTICS OF TIDAL AREA SOILS
TIDAL AREA QEA, NWS SBD CONCORD

Sample Location	Depth (feet bgs)	Grain Size Distribution[a]					Other Soil Parameters		
		Percent Clay	Percent Silt	Percent Sand	Percent Gravel	Percent Cobbles	Percent Moisture	pH	TOC (mg/kg)
R Area Terrestrial Unit (Continued)									
RADSB015	0 - 0.5	NA	NA	NA	NA	NA	NA	6.50	47,300
RADSB017	0 - 0.5	NA	NA	NA	NA	NA	NA	7.20	NA
RADSB018	0 - 0.5	NA	NA	NA	NA	NA	NA	6.50	NA
RADSB019	0 - 0.5	NA	NA	NA	NA	NA	NA	6.40	NA
RADSB020	0 - 0.5	NA	NA	NA	NA	NA	NA	5.30	NA
RADSB021	0 - 0.5	NA	NA	NA	NA	NA	NA	5.80	NA
RADSB022	0 - 0.5	NA	NA	NA	NA	NA	NA	5.50	NA
RADSB023	0 - 0.5	NA	NA	NA	NA	NA	NA	4.40	NA
RADSB024	0 - 0.5	NA	NA	NA	NA	NA	NA	3.30	NA
RADSB025	0 - 0.5	NA	NA	NA	NA	NA	NA	4.50	NA
RADSB026	0 - 0.5	NA	NA	NA	NA	NA	NA	6.20	NA
RADSB028	0 - 0.5	NA	NA	NA	NA	NA	NA	4.70	NA
RADSB029	0 - 0.5	NA	NA	NA	NA	NA	NA	4.80	NA
RADSB030	0 - 0.5	NA	NA	NA	NA	NA	NA	8.50	NA
RADSBA08	0 - 0.5	NA	NA	NA	NA	NA	NA	7.80	NA
RADSBB01	0 - 0.5	NA	NA	NA	NA	NA	NA	7.30	110
RADSBB02	0 - 0.5	NA	NA	NA	NA	NA	NA	8.80	NA
RADSBB03	0 - 0.5	NA	NA	NA	NA	NA	NA	8.20	36,500
RADSBB04	0 - 0.5	32.7	28.0	39.3	0.0	0.0	43.90	7.30	42,600
	0.9 - 1.5	36.0	49.9	14.1	0.0	0.0	37.80	7.30	6,420
	4 - 5.2	31.9	33.1	35.0	0.0	0.0	25.20	7.50	113,000
RADSBB05	0 - 0.5	NA	NA	NA	NA	NA	NA	9.20	NA
RADSBB06	0 - 0.5	13.4	19.0	67.6	0.0	0.0	72.40	8.50	10,500
	1.2 - 2	NA	NA	NA	NA	NA	NA	7.30	NA
RADSBB07	0 - 0.5	NA	NA	NA	NA	NA	NA	7.60	11,000
RADSBB08	0 - 0.5	33.7	32.0	33.2	1.2	0.0	26.70	7.50	109
	1.5 - 2	NA	NA	NA	NA	NA	NA	7.60	117
RADSBC03	0 - 0.5	NA	NA	NA	NA	NA	NA	7.70	2,450
RADSBC04	0 - 0.5	NA	NA	NA	NA	NA	NA	7.50	NA
RADSBC05	0 - 0.5	26.3	16.2	57.5	0.0	0.0	34.80	7.80	24,900
	1.1 - 2	NA	NA	NA	NA	NA	NA	7.30	135
RADSBC06	0 - 0.5	NA	NA	NA	NA	NA	NA	6.30	NA

TABLE 9-1

PHYSICAL CHARACTERISTICS OF TIDAL AREA SOILS
TIDAL AREA QEA, NWS SBD CONCORD

Sample Location	Depth (feet bgs)	Grain Size Distribution[a]					Other Soil Parameters		
		Percent Clay	Percent Silt	Percent Sand	Percent Gravel	Percent Cobbles	Percent Moisture	pH	TOC (mg/kg)
R Area Terrestrial Unit (Continued)									
RADSBC07	0 - 0.5	NA	NA	NA	NA	NA	NA	5.50	NA
RADSBC08	0 - 0.5	NA	NA	NA	NA	NA	NA	6.80	12,900
RADSBD03	0 - 0.5	NA	NA	NA	NA	NA	NA	7.00	34,100
RADSBD04	0 - 0.5	NA	NA	NA	NA	NA	NA	5.90	NA
RADSBD05	0 - 0.5	64.8	33.5	1.7	0.0	0.0	40.70	6.10	28,600
	1.2 - 2	NA	NA	NA	NA	NA	NA	4.30	26,100
RADSBD06	0 - 0.5	54.0	42.7	3.3	0.0	0.0	43.60	6.00	41,800
	0.6 - 1	NA	NA	NA	NA	NA	NA	4.40	14,900
	4.5 - 5.7	62.6	35.4	2.0	0.0	0.0	97.00	4.40	16,100
RADSBD07	0 - 0.5	NA	NA	NA	NA	NA	NA	6.30	9,970
RADSBD08	0 - 0.5	NA	NA	NA	NA	NA	NA	5.50	17,400
RADSBE02	0 - 0.5	NA	NA	NA	NA	NA	NA	8.70	1,640
RADSBE03	0 - 0.5	80.5	17.5	2.0	0.0	0.0	98.00	5.20	110,000
	1.5 - 2.3	NA	NA	NA	NA	NA	NA	7.80	220,000
RADSBE04	0 - 0.5	NA	NA	NA	NA	NA	NA	4.10	NA
RADSBE05	0 - 0.5	NA	NA	NA	NA	NA	NA	6.60	12,500
RADSBE06	0 - 0.5	NA	NA	NA	NA	NA	NA	4.60	NA
RADSBE07	0 - 0.5	NA	NA	NA	NA	NA	NA	5.00	NA
RADSBE08	0 - 0.5	NA	NA	NA	NA	NA	NA	8.20	1,650
RADSBF02	0 - 0.5	NA	NA	NA	NA	NA	NA	5.30	27,000
RADSBF03	0 - 0.5	NA	NA	NA	NA	NA	NA	4.10	15,600
RADSBF04	0 - 0.5	NA	NA	NA	NA	NA	NA	4.80	NA
RADSBF05	0 - 0.5	NA	NA	NA	NA	NA	NA	5.00	NA
RADSBF06	0 - 0.5	67.1	15.5	15.7	1.8	0.0	44.90	5.00	36,500
RADSBF07	0 - 0.5	NA	NA	NA	NA	NA	NA	5.80	NA
RADSBF08	0 - 0.5	NA	NA	NA	NA	NA	NA	8.10	68,800
RADSBG02	0 - 0.5	NA	NA	NA	NA	NA	NA	7.20	NA
RADSBG03	0 - 0.5	NA	NA	NA	NA	NA	NA	4.80	NA
RADSBG04	0 - 0.5	44.6	45.8	9.4	0.3	0.0	55.20	4.40	39,600
	1 - 2	67.7	31.2	1.1	0.0	0.0	118.30	4.60	39,800
	4.5 - 5.8	57.2	40.3	2.5	0.0	0.0	91.90	7.40	20,900
RADSBG05	0 - 0.5	NA	NA	NA	NA	NA	NA	4.70	35,900

TABLE 9-1

PHYSICAL CHARACTERISTICS OF TIDAL AREA SOILS
TIDAL AREA QEA, NWS SBD CONCORD

Sample Location	Depth (feet bgs)	Grain Size Distribution[a]					Other Soil Parameters		
		Percent Clay	Percent Silt	Percent Sand	Percent Gravel	Percent Cobbles	Percent Moisture	pH	TOC (mg/kg)
R Area Terrestrial Unit (Continued)									
RADSBG06	0 - 0.5	NA	NA	NA	NA	NA	NA	5.20	63,000
RADSBG07	0 - 0.5	NA	NA	NA	NA	NA	NA	6.20	NA
RADSBG08	0 - 0.5	23.9	42.9	31.1	2.1	0.0	31.50	7.70	1,640
	0.7 - 2	39.3	32.2	24.2	4.4	0.0	27.20	7.60	12,600
	4 - 5.3	52.8	39.1	8.1	0.0	0.0	135.80	6.70	319,000
RADSBH02	0 - 0.5	NA	NA	NA	NA	NA	NA	7.10	106
RADSBH03	0 - 0.5	NA	NA	NA	NA	NA	NA	4.70	14,500
RADSBH04	0 - 0.5	NA	NA	NA	NA	NA	NA	4.70	NA
RADSBH05	0 - 0.5	NA	NA	NA	NA	NA	NA	4.90	32,300
RADSBH06	0 - 0.5	56.4	31.8	11.8	0.0	0.0	94.30	5.40	237,000
	1.5 - 2	NA	NA	NA	NA	NA	NA	5.00	12,200
RADSBH07	0 - 0.5	NA	NA	NA	NA	NA	NA	3.90	143,000
RADSBH08	0 - 0.5	NA	NA	NA	NA	NA	NA	8.50	NA
RADSBI01	0 - 0.5	NA	NA	NA	NA	NA	NA	7.10	28,300
RADSBI02	0 - 0.5	32.8	46.4	20.9	0.0	0.0	38.60	5.40	3,570
RADSBI03	0 - 0.5	NA	NA	NA	NA	NA	NA	6.20	NA
RADSBI04	0 - 0.5	41.8	52.2	6.0	0.0	0.0	63.90	4.90	13,300
	1.5 - 2	NA	NA	NA	NA	NA	NA	6.20	323,000
RADSBI05	0 - 0.5	NA	NA	NA	NA	NA	NA	5.00	22,800
RADSBI06	0 - 0.5	NA	NA	NA	NA	NA	NA	4.50	NA
RADSBI07	0 - 0.5	NA	NA	NA	NA	NA	NA	4.30	NA
RADSBI08	0 - 0.5	20.0	33.6	38.1	8.3	0.0	47.80	7.80	6,200
	1.5 - 2	NA	NA	NA	NA	NA	NA	7.60	141,000
RADSBJ01	0 - 0.5	NA	NA	NA	NA	NA	NA	6.50	NA
RADSBJ02	0 - 0.5	22.1	32.0	46.0	0.0	0.0	43.80	4.60	8,050
	1 - 2.2	8.0	8.9	83.0	0.0	0.0	12.70	4.70	104
	4.7 - 6	48.8	41.6	9.6	0.0	0.0	32.80	8.50	1,730
RADSBJ03	0 - 0.5	NA	NA	NA	NA	NA	NA	4.70	17,100
RADSBJ04	0 - 0.5	NA	NA	NA	NA	NA	NA	4.60	NA
RADSBJ06	0 - 0.5	NA	NA	NA	NA	NA	NA	7.10	NA
RADSBJ07	0 - 0.5	62.2	34.9	2.9	0.0	0.0	84.60	5.10	23,500
RADSBJ08	0 - 0.5	NA	NA	NA	NA	NA	NA	6.50	NA

TABLE 9-1

PHYSICAL CHARACTERISTICS OF TIDAL AREA SOILS
TIDAL AREA QEA, NWS SBD CONCORD

Sample Location	Depth (feet bgs)	Grain Size Distribution[a]					Other Soil Parameters		
		Percent Clay	Percent Silt	Percent Sand	Percent Gravel	Percent Cobbles	Percent Moisture	pH	TOC (mg/kg)
R Area Terrestrial Unit (Continued)									
RADSBK01	0 - 0.5	NA	NA	NA	NA	NA	NA	6.50	NA
RADSBK02	0 - 0.5	NA	NA	NA	NA	NA	NA	8.20	5,280
RADSBK03	0 - 0.5	NA	NA	NA	NA	NA	NA	5.90	8,740
RADSBK04	0 - 0.5	NA	NA	NA	NA	NA	NA	6.50	NA
RADSBK07	0 - 0.5	NA	NA	NA	NA	NA	NA	7.70	67,300
RADSBK08	0 - 0.5	36.7	36.9	22.3	4.2	0.0	38.20	8.60	64,100
	1.3 - 2	NA	NA	NA	NA	NA	NA	8.80	120
RADSBL03	0 - 0.5	NA	NA	NA	NA	NA	NA	7.70	17,600
RADSBL08	0 - 0.5	NA	NA	NA	NA	NA	NA	7.80	3,540
RADSBM08	0 - 0.5	26.3	27.7	22.6	23.4	0.0	30.60	8.20	56,800
	1.3 - 2	NA	NA	NA	NA	NA	NA	8.60	10,600
RADSBN08	0 - 0.5	NA	NA	NA	NA	NA	NA	7.20	NA
R Area Terrestrial and Aquatic Unit									
RADSB013	0 - 0.5	NA	NA	NA	NA	NA	NA	7.50	13,900
RADSB027	0 - 0.5	NA	NA	NA	NA	NA	NA	9.70	NA
Froid and Taylor Roads Aquatic Unit									
FTSSB001	0 - .3	24.6	33.1	42.3	0.0	0.0	21.70	8.40	13,400
	0.35 - 1.3	21.6	34.9	43.6	0.0	0.0	15.00	7.50	3,740
FTSSB002	0 - 0.5	38.7	26.1	35.3	0.0	0.0	42.30	7.30	74,600
	0.75 - 1.8	60.8	32.4	6.9	0.0	0.0	110.70	6.40	128,000
FTSSB003	0 - .25	38.7	35.8	25.5	0.0	0.0	100.90	6.00	136,000
	0.75 - 1.75	NA	NA	NA	NA	NA	NA	5.80	83,100
FTSSB004	0 - 0.5	53.1	26.1	15.9	4.9	0.0	60.60	7.30	42,000
	1.5 - 2.5	62.9	29.7	7.4	0.0	0.0	77.60	6.80	20,100
FTSSB005	0 - 0.5	54.9	28.3	16.8	0.0	0.0	97.40	7.20	72,300
	2 - 3	NA	NA	NA	NA	NA	NA	6.50	331,000
FTSSB006	0 - 0.5	49.6	27.8	22.6	0.0	0.0	129.30	6.70	270,000
	1.1 - 2	15.0	21.3	63.7	0.0	0.0	341.80	7.10	269,000
FTSSB007	0 - .25	13.1	26.7	53.5	6.7	0.0	24.70	8.30	125
	1.5 - 2.3	NA	NA	NA	NA	NA	0.00	8.00	1,630
FTSSB008	0 - 0.5	39.1	32.9	25.9	2.1	0.0	63.20	7.40	49,800
	1.2 - 1.75	NA	NA	NA	NA	NA	0.00	6.20	47,800

TABLE 9-1

PHYSICAL CHARACTERISTICS OF TIDAL AREA SOILS
TIDAL AREA QEA, NWS SBD CONCORD

Sample Location	Depth (feet bgs)	Grain Size Distribution[a]					Other Soil Parameters		
		Percent Clay	Percent Silt	Percent Sand	Percent Gravel	Percent Cobbles	Percent Moisture	pH	TOC (mg/kg)
Froid and Taylor Roads Aquatic Unit (Continued)									
FTSSB009	0 - 0.12	20.2	14.9	48.5	16.4	0.0	40.30	8.30	21,500
	0.12 - 1.3	4.7	3.1	45.5	46.7	0.0	0.00	9.20	128
FTSSL102	0 - 0.5	80.8	13.8	5.4	0.0	0.0	NA	6.8	NA
FTSSL103	0 - 0.5	96.8	2.5	0.7	0.0	0.0	NA	7.7	NA
FTSSL104	0 - 0.5	49.1	11.5	19.3	10.7	9.4	NA	7.5	NA
Froid and Taylor Roads Terrestrial Unit									
FTSSB100	0 - 0.5	75.3	13.6	5.2	2.9	3.0	NA	7.5	NA
FTSSB101	0 - 0.5	69.4	22.5	4.5	1.0	2.6	NA	7.6	NA
Wood Hogger Site Terrestrial Unit									
WHSSB006	0 - 0.5	NA	NA	NA	NA	NA	NA	8.46	44,300
WHSSB007	0 - 0.5	NA	NA	NA	NA	NA	NA	7.90	10,900
WHSSB008	0 - 0.5	NA	NA	NA	NA	NA	NA	8.30	3,750
WHSSB009	0 - 0.5	NA	NA	NA	NA	NA	NA	7.10	45,000
WHSSB010	0 - 0.5	NA	NA	NA	NA	NA	NA	7.10	6,050
WHSSB011	0 - 0.5	NA	NA	NA	NA	NA	NA	8.07	5,800
WHSSB012	0 - 0.5	NA	NA	NA	NA	NA	NA	8.20	12,000
WHSSB013	0 - 0.5	NA	NA	NA	NA	NA	NA	7.00	44,900
WHSSB014	0 - 0.5	NA	NA	NA	NA	NA	NA	7.00	110,000
WHSSB015	0 - 0.5	NA	NA	NA	NA	NA	NA	6.60	131,000
WHSSB016	0 - 0.5	NA	NA	NA	NA	NA	NA	5.60	455,000
WHSSB017	0 - 0.5	NA	NA	NA	NA	NA	NA	7.10	51,100
WHSSB024	0 - 0.5	NA	NA	NA	NA	NA	NA	7.20	NA
WHSSB025	0 - 0.5	NA	NA	NA	NA	NA	NA	7.70	NA
WHSSB027	0 - 0.5	NA	NA	NA	NA	NA	NA	7.70	NA
WHSSB028	0 - 0.5	NA	NA	NA	NA	NA	NA	8.40	NA
WHSSB029	0 - 0.5	NA	NA	NA	NA	NA	NA	8.60	NA
WHSSB050	0 - 0.5	NA	NA	NA	NA	NA	12.80	NA	NA
	2.0 - 2.5	NA	NA	NA	NA	NA	18.30	NA	NA
WHSSB051	0 - 0.5	NA	NA	NA	NA	NA	7.80	NA	NA
	2.0 - 2.5	NA	NA	NA	NA	NA	14.80	NA	NA

TABLE 9-1

PHYSICAL CHARACTERISTICS OF TIDAL AREA SOILS
TIDAL AREA QEA, NWS SBD CONCORD

Sample Location	Depth (feet bgs)	Grain Size Distribution[a]					Other Soil Parameters		
		Percent Clay	Percent Silt	Percent Sand	Percent Gravel	Percent Cobbles	Percent Moisture	pH	TOC (mg/kg)
Wood Hogger Site Terrestrial Unit (Continued)									
WHSSBA06	0 - 0.5	4.2	6.9	37.5	51.4	0.0	0.00	7.80	316
	1 - 2	NA	NA	NA	NA	NA	NA	8.20	117
	4.5 - 5	NA	NA	NA	NA	NA	NA	7.80	124
	9 - 10.9	29.2	38.3	32.5	0.0	0.0	25.20	8.20	128
	13 - 14	NA	NA	NA	NA	NA	NA	8.80	127
WHSSBA08	0 - 0.5	NA	NA	NA	NA	NA	NA	6.70	NA
WHSSBB03	0 - 0.5	37.2	35.1	27.7	0.0	0.0	291.70	7.80	56,100
WHSSBB07	0 - 0.5	12.4	11.4	56.0	20.2	0.0	115.00	6.90	58,800
WHSSBC02	0 - 0.5	54.1	32.5	13.4	0.0	0.0	231.70	6.50	271,000
	1.3 - 2	NA	NA	NA	NA	NA	NA	7.00	329,000
	4 - 5.5	49.1	16.0	35.0	0.0	0.0	494.80	7.30	184,000
	8.8 - 10	23.5	27.2	49.3	0.0	0.0	507.00	7.30	267,000
WHSSBC04	0 - 0.5	NA	NA	NA	NA	NA	NA	7.00	NA
WHSSBC06	0 - 0.5	NA	NA	NA	NA	NA	NA	7.34	24,400
WHSSBC08	0 - 0.5	20.0	16.0	40.5	23.5	0.0	44.00	8.90	42,100
WHSSBD03	0 - 0.5	51.3	21.3	27.4	0.0	0.0	240.10	7.00	156,000
	1.5 - 2	NA	NA	NA	NA	NA	NA	6.60	201,000
	4.5 - 5.8	45.9	35.0	19.1	0.0	0.0	293.00	6.90	251,000
	9.5 - 10.4	24.3	42.3	33.4	0.0	0.0	242.50	7.40	393,000
	18.5 - 20	NA	NA	NA	NA	NA	NA	7.20	333,000
WHSSBD07	0 - 0.5	NA	NA	NA	NA	NA	NA	6.10	71,100
	1.5 - 2.3	NA	NA	NA	NA	NA	NA	7.10	45,900
	4.5 - 5.3	NA	NA	NA	NA	NA	NA	7.00	118
	9.3 - 10	NA	NA	NA	NA	NA	NA	7.80	121
WHSSBE02	0 - 0.5	33.5	37.3	22.6	6.5	0.0	27.60	7.20	3,380
WHSSBE04	0 - 0.5	NA	NA	NA	NA	NA	NA	7.60	NA
WHSSBE06	0 - 0.5	35.9	45.8	14.9	3.4	0.0	21.30	6.70	41,700
WHSSBE08	0 - 0.5	15.3	13.7	44.3	26.8	NA	77.80	8.20	89,400
	2.5 - 4	NA	NA	NA	NA	NA	NA	8.10	112
	5.5 - 6.5	NA	NA	NA	NA	NA	NA	8.30	120
	9 - 10.3	NA	NA	NA	NA	NA	NA	8.00	69,800

TABLE 9-1

PHYSICAL CHARACTERISTICS OF TIDAL AREA SOILS
TIDAL AREA QEA, NWS SBD CONCORD

Sample Location	Depth (feet bgs)	Grain Size Distribution[a]					Other Soil Parameters		
		Percent Clay	Percent Silt	Percent Sand	Percent Gravel	Percent Cobbles	Percent Moisture	pH	TOC (mg/kg)
Wood Hogger Site Terrestrial Unit (Continued)									
WHSSBF03	0 - 0.5	27.7	27.7	37.6	7.0	0.0	27.20	8.80	125
	1.5 - 2.3	NA	NA	NA	NA	NA	NA	7.10	31,200
	4.5 - 5.9	69.5	29.8	0.8	0.0	0.0	72.50	7.70	6,690
	9.5 - 10.8	58.4	37.6	4.1	0.0	0.0	120.50	8.10	16,800
WHSSBF07	0 - 0.5	NA	NA	NA	NA	NA	NA	6.80	37,000
WHSSBG02	0 - 0.5	NA	NA	NA	NA	NA	NA	7.00	118,000
WHSSBG06	0 - 0.5	43.0	40.7	16.3	0.0	0.0	23.30	7.90	1,670
	1.1 - 2	NA	NA	NA	NA	NA	NA	8.80	121
	4.5 - 5	24.2	17.9	53.9	4.1	0.0	20.00	9.10	258
	9 - 11	46.0	30.8	23.2	0.0	0.0	334.60	7.60	284,000
WHSSBH03	0 - 0.5	NA	NA	NA	NA	NA	NA	8.40	43,200
WHSSBH07	0 - 0.5	15.8	16.7	38.8	28.7	0.0	19.20	8.70	44,400
	1.3 - 2.3	NA	NA	NA	NA	NA	NA	7.30	355,000
	4 - 5	NA	NA	NA	NA	NA	NA	7.90	190,000
	8 - 10.1	47.0	40.1	12.9	0.0	0.0	315.30	8.00	294,000
WHSSBI02	0 - 0.5	48.5	29.9	21.5	0.0	0.0	136.50	8.00	94,600
WHSSBI06	0 - 0.5	NA	NA	NA	NA	NA	NA	7.60	NA
WHSSBI08	0 - 0.5	NA	NA	NA	NA	NA	NA	7.77	57,100
WHSSBJ05	0 - 0.5	NA	NA	NA	NA	NA	NA	7.40	NA
WHSSBJ07	0 - 0.5	NA	NA	NA	NA	NA	NA	7.80	NA
WHSSBK04	0 - 0.5	NA	NA	NA	NA	NA	NA	7.20	110
WHSSBK06	0 - 0.5	25.4	23.0	40.5	11.2	0.0	20.40	6.80	8,450
	1.5 - 2.3	NA	NA	NA	NA	NA	NA	6.90	3,910
	4.5 - 5.3	34.8	26.3	23.1	15.9	0.0	237.20	6.60	59,200
	9.5 - 10.4	59.9	34.9	5.2	0.0	0.0	111.20	7.40	28,900
WHSSBL05	0 - 0.5	31.4	42.1	23.1	3.5	0.0	28.00	8.40	909
WHSSBL07	0 - 0.5	NA	NA	NA	NA	NA	NA	7.70	29,200
WHSSBM04	0 - 0.5	NA	NA	NA	NA	NA	NA	7.80	N
WHSSBM06	0 - 0.5	NA	NA	NA	NA	NA	NA	8.70	7,140

TABLE 9-1

PHYSICAL CHARACTERISTICS OF TIDAL AREA SOILS
TIDAL AREA QEA, NWS SBD CONCORD

Sample Location	Depth (feet bgs)	Grain Size Distribution[a]					Other Soil Parameters		
		Percent Clay	Percent Silt	Percent Sand	Percent Gravel	Percent Cobbles	Percent Moisture	pH	TOC (mg/kg)
Wood Hogger Site Terrestrial Unit (Continued)									
WHSSBM08	0 - 0.5	11.5	8.9	78.2	1.4	0.0	26.10	8.20	1,970
	1 - 1.7	NA	NA	NA	NA	NA	NA	8.10	743
	4.1 - 5.2	47.7	31.9	19.9	0.5	0.0	27.60	8.70	124
	9 - 10.5	35.7	32.8	31.6	0.0	0.0	407.00	8.20	355,000
North Otter Sluice Aquatic Unit									
OSLSL001	0 - 0.5	97.5	2.4	0.1	0.0	0.0	NA	7.4	22,000
OSLSL002	0 - 0.5	99.8	0.2	0.0	0.0	0.0	NA	7.7	19,600
OSLSL003	0 - 0.5	96.6	3.1	0.3	0.0	0.0	NA	7.8	17,600
RADSB001	0 - 0.5	NA	NA	NA	NA	NA	NA	8.00	55,400
RADSB002	0 - 0.5	NA	NA	NA	NA	NA	NA	8.20	27,500
RADSB003	0 - 0.5	NA	NA	NA	NA	NA	NA	8.30	41,200
RADSB004	0 - 0.5	NA	NA	NA	NA	NA	NA	7.80	35,300
RADSB005	0 - 0.5	NA	NA	NA	NA	NA	NA	8.30	14,600
RADSB006	0 - 0.5	NA	NA	NA	NA	NA	NA	7.40	68,900
RADSB016	0 - 0.5	NA	NA	NA	NA	NA	NA	6.40	NA
RADSBA01	0 - 0.5	51.1	29.8	19.1	0.0	0.0	76.50	8.20	11,200
RADSBA02	0 - 0.5	NA	NA	NA	NA	NA	NA	7.20	NA
RADSBA03	0 - 0.5	NA	NA	NA	NA	NA	NA	7.60	NA
RADSBA04	0 - 0.5	NA	NA	NA	NA	NA	NA	8.00	37,200
RADSBA05	0 - 0.5	NA	NA	NA	NA	NA	NA	6.90	53,000
RADSBA06	0 - 0.5	NA	NA	NA	NA	NA	NA	7.00	NA
RADSBA07	0 - 0.5	45.2	25.8	29.0	0.0	0.0	193.30	6.70	53,500
RADSL001	0 - 0.5	27.2	16.1	47.9	8.8	0.0	82.40	8.10	9,420
RADSL002	0 - 0.5	42.5	45.4	12.1	0.0	0.0	129.00	7.80	22,800
South Otter Sluice Aquatic Unit									
OSLSL004	0 - 0.5	93.3	5.5	1.2	0.0	0.0	NA	7.6	30,700
OSLSL005	0 - 0.5	96.2	3.3	0.5	0.0	0.0	NA	7.8	31,600
OSLSL006	0 - 0.5	95.4	3.5	1.1	0.0	0.0	NA	7.7	39,900
OSLSL007	0 - 0.5	97.3	1.9	0.8	0.0	0.0	NA	7.0	39,400
OSLSL008	0 - 0.5	94.2	3.2	2.6	0.0	0.0	88.90	7.6	66,100
OSLSL009	0 - 0.5	91.2	4.5	4.3	0.0	0.0	84.60	7.8	49,800
WHSSB001	0 - 0.5	NA	NA	NA	NA	NA	NA	7.80	47,800

TABLE 9-1

PHYSICAL CHARACTERISTICS OF TIDAL AREA SOILS
TIDAL AREA QEA, NWS SBD CONCORD

Sample Location	Depth (feet bgs)	Grain Size Distribution[a]					Other Soil Parameters		
		Percent Clay	Percent Silt	Percent Sand	Percent Gravel	Percent Cobbles	Percent Moisture	pH	TOC (mg/kg)
South Otter Sluice Aquatic Unit (Continued)									
WHSSB002	0 - 0.5	NA	NA	NA	NA	NA	NA	8.06	31,400
WHSSB003	0 - 0.5	NA	NA	NA	NA	NA	NA	7.99	46,900
WHSSB004	0 - 0.5	NA	NA	NA	NA	NA	NA	7.85	44,000
WHSSB005	0 - 0.5	NA	NA	NA	NA	NA	NA	8.92	878
WHSSB018	0 - 0.5	NA	NA	NA	NA	NA	NA	7.84	3,700
WHSSB021	0 - 0.5	NA	NA	NA	NA	NA	NA	6.50	NA
WHSSB022	0 - 0.5	NA	NA	NA	NA	NA	NA	8.80	NA
WHSSB023	0 - 0.5	NA	NA	NA	NA	NA	NA	7.80	NA
WHSSB026	0 - 0.5	NA	NA	NA	NA	NA	NA	7.62	NA
WHSSBA02	0 - 0.5	NA	NA	NA	NA	NA	NA	8.05	NA
WHSSBA04	0 - 0.5	54.3	28.5	16.4	0.8	0.0	29.50	8.20	265
WHSSBB01	0 - 0.5	NA	NA	NA	NA	NA	NA	8.80	NA
WHSSBB05	0 - 0.5	NA	NA	NA	NA	NA	NA	7.50	66,500
WHSSBD01	0 - 0.5	NA	NA	NA	NA	NA	NA	7.60	15,500
WHSSBG08	0 - 0.5	NA	NA	NA	NA	NA	NA	8.02	NA
WHSSBK08	0 - 0.5	28.5	25.6	17.0	29.0	0.0	27.40	8.41	554
WHSSL001	0 - 0.5	55.0	31.0	14.0	0.0	0.0	127.10	7.91	37,700
WHSSL002	0 - 0.5	62.8	33.9	3.2	0.0	0.0	142.20	8.45	22,500
WHSSL003	0 - 0.5	55.0	34.4	10.6	0.0	0.0	168.20	7.69	26,200

Notes:

a Grain sizes:

Clay	<0.005 mm
Silt	0.005 to 0.74 mm
Sand	0.074 to 4.75 mm
Gravel	4.75 to 76.2 mm
Cobbles	76.2 to 305 mm

bgs	Below ground surface
mg/kg	Milligrams per kilogram
mm	Millimeters
NA	Not analyzed
TOC	Total organic carbon

TABLE 9-2

SEM/AVS RATIOS WITH CONCENTRATIONS OF METALS AND SULFIDES
TIDAL AREA QEA, NWS SBD CONCORD

Location	SEM/AVS (μmoles)	SEM	Concentrations (μmoles)							Extraction Concentrations (mg/kg)						
			AVS	Cd	Cu	Pb	Hg	Ni	Zn	AVS	Cd	Cu	Pb	Hg	Ni	Zn
OSLSL001	0.17	2.27	13.19	0.002	0.52	0.10	0.00	0.51	1.14	423.00	0.28	32.90	20.50	0.02	30.20	74.40
OSLSL002	0.04	2.40	67.37	0.003	0.55	0.08	0.00	0.59	1.18	2160.00	0.29	34.90	16.10	0.01	34.60	77.40
OSLSL003	0.03	1.49	57.39	0.002	0.24	0.07	0.00	0.41	0.97	1840.00	0.25	15.30	15.20	0.01	23.90	63.40
OSLSL004	0.03	1.45	46.16	0.002	0.20	0.07	0.00	0.32	0.86	1480.00	0.28	13.00	14.20	0.01	19.00	56.50
OSLSL005	0.03	2.45	74.86	0.010	0.27	0.11	0.00	0.30	1.76	2400.00	1.1	17.30	22.90	0.01	17.70	115.00
OSLSL006	0.03	2.46	80.16	0.008	0.36	0.13	0.00	0.31	1.65	2570.00	0.92	23.00	25.90	0.01	18.30	108.00
OSLSL007	0.20	1.91	9.61	0.003	0.41	0.07	0.00	0.33	1.10	308.00	0.33	26.10	15.30	0.03	19.60	72.10
OSLSL008	0.03	4.64	182.16	0.004	0.90	ND	0.00	0.60	3.14	5840.00	0.5	57.00	ND	0.01	35.40	205.00
OSLSL009	0.02	3.18	146.91	0.002	0.58	0.14	0.00	0.40	2.06	4710.00	0.2	36.60	29.40	0.01	23.60	135.00

Notes:

AVS Acid volatile sulfides
Cd Cadmium
Cu Copper
mg/kg Milligrams per kilogram
ND Nondetect
Ni Nickel
Pb Lead
SEM Simultaneously extractable metals
Zn Zinc
μmoles Micromoles

TABLE 9-3

SEM/AVS RATIOS AND SULFIDE CONCENTRATIONS AFTER METAL BINDING
TIDAL AREA QEA, NWS SBD CONCORD

Location	SEM/AVS (μmoles)	Concentrations (μmoles)							AVS-[Cu] (μmoles)	([Cu]+[Pb]) (μmoles)	([Cu]+[Pb]+[Cd])	([Cu]+[Pb]+[Cd]+ [Zn])	([Cu]+[Pb]+[Cd]+[Zn]+[Ni])	([Cu]+[Pb]+[Cd]+[Zn]+[Ni]+[Hg])
		AVS	Cd	Cu	Hg	Ni	Pb	Zn						
OSLSL001	0.17	13.19	0	0.518	0.099	0	0.51	1.14	12.68	12.16	12.16	11.02	11.54	10.92
OSLSL002	0.04	67.374	0	0.5492	0.0777	5E-05	0.59	1.184	66.82	66.23	66.23	65.05	65.60	64.97
OSLSL003	0.03	57.39	0	0.24	0.0734	0.00	0.41	0.97	57.15	56.74	56.74	55.77	56.01	55.70
OSLSL004	0.03	46.16	0	0.20	0.0685	0.00	0.32	0.86	45.96	45.64	45.63	44.77	44.97	44.70
OSLSL005	0.03	74.86	0.01	0.27	0.1105	0.00	0.30	1.76	74.59	74.29	74.28	72.52	72.79	72.41
OSLSL006	0.03	80.16	0.01	0.36	0.125	0.00	0.31	1.65	79.80	79.49	79.48	77.83	78.19	77.70
OSLSL007	0.20	9.61	0	0.41	0.0738	0.00	0.33	1.10	9.20	8.86	8.86	7.76	8.17	7.68
OSLSL008	0.03	182.16	0	0.90	ND	0.00	0.60	3.14	181.26	180.66	180.65	177.52	177.52	177.52
OSLSL009	0.02	146.91	0	0.58	0.1419	0.00	0.40	2.06	146.34	145.93	145.93	143.87	144.44	143.73

Notes: This table presents sediment samples with SEM/AVS ratios over 1.0, with each SEM subtracted from the total AVS beginning with least soluble (Cu) and continuing through the most soluble (Ni). Values for SEM metals are cumulative, or summed for each additional metal prior to subtracting the total from AVS concentration. Negative values indicate that the AVS concentration has been exceeded, and metals may become bioavailable.

AVS Acid volatile sulfides
Cd Cadmium
Cu Copper
Hg Mercury
ND Nondetect
Ni Nickel
Pb Lead
SEM Simultaneously extractable metals
Zn Zinc
μmoles Micromoles

TABLE 10-1

IDENTIFICATION OF COPECs FOR PLANTS AND SOIL BIOTA AND TERRESTRIAL INVERTEBRATES
LANDFILL TERRESTRIAL UNIT
TIDAL AREA QEA, NWS SBD CONCORD

COPEC[g]	Rationale for Identification as COPEC			Highest Screening Value Exceeded[d]
	Exceeds Tidal Area 99th UCL[a], SF Bay Ambient[b], and ER-L[c]	Exceeds Tidal Area 99th UCL[a] and/or SF Bay Ambient[b], but No ER-L[c] Available	Detected, but No Screening Value Available	
Inorganic Constituents				
Antimony	X			ER-L
Arsenic	X			ER-L
Beryllium		X		Ambient[a]
Cadmium	X			ER-L
Copper	X			ER-L
Lead	X			ER-L
Mercury	X			ER-L
Zinc	X			ER-M
Low Detection Limit PCBs[e]				
Total PCBs[f]	X			ER-L
CLP PCBs[e]				
Total PCBs[f]	X			ER-M
Low Detection Limit Pesticides[e]				
2,4'-DDD			X	--
2,4'-DDE			X	--
2,4'-DDT			X	--
4,4'-DDD	X			ER-M
4,4'-DDE	X			ER-L
4,4'-DDT	X			ER-L
Total DDTs[f]	X			ER-M
Aldrin			X	--

TABLE 10-1

IDENTIFICATION OF COPECs FOR PLANTS AND SOIL BIOTA AND TERRESTRIAL INVERTEBRATES
LANDFILL TERRESTRIAL UNIT
TIDAL AREA QEA, NWS SBD CONCORD

COPEC[g]	Rationale for Identification as COPEC			Highest Screening Value Exceeded[d]
	Exceeds Tidal Area 99th UCL[a], SF Bay Ambient[b], and ER-L[c]	Exceeds Tidal Area 99th UCL[a] and/or SF Bay Ambient[b], but No ER-L[c] Available	Detected, but No Screening Value Available	
Low Detection Limit Pesticides[e] (Continued)				
alpha-Chlordane			X	--
Total Chlordanes[f]	X			ER-L
Dieldrin	X			ER-L
Heptachlor			X	--
Hexachlorobenzene		X		SF Ambient[b]
Mirex			X	--
trans-Nonachlor			X	--
CLP Pesticides[e]				
Total DDTs[f]	X			ER-L
Total BHCs[f]		X		SF Ambient[b]
Total Chlordanes	X			ER-M
Low Detection Level SVOAs[e]				
2,6-Dimethylnaphthalene		X		SF Ambient[b]
Benzoic Acid			X	--
Butylbenzylphthalate			X	--
Phenol			X	--
Pyrene	X			ER-L
Total LMW PAHs[f]	X			ER-M
Total PAHs[f]	X			ER-L
CLP SVOAs[e]				
Phenol			X	--
Total LMW PAHs[f]	X			ER-M
Total PAHs[f]	X			ER-L

TABLE 10-1

IDENTIFICATION OF COPECs FOR PLANTS AND SOIL BIOTA AND TERRESTRIAL INVERTEBRATES
LANDFILL TERRESTRIAL UNIT
TIDAL AREA QEA, NWS SBD CONCORD

COPEC[g]	Rationale for Identification as COPEC			Highest Screening Value Exceeded[d]
	Exceeds Tidal Area 99th UCL[a], SF Bay Ambient[b], and ER-L[c]	Exceeds Tidal Area 99th UCL[a] and/or SF Bay Ambient[b], but No ER-L[c] Available	Detected, but No Screening Value Available	
CLP VOAs[e]				
2-Butanone			X	--
Acetone			X	--
Carbon Disulfide			X	--
Chloromethane			X	--

Notes:

BHC	Hexachlorocyclohexane	HMW	High molecular weight
CLP	Contract laboratory program	LMW	Low molecular weight
COEC	Chemical of ecological concern	NA	Screening value not available
DDD	Dichlorodiphenyldichloroethane	PAH	Polynuclear aromatic hydrocarbon
DDE	Dichlorodiphenyldichloroethene	PCB	Polychlorinated biphenyl
DDT	Dichlorodiphenyltrichloroethane	SVOA	Semivolatile organic analyte
ER-L	Effects-range low	UCL	Upper confidence level
ER-M	Effects-range median	VOA	Volatile organic analyte

a PRC Environmental Management, Inc. (PRC). 1996a. "Estimation of Ambient Metals Concentrations in the Tidal Area Soils." Technical Memorandum. Naval Weapons Station, Concord California. March.

b San Francisco Bay Regional Water Quality Control Board (RWQCB). 1998. "Ambient Concentrations of Toxic Chemicals in Sediments." April.

c National Oceanic and Atmospheric Administration (NOAA). 1991. "The Potential for Biological Effects of Sediment-Sorbed Contaminants Tested in the National Status and Trends Program." Technical Memorandum NOS OMA 52. NOAA, Office of Oceanography and Marine Assessment. Seattle, WA. *and* Long, E.R., D.D. MacDonald, S.L. Smith, and F.D. Calder. 1995. "Incidence of Adverse Biological Effects Within Ranges of Chemical Concentrations in Marine and Estuarine Sediments." *Environmental Management*. Volume 19. Number 1. Pages 81 through 97.

d While exceedance of ER-M is noted in this column, ER-M values were not used to determine if a chemical was a COPEC.

e Tidal Area 99th UCL is not available for these constituents.

f Where total values were calculated (for example, total PCBs, total DDTs, etc.) 1/2 of the standard quantitation limit was used for nondetected analytes.

g Only detected chemicals are listed.

TABLE 10-2

IDENTIFICATION OF COPECs FOR PLANTS AND SOIL BIOTA AND INVERTEBRATES
R AREA TERRESTRIAL UNIT
TIDAL AREA QEA, NWS SBD CONCORD

COPEC[g]	Rationale for Identification as COPEC			Highest Screening Value Exceeded[d]
	Exceeds Tidal Area 99th UCL[a], SF Bay Ambient[b], and ER-L[c]	Exceeds Tidal Area 99th UCL[a] and/or SF Bay Ambient[b], but No ER-L[c] Available	Detected, but No Screening Value Available	
Inorganic Constituents				
Antimony	X			ER-L
Arsenic	X			ER-L
Barium		X		Ambient[a]
Beryllium		X		Ambient[a]
Cobalt		X		Ambient[a]
Copper	X			ER-L
Lead	X			ER-M
Manganese		X		Ambient
Mercury	X			ER-L
Molybdenum		X		Ambient[a]
Nickel	X			ER-M
Selenium	X			ER-L
Zinc	X			ER-M
CLP PCBs[e]				
Total PCBs[f]	X			ER-M
Low Detection Limit Pesticides[e]				
2,4'-DDD			X	--
2,4'-DDE			X	--
2,4'-DDT			X	--
4,4'-DDD	X			ER-M
4,4'-DDE	X			ER-L
4,4'-DDT	X			ER-M

TABLE 10-2

IDENTIFICATION OF COPECs FOR PLANTS AND SOIL BIOTA AND INVERTEBRATES
R AREA TERRESTRIAL UNIT
TIDAL AREA QEA, NWS SBD CONCORD

COPEC[g]	Rationale for Identification as COPEC			Highest Screening Value Exceeded[d]
	Exceeds Tidal Area 99th UCL[a], SF Bay Ambient[b], and ER-L[c]	Exceeds Tidal Area 99th UCL[a] and/or SF Bay Ambient[b], but No ER-L[c] Available	Detected, but No Screening Value Available	
Low Detection Limit Pesticides[e] (Continued)				
Total DDTs[f]	X			ER-M
Aldrin			X	--
gamma-BHC			X	--
Total BHCs[f]		X		SF Ambient[b]
alpha-Chlordane			X	--
Total Chlordanes[f]	X			ER-M
Dieldrin	X			ER-L
Heptachlor			X	--
Heptachlor epoxide			X	--
Hexachlorobenzene		X		SF Ambient[b]
Mirex			X	--
trans-Nonachlor			X	--
CLP Pesticides[e]				
Total DDTs[f]	X			ER-L
Total BHCs[f]		X		SF Ambient[b]
Total Chlordanes[f]	X			ER-M
Low Detection Level SVOAs[e]				
1-Methylphenanthrene		X		SF Ambient[b]
2,4-Dimethylphenol			X	--
4-Methylphenol			X	--
Acenaphthene	X[h]			ER-L
Anthracene	X			ER-L

TABLE 10-2

IDENTIFICATION OF COPECs FOR PLANTS AND SOIL BIOTA AND INVERTEBRATES
R AREA TERRESTRIAL UNIT
TIDAL AREA QEA, NWS SBD CONCORD

COPEC[g]	Rationale for Identification as COPEC			Highest Screening Value Exceeded[d]
	Exceeds Tidal Area 99th UCL[a], SF Bay Ambient[b], and ER-L[c]	Exceeds Tidal Area 99th UCL[a] and/or SF Bay Ambient[b], but No ER-L[c] Available	Detected, but No Screening Value Available	
Low Detection Level SVOAs[e] (Continued)				
Benzo(a)anthracene	X			ER-L
Benzo(b)fluoranthene		X		SF Ambient[b]
Benzo(k)fluoranthene		X		SF Ambient[b]
Benzoic Acid			X	--
Bis(2-ethylhexyl)phthalate			X	--
Carbazole			X	--
Chrysene	X			ER-L
Dibenz(a,h)anthracene	X			ER-L
Dibenzothiophene			X	--
Diethylphthalate			X	--
Fluoranthene	X			ER-L
Isophorone			X	--
Phenanthrene	X			ER-L
Pyrene	X			ER-L
Total LMW PAHs[f]	X			ER-L
Total PAHs[f]	X			ER-L
CLP SVOAs[e]				
Acenaphthene	X			ER-M
Anthracene	X			ER-M
Benzo(a)anthracene	X			ER-M
Benzo(a)pyrene	X			ER-L
Benzo(b)fluoranthene		X		SF Ambient[b]

TABLE 10-2

IDENTIFICATION OF COPECs FOR PLANTS AND SOIL BIOTA AND INVERTEBRATES
R AREA TERRESTRIAL UNIT
TIDAL AREA QEA, NWS SBD CONCORD

COPEC[g]	Rationale for Identification as COPEC			
	Exceeds Tidal Area 99th UCL[a], SF Bay Ambient[b], and ER-L[c]	Exceeds Tidal Area 99th UCL[a] and/or SF Bay Ambient[b], but No ER-L[c] Available	Detected, but No Screening Value Available	Highest Screening Value Exceeded[d]
CLP SVOAs[e] (Continued)				
Benzo(g,h,i)perylene		X		SF Ambient[b]
Benzo(k)fluoranthene		X		SF Ambient[b]
Carbazole			X	--
Chrysene	X			ER-L
Dibenzofuran			X	--
Fluoranthene	X			ER-L
Fluorene	X			ER-M
Naphthalene	X			ER-L
Phenanthrene	X			ER-M
Phenol			X	--
Pyrene	X			ER-M
Total HMW PAHs[f]	X			ER-L
Total LMW PAHs[f]	X			ER-M
Total PAHs[f]	X			ER-L

TABLE 10-2

IDENTIFICATION OF COPECs FOR PLANTS AND SOIL BIOTA AND INVERTEBRATES
R AREA TERRESTRIAL UNIT
TIDAL AREA QEA, NWS SBD CONCORD

COPEC[g]	Rationale for Identification as COPEC			Highest Screening Value Exceeded[d]
	Exceeds Tidal Area 99th UCL[a], SF Bay Ambient[b], and ER-L[c]	Exceeds Tidal Area 99th UCL[a] and/or SF Bay Ambient[b], but No ER-L[c] Available	Detected, but No Screening Value Available	
CLP VOAs[e]				
2-Butanone			X	--
Carbon disulfide			X	--
Chloromethane			X	--

Notes:

BHC	Hexachlorocyclohexane	HMW	High molecular weight
CLP	Contract laboratory program	LMW	Low molecular weight
COEC	Chemical of ecological concern	NA	Screening value not available
DDD	Dichlorodiphenyldichloroethane	PAH	Polynuclear aromatic hydrocarbon
DDE	Dichlorodiphenyldichloroethene	PCB	Polychlorinated biphenyl
DDT	Dichlorodiphenyltrichloroethane	SVOA	Semivolatile organic analyte
ER-L	Effects-range low	UCL	Upper confidence level
ER-M	Effects-range median	VOA	Volatile organic analyte

a PRC Environmental Management, Inc. (PRC). 1996a. "Estimation of Ambient Metals Concentrations in the Tidal Area Soils." Technical Memorandum. Naval Weapons Station, Concord California. March.

b San Francisco Bay Regional Water Quality Control Board (RWQCB). 1998. "Ambient Concentrations of Toxic Chemicals in Sediments." April.

c National Oceanic and Atmospheric Administration (NOAA). 1991. "The Potential for Biological Effects of Sediment-Sorbed Contaminants Tested in the National Status and Trends Program. " Technical Memorandum NOS OMA 52. NOAA, Office of Oceanography and Marine Assessment. Seattle, WA. *and* Long, E.R., D.D. MacDonald, S.L. Smith, and F.D. Calder. 1995. "Incidence of Adverse Biological Effects Within Ranges of Chemical Concentrations in Marine and Estuarine Sediments." *Environmental Management*. Volume 19. Number 1. Pages 81 through 97.

d While exceedance of ER-M is noted in this column, ER-M values were not used to determine if a chemical was a COPEC.

e Tidal Area 99th UCL is not available for these constituents.

f Where total values were calculated (for example, total PCBs, total DDTs, etc.) 1/2 of the standard quantitation limit was used for nondetected analytes.

g Only detected chemicals are listed.

TABLE 10-3

IDENTIFICATION OF COPECs FOR PLANTS AND SOIL BIOTA AND INVERTEBRATES
R AREA TERRESTRIAL AND AQUATIC UNIT
TIDAL AREA QEA, NWS SBD CONCORD

COPEC[g]	Rationale for Identification as COPEC			Highest Screening Value Exceeded[d]
	Exceeds Tidal Area 99th UCL[a], SF Bay Ambient[b], and ER-L[c]	Exceeds Tidal Area 99th UCL[a] and/or SF Bay Ambient[b], but No ER-L[c] Available	Detected, but No Screening Value Available	
Inorganic Constituents				
Arsenic	X			ER-L
Copper	X			ER-L
Zinc	X			ER-M
Low Detection Limit Pesticides[e]				
2,4'-DDD			X	--
Total DDTs[f]	X			ER-L
Aldrin			X	--
alpha-Chlordane			X	--
Total Chlordanes[f]	X			ER-L
Dieldrin	X			ER-L
Mirex			X	--
trans-Nonachlor			X	--
Low Detection Level SVOAs[e]				
Total LMW PAHs[f]	X			ER-L

Notes:

CLP Contract laboratory program
COEC Chemical of ecological concern
DDT Dichlorodiphenyltrichloroethane
ER-L Effects-range low
ER-M Effects-range median
HMW High molecular weight
LMW Low molecular weight
NA Screening value not available
PAH Polynuclear aromatic hydrocarbon
PCB Polychlorinated biphenyl
SVOA Semivolatile organic analyte
UCL Upper confidence level

TABLE 10-3

IDENTIFICATION OF COPECs FOR PLANTS AND SOIL BIOTA AND INVERTEBRATES
R AREA TERRESTRIAL AND AQUATIC UNIT
TIDAL AREA QEA, NWS SBD CONCORD

Notes (Continued):

a PRC Environmental Management, Inc. (PRC). 1996a. "Estimation of Ambient Metals Concentrations in the Tidal Area Soils." Technical Memorandum. Naval Weapons Station, Concord California. March.

b San Francisco Bay Regional Water Quality Control Board (RWQCB). 1998. "Ambient Concentrations of Toxic Chemicals in Sediments." April.

c National Oceanic and Atmospheric Administration (NOAA). 1991. "The Potential for Biological Effects of Sediment-Sorbed Contaminants Tested in the National Status and Trends Program. " Technical Memorandum NOS OMA 52. NOAA, Office of Oceanography and Marine Assessment. Seattle, WA. *and* Long, E.R., D.D. MacDonald, S.L. Smith, and F.D. Calder. 1995. "Incidence of Adverse Biological Effects Within Ranges of Chemical Concentrations in Marine and Estuarine Sediments." *Environmental Management*. Volume 19. Number 1. Pages 81 through 97.

d While exceedance of ER-M is noted in this column, ER-M values were not used to determine if a chemical was a COPEC.

e While exceedance of ER-M is noted in this column, ER-M values were not used to determine if a chemical was a COPEC.

f Where total values were calculated (for example, total PCBs, total DDTs, etc.) 1/2 of the standard quantitation limit was used for nondetected analytes.

g Only detected chemicals are listed.

TABLE 10-4

IDENTIFICATION OF COPECs FOR PLANTS AND SOIL BIOTA AND INVERTEBRATES
FROID AND TAYLOR TERRESTRIAL UNIT
TIDAL AREA QEA, NWS SBD CONCORD

COPEC[g]	Rationale for Identification as COPEC			Highest Screening Value Exceeded[d]
	Exceeds Tidal Area 99th UCL[a], SF Bay Ambient[b], and ER-L[c]	Exceeds Tidal Area 99th UCL[a] and/or SF Bay Ambient[b], but No ER-L[c] Available	Detected, but No Screening Value Available	
Inorganic Constituents				
Lead	X			ER-L
Mercury	X			ER-L
CLP PCBs[e]				
Total PCBs[f]	X			ER-M
Low Detection Limit Pesticides[e]				
2,4'-DDD			X	--
2,4'-DDE			X	--
2,4'-DDT			X	--
4,4'-DDD	X			ER-L
4,4'-DDE	X			ER-L
4,4'-DDT	X			ER-M
Total DDTs[f]	X			ER-L
alpha-Chlordane			X	--
Total Chlordanes[f]	X			ER-M
trans-Nonachlor			X	--
CLP Pesticides[e]				
4,4'-DDE	X			ER-L
4,4'-DDT	X			ER-M
Total DDTs[f]	X			ER-M
Total BHCs[f]		X		SF Ambient[b]
alpha-Chlordane			X	--
gamma-Chlordane			X	--
Total Chlordanes[f]	X			ER-M
Low Detection Limit SVOAs[e]				
2,4-Dimethylphenol			X	--
Benzoic Acid			X	--

TABLE 10-4

IDENTIFICATION OF COPECs FOR PLANTS AND SOIL BIOTA AND INVERTEBRATES
FROID AND TAYLOR TERRESTRIAL UNIT
TIDAL AREA QEA, NWS SBD CONCORD

COPEC[g]	Rationale for Identification as COPEC			Highest Screening Value Exceeded[d]
	Exceeds Tidal Area 99th UCL[a], SF Bay Ambient[b], and ER-L[c]	Exceeds Tidal Area 99th UCL[a] and/or SF Bay Ambient[b], but No ER-L[c] Available	Detected, but No Screening Value Available	
CLP SVOAs[e]				
Total LMW PAHs[f]	X			ER-L
Total PAHs[f]	X			ER-L
TPH - Extractable				
Motor Oil			X	--

Notes:

BHC	Hexachlorocyclohexane	HMW	High molecular weight
CLP	Contract laboratory program	LMW	Low molecular weight
COEC	Chemical of ecological concern	NA	Screening value not available
DDD	Dichlorodiphenyldichloroethane	PAH	Polynuclear aromatic hydrocarbon
DDE	Dichlorodiphenyldichloroethene	PCB	Polychlorinated biphenyl
DDT	Dichlorodiphenyltrichloroethane	SVOA	Semivolatile organic analyte
ER-L	Effects-range low	TPH	Total petroleum hydrocarbons
ER-M	Effects-range median	UCL	Upper confidence level

a PRC Environmental Management, Inc. (PRC). 1996a. "Estimation of Ambient Metals Concentrations in the Tidal Area Soils." Technical Memorandum. Naval Weapons Station, Concord California. March.

b San Francisco Bay Regional Water Quality Control Board (RWQCB). 1998. "Ambient Concentrations of Toxic Chemicals in Sediments." April.

c National Oceanic and Atmospheric Administration (NOAA). 1991. "The Potential for Biological Effects of Sediment-Sorbed Contaminants Tested in the National Status and Trends Program." Technical Memorandum NOS OMA 52. NOAA, Office of Oceanography and Marine Assessment. Seattle, WA. *and* Long, E.R., D.D. MacDonald, S.L. Smith, and F.D. Calder. 1995. "Incidence of Adverse Biological Effects Within Ranges of Chemical Concentrations in Marine and Estuarine Sediments." *Environmental Management*. Volume 19. Number 1. Pages 81 through 97.

d While exceedance of ER-M is noted in this column, ER-M values were not used to determine if a chemical was a COPEC.

e Tidal Area 99th UCL is not available for these constituents.

f Where total values were calculated (for example, total PCBs, total DDTs, etc.) 1/2 of the standard quantitation limit was used for nondetected analytes.

g Only detected chemicals are listed.

TABLE 10-5

IDENTIFICATION OF COPECs FOR PLANTS AND SOIL BIOTA AND INVERTEBRATES
FROID AND TAYLOR AQUATIC UNIT
TIDAL AREA QEA, NWS SBD CONCORD

COPEC[g]	Rationale for Identification as COPEC			Highest Screening Value Exceeded[d]
	Exceeds Tidal Area 99th UCL[a], SF Bay Ambient[b], and ER-L[c]	Exceeds Tidal Area 99th UCL[a] and/or SF Bay Ambient[b], but No ER-L[c] Available	Detected, but No Screening Value Available	
Inorganic Constituents				
Antimony	X			ER-L
Arsenic	X			ER-L
Beryllium		X		Ambient[a]
Cadmium	X			ER-L
Copper	X			ER-L
Lead	X			ER-M
Mercury	X			ER-L
Selenium	X			ER-M
Zinc	X			ER-M
CLP PCBs[e]				
Total PCBs[f]	X			ER-M
Low Detection Limit Pesticides[e]				
2,4'-DDD			X	--
2,4'-DDE			X	--
2,4'-DDT			X	--
4,4'-DDD	X			ER-L
4,4'-DDE	X			ER-L
4,4'-DDT	X			ER-M
Total DDTs[f]	X			ER-L
Aldrin			X	--
alpha-BHC			X	--
gamma-BHC (Lindane)			X	--
Total BHCs[f]		X		SF Ambient[b]
alpha-Chlordane			X	--
gamma-Chlordane			X	--
Total Chlordanes[f]	X			ER-M
Dieldrin	X			ER-L

TABLE 10-5

IDENTIFICATION OF COPECs FOR PLANTS AND SOIL BIOTA AND INVERTEBRATES
FROID AND TAYLOR AQUATIC UNIT
TIDAL AREA QEA, NWS SBD CONCORD

COPEC[g]	Rationale for Identification as COPEC			Highest Screening Value Exceeded[d]
	Exceeds Tidal Area 99th UCL[a], SF Bay Ambient[b], and ER-L[c]	Exceeds Tidal Area 99th UCL[a] and/or SF Bay Ambient[b], but No ER-L[c] Available	Detected, but No Screening Value Available	
Low Detection Limit Pesticides[e] (Continued)				
Hexachlorobenzene		X		SF Ambient[b]
trans-Nonachlor			X	--
CLP Pesticides[e]				
4,4'-DDD	X			ER-L
Total DDTs[f]	X			ER-L
Total BHCs[f]		X		SF Ambient[b]
Total Chlordanes[f]	X			ER-M
Low Detection Limit SVOAs[e]				
1,1'-Biphenyl			X	--
1-Methylnaphthalene		X		SF Ambient[b]
2,4-Dimethylphenol			X	--
2,6-Dimethylnaphthalene		X		SF Ambient[b]
4-Methylphenol			X	--
Benzoic Acid			X	--
Bis(2-thylhexyl)phthalate			X	--
Carbazole			X	--
Dibenzofuran			X	--
Total LMW PAHs[f]	X			ER-L
Total PAHs[f]	X			ER-L
CLP SVOAs[e]				
4-Methylphenol			X	--
Phenol			X	--
Total LMW PAHs[f]	X			ER-M
Total PAHs[f]	X			ER-L

TABLE 10-5

IDENTIFICATION OF COPECs FOR PLANTS AND SOIL BIOTA AND INVERTEBRATES
FROID AND TAYLOR AQUATIC UNIT
TIDAL AREA QEA, NWS SBD CONCORD

COPEC[g]	Rationale for Identification as COPEC			Highest Screening Value Exceeded[d]
	Exceeds Tidal Area 99th UCL[a], SF Bay Ambient[b], and ER-L[c]	Exceeds Tidal Area 99th UCL[a] and/or SF Bay Ambient[b], but No ER-L[c] Available	Detected, but No Screening Value Available	
CLP VOAs[e]				
4-Methyl-2-Pentanone			X	--
TPH - Extractables[e]				
Motor Oil			X	--

Notes:

BHC	Hexachlorocyclohexane	HMW	High molecular weight
CLP	Contract laboratory program	LMW	Low molecular weight
COEC	Chemical of ecological concern	NA	Screening value not available
DDD	Dichlorodiphenyldichloroethane	PAH	Polynuclear aromatic hydrocarbon
DDE	Dichlorodiphenyldichloroethene	PCB	Polychlorinated biphenyl
DDT	Dichlorodiphenyltrichloroethane	SVOA	Semivolatile organic analyte
ER-L	Effects-range low	TPH	Total petroleum hydrocarbons
ER-M	Effects-range median	UCL	Upper confidence level

a PRC Environmental Management, Inc. (PRC). 1996a. "Estimation of Ambient Metals Concentrations in the Tidal Area Soils." Technical Memorandum. Naval Weapons Station, Concord California. March.

b San Francisco Bay Regional Water Quality Control Board (RWQCB). 1998. "Ambient Concentrations of Toxic Chemicals in Sediments." April.

c National Oceanic and Atmospheric Administration (NOAA). 1991. "The Potential for Biological Effects of Sediment-Sorbed Contaminants Tested in the National Status and Trends Program. " Technical Memorandum NOS OMA 52. NOAA, Office of Oceanography and Marine Assessment. Seattle, WA. *and* Long, E.R., D.D. MacDonald, S.L. Smith, and F.D. Calder. 1995. "Incidence of Adverse Biological Effects Within Ranges of Chemical Concentrations in Marine and Estuarine Sediments." *Environmental Management*. Volume 19. Number 1. Pages 81 through 97.

d While exceedance of ER-M is noted in this column, ER-M values were not used to determine if a chemical was a COPEC.

e Tidal Area 99th UCL is not available for these constituents.

f Where total values were calculated (for example, total PCBs, total DDTs, etc.) 1/2 of the standard quantitation limit was used for nondetected analytes.

g Only detected chemicals are listed.

TABLE 10-6

IDENTIFICATION OF COPECs FOR PLANTS AND SOIL BIOTA AND INVERTEBRATES
WOOD HOGGER TERRESTRIAL UNIT
TIDAL AREA QEA, NWS SBD CONCORD

COPEC[g]	Rationale for Identification as COPEC			Highest Screening Value Exceeded[d]
	Exceeds Tidal Area 99th UCL[a], SF Bay Ambient[b], and ER-L[c]	Exceeds Tidal Area 99th UCL[a] and/or SF Bay Ambient[b], but No ER-L[c] Available	Detected, but No Screening Value Available	
Inorganic Constituents				
Antimony	X			ER-L
Arsenic	X			ER-L
Beryllium		X		Ambient[a]
Cadmium	X			ER-M
Copper	X			ER-M
Lead	X			ER-M
Mercury	X			ER-M
Selenium	X			ER-M
Zinc	X			ER-M
Low Detection Limit PCB[e]				
Total PCBs	X			ER-L
CLP PCBs[e]				
Total PCBs	X			ER-M
Low Detection Limit Pesticides[e]				
2,4'-DDD			X	--
2,4'-DDE			X	--
2,4'-DDT			X	--
4,4'-DDD	X			ER-M
4,4'-DDE	X			ER-M
4,4'-DDT	X			ER-M
Total DDTs[f]	X			ER-M
Aldrin			X	--
gamma-BHC (Lindane)			X	--
Total BHCs[f]		X		SF Ambient[b]

TABLE 10-6

IDENTIFICATION OF COPECs FOR PLANTS AND SOIL BIOTA AND INVERTEBRATES
WOOD HOGGER TERRESTRIAL UNIT
TIDAL AREA QEA, NWS SBD CONCORD

COPEC[g]	Rationale for Identification as COPEC			Highest Screening Value Exceeded[d]
	Exceeds Tidal Area 99th UCL[a], SF Bay Ambient[b], and ER-L[c]	Exceeds Tidal Area 99th UCL[a] and/or SF Bay Ambient[b], but No ER-L[c] Available	Detected, but No Screening Value Available	
Low Detection Limit Pesticides[e] (Continued)				
alpha-Chlordane			X	--
Total Chlordanes[f]	X			ER-M
Dieldrin	X			ER-L
Heptachlor			X	--
Heptachlor Epoxide			X	--
Mirex			X	--
trans-Nonachlor			X	--
CLP Pesticides[e]				
4,4'-DDD	X			ER-L
4,4'-DDT	X			ER-L
Total DDTs[f]	X			ER-M
Total BHCs[f]		X		SF Ambient[b]
alpha-Chlordane			X	--
Total Chlordanes[f]	X			ER-M
Endrin ketone			X	--
Dioxins[e]				
1,2,3,4,6,7,8,9-OCDD			X	--
1,2,3,4,6,7,8,9-OCDF			X	--
1,2,3,4,6,7,8-HPCDD			X	--
1,2,3,4,6,7,8-HPCDF			X	--
Total OCDD[f]			X	--
Total HPCDD[f]			X	--
Total HPCDF[f]			X	--
Total HXCDF[f]			X	--
Total TCDD[f]			X	--

TABLE 10-6

IDENTIFICATION OF COPECs FOR PLANTS AND SOIL BIOTA AND INVERTEBRATES
WOOD HOGGER TERRESTRIAL UNIT
TIDAL AREA QEA, NWS SBD CONCORD

COPEC[g]	Rationale for Identification as COPEC			Highest Screening Value Exceeded[d]
	Exceeds Tidal Area 99th UCL[a], SF Bay Ambient[b], and ER-L[c]	Exceeds Tidal Area 99th UCL[a] and/or SF Bay Ambient[b], but No ER-L[c] Available	Detected, but No Screening Value Available	
Low Detection Level SVOAs[e]				
1-Methylphenanthrene		X		SF Ambient[b]
Acenaphthene	X			ER-L
Acenaphthylene	X			ER-L
Anthracene	X			ER-M
Benzo(a)anthracene	X			ER-M
Benzo(a)pyrene	X			ER-M
Benzo(b)fluoranthene		X		SF Ambient[b]
Benzo(e)pyrene		X		SF Ambient[b]
Benzo(g,h,i)perylene		X		SF Ambient[b]
Benzo(k)fluoranthene		X		SF Ambient[b]
Benzoic Acid			X	--
Butylbenzylphthalate			X	--
Carbazole			X	--
Chrysene	X			ER-M
Dibenz(a,h)anthracene	X			ER-M
Dibenzofuran			X	--
Dibenzothiophene			X	--
Fluoranthene	X			ER-M
Fluorene	X			ER-L
Indeno(1,2,3-cd)pyrene		X		SF Ambient[b]
Pentachlorophenol			X	--
Perylene		X		SF Ambient[b]
Phenanthrene	X			ER-M
Pyrene	X			ER-M
Total HMW PAHs[f]	X			ER-M
Total LMW PAHs[f]	X			ER-M
Total PAHs[f]	X			ER-M

TABLE 10-6

IDENTIFICATION OF COPECs FOR PLANTS AND SOIL BIOTA AND INVERTEBRATES
WOOD HOGGER TERRESTRIAL UNIT
TIDAL AREA QEA, NWS SBD CONCORD

COPEC[a]	Rationale for Identification as COPEC			Highest Screening Value Exceeded[d]
	Exceeds Tidal Area 99th UCL[a], SF Bay Ambient[b], and ER-L[c]	Exceeds Tidal Area 99th UCL[a] and/or SF Bay Ambient[b], but No ER-L[c] Available	Detected, but No Screening Value Available	
CLP SVOAs[e]				
Benzo(b)fluoranthene		X		SF Ambient[b]
Carbazole			X	--
Fluoranthene	X			ER-L
Phenanthrene	X			ER-L
Phenol			X	--
Total LMW PAHs[f]	X			ER-M
Total PAHs[f]	X			ER-L
CLP VOAs[e]				
2-Butanone			X	--
Acetone			X	--
Carbon Disulfide			X	--
Xylene (Total)			X	--
Aromatic Volatiles[e]				
Ethylbenzene			X	--
Xylene (Total)			X	--
TPH - Extractables[e]				
Diesel			X	--
Motor Oil			X	--
TPH - Purgeables[e]				
Gasoline			X	--

TABLE 10-6

IDENTIFICATION OF COPECs FOR PLANTS AND SOIL BIOTA AND INVERTEBRATES
WOOD HOGGER TERRESTRIAL UNIT
TIDAL AREA QEA, NWS SBD CONCORD

COPEC[g]	Rationale for Identification as COPEC			Highest Screening Value Exceeded[d]
	Exceeds Tidal Area 99th UCL[a], SF Bay Ambient[b], and ER-L[c]	Exceeds Tidal Area 99th UCL[a] and/or SF Bay Ambient[b], but No ER-L[c] Available	Detected, but No Screening Value Available	
Explosives[e]				
1,3-Dinitrobenzene			X	–
HMX			X	--

Notes:

BHC Hexachlorocyclohexane
CLP Contract laboratory program
COEC Chemical of ecological concern
DDD Dichlorodiphenyldichloroethane
DDE Dichlorodiphenyldichloroethene
DDT Dichlorodiphenyltrichloroethane
ER-L Effects-range low
ER-M Effects-range median
HMX Cyclotetramethylene tetranitramine
HMW High molecular weight
HPCDD Heptachlorodibenzodioxin
HPCDF Heptachlorodibenzofuran
LMW Low molecular weight
NA Screening value not available
OCDD Octachlorodibenzodioxin
OCDF Octachlorodibenzofuran
PAH Polynuclear aromatic hydrocarbon
PCB Polychlorinated biphenyl
SVOA Semivolatile organic analyte
TCDD Tetrachlorodibenzodioxin
TPH Total petroleum hydrocarbons
UCL Upper confidence level
VOA Volatile organic analyte

a PRC Environmental Management, Inc. (PRC). 1996a. "Estimation of Ambient Metals Concentrations in the Tidal Area Soils." Technical Memorandum. Naval Weapons Station, Concord California. March.

b San Francisco Bay Regional Water Quality Control Board (RWQCB). 1998. "Ambient Concentrations of Toxic Chemicals in Sediments." April.

c National Oceanic and Atmospheric Administration (NOAA). 1991. "The Potential for Biological Effects of Sediment-Sorbed Contaminants Tested in the National Status and Trends Program. " Technical Memorandum NOS OMA 52. NOAA, Office of Oceanography and Marine Assessment. Seattle, WA. *and* Long, E.R., D.D. MacDonald, S.L. Smith, and F.D. Calder. 1995. "Incidence of Adverse Biological Effects Within Ranges of Chemical Concentrations in Marine and Estuarine Sediments." *Environmental Management*. Volume 19. Number 1. Pages 81 through 97.

d While exceedance of ER-M is noted in this column, ER-M values were not used to determine if a chemical was a COPEC.

e Tidal Area 99th UCL is not available for these constituents.

f Where total values were calculated (for example, total PCBs, total DDTs, etc.) 1/2 of the standard quantitation limit was used for nondetected analytes.

g Only detected chemicals are listed.

TABLE 10-7

POTENTIAL CRITICAL VALUES FOR SELECTED SOIL FACTORS (PHYSICAL AND CHEMICAL) ASSOCIATED WITH POOR VEGETATIVE GROWTH TIDAL AREA QEA, NWS SBD CONCORD

Soil Factor	Critical Value[a]	Tidal Area	Ambient
Physical Characteristic			
pH	< 5.5 or > 8.5	4.4 to 8.8	NA
Conductivity	> 4 - 6 μmhos/cm	NA	NA
SAR	≥ 12	NA	NA
Texture	> 40% fines	8% - 99% fines	NA
Chemical Characteristic (mg/kg)			
Arsenic	>10 - 20	40 (maximum)	24
Boron	≥ 8	NA	NA
Cadmium	> 0.1 - 1.0 or greater	1.9 (maximum)	0.29
Copper	≥ 40	81 (maximum)	59
Lead	> 10 - 15 (at pH less than 6.0) > 15 - 20 (at pH greater than 6.0)	1,160 (maximum)	61
Manganese	≥ 60	1,470 (maximum)	840
Mercury	≥ 150	0.28 (maximum)	0.22
Selenium	≥ 2.0	5.3 (maximum)	NA
Zinc	≥ 40	3,010 (maximum)	180

Notes:

fines	Defined as clay and silt (particle size less than 62.5 micrograms)
mg/kg	Milligrams per kilogram
μmhos/cm	Micromhos per centimeter
NA	Not available for Tidal Area
a	Critical value represents a "safe" level for most plants

TABLE 10-8

SOIL CONCENTRATIONS IN REFERENCE TO PRELIMINARY REMEDIATION GOALS AND TOXICOLOGICAL BENCHMARKS
LANDFILL TERRESTRIAL UNIT
TIDAL AREA QEA, NWS SBD CONCORD

Tidal Area COEC	LFT Max	Tidal 99% UCL Ambient	RWQCB SF Bay Ambient[1] (<100% fines)	CDFG Plant PRGs[2]	CDFG Invertebrate PRGs[2]	ORNL PRG[3]; endpoint (mg/kg soil)	Soil and Litter Benchmark[4] (mg/kg soil)	Benchmark Based on Critical Soil and Litter Receptor[4] (mg/kg soil)	Terrestrial Plant Benchmark[5] (mg/kg soil)
Metals (mg/kg)									
Antimony	3.1	2.2	---	5.0	NA	5[a]; plant[b,c]	NA[4]	---	5.0
Arsenic	57.6	27	15.3	3.0	NA	9.9; shrew, plant	---	---	10
Beryllium	0.56	0.18	---	10	NA	10[a]; plant[b,c]	NA	---	10
Cadmium	5.8	1.9	0.33	2.0	1.00		20	Earthworms	3.0
Copper	264	81	68.1	40	15	20[a]; plant[b,c]	50	Earthworms	100
Lead	156	95	43.2	200	100		500	Earthworms	50
Mercury	0.48	0.32	0.43	0.30	0.12		0.10	Earthworms	0.30
Zinc	743	264	158	93	75		200	Earthworms	50
Organics (mg/kg)									
Total PCBs	0.80	---	0.022	---	---		---	---	40
Acenaphthene	---	---	0.027	---	---	20[a]; plant[b,c]	---	---	20
Biphenyl	---	---	0.013	---	---	60[a]; plant[b,c]	---	---	60
Chlorobenzene	---	---	---	---	---	40[a]; earthworm[c,e]	---	---	---
Phenol	19	---	---	---	---	30[a]; earthworm[c]	---	---	70
Pentachlorophenol	---	---	---	---	---	---	---	---	3.0
Di-n-butyl phthalate	---	---	---	---	---	200[a]; plant[b,c]	---	---	200
Diethylphthalate	---	---	---	---	---	100[a]; plant[b,c]	---	---	100

Notes:

CDFG California Department of Fish and Game
COEC Chemical of ecological concern
LFT Landfill Terrestrial Unit
ORNL Oak Ridge National Laboratory
mg/kg Milligrams per kilogram
NA Not analyzed
ND Not detected
PCB Polychlorinated biphenyl
PRG Preliminary remediation goal
RWQCB Regional Water Quality Control Board
UCL Upper confidence limit

TABLE 10-8

SOIL CONCENTRATIONS IN REFERENCE TO PRELIMINARY REMEDIATION GOALS AND TOXICOLOGICAL BENCHMARKS
LANDFILL TERRESTRIAL UNIT
TIDAL AREA QEA, NWS SBD CONCORD

Notes (Continued):

1 Regional Water Quality Control Board, San Francisco Bay Region. 1998. "Ambient Concentrations of Toxic Chemicals in Sediments." April.

2 California Department of Fish And Game. 1997. "Department of Fish and Game's Recommended Soil PRGs for Initial Risk Assessment Screening." July.

3 Efroymson, R.A. and Others. 1997. "Preliminary Remediation Goals for Ecological Endpoints." U.S. Department of Energy. August.

4 Will, M.E. and G.W. Suter. 1995. "Toxicological Benchmarks for Potential Contaminants of Concern for Effects on Soil and Litter Invertebrates and Heterotrophic Processes:1995 Revision." U.S. Department of Energy. September.

5 Will, M.E. and G.W. Suter. 1995. "Toxicological Benchmarks for Screening Potential Contaminants of Concern for Effectes on Terrestrial Plants: 1995 Revision." U.S. Department of Energy. September.

a Efrymson and others (1997) have low confidence in this value.

b Toxic concentration benchmarks are not available for earthworms. Therefore, the PRG cannot be assumed to protect earthworms.

c Soil-plant uptake models, soil-earthworm uptake models or LOAELs were not available for this chemical for at least one wildlife endpoint. Therefore, the PRG cannot be assumed to protect wildlife.

d This value is so low that it may often be within background soil concentrations. We do not recommend that remedial goals be set within the range of background concentrations.

e Toxic Concentration benchmarks are not available for plants in soils. Therefore, the PRG cannot be be assumed to protect plants.

--- Not applicable

TABLE 10-9

SOIL CONCENTRATIONS IN REFERENCE TO PRELIMINARY REMEDIATION GOALS AND TOXICOLOGICAL BENCHMARKS
R AREA TERRESTRIAL UNIT
TIDAL AREA QEA, NWS SBD CONCORD

Tidal Area COEC	RAT Max	RATA Max	99% UCL Tidal Ambient	RWQCB SF Bay Ambient[1] (<100% fines)	CDFG Plant PRGs[2]	CDFG Invertebrate PRGs[2]	ORNL PRG[3]; Endpoint (mg/kg soil)	Soil and Litter Benchmark[4] (mg/kg soil)	Benchmark Based on Critical Soil and Litter Receptor[4] (mg/kg soil)	Terrestrial Plant Benchmark[5] (mg/kg soil)
Metals (mg/kg)										
Antimony	5.6	NC	2.2	---	5.0	NA	5[a]; plant[b,c]	NA[4]	---	5.0
Arsenic	42.0	NC	27	15.3	3.0	NA	9.9; shrew, plant	---	---	10
Barium	7,705	NC	530	---	500	NA		3,000	Microbial process	500
Beryllium	0.57	NC	0.18	---	10	NA	10[a]; plant[b,c]	NA	---	10
Copper	87.8	NC	81	68.1	40	15	20[a]; plant[b,c]	50	Earthworms	100
Lead	1,160	NC	95	43.2	200	100		500	Earthworms	50
Mercury	0.58	NC	0.32	0.43	0.30	0.12		0.10	Earthworms	0.30
Nickel	242	NC	120	112	20	50	30; plant[c]	200	Earthworms	30
Selenium	1.3	NC	0.64	1.0	---	---			0.70	
Zinc	959	424	264	158	93	75		200	Earthworms	50
Organics (mg/kg)										
Total PCBs	0.565	0.004	---	0.022	---	---		---	---	40
Acenaphthene	0.18	---	---	0.027	---	---	20[a]; plant[b,c]	---	---	20
Biphenyl	---	---	---	0.013	---	---	60[a]; plant[b,c]	---	---	60
Chlorobenzene	---	---	---	---	---	---	40[a]; earthworm[c,e]	---	---	---
Phenol	0.60	---	---	---	---	---	30[a]; earthworm[c]	---	---	70
Pentachlorophenol	---	---	---	---	---	---	---	---	---	3.0
Di-n-butyl phthalate	---	---	---	---	---	---	200[a]; plant[b,c]	---	---	200
Diethylphthalate	---	---	---	---	---	---	100[a]; plant[b,c]	---	---	100

Notes:

CDFG California Department of Fish and Game
COEC Chemical of ecological concern
ORNL Oak Ridge National Laboratory
mg/kg Milligrams per kilogram
NA Not Available
NC Not a COEC
PCB Polychlorinated biphenyl
PRG Preliminary remediation goal
RAT R Area terrestrial
RATA R Area terrestrial and aquatic
RWQCB Regional Water Quality Control Board
UCL Upper confidence limit

TABLE 10-9

SOIL CONCENTRATIONS IN REFERENCE TO PRELIMINARY REMEDIATION GOALS AND TOXICOLOGICAL BENCHMARKS
R AREA TERRESTRIAL UNIT
TIDAL AREA QEA, NWS SBD CONCORD

Notes (Continued):

1 Regional Water Quality Control Board, San Francisco Bay Region. 1998. "Ambient Concentrations of Toxic Chemicals in Sediments." April.

2 California Department of Fish And Game. 1997. "Department of Fish and Game's Recommended Soil PRGs for Initial Risk Assessment Screening." July.

3 Efroymson, R.A. and Others. 1997. "Preliminary Remediation Goals for Ecological Endpoints." U.S. Department of Energy. August.

4 Will, M.E. and G.W. Suter. 1995. "Toxicological Benchmarks for Potential Contaminants of Concern for Effects on Soil and Litter Invertebrates and Heterotrophic Processes:1995 Revision." U.S. Department of Energy. September.

5 Will, M.E. and G.W. Suter. 1995. "Toxicological Benchmarks for Screening Potential Contaminants of Concern for Effectes on Terrestrial Plants: 1995 Revision." U.S. Department of Energy. September.

a Efrymson and others (1997) have low confidence in this value.

b Toxic concentration benchmarks are not available for earthworms. Therefore, the PRG cannot be assumed to protect earthworms.

c Soil-plant uptake models, soil-earthworm uptake models or LOAELs were not available for this chemical for at least one wildlife endpoint. Therefore, the PRG cannot be assumed to protect wildlife.

d This value is so low that it may often be within background soil concentrations. We do not recommend that remedial goals be set within the range of background concentrations.

e Toxic Concentration benchmarks are not available for plants in soils. Therefore, the PRG cannot be be assumed to protect plants.

--- Not applicable

TABLE 10-10

SOIL CONCENTRATIONS IN REFERENCE TO PRELIMINARY REMEDIATION GOALS AND TOXICOLOGICAL BENCHMARKS
FROID AND TAYLOR TERRESTRIAL UNIT
TIDAL AREA QEA, NWS SBD CONCORD

Tidal Area COEC	FTT Max	FTA Max	99% UCL Tidal Ambient	RWQCB SF Bay Ambient[1] (<100% fines)	DFG Plant PRGs[2]	DFG Invertebrate PRGs[2]	ORNL PRG[3]; Endpoint (mg/kg soil)	Soil and Litter Benchmark[4] (mg/kg soil)	Benchmark Based on Critical Soil and Litter Receptor[4] (mg/kg soil)	Terrestrial Plant Benchmark[5] (mg/kg soil)
Metals (mg/kg)										
Antimony	ND	2.2	2.2	---	5.0	NA	5[a]; plant[b,c]	NA[4]	---	5.0
Arsenic	4.5	26.6	27	15.3	3.0	NA	9.9; shrew, plant	---	---	10
Barium	165	234	530	---	500	NA		3,000	Microbial process	500
Beryllium	ND	0.35	0.18	---	10.0	NA	10[a]; plant[b,c]	NA	---	10
Cadmium	0.38	1.9	1.9	0.33	2.0	1.0		20	Earthworms	3.0
Copper	30.3	92	81	68.1	40	15	20[a]; plant[b,c]	50	Earthworms	100
Lead	72	515	95	43.2	200	100		500	Earthworms	50
Mercury	0.25	0.49	0.32	0.43	0.30	0.12		0.10	Earthworms	0.30
Selenium	ND	1.5	0.64	1.0	---	---			0.70	
Zinc	106	436	264	158	93	75		200	Earthworms	50
Organics (mg/kg)										
Total PCBs	2.94	0.761	---	0.022	---	---		---	---	40
Acenaphthene	---	---	---	0.027	---	---	20[a]; plant[b,c]	---	---	20
Biphenyl	---	---	---	0.013	---	---	60[a]; plant[b,c]	---	---	60
Chlorobenzene	---	---	---	---	---	---	40[a]; earthworm[b,c]	---	---	---
Phenol	---	---	---	---	---	---	30[a]; earthworm[c]	---	---	70
Pentachlorophenol	---	---	---	---	---	---	---	---	---	3.0
Di-n-butyl phthalate	---	---	---	---	---	---	200[a]; plant[b,c]	---	---	200
Diethylphthalate	---	---	---	---	---	---	100[a]; plant[b,c]	---	---	100

Notes:

CDFG California Department
COEC Chemical of ecological concern
FTA Froid and Taylor Aquatic
FTT Froid and Taylor Terrestrial
ORNL Oak Ridge National Laboratory
mg/kg Milligrams per kilogram
NA Not analyzed
ND Not detected
PCB Polychlorinated biphenyl
PRG Preliminary remediation goal
RWQCB Regional Water Quality Control Board
UCL Upper confidence limit

TABLE 10-10

SOIL CONCENTRATIONS IN REFERENCE TO PRELIMINARY REMEDIATION GOALS AND TOXICOLOGICAL BENCHMARKS
FROID AND TAYLOR TERRESTRIAL UNIT
TIDAL AREA QEA, NWS SBD CONCORD

Notes (Continued):

1 Regional Water Quality Control Board, San Francisco Bay Region. 1998. "Ambient Concentrations of Toxic Chemicals in Sediments." April.

2 California Department of Fish And Game. 1997. "Department of Fis

3 Efroymson, R.A. and Others. 1997. "Preliminary Remediation Goals for Ecological Endpoints." U.S. Department of Energy. August.

4 Will, M.E. and G.W. Suter. 1995. "Toxicological Benchmarks for Potential Contaminants of Concern for Effects on Soil and Litter Invertebrates and Heterotrophic Processes:1995 Revision." U.S. Department of Energy. September.

5 Will, M.E. and G.W. Suter. 1995. "Toxicological Benchmarks for Screening Potential Contaminants of Concern for Effectes on Terrestrial Plants: 1995 Revision." U.S. Department of Energy. September.

a Efrymson and others (1997) have low confidence in this value.

b Toxic concentration benchmarks are not available for earthworms. Therefore, the PRG cannot be assumed to protect earthworms.

c Soil-plant uptake models, soil-earthworm uptake models or LOAELs were not available for this chemical for at least one wildlife endpoint. Therefore, the PRG cannot be assumed to protect wildlife.

d This value is so low that it may often be within background soil concentrations. We do not recommend that remedial goals be set within the range of background concentrations.

e Toxic Concentration benchmarks are not available for plants in soils. Therefore, the PRG cannot be be assumed to protect plants.

--- Not applicable

TABLE 10-11

SOIL CONCENTRATIONS IN REFERENCE TO PRELIMINARY REMEDIATION GOALS AND TOXICOLOGICAL BENCHMARKS
WOOD HOGGER TERRESTRIAL UNIT
TIDAL AREA QEA, NWS SBD CONCORD

Tidal Area COEC	WHT Max	Tidal 99%UCL Ambient	RWQCB SF Bay Ambient[1] (<100% fines)	CDFG Plant PRGs[2]	CDFG Invertebrate PRGs[2]	ORNL PRG[3]; Endpoint (mg/kg soil)	Soil and Litter Benchmark[4] (mg/kg soil)	Benchmark Based on Critical Soil and Litter Receptor[4] (mg/kg soil)	Terrestrial Plant Benchmark[5] (mg/kg soil)
Metals (mg/kg)									
Antimony	7.1	2.2	---	5.0	NA	5[a]; plant[b,c]	NA[4]	---	5.0
Arsenic	27.1	27	15.3	3.0	NA	9.9; shrew, plant	---		10
Barium	546	530	---	500	NA		3,000	Microbial process	500
Beryllium	0.52	0.18	---	10	NA	10[a]; plant[b,c]	NA	---	10
Cadmium	20.8	1.9	0.33	2.0	1.0		20	Earthworms	3.0
Copper	607	81	68.1	40	15	20[a]; plant[b,c]	50	Earthworms	100
Lead	598	95	43.2	200	100		500	Earthworms	50
Mercury	7.1	0.32	0.43	0.30	0.12		0.10	Earthworms	0.30
Selenium	4.8	---	0.64	1.0	---	---			0.70
Zinc	3,010	264	158	93	75		200	Earthworms	50
Organics (mg/kg)									
Total PCBs	1.6	---	0.022	---	---		---	---	40
Acenaphthene	0.28	---	0.027	---	---	20[a]; plant[b,c]	---	---	20
Biphenyl	---	---	0.013	---	---	60[a]; plant[b,c]	---	---	60
Chlorobenzene	---	---	---	---	---	40[a]; earthworm[c,e]	---	---	---
Phenol	2.6	---	---	---	---	30[a]; earthworm[c]	---	---	70
Pentachlorophenol	0.78	---	---	---	---	---	---	---	3.0
Di-n-butyl phthalate	---	---	---	---	---	200[a]; plant[b,c]	---	---	200
Diethylphthalate	---	---	---	---	---	100[a]; plant[b,c]	---	---	100

Notes:

CDFG California Department of Fish and Game
COEC Chemical of ecological concern
ORNL Oak Ridge National Laboratory
mg/kg Milligrams per kilogram
NA Not analyzed
ND Not detected
PCB Polychlorinated biphenyl
PRG Preliminary remediation goal
RWQCB Regional Water Quality Control Board
UCL Upper confidence limit
WHT Wood Hogger terrestrial

TABLE 10-11

SOIL CONCENTRATIONS IN REFERENCE TO PRELIMINARY REMEDIATION GOALS AND TOXICOLOGICAL BENCHMARKS
WOOD HOGGER TERRESTRIAL UNIT
TIDAL AREA QEA, NWS SBD CONCORD

Notes (Continued):

1 Regional Water Quality Control Board, San Francisco Bay Region. 1998. "Ambient Concentrations of Toxic Chemicals in Sediments." April.

2 California Department of Fish And Game. 1997. "Department of Fish and Game's Recommended Soil PRGs for Initial Risk Assessment Screening." July.

3 Efroymson, R.A. and Others. 1997. "Preliminary Remediation Goals for Ecological Endpoints." U.S. Department of Energy. August.

4 Will, M.E. and G.W. Suter. 1995. "Toxicological Benchmarks for Potential Contaminants of Concern for Effects on Soil and Litter Invertebrates and Heterotrophic Processes:1995 Revision." U.S. Department of Energy. September.

5 Will, M.E. and G.W. Suter. 1995. "Toxicological Benchmarks for Screening Potential Contaminants of Concern for Effectes on Terrestrial Plants: 1995 Rev

a Efrymson and others (1997) have low confidence in this value.

b Toxic concentration benchmarks are not available for earthworms. Therefore, the PRG cannot be assumed to protect earthworms.

c Soil-plant uptake models, soil-earthworm uptake models or LOAELs were not available for this chemical for at least one wildlife endpoint. Therefore, the PRG cannot be assumed to protect wildlife.

d This value is so low that it may often be within background soil concentrations. We do not recommend that remedial goals be set within the range of background concentrations.

e Toxic Concentration benchmarks are not available for plants in soils. Therefore, the PRG cannot be be assumed to protect plants.

— Not applicable

TABLE 10-12

SUMMARY OF CONCENTRATIONS OF SELECTED PLANT NUTRIENTS IN WESTERN SOILS TIDAL AREA QEA, NWS SBD CONCORD

Element	Range of Total Concentration	Extractable or Soluble[1]	Low or Deficient[1]	High or Toxic[1]
Aluminum	0.5% - 10%	varies with pH	NA[2]	> 10
Barium	20 - 70 mg/kg	< 1 - 8	0.5	> 10
Cadmium	0.1 - 2 mg/kg	0.01 - 0.05	NA	Not known
Copper	2 - 90	0.1 - 0.7	0.2	> 40 – 100
Iron	0.3% - 6.8%	1.5 - 200	2.0	Not known under natural conditions
Manganese	65 - 1300 mg/kg	1 - 40	1.0	Not known
Molybdenum	0.5 - 20 mg/kg	0.05 - 0.3	Varies with copper concentration	Varies with copper concentration
Lead	3 - 25 mg/kg	0.1 - 3	NA	> 50
Selenium	2 - 20 mg/kg	0.01 - 10	vegetation levels < 0.05	vegetation levels > 0.05

Notes:

1 Concentrations in mg/kg unless otherwise noted.

2 NA = not applicable (element not required for plant growth)

3 Information compiled from Linder and others 1996 and Munshower 1994

TABLE 12-1

IDENTIFICATION OF COPECs FOR FISH TIDAL AREA QEA, NWS SBD CONCORD

COPEC	Concord QEA Water Screening Value[a]	R Area Terrestrial and Aquatic Unit	Froid and Taylor Aquatic Unit	North Otter Sluice Aquatic Unit	South Otter Sluice Aquatic Unit
Inorganics (μg/L)					
Aluminum	87	X	X	X	X
Antimony	NA	--	X	X	--
Arsenic	36	X	X	--	--
Barium	NA	X	X	X	X
Cadmium	1.1	X	--	--	--
Chromium	86	--	--	X	--
Cobalt	NA	X	X	X	X
Copper	3.2	X	X	X	X
Lead	3.1	X	X	X	--
Manganese	NA	X	X	X	X
Mercury	0.025	X	X	X	X
Molybdenum	NA	X	X	X	X
Nickel	8.2	X	X	X	--
Silver	0.22	--	X	--	--
Thallium	NA	X	X	X	X
Vanadium	NA	X	X	X	X
Zinc	58	X	X	X	X
Pesticides and PCBs (μg/L)					
4,4'-DDT	0.001	--	--	X	--
Total DDTs	NA	X	X	X	X
alpha-BHC	NA	X	--	--	--
Total BHC	NA	X	X	X	X
alpha-Chlordane	NA	--	--	X	--
Total Chlordanes	0.004	X	X	X	X
Dieldrin	0.0019	--	--	X	--
Endrin	0.0023	--	--	X	--
Heptachlor	0.0036	--	--	X	--
Heptachlor epoxide	0.0036	X	--	--	--

TABLE 12-1 (Continued)

IDENTIFICATION OF COPECs FOR FISH
TIDAL AREA QEA, NWS SBD CONCORD

COPEC	Concord QEA Water Screening Value[a]	R Area Terrestrial and Aquatic Unit	Froid and Taylor Aquatic Unit	North Otter Sluice Aquatic Unit	South Otter Sluice Aquatic Unit
Pesticides and PCBs (μg/L) (Continued)					
Total PCBs	NA	X	X	X	X
SVOCs (μg/L)					
4-Methylphenol	NA	--	X	--	--
Bis(2-ethylhexyl)phthalate	NA	--	--	--	X
Chrysene	NA	--	X	--	--
Phenol	NA	--	X	--	--
Total HMW PAHs	NA	X	X	X	X
Total LMW PAHs	NA	X	X	X	X
Total PAHs	15	X	X	X	X
VOCs (μg/L)					
Carbon disulfide	NA	--	X	--	--
Chloromethane	NA	--	--	X	--
TPH-Extractables (mg/L)					
Diesel range organics	NA	--	X	--	--
Motor oil range organics	NA	--	X	--	--

Note:

BHC Hexachlorocyclohexane
COPEC Chemical of ecological concern
DDT Dichlorodiphenyltrichloroethane
HMW High molecular weight
LMW Low molecular weight
mg/L Milligrams per liter
NA No screening value available
PAH Polynuclear aromatic hydrocarbon
PCB Polychlorinated biphenyl
QEA Qualitative ecological assessment
μg/L Micrograms per liter

a See Table 5-2 for selection of QEA water screening values.
-- Chemical did not exceed the QEA screening value or was not detected.
X Chemical exceeded the QEA screening value or chemical was detected and no screening value is available.

TABLE 12-2

COMPARISION OF SITE AND REGIONAL FISH TISSUE
TIDAL AREA QEA, NWS SBD CONCORD

Analyte	FTA Concentration	NOSA Concentration	SOSA Concentrations	Regional Fish Concentrations	Species	Reference
Inorganic Chemicals (mg/kg wet weight)						
Aluminum	75.00	20.30	14.2 - 26.6	---	---	---
Antimony	ND	ND	0.25	---	---	---
Barium	4.30	2.00	2.3 - 4.0	---	---	---
Chromium	0.29	0.17	0.14 - 0.26	---	---	---
Copper	1.50	1.20	0.77 - 2.20	---	---	---
Iron	106.00	43.30	36.7 - 82.6	---	---	---
Lead	0.22	ND	ND	0.21 - 5.1	Rockfish, anchovy	Jarman 1996
Magnesium	437.00	197.00	177 - 237	---	---	---
Manganese	13.90	3.50	1.7 - 14.2	---	---	---
Mercury	0.09	0.07	0.03 - 0.10	0.53	Striped Bass, Suisun Bay	SFEI 1997
Nickel	0.19	ND	ND	0.81 - 3.71	Sturgeon, San Pablo Bay	SFEI 1997
Selenium	0.45	0.49	0.35 - 0.52	---	---	---
Vanadium	0.58	0.30	0.19 - 0.29	---	---	---
Zinc	21.20	20.40	12.1 - 26.4	---	---	---
PCBs (µg/kg wet weight)						
Total PCBs	8.20	5.00	1.3 - 9.1	17.00	Striped Bass, Suisun Bay	SFEI 1997
Pesticides (µg/kg wet weight)						
Total DDTs	25.00	16.00	6.0 - 9.0	14.40	Striped Bass, Suisun Bay	SFEI 1997
Dieldrin	2.00	ND	1.0 - 2.0	0.60	Striped Bass, Suisun Bay	SFEI 1997
Endrin Aldehyde	ND	ND	0.3 - 0.4	---	---	---
Hexachlorobenzene	0.70	ND	0.70	---	---	---
Methoxychlor	1.00	2.00	1.0 - 2.0	---	---	---
Oxychlordane	ND	ND	0.40	---	---	---
trans-Nonachlor	ND	4.00	2.0 - 3.0	1.00	Striped Bass, Suisun Bay	SFEI 1997
Dioxins (TEQs µg/kg wet weight)						
Total Dioxin	NA	NA	0.21-0.62	1.2-1.6 0.15	White Croaker, Berkely, San Pablo Bay; halibut, San Francisco Bay	SFEI 1997, RWQCB (1994)

Notes: Site fish include gobies, sculpins, stickleback, and mosquitofish.

DDT	Dichlorodiphenyltrichloroethane	NOSA	North Otter Sluice Aquatic Unit
FTA	Froid and Taylor aquatic	PCB	Polychlorinated biphenyl
LS	Leopard shark	SFEI	San Francisco Estuary Institute (RMP data)
mg/kg	Milligrams per kilogram	SOSA	South Otter Sluice Aquatic Unit
NA	Not analyzed	µg/kg	Micrograms per kilogram
ND	Not detected	---	Not applicable

TABLE 13-1

IDENTIFCATION OF COPECs FOR AQUATIC INVERTEBRATES
R AREA TERRESTRIAL AND AQUATIC UNIT
TIDAL AREA QEA, NWS SBD CONCORD

COPEC[g]	Rationale for Identification as COPEC			Highest Screening Value Exceeded[d]
	Exceeds Tidal Area 99th UCL[a], SF Bay Ambient[b], and ER-L[c]	Exceeds Tidal Area 99th UCL[a] and/or SF Bay Ambient[b], but No ER-L[c] Available	Detected, but No Screening Value Available	
Inorganic Constituents				
Arsenic	X			Ambeint[a]
Zinc	X			ER-M
Low Detection Limit Pesticides[e]				
2,4'-DDD			X	--
Total DDTs[f]	X			ER-L
Aldrin			X	--
alpha-Chlordane			X	--
Total Chlordanes[f]	X			ER-L
Dieldrin	X			ER-L
Mirex			X	--
trans-Nonachlor			X	--
Low Detection Level SVOAs[e,h]				
Total HMW PAHs[f]	X			ER-L
Total LMW PAHs[f]	X			ER-L

Notes:

CLP Contract laboratory program
COPEC Chemical of potential ecological concern
DDT Dichlorodiphenyltrichloroethane
ER-L Effects-range low
ER-M Effects-range median
HMW High molecular weight
LMW Low molecular weight
NA Screening value not available
PAH Polynuclear aromatic hydrocarbon
PCB Polychlorinated biphenyl
SVOA Semivolatile organic analyte
UCL Upper confidence level

TABLE 13-1

IDENTIFCATION OF COPECs FOR AQUATIC INVERTEBRATES
R AREA TERRESTRIAL AND AQUATIC UNIT
TIDAL AREA QEA, NWS SBD CONCORD

Notes (Continued):

a PRC Environmental Management, Inc. (PRC). 1996a. "Estimation of Ambient Metals Concentrations in the Tidal Area Soils." Technical Memorandum. Naval Weapons Station, Concord California. March.

b San Francisco Bay Regional Water Quality Control Board (RWQCB). 1998. "Ambient Concentrations of Toxic Chemicals in Sediments." April.

c National Oceanic and Atmospheric Administration (NOAA). 1991. "The Potential for Biological Effects of Sediment-Sorbed Contaminants Tested in the National Status and Trends Program. " Technical Memorandum NOS OMA 52. NOAA, Office of Oceanography and Marine Assessment. Seattle, WA. *and* Long, E.R., D.D. MacDonald, S.L. Smith, and F.D. Calder. 1995. "Incidence of Adverse Biological Effects Within Ranges of Chemical Concentrations in Marine and Estuarine Sediments." *Environmental Management*. Volume 19. Number 1. Pages 81 through 97.

d While exceedance of ER-M is noted in this column, ER-M values were not used to determine if a chemical was a COPEC.

e While exceedance of ER-M is noted in this column, ER-M values were not used to determine if a chemical was a COPEC.

f Where total values were calculated (for example, total PCBs, total DDTs, etc.) 1/2 of the standard quantitation limit was used for nondetected analytes.

g Only detected chemicals are listed.

h The following SVOCs were detected at concentrations below the San Francisco Bay ambient value and are considered COPECs (no effects range values are available): Hexachlorobenzene, benzo(b)fluoranthene, benzo(e)pyrene, benzo(g,h,i)perylene, benzo(k)fluoranthene, indeno(1,2,3-cd)pyrene.

TABLE 13-2

IDENTIFCATION OF COPECs FOR AQUATIC INVERTEBRATES
FROID AND TAYLOR AQUATIC UNIT
TIDAL AREA QEA, NWS SBD CONCORD

COPEC[g]	Rationale for Identification as COPEC			Highest Screening Value Exceeded[d]
	Exceeds Tidal Area 99th UCL[a], SF Bay Ambient[b], and ER-L[c]	Exceeds Tidal Area 99th UCL[a] and/or SF Bay Ambient[b], but No ER-L[c] Available	Detected, but No Screening Value Available	
Inorganic Constituents				
Beryllium		X		Ambient[a]
Copper	X			Ambient[a]
Lead	X			ER-M
Mercury	X			Ambient[a]
Selenium	X			ER-M
Zinc	X			ER-M
CLP PCBs[e]				
Total PCBs[f]	X			ER-M
Low Detection Limit Pesticides[e]				
2,4'-DDD			X	--
2,4'-DDE			X	--
2,4'-DDT			X	--
4,4'-DDD	X			ER-L
4,4'-DDE	X			ER-L
4,4'-DDT	X			ER-M
Total DDTs[f]	X			SF Ambient[b]
Aldrin			X	--
alpha-BHC			X	--
gamma-BHC (Lindane)			X	--
Total BHCs[f]		X		SF Ambient[b]
alpha-Chlordane			X	--
gamma-Chlordane			X	--
Total Chlordanes[f]	X			ER-M
Dieldrin	X			SF Ambient[b]
Hexachlorobenzene		X		SF Ambient[b]
trans-Nonachlor			X	--

TABLE 13-2

IDENTIFCATION OF COPECs FOR AQUATIC INVERTEBRATES
FROID AND TAYLOR AQUATIC UNIT
TIDAL AREA QEA, NWS SBD CONCORD

COPEC[g]	Rationale for Identification as COPEC			Highest Screening Value Exceeded[d]
	Exceeds Tidal Area 99th UCL[a], SF Bay Ambient[b], and ER-L[c]	Exceeds Tidal Area 99th UCL[a] and/or SF Bay Ambient[b], but No ER-L[c] Available	Detected, but No Screening Value Available	
CLP Pesticides[e]				
4,4'-DDD	X			ER-L
Total DDTs[f]	X			ER-L
Total BHCs[f]		X		SF Ambient[b]
Total Chlordanes[f]	X			ER-M
Low Detection Limit SVOAs[e,h]				
1,1'-Biphenyl			X	--
1-Methylnaphthalene		X		SF Ambient[b]
2,4-Dimethylphenol			X	--
2,6-Dimethylnaphthalene		X		SF Ambient[b]
4-Methylphenol			X	--
Benzoic Acid			X	--
Bis(2-thylhexyl)phthalate			X	--
Carbazole			X	--
Dibenzofuran			X	--
Total LMW PAHs[f]	X			ER-L
Total HMW PAH[f]	X			SF Ambient[b]
Total PAHs[f]	X			ER-L
CLP SVOAs[e,h]				
4-Methylphenol			X	--
Phenol			X	--
Total LMW PAHs[f]	X			ER-M
Total HMW PAH[f]	X			SF Ambient[b]
Total PAHs[f]	X			ER-L

TABLE 13-2

IDENTIFCATION OF COPECs FOR AQUATIC INVERTEBRATES
FROID AND TAYLOR AQUATIC UNIT
TIDAL AREA QEA, NWS SBD CONCORD

COPEC[g]	Rationale for Identification as COPEC			Highest Screening Value Exceeded[d]
	Exceeds Tidal Area 99th UCL[a], SF Bay Ambient[b], and ER-L[c]	Exceeds Tidal Area 99th UCL[a] and/or SF Bay Ambient[b], but No ER-L[c] Available	Detected, but No Screening Value Available	
CLP VOAs[e]				
4-Methyl-2-Pentanone			X	--
TPH - Extractables[e]				
Motor Oil			X	--

Notes:

BHC	Hexachlorocyclohexane	HMW	High molecular weight
CLP	Contract laboratory program	LMW	Low molecular weight
COPEC	Chemical of potential ecological concern	NA	Screening value not available
DDD	Dichlorodiphenyldichloroethane	PAH	Polynuclear aromatic hydrocarbon
DDE	Dichlorodiphenyldichloroethene	PCB	Polychlorinated biphenyl
DDT	Dichlorodiphenyltrichloroethane	SVOA	Semivolatile organic analyte
ER-L	Effects-range low	TPH	Total petroleum hydrocarbons
ER-M	Effects-range median	UCL	Upper confidence level

a PRC Environmental Management, Inc. (PRC). 1996a. "Estimation of Ambient Metals Concentrations in the Tidal Area Soils." Technical Memorandum. Naval Weapons Station, Concord California. March.

b San Francisco Bay Regional Water Quality Control Board (RWQCB). 1998. "Ambient Concentrations of Toxic Chemicals in Sediments." April.

c National Oceanic and Atmospheric Administration (NOAA). 1991. "The Potential for Biological Effects of Sediment-Sorbed Contaminants Tested in the National Status and Trends Program. " Technical Memorandum NOS OMA 52. NOAA, Office of Oceanography and Marine Assessment. Seattle, WA. and Long, E.R., D.D. MacDonald, S.L. Smith, and F.D. Calder. 1995. "Incidence of Adverse Biological Effects Within Ranges of Chemical Concentrations in Marine and Estuarine Sediments." Environmental Management. Volume 19. Number 1. Pages 81 through 97.

d While exceedance of ER-M is noted in this column, ER-M values were not used to determine if a chemical was a COPEC.

e Tidal Area 99th UCL is not available for these constituents.

f Where total values were calculated (for example, total PCBs, total DDTs, etc.) 1/2 of the standard quantitation limit was used for nondetected analytes.

g Only detected chemicals are listed.

h The following SVOCs were detected at concentrations below the San Francisco Bay ambient value and are considered COPECs (no effects range values are available): Benzo(b)fluoranthene, benzo(e)pyrene, benzo(g,h,i)perylene, benzo(k)fluoranthene, and indeno(1,2,3-cd)pyrene.

TABLE 13-3

IDENTIFICATION OF COPECs FOR AQUATIC INVERTEBRATES
NORTH OTTER SLUICE AQUATIC UNIT
TIDAL AREA QEA, NWS SBD CONCORD

COPEC[g]	Rationale for COPEC Selection			Highest Screening Value Exceeded[d]
	Exceeds Tidal Area 99th UCL[a], SF Bay Ambient[b], and ER-L[c]	Exceeds Tidal Area 99th UCL[a] and/or SF Bay Ambient[b], but No ER-L[c] Available	Detected, but No Screening Value Available	
Inorganic Constituents				
Antimony	X			Ambient[a]
Arsenic	X			Ambient[a]
Beryllium		X		Ambient[a]
Copper	X			ER-M
Lead	X			ER-L
Mercury	X			ER-M
Molybdenum		X		Ambient[a]
Selenium	X			ER-L
Zinc	X			ER-M
Low Detection Limit Pesticides[e]				
2,4'-DDD			X	--
2,4'-DDT			X	--
4,4'-DDD	X			ER-L
4,4'-DDE	X			ER-L
Total DDTs[f]	X			SF Ambient[b]
Total BHCs[f]		X		SF Ambient[b]
alpha-Chlordane			X	--
Total Chlordanes[f]	X			SF Ambient[b]
Dieldrin	X			SF Ambient[b]
Mirex			X	--
trans-Nonachlor			X	--
Low Detection Level SVOAs[e,h]				
2,6-Dimethylnaphthalene		X		SF Ambient[b]
4-Methylphenol			X	--
Acenaphthene	X			SF Ambient[b]
Benzoic Acid			X	--
Fluorene	X			ER-L
Naphthalene	X			ER-L
Perylene		X		SF Ambient[b]

TABLE 13-3

IDENTIFICATION OF COPECs FOR AQUATIC INVERTEBRATES
NORTH OTTER SLUICE AQUATIC UNIT
TIDAL AREA QEA, NWS SBD CONCORD

COPEC[g]	Rationale for COPEC Selection			Highest Screening Value Exceeded[d]
	Exceeds Tidal Area 99th UCL[a], SF Bay Ambient[b], and ER-L[c]	Exceeds Tidal Area 99th UCL[a] and/or SF Bay Ambient[b], but No ER-L[c] Available	Detected, but No Screening Value Available	
Low Detection Level SVOAs[e,h] (Continued)				
Total LMW PAHs[f]	X			ER-M
Total HMW PAH[f]	X			SF Ambient[b]
Total PAHs[f]	X			ER-L
CLP SVOAs[e,h]				
4-Methylphenol			X	--
Total LMW PAHs[f]	X			ER-M
Total HMW PAH[f]	X			SF Ambient[b]
Total PAHs[f]	X			ER-L

Notes:

BHC Hexachlorocyclohexane
CLP Contract laboratory program
COPEC Chemical ofpotential ecological concern
DDD Dichlorodiphenyldichloroethane
DDE Dichlorodiphenyldichloroethene
DDT Dichlorodiphenyltrichloroethane
ER-L Effects range-low
ER-M Effects range-median
HMW High molecular weight
LMW Low molecular weight
PAH Polynuclear aromatic hydrocarbon
SVOA Semivolatile organic analyte
UCL Upper confidence limit

a PRC Environmental Management, Inc. (PRC). 1996a. "Estimation of Ambient Metals Concentrations in the Tidal Area Soils." Technical Memorandum. Naval Weapons Station, Concord California. March.

b San Francisco Bay Regional Water Quality Control Board (RWQCB). 1998. "Ambient Concentrations of Toxic Chemicals in Sediments." April.

c National Oceanic and Atmospheric Administration (NOAA). 1991. "The Potential for Biological Effects of Sediment-Sorbed Contaminants Tested in the National Status and Trends Program." Technical Memorandum NOS OMA 52. NOAA, Office of Oceanography and Marine Assessment. Seattle, WA. and Long, E.R., D.D. MacDonald, S.L. Smith, and F.D. Calder. 1995. "Incidence of Adverse Biological Effects Within Ranges of Chemical Concentrations in Marine and Estuarine Sediments." Environmental Management. Volume 19. Number 1. Pages 81 through 97.

d While exceedance of ER-M is noted in this column, ER-M values were not used to determine if a chemical was a COPEC.

e Tidal Area 99th UCL is not available for these constituents.

f Where total values were calculated (for example, total PCBs, total DDTs, etc.) 1/2 of the standard quantitation limit was used for nondetected analytes.

g Only detected chemicals are listed.

h The following SVOCs were detected at concentrations below the San Francisco Bay ambient value and are considered COPECs (no effects range values are available): Benzo(b)fluoranthene, benzo(e)pyrene, benzo(g,h,i)perylene, benzo(k)fluoranthene, and indeno(1,2,3-cd)pyrene.

TABLE 13-4

IDENTIFICATION OF COPECs FOR AQUATIC INVERTEBRATES
SOUTH OTTER SLUICE AQUATIC UNIT
TIDAL AREA QEA, NWS SBD CONCORD

COPEC[g]	Rationale for COPEC Selection			Highest Screening Value Exceeded[d]
	Exceeds Tidal Area 99th UCL[a], SF Bay Ambient[b], and ER-L[c]	Exceeds Tidal Area 99th UCL[a] and/or SF Bay Ambient[b], but No ER-L[c] Available	Detected, but No Screening Value Available	
Inorganic Constituents				
Aluminum		X		Ambient[a]
Antimony	X			Ambient[a]
Beryllium		X		Ambient[a]
Cadmium	X			Ambient[a]
Copper	X			Ambient[a]
Lead	X			Ambient[a]
Mercury	X			ER-M
Selenium	X			ER-M
Zinc	X			ER-M
Low Detection Limit Pesticides[e]				
2,4'-DDD			X	--
2,4'-DDT			X	--
4,4'-DDE	X			ER-L
Total DDTs[f]	X			ER-L
alpha-BHC			X	--
gamma-BHC			X	--
Total BHCs[f]		X		SF Ambient[b]
alpha-Chlordane			X	--
gamma-Chlordane			X	--
Low Detection Limit Pesticides[e]				
Total Chlordanes[f]	X			SF Ambient[b]
Heptachlor			X	--
Methoxychlor			X	--
trans-Nonachlor			X	--

TABLE 13-4

IDENTIFICATION OF COPECs FOR AQUATIC INVERTEBRATES
SOUTH OTTER SLUICE AQUATIC UNIT
TIDAL AREA QEA, NWS SBD CONCORD

COPEC[g]	Rationale for COPEC Selection			Highest Screening Value Exceeded[d]
	Exceeds Tidal Area 99th UCL[a], SF Bay Ambient[b], and ER-L[c]	Exceeds Tidal Area 99th UCL[a] and/or SF Bay Ambient[b], but No ER-L[c] Available	Detected, but No Screening Value Available	
Dioxins[e]				
1,2,3,4,6,7,8,9-OCDD			X	--
1,2,3,4,6,7,8,9-OCDF			X	--
1,2,3,4,6,7,8-HPCDD			X	--
1,2,3,4,6,7,8-HPCDF			X	--
Total HPCDD[f]			X	--
Total HPCDF[f]			X	--
Total TCDD[f]			X	--
Low Detection Level SVOAs[e,h]				
2,6-Dimethylnaphthalene		X		SF Ambient[b]
Benzo(k)fluoranthene		X		SF Ambient[b]
Benzoic Acid			X	--
Total LMW PAHs[f]	X			ER-M
Total HMW PAHs[f]	X			SF Ambient[b]
Total PAHs[f]	X			ER-L
CLP SVOAs[e,h]				
4-Methylphenol			X	--
Total LMW PAHs[f]	X			ER-M
Total HMW PAHs[f]	X			SF Ambient[b]
Total PAHs[f]	X			ER-L

TABLE 13-4

IDENTIFICATION OF COPECs FOR AQUATIC INVERTEBRATES
SOUTH OTTER SLUICE AQUATIC UNIT
TIDAL AREA QEA, NWS SBD CONCORD

Notes:

BHC	Hexachlorocyclohexane
CLP	Contract laboratory program
COPEC	Chemical of potential ecological concern
DDD	Dichlorodiphenyldichloroethane
DDE	Dichlorodiphenyldichloroethene
DDT	Dichlorodiphenyltrichloroethane
ER-L	Effects range-low
ER-M	Effects range-median
HMW	High molecular weight
HPCDD	Heptachlorodibenzodioxin
HPCDF	Heptachlorodibenzofuran
LMW	Low molecular weight
OCDD	Octachlorodibenzodioxin
OCDF	Octachlorodibenzofuran
PAH	Polynuclear aromatic hydrocarbon
PCB	Polychlorinated biphenyl
SVOA	Semivolatile organic analyte
TCDD	Tetrachlorodibenzodioxin
UCL	Upper confidence limit

a PRC Environmental Management, Inc. (PRC). 1996a. "Estimation of Ambient Metals Concentrations in the Tidal Area Soils." Technical Memorandum. Naval Weapons Station, Concord California. March.

b San Francisco Bay Regional Water Quality Control Board (RWQCB). 1998. "Ambient Concentrations of Toxic Chemicals in Sediments." April.

c National Oceanic and Atmospheric Administration (NOAA). 1991. "The Potential for Biological Effects of Sediment-Sorbed Contaminants Tested in the National Status and Trends Program." Technical Memorandum NOS OMA 52. NOAA, Office of Oceanography and Marine Assessment. Seattle, WA. and Long, E.R., D.D. MacDonald, S.L. Smith, and F.D. Calder. 1995. "Incidence of Adverse Biological Effects Within Ranges of Chemical Concentrations in Marine and Estuarine Sediments." Environmental Management. Volume 19. Number 1. Pages 81 through 97.

d While exceedance of ER-M is noted in this column, ER-M values were not used to determine if a chemical was a COPEC.

e Tidal Area 99th UCL is not available for these constituents.

f Where total values were calculated (for example, total PCBs, total DDTs, etc.) 1/2 of the standard quantitation limit was used for nondetected analytes.

g Only detected chemicals are listed.

h The following SVOCs were detected at concentrations below the San Francisco Bay ambient value and are considered COPECs (no effects range values are available): Hexachlorobenzene, benzo(b)fluoranthene, benzo(e)pyrene, benzo(g,h,i)perylene, and indeno(1,2,3-cd)pyrene.

TABLE 13-5

TISSUE RESIDUES OF CLAMS FROM THE TIDAL AREA COMPARED TO REGIONAL BIVALVE DATA TIDAL AREA QEA, NWS SBD CONCORD

Analyte	NOSA - Clam Concentration	SOSA - Clam Concentrations	Regional Bivalve[a] Tissue Concentrations (SFEI 1997)	Location, Reference
Inorganic Chemicals (mg/kg dry weight)				
Aluminum	1568.18	723.3 - 1909		
Arsenic	6.93	4.4 - 8.05	9.0 - 15.9	Grizzly Bay - SFEI 97
Barium	23.86	26.08 - 28.57		
Cadmium	1.14	1.16 - 1.50	1-1.5	Grizzly Bay - SFEI 97
Chromium	5.68	3.17 - 6.62	12.1 - 43.6	Grizzly Bay - SFEI 97
Cobalt	1.82	1.81 - 2.34		
Copper	56.82	61.11 - 66.67	97 - 180	Grizzly Bay - SFEI 97
Iron	3068.18	2500 - 3571		
Lead	7.50	2.60 - 3.19	1	Grizzly Bay - SFEI 97
Magnesium	1829.55	1819 - 2155		
Manganese	57.95	41.67 - 77.78		
Mercury	0.45	0.39 - 0.56	0.22 - 0.23	Grizzly Bay - SFEI 97
Molybdenum	1.36	1.94 - 2.5		
Nickel	5.45	4.58 - 7.14	3.5 - 7.1	Grizzly Bay - SFEI 97
Selenium	6.59	6.36 - 7.39	3.3 - 3.4	Grizzly Bay - SFEI 97
Vanadium	5.57	3.75 - 5.97		
Zinc	186.36	205.19 - 295	127 - 218	Grizzly Bay - SFEI 97
PCBs (μg/kg dry weight)				
Total PCBs	79.54	6.94 - 55.8	96-132	Grizzly Bay - SFEI 97
Pesticides (μg/kg dry weight)				
Total DDTs	87.5	8.3 - 85.71	386-943	Grizzly Bay - SFEI 97
Dieldrin	ND	10.39	7.6-26.6	Grizzly Bay - SFEI 97
Gamma BHC (Lindane)	ND	7.79		
Methoxychlor	22.73	12.99 - 43.48		
alpha-Chlordane	11.36	11.67 - 12.9	4.9-18.8	Grizzly Bay - SFEI 97
gamma-Chlordane	3.41	ND	4.9-14.7	Grizzly Bay - SFEI 97
trans-Nonachlor	9.09	10	13.2-22.9	Grizzly Bay - SFEI 97
Dioxins (μg/kg dry weight	NA	0.13 - 0.35		

Notes:

DDT Dichlorodiphenyltrichloroethane
LS Leopard shark
mg/kg Milligrams per kilogram
NA Not analyzed
ND Not detected
NOSA North Otter Sluice aquatic
PCB Polychlorinated biphenyl
SFEI San Francisco Estuary Institute (RMP data)
SOSA South Otter Sluice aquatic
μg/kg Micrograms per kilogram
a Jarmon and others (1996). Anchovy and rockfish from Gulf of Farrallones

TABLE 14-1

IDENTIFICATION OF COPECs FOR REPTILES AND AMPHIBIANS
TIDAL AREA QEA, NWS SBD CONCORD

COPEC	Concord QEA Water Screening Value[a]	Landfill Terrestrial Unit	R Area Terrestrial and Aquatic Unit	Froid and Taylor Aquatic Unit	Wood Hogger Terrestrial Unit	North Otter Sluice Aquatic Unit	South Otter Sluice Aquatic Unit
Inorganics (μg/L)							
Aluminum	87	X	X	X	X	X	X
Antimony	NA	--	--	X	X	X	--
Arsenic	36	--	X	X	--	--	--
Barium	NA	--	X	--	--	--	--
Cadmium	1.1	X	X	X	X	--	--
Chromium	86	--	--	--	--	X	--
Cobalt	NA	X	X	--	X	X	X
Copper	3.2	X	X	X	X	X	X
Lead	3.1	--	X	X	X	X	--
Manganese	NA	X	X	X	X	X	X
Mercury	0.025	--	X	X	X	X	X
Molybdenum	NA	X	X	X	X	X	X
Nickel	8.2	X	X	X	--	X	--
Zinc	58	--	X	X	X	X	X
Pesticides and PCBs (μg/L)							
4,4'-DDT	0.0023	--	--	--		X	--
Total DDTs	NA	X	X	X	X	X	X
alpha-BHC	NA	--	X	--		--	--

TABLE 14-1 (continued)

IDENTIFICATION OF COPECs FOR REPTILES AND AMPHIBIANS
CONCORD TIDAL QEA, NWS SBD CONCORD

COPEC	Concord QEA Water Screening Value[a]	Landfill Terrestrial Unit	R Area Terrestrial and Aquatic Unit	Froid and Taylor Aquatic Unit	Wood Hogger Terrestrial Unit	North Otter Sluice Aquatic Unit	South Otter Sluice Aquatic Unit
Pesticides and PCBs (μg/L) (Continued)							
Total BHC	NA	X	X	X	X	X	X
alpha-Chlordane	NA	--	--	--		X	--
Total Chlordanes	NA	X	X	X	X	X	X
Dieldrin	0.004	--	--	--		X	--
Endrin	0.0019	--	--	--		X	--
Heptachlor	0.0036	--	--	--		X	--
Heptachlor epoxide	0.0036	--	X	--		--	--
Total PCBs	NA	X	X	X	X	X	X
SVOCs (μg/L)							
4-Methylphenol	NA	--	--	X	--	--	--
Bis(2-ethylhexyl)phthalate	NA	--	--	--	--	--	X
Chrysene	NA	--	--	X	--	--	--
Phenol	NA	--	--	X	--	--	--
Total HMW PAHs	NA	X	X	X	X	X	X
Total LMW PAHs	NA	X	X	X	X	X	X
Total PAHs	15	X	X	X	X	X	X

TABLE 14-1 (continued)

IDENTIFICATION OF COPECs FOR REPTILES AND AMPHIBIANS
CONCORD TIDAL QEA, NWS SBD CONCORD

COPEC	Concord QEA Water Screening Value[a]	Landfill Terrestrial Unit	R Area Terrestrial and Aquatic Unit	Froid and Taylor Aquatic Unit	Wood Hogger Terrestrial Unit	North Otter Sluice Aquatic Unit	South Otter Sluice Aquatic Unit
VOCs (μg/L)							
Carbon disulfide	NA	--	--	X	--	--	--
Chloromethane	NA	--	--	--	--	X	--
Xylene (total)	NA	--	--	--	X	--	--
TPH-Extractables (mg/L)							
Diesel range organics	NA	--	--	X	--	--	--
Motor oil range organics	NA	--	--	X	--	--	--

Notes:

BHC Hexachlorocyclohexane
HMW High molecular weight
LMW Low molecular weight
mg/L Milligrams per liter
PAH Polynuclear aromatic hydrocarbon
PCB Polychlorinated biphenyl
QEA Qualitative ecological assessment
SVOC Semivolatile organic compound
TPH Total petroleum hydrocarbon
VOC Volatile organic compound
μg/L Micrograms per liter
NA No screening value available.

a See Table 5-2 for selection of QEA water screening values.
X Chemical exceeded the QEA screening value or chemical was detected and no screening value is available.
-- Chemical did not exceed the QEA screening value or was not detected.

TABLE 15-1

BACK-CALCULATED SOIL OR SEDIMENT CONCENTRATIONS INDICATING NO RISK
TIDAL AREA QEA, NWS SBD CONCORD

Analyte	Sample Location	Back-Calculated Soil Concentration (mg/kg)[b]	Number of Samples Exceeding Back-Calculated Soil Concentration	Maximum Soil Concentration (mg/kg)	Tidal Area/ RWQCB Ambient Concentration (mg/kg)[a]
Landfill Perimeter Terrestrial Unit					
Salt Marsh Harvest Mouse (back-calculation based on HQ_2)[c]					
Lead	TLSSB007	0.31	8 of 8	156	95
Nickel	TLSSB002	30	8 of 8	131	120
Northern Harrier (back-calculation based on HQ_4)[d]					
Lead	TLSSB007	3.53	8 of 8	156	95
Gray Fox (back-calculation based on HQ_4)[d]					
Lead	TLSSB007	0.39	8 of 8	156	95
Nickel	TLSSB002	39	8 of 8	131	120
Zinc	TLSSB002	652	1 of 8	743	264
R Area Terrestrial Unit					
Salt Marsh Harvest Mouse (back-calculation based on HQ_2)[c]					
Lead	RADSBG08	0.32	94 of 94	1,160	95
Manganese	RADSBI08	1,785	1 of 94	6,300	1,500
Nickel	RADSBH06	30	91of 94	242	120
Gray Fox (back-calculation based on HQ_4)[d]					
Lead	RADSBG08	0.36	94 of 94	1,160	95
Nickel	RADSBH06	31.9	91 of 94	242	120
Selenium	RADSBG08	1.46	1 of 94	1.3	0.64
Zinc	RADSB017	575.6	1 of 94	959	264

TABLE 15-1 (Continued)

BACK-CALCULATED SOIL OR SEDIMENT CONCENTRATIONS INDICATING NO RISK
TIDAL AREA QEA, NWS SBD CONCORD

Analyte	Sample Location	Back-Calculated Soil Concentration (mg/kg)[b]	Number of Samples Exceeding Back-Calculated Soil Concentration	Maximum Soil Concentration (mg/kg)	Tidal Area/ RWQCB Ambient Concentration (mg/kg)[a]
R Area Terrestrial Unit (Continued)					
Northern Harrier (back-calculation based on HQ_4)[d]					
Lead	RADSBG08	4.84	94 of 94	1,160	95
Froid and Taylor Aquatic Unit					
Black-Necked Stilt (back-calculation based on HQ_4)[d]					
Lead	FTSSB002	0.38	10 of 11	515	43.2
Great Blue Heron (back-calculation based on HQ_4)[d]					
Lead	FTSSB002	0.35	10 of 11	515	43.2
Wood Hogger Terrestrial Unit					
Salt Marsh Harvest Mouse (back-calculation based on HQ_2)[c]					
Cadmium	WHSSBI02	8.3	2 of 69	20.8	1.9
Copper	WHSSBH03	353	1 of 69	607	81
Lead	WHSSBF03	0.32	69 of 69	598	95
Selenium	WHSSBC02	4.2	1 of 69	4.8	0.64
Zinc	WHSSBI02	1,136	3 of 69	3,010	264
PCDDs and PCDFs	WHSSB016	0.3E-3 (TEQs)	10 of 10	1.53E-3 (TEQs)	No ambient

TABLE 15-1 (Continued)

BACK-CALCULATED SOIL OR SEDIMENT CONCENTRATIONS INDICATING NO RISK
TIDAL AREA QEA, NWS SBD CONCORD

Analyte	Sample Location	Back-Calculated Soil Concentration (mg/kg)[b]	Number of Samples Exceeding Back-Calculated Soil Concentration	Maximum Soil Concentration (mg/kg)	Tidal Area/ RWQCB Ambient Concentration (mg/kg)[a]
Wood Hogger Terrestrial Unit (Continued)					
Gray Fox (back-calculation based on HQ_4)[d]					
Cadmium	WHSSBI02	7.6	2 of 69	20.8	1.9
Copper	WHSSBH03	285	1 of 69	607	81
Lead	WHSSBF03	0.28	69 of 69	598	95
Selenium	WHSSBC02	2.0	2 of 69	4.8	0.64
Zinc	WHSSBI02	715	3 of 69	3010	264
PCDs and PCDFs	WHSSB016	0.2E-3 (TEQs)	10 of 10	1.53E-3 (TEQs)	No ambient
Northern Harrier (back-calculation based on HQ_4)[d]					
Lead	WHSSBF03	3.5	69 of 69	598	95
North Otter Sluice Aquatic Unit					
River Otter (back-calculation based on HQ_4)[d]					
Lead	RADSBA02	2.30	19 of 19	182	43.2
Great Blue Heron (back-calculation based on HQ_4)[d]					
Lead	RADSBA02	0.33	19 of 19	182	43.2
California Black Rail (back-calculation based on HQ_2)[e]					
Lead	RADSBA02	0.35	19 of 19	182	43.2

TABLE 15-1 (Continued)

BACK-CALCULATED SOIL OR SEDIMENT CONCENTRATIONS INDICATING NO RISK
TIDAL AREA QEA, NWS SBD CONCORD

Analyte	Sample Location	Back-Calculated Soil Concentration (mg/kg)[b]	Number of Samples Exceeding Back-Calculated Soil Concentration	Maximum Soil Concentration (mg/kg)	Tidal Area/ RWQCB Ambient Concentration (mg/kg)[a]
South Otter Sluice Aquatic Unit					
River Otter (back-calculation based on HQ_4)[d]					
Lead	WHSSB002	2.40	26 of 26	99.5	43.2
PCDD/Fs	OSLS008	0.93 E-3 (TEQs)	2 of 4	2.2 E-3 (TEQs)	No ambient
Great Blue Heron (back-calculation based on HQ_4)[d]					
Lead	WHSSB002	0.35	26 of 26	99.5	43.2
Mercury	WHSSB022	10.2	1 of 26	18.5	0.43
PCDDs and PCDFs	OSLS008	0.49E-3 (TEQs)	4 of 4	2.6E-3 (TEQs)	No ambient
California Black Rail (back-calculation based on HQ_2)[c]					
Lead	WHSSB002	0.54	26 of 26	99.5	43.2
Mercury	WHSSB022	18	1 of 26	18.5	0.43
PCDDs and PCDFs	OSLS008	0.71E-3 (TEQs)	4 of 4	2.6E-3 (TEQs)	No ambient

Notes:

HQ Hazard quotient
mg/kg Milligram per kilogram
PCDD Polychlorinated dibenzodioxin
PCDF Polychlorinated dibenzofuran
RWQCB Regional Water Quality Control Board, San Francisco Bay Region
TEQ Toxicity equivalent
TRV Toxicity reference value
UCL Upper confidence limit

a Tidal Area ambient value used for the R Area Terrestrial, Wood Hogger, and North Otter Sluice Aquatic units. RWQCB (1998) ambient concentration for inorganic chemicals only at the Landfill Perimeter Terrestrial, Froid and Taylor Aquatic, and South Otter Sluice Aquatic units.

b The back-calculated soil or sediment concentration below which there is little or no risk to representative receptors.

c HQ_2 less than 1.0 indicates little or no risk to special status representative receptors. HQ_2 is high dose/low TRV.

d HQ_4 less than 1.0 indicates little or no risk to typical representative receptors. HQ_4 is typical dose/low TRV.

TABLE 15-2

TERRESTRIAL SAMPLE LOCATIONS AT WHICH CONCENTRATIONS POSE A POSSIBLE RISK TO BIRDS AND MAMMALS (BY UNIT AREA)[a]
TIDAL AREA QEA, NWS SBD CONCORD

Sample Location at Which Back-Calculated Concentration Was Exceeded	COPECs	Soil Concentration (mg/kg)	Back-Calculated Soil Concentration at Which HQ_2 = 1.0 (Lowest For All Receptors)	Tidal Area Ambient 99th Percent UCL Concentration (mg/kg)
Landfill Perimeter Terrestrial Unit				
All (8 of 8)	Lead		0.31	95
TLSSB007	Lead Nickel	156 (area max.) 62	0.31 30	95 120
TLSSB001	Nickel	80	30	120
TLSSB002	Nickel Zinc	131 743	30 652	120 264
TLSSB003	Nickel	94	30	120
TLSSB004	Nickel	82	30	120
TLSSB005	Nickel	68	30	120
TLSSB006	Nickel	78	30	120
TLSSB008	Nickel	100	30	120
R Area Terrestrial Unit				
All (94 of 94)	Lead Nickel		0.32 30	95 120
RADSBH06	Nickel	242 (area max.)	30	120
RADSBG08	Lead Selenium Zinc	1,160 (area max.) 1.3 488	0.32 1.46 330	95 0.64
RADSB029	Selenium	1.3	1.46	0.64
RADSBL03	Selenium	1.0	1.46	0.64
RADSBI08	Manganese	6,300	1785	1,500
RADSB017	Zinc	959	575.6	264
R Area Terrestrial and Aquatic Unit				
Little or no risk indicated (all HQs less than 1.0) for chemicals exceeding ambient				
Wood Hogger Terrestrial Unit				
All (69 of 69)	Lead			95
All (10 of 10)	PCDDs and PCDFs			N/A
WHSSB016	PCDDs and PCDFs	1.53E-3 (TEQs) (area max)	0.2E-3 (TEQs)	N/A

TABLE 15-2 (Continued)

TERRESTRIAL SAMPLE LOCATIONS AT WHICH CONCENTRATIONS POSE A POSSIBLE RISK TO BIRDS AND MAMMALS (BY UNIT AREA)[a]
TIDAL AREA QEA, NWS SBD CONCORD

Sample Location at Which Back-Calculated Concentration Was Exceeded	COPECs	Soil Concentration (mg/kg)	Back-Calculated Soil Concentration at Which HQ_2 = 1.0 (Lowest For All Receptors)	Tidal Area Ambient 99th Percent UCL Concentration (mg/kg)
Wood Hogger Terrestrial Unit (Continued)				
WHSSBF03	Lead Zinc	598 (area max.) 1,440	0.28 715	95 264
WHSSBH03	Copper Zinc	607 2,540	285 715	81 264
WHSSBI02	Cadmium Zinc	20.8 3,010	7.6 715	1.9 264
WHSSBE04	Cadmium	16.2	7.6	1.9
WHSSBC02	Selenium	4.8	2.0	0.64
WHSSBD03	Selenium	2.1	2.0	0.64

Notes:

COPEC Chemical of potential ecological concern
HQ Hazard quotient
mg/kg Milligram per kilogram
N/A Not applicable
UCL Upper confidence limit

a For each chemical that exceeds ambient in at least one sample location and maximum HQ_2 less than 1.0.

TABLE 15-3

AQUATIC SAMPLE LOCATIONS AT WHICH CONCENTRATIONS POSE A POSSIBLE RISK TO BIRDS AND MAMMALS (BY UNIT AREA)[a] TIDAL AREA QEA, NWS SBD CONCORD

Sample Location at Which Back-Calculated Concentration Exceeded	COPECs	Soil Concentration (mg/kg)	Back-Calculated Soil Concentration at Which HQ_2 = 1.0 (Lowest For All Receptors)	RWQCB Ambient Concentration (mg/kg)
Froid and Taylor Aquatic Unit				
FTSSB002	Lead	515 (area max.)	0.24	43.2
FTSSB003	Lead	211	0.24	43.2
FTSSB005	Lead	3.5	0.24	43.2
FTSSB006	Lead	157	0.24	43.2
FTSSB007	Lead	86	0.24	43.2
FTSSB008	Lead	84	0.24	43.2
FTSSB009	Lead	143	0.24	43.2
FTSSL102	Lead	80	0.24	43.2
FTSSL104	Lead	56	0.24	43.2
Froid and Taylor Terrestrial and Aquatic Unit				
Little or no risk indicated (all HQs less than 1.0) for chemicals exceeding ambient				
North Otter Sluice Aquatic Unit				
All (19 of 19)	Lead		0.33	43.2
RADSBA02	Lead	182 (area max.)	0.33	43.2
South Otter Sluice Aquatic Unit				
All (26 of 26)	Lead		0.29	43.2
WHSSB002	Lead	99.5 (area max.)	0.29	43.2
OSLSL005	PCDDs and PCDFs	0.77E-3 (TEQs)	0.71E-3 (TEQs)	N/A
OSLSL006	PCDDs and PCDFs	1.4E-3 (TEQs)	0.71E-3 (TEQs)	N/A
OSLSL007	PCDDs and PCDFs	0.96E-3 (TEQs)	0.71E-3 (TEQs)	N/A
OSLSL008	PCDDs and PCDFs	2.6E-3 (TEQs)	0.71E-3 (TEQs)	N/A
WHSSB022	Mercury	18.5	10.2	0.43

Notes:

COPEC	Chemical of potential ecological concern	PCDD	Polychlorinated dibenzodioxin
HQ	Hazard quotient	PCDF	Polychlorinated dibenzofuran
mg/kg	Milligrams per kilogram	RWQCB	California Regional Water Quality Control Board
N/A	Not available	TEQ	Toxic equivalent

a For each chemical that exceeds ambient in at least one sample location and maximum HQ_2 greater than 1.0.

TABLE 16-1

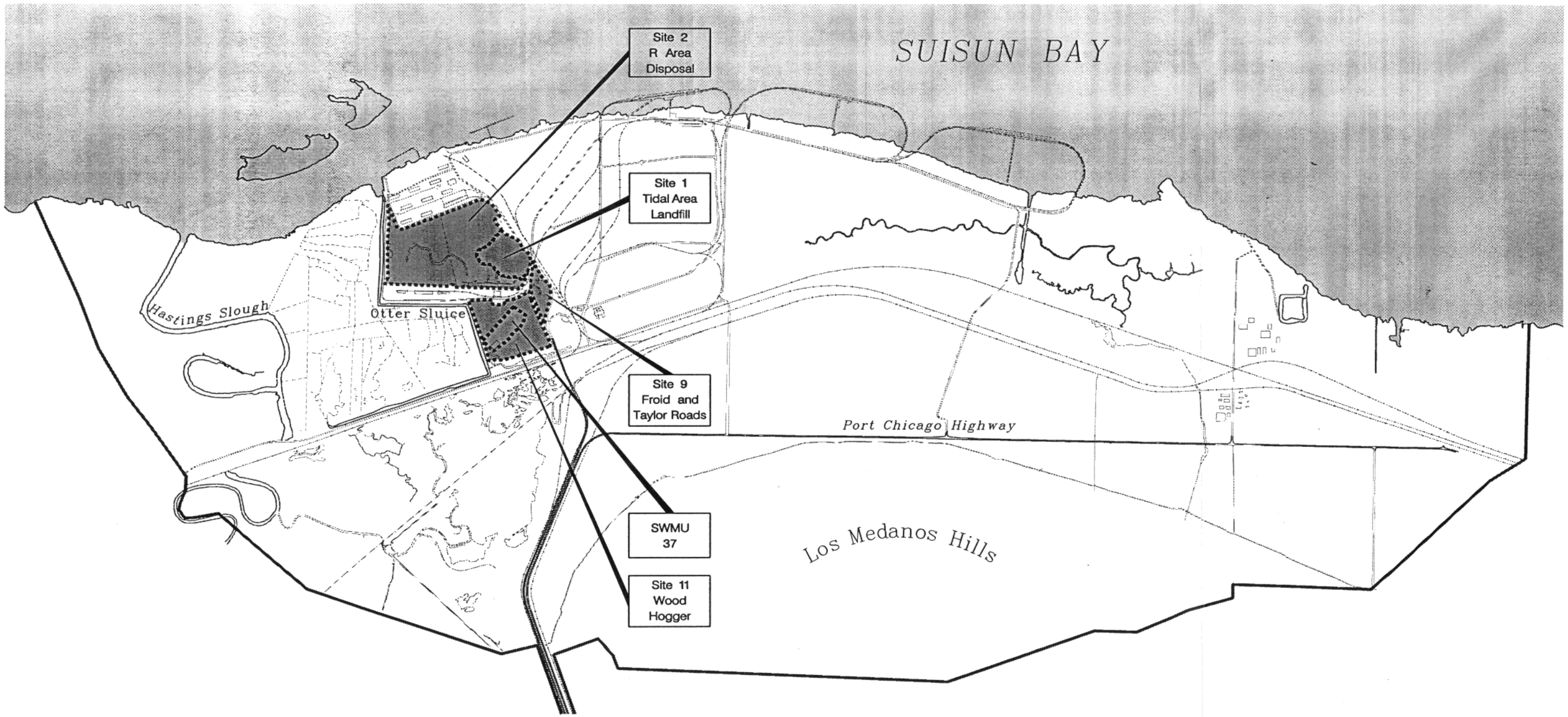
WEIGHT-OF EVIDENCE APPROACH BY HABITAT UNIT
TIDAL AREA QEA, NWS SBD CONCORD

Lines of Evidence	Landfill Terrestrial Unit	R Area Terrestrial Unit	R Area Terrestrial and Aquatic Unit	Froid and Taylor Terrestrial Unit	Froid and Taylor Aquatic Unit	Wood Hogger Terrestrial Unit	North Otter Sluice Aquatic Unit	South Otter Sluice Aquatic Unit
Inorganic Chemical Concentrations								
Soil/sediment exceed ambient and ER-Ls?	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Soil/sediment exceed ER-Ms?	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes
Surface water exceeds AWQC?	Yes	---	Yes	---	Yes	Yes	Yes	Yes
Detected in tissue residue?	---	Yes	---	---	Yes	Yes	Yes	Yes
Organic Chemical Concentrations								
Soil/sediment exceed ambient and ER-Ls?	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Soil/sediment exceed ER-Ms?	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes
Surface water exceeds AWQC?	Yes	---	Yes	---	Yes	Yes	Yes	Yes
Detected in tissue residue?	---	Yes	---	---	Yes	Yes	Yes	Yes
Bioassays								
Amphipod bioassays indicate effects?	---	---	---	---	---	---	Yes	Yes
SWI topsmelt bioassays indicate effects?	---	---	---	---	---	---	Potential	Potential
Microtox/P450 assays indicate effects?	---	No	No	No	---	Potential	No	No
Risk Characterization								
Risk to plants?	No	No	No	No	No	No	---	---
Risk to invertebrates?	No	Yes	No	Yes	No	Yes	No	No
Risk to fish?	---	---	---	---	No	---	Potential	Potential
Risk to herpetofauna?	Potential	---	Potential	---	Potential	Potential	Potential	Potential
Risk to birds and mammals?								
(a) HQ_1, HQ_3, or $HQ_5 > 1.0$? (significant risk)	No	No	No	No	No	No	No	No
(b) HQ_2 or $HQ_4 > 1.0$? (potential risk)	Yes	Yes	No	No	Yes	Yes	Yes	Yes
Conclusion								
Further evaluation required?	No	No	No	No	No	No	No	No
Response action required?	No	No	No	No	No	Potential	No	No

TABLE 16-2

WEIGHT-OF EVIDENCE APPROACH BY ASSESSMENT ENDPOINT
TIDAL AREA QEA, NWS SBD CONCORD

Lines of Evidence	Upland and Wetland Plants	Soil Biota/Terrestrial Invertebrates	Benthic Invertebrates	Fish	Gray Fox	Northern Harrier	River Otter	Black-Necked Stilt	California Black Rail	Great Blue Heron	Salt Marsh Harvest Mouse	Herpetofauna
Inorganic Chemical Concentrations												
Soil/sediment exceed ER-Ls?	---	Yes	Yes	---	---	---	---	---	---	---	---	---
Soil/sediment exceed ER-Ms?	---	Yes	Yes	---	---	---	---	---	---	---	---	---
Surface water exceeds AWQC?	---	---	Yes	Yes	---	---	---	---	---	---	---	Yes
WET extractions exceed AWQC?	---	---	Yes	---	---	---	---	---	---	---	---	---
Detected in tissue residue?	Yes	---	Yes	Yes	---	---	---	---	---	---	---	---
Organic Chemical Concentrations												
Soil/sediment exceed ambient and ER-Ls?	---	---	Yes	---	---	---	---	---	---	---	---	---
Soil/sediment exceed ER-Ms?	---	---	Yes	---	---	---	---	---	---	---	---	---
Surface water exceed AWQC?	---	---	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	---
WET extractions exceed AWQC?	---	---	Yes	---	---	---	---	---	---	---	---	---
Detected in tissue residue?	---	---	Yes	Yes	---	---	---	---	---	---	---	---
Bioassays												
Amphipod bioassays indicate effects?	---	---	No	---	---	---	---	---	---	---	---	---
SWI topsmelt bioassays indicate effects?	---	---	---	---	---	---	---	---	---	---	---	---
Microtox/P450 assays indicated effects?	---	Yes	---	---	---	---	---	---	---	---	---	---
Literature Review												
Literature reviews indicate effects?	No	Potential	---	No	---	---	---	---	---	---	---	Potential
Food-Chain Modeling												
HQ_1, HQ_3, or $HQ_5 > 1.0$? (significant risk)	---	---	---	---	No	No	No	No	No	No	No	---
HQ_2 or $HQ_4 > 1.0$? (potential risk)	---	---	---	---	Yes	Yes	Yes	Yes	Yes	Yes	Yes	---
Conclusions												
Further evaluation required?	No	No	No	No	No	No	No	No	No	No	No	No
Response action required?	No	No	No	No	No	No	No	No	No	No	No	No



1000 0 1000 2000
SCALE IN FEET

LEGEND

- NWS Tidal Area Boundary
- Site Boundary
- Railroad Tracks
- Road
- Building

DEPARTMENT OF THE NAVY — NAVAL FACILITIES ENGINEERING COMMAND
ENGINEERING FIELD ACTIVITY WEST
SAN BRUNO, CALIFORNIA

NAVAL WEAPONS STATION
SEAL BEACH DETACHMENT — CONCORD, CALIFORNIA

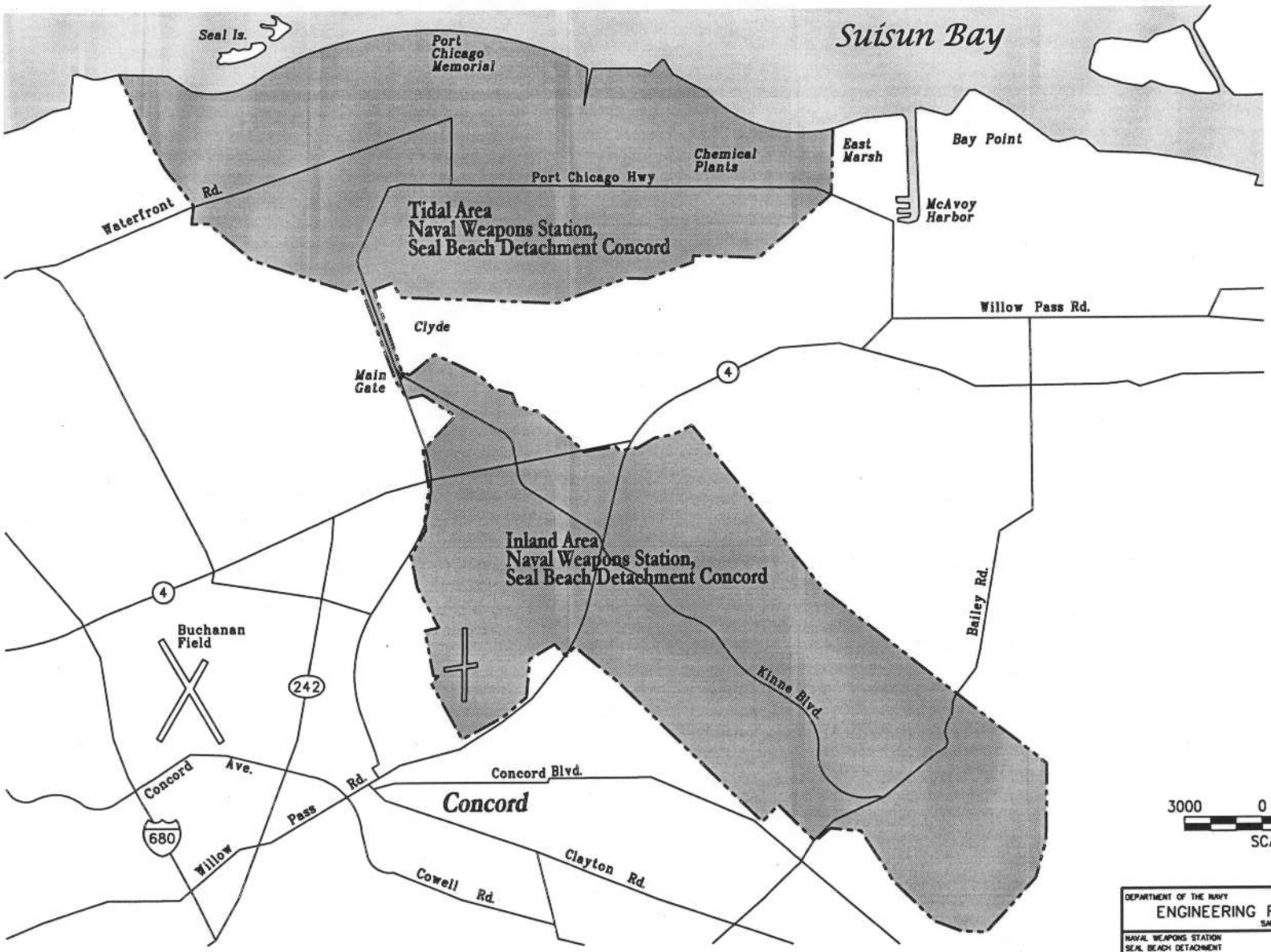
FIGURE 1-2
TIDAL AREA SITES

18 MAY 99 j:\concord1\dgn\cto217\fig1-2_sites.dgn

Figure 2-1

This detailed station map has been deleted from the Internet-accessible version of this document as per Department of the Navy Internet security regulations.

25 MAY 1999 j:\concordf1\dgn\cto217\fig1-1_vicinity.dgn



DEPARTMENT OF THE NAVY — NAVAL FACILITIES ENGINEERING COMMAND

ENGINEERING FIELD ACTIVITY WEST

SAN BRUNO, CALIFORNIA

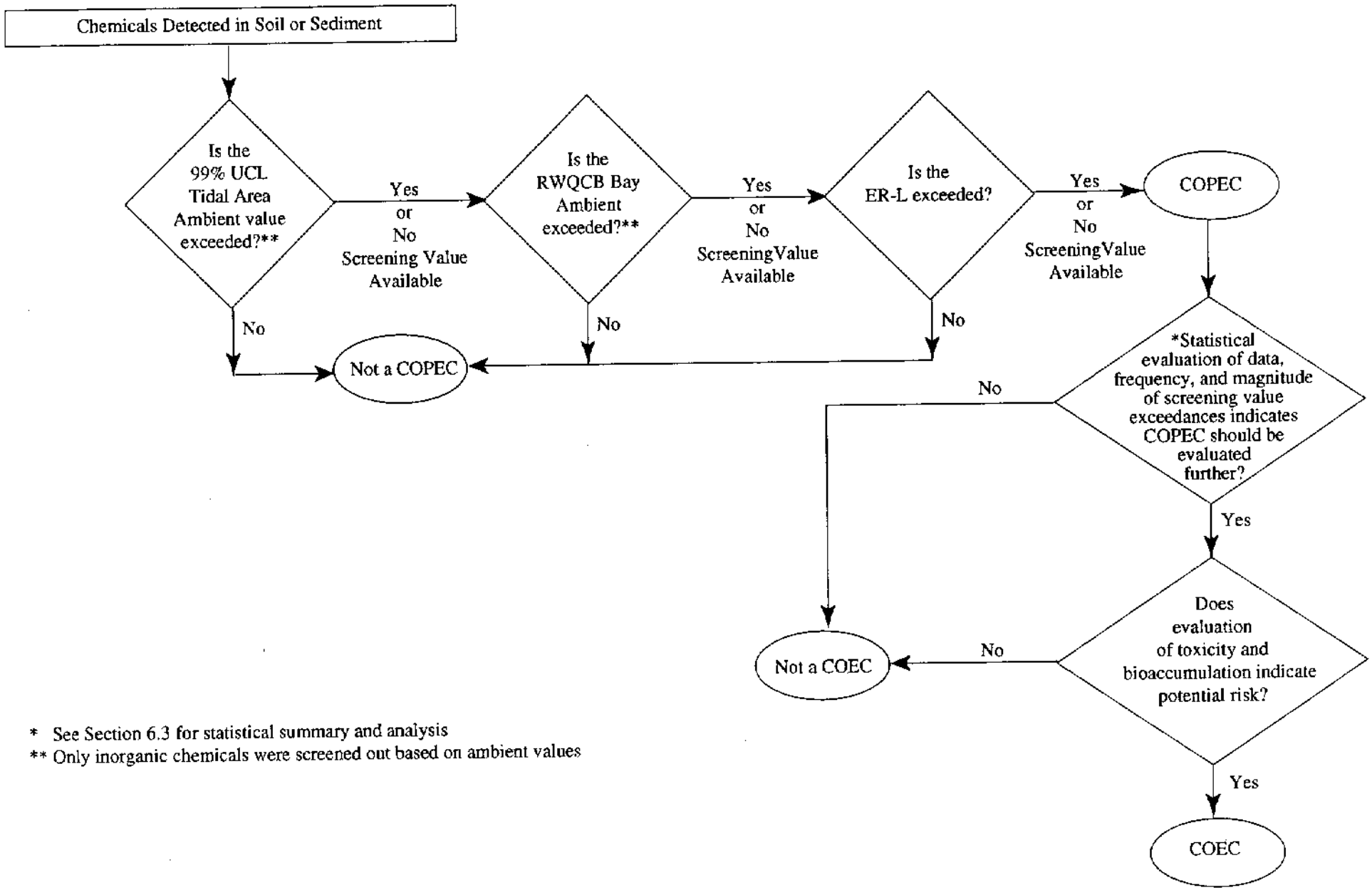
NAVAL WEAPONS STATION SEAL BEACH DETACHMENT — CONCORD, CALIFORNIA

FIGURE 1-1
VICINITY OF
NWS SBD CONCORD

Figures 2-2 and 2-3

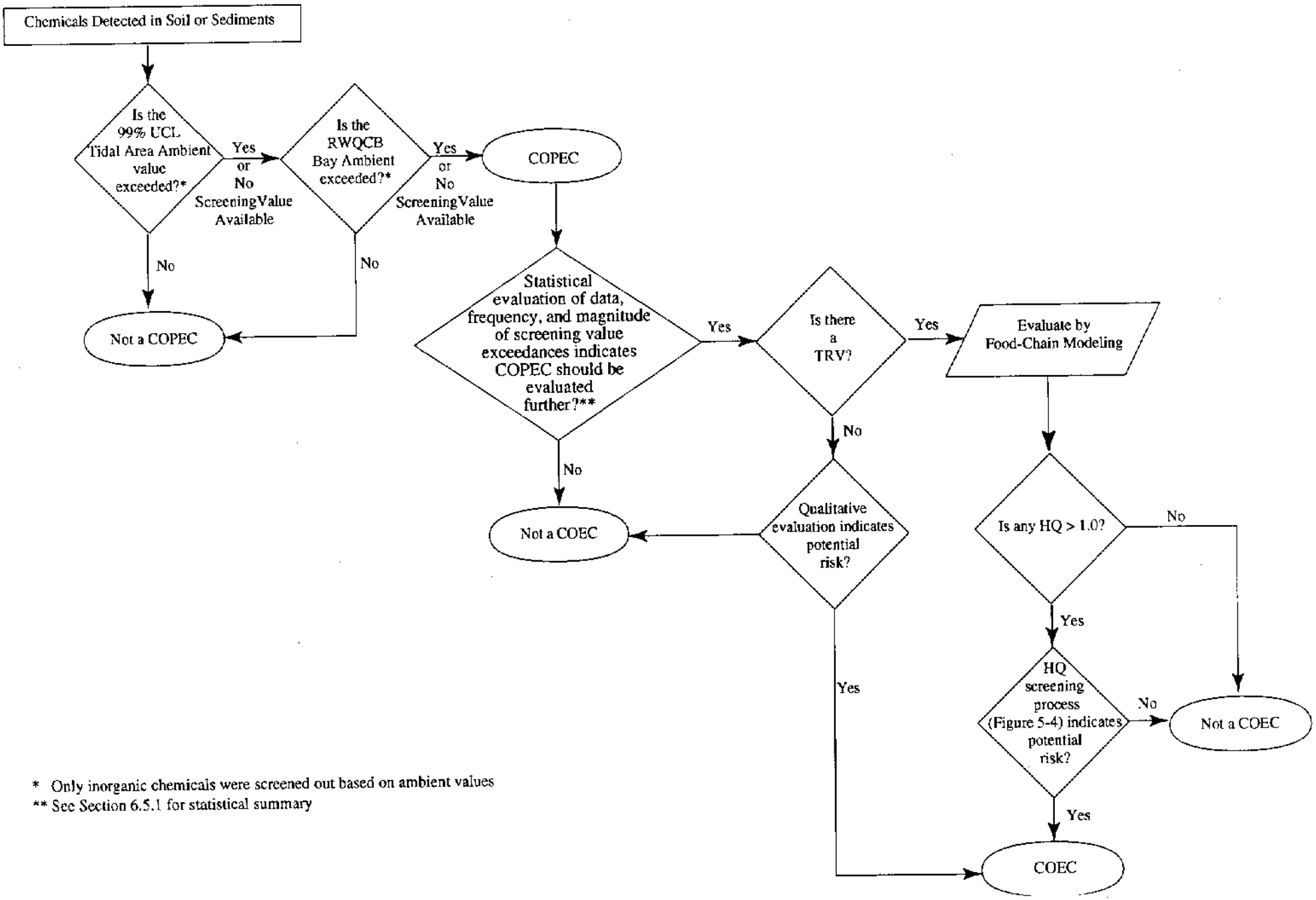
These detailed station maps have been deleted from the Internet-accessible version of this document as per Department of the Navy Internet security regulations.

Figure 5-1
Screening Process for Soil and Sediment:
Selecting Chemicals of Ecological Concern (COEC) for Invertebrates and Plants



* See Section 6.3 for statistical summary and analysis
** Only inorganic chemicals were screened out based on ambient values

Figure 5-2
Screening Process for Soil and Sediment:
Selecting Chemicals of Ecological Concern (COECs) for Birds and Mammals



* Only inorganic chemicals were screened out based on ambient values
** See Section 6.5.1 for statistical summary

Figure 5-3
Screening Values Selection and Screening Process for Surface Water: Selecting Chemicals of Ecological Concern (COEC) for Aquatic Receptors

SCREENING VALUES SELECTION

Convert EPA AWQC from Dissolved to Total Recoverable Concentrations Using Conversion Factor (EPA 1998)

↓

Select Lowest of:

✓ EPA National Chronic Freshwater or Saltwater AWQC (EPA 1998)
✓ EPA California Proposed Freshwater or Saltwater AWQC (EPA 1997)

✓ Bay Basin Plan Water Quality Objectives Upstream of San Pablo Bay (RWQCB 1986)

↓

If No Chronic Values Available, Select Lowest of:

✓ EPA National Acute Freshwater or Saltwater AWQC x 0.10
✓ EPA California Proposed Freshwater or Saltwater AWQC x 0.10

SCREENING PROCESS

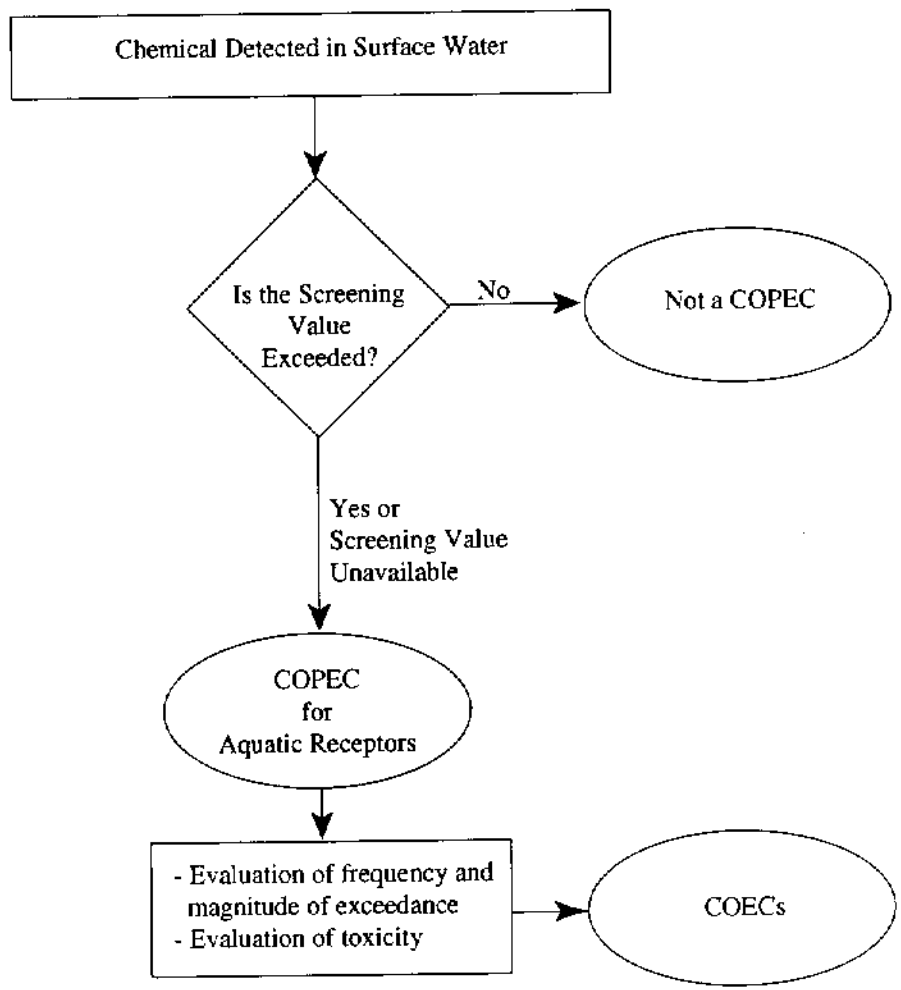


Figure 5-4
Food-Chain Modeling Hazard Quotient Screening Process

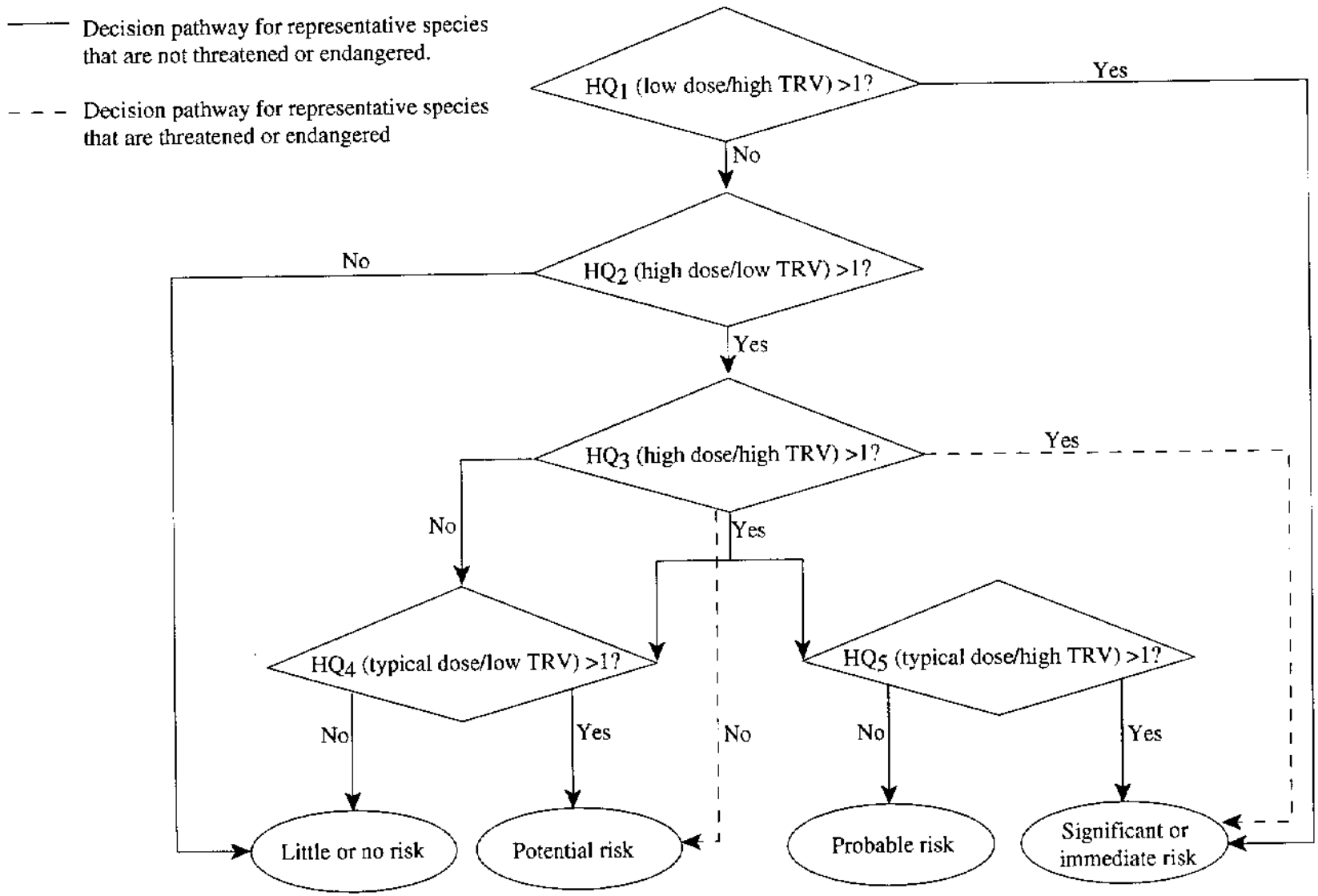
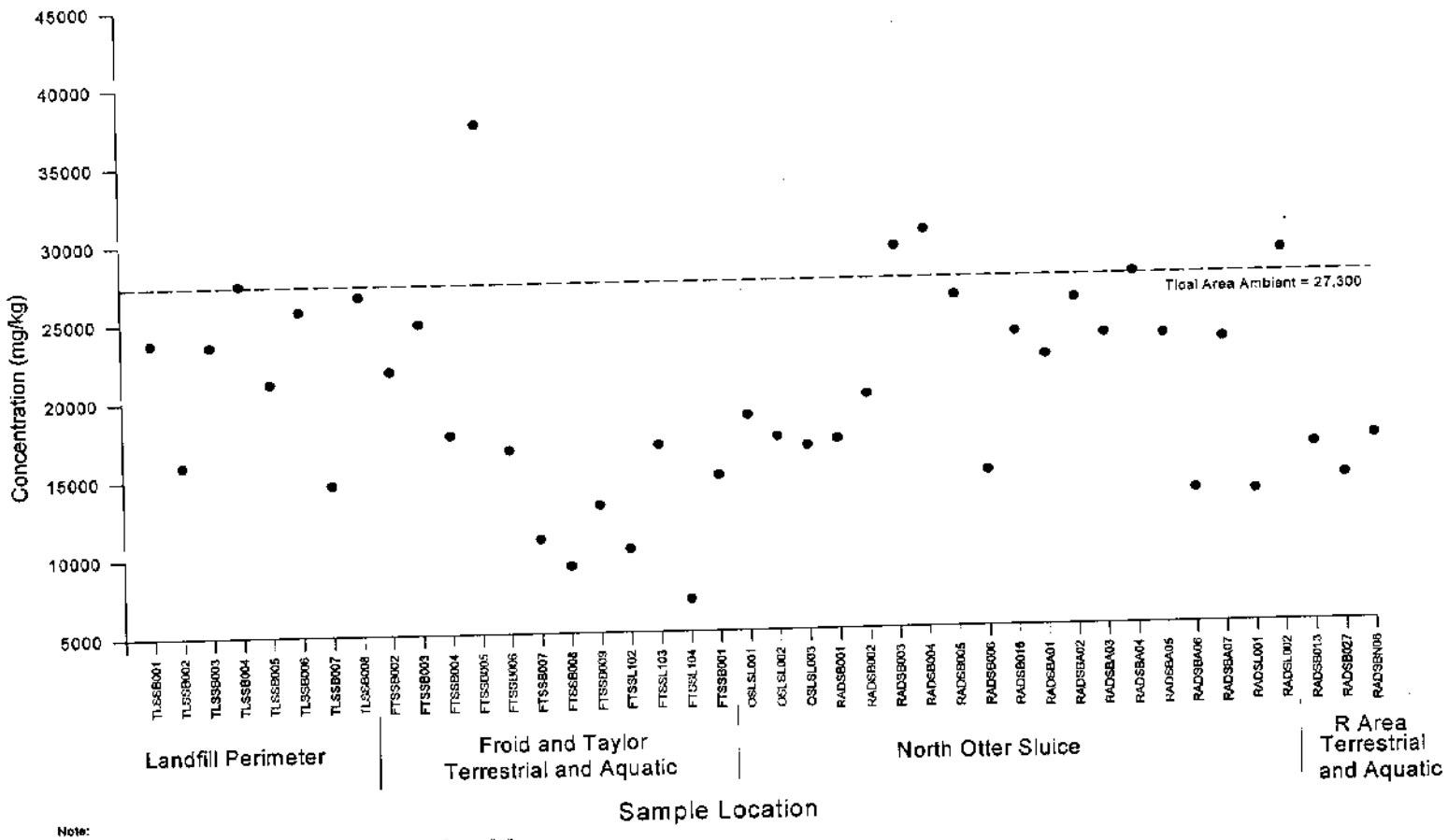
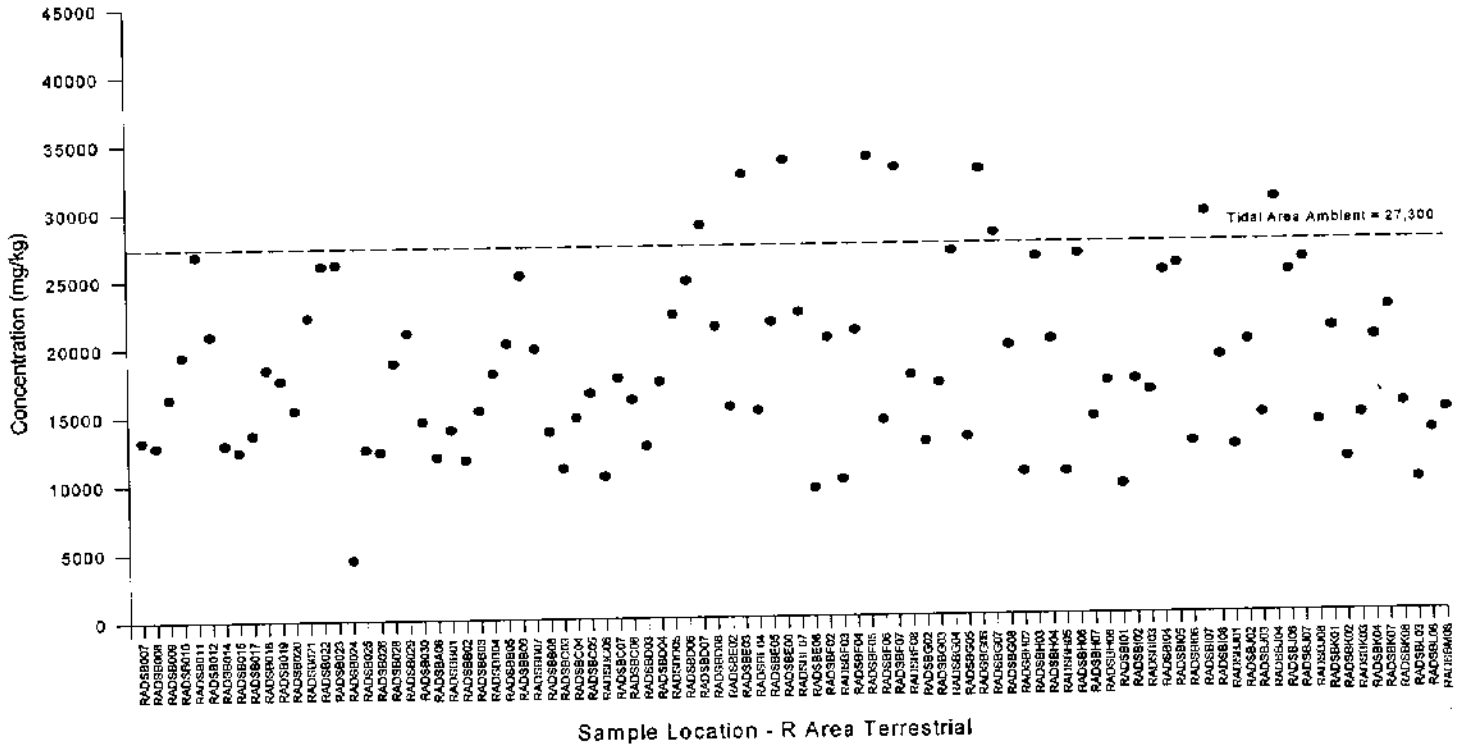


FIGURE 6-1A
DETECTED CONCENTRATIONS OF ALUMINUM IN THE LANDFILL PERIMETER TERRESTRIAL, FROID AND TAYLOR TERRESTRIAL, FROID AND TAYLOR AQUATIC, R AREA TERRESTRIAL AND AQUATIC, AND NORTH OTTER SLUICE AQUATIC UNITS, SOIL AND SEDIMENT
TIDAL AREA QEA, NWS SBD CONCORD



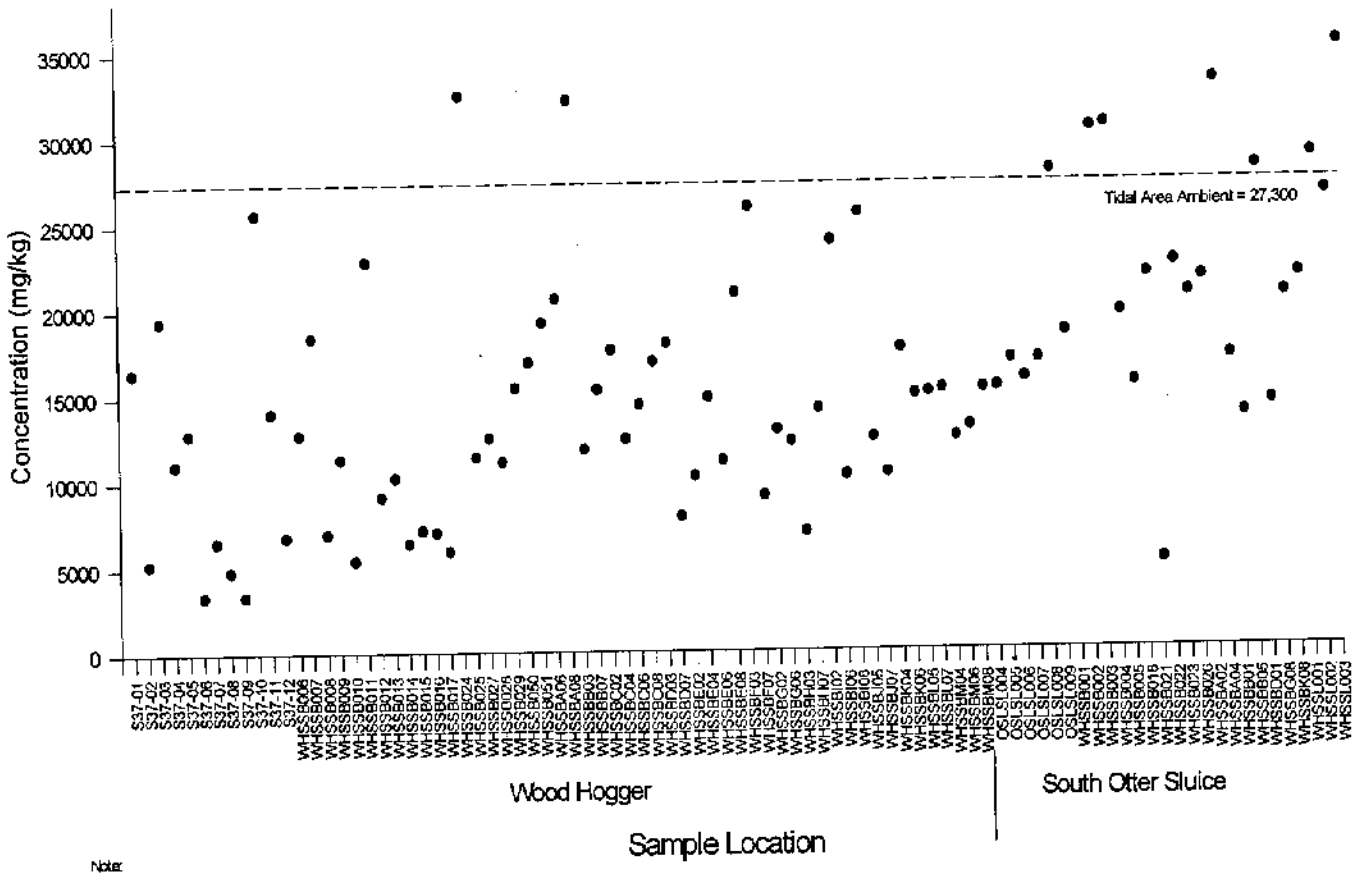
Note:
Tidal Area Ambient = Calculated using the 99 percent upper confidence limit

FIGURE 6-1B
DETECTED CONCENTRATIONS OF ALUMINUM IN THE R AREA TERRESTRIAL UNIT, SOIL AND SEDIMENT TIDAL AREA QEA, NWS SBD CONCORD



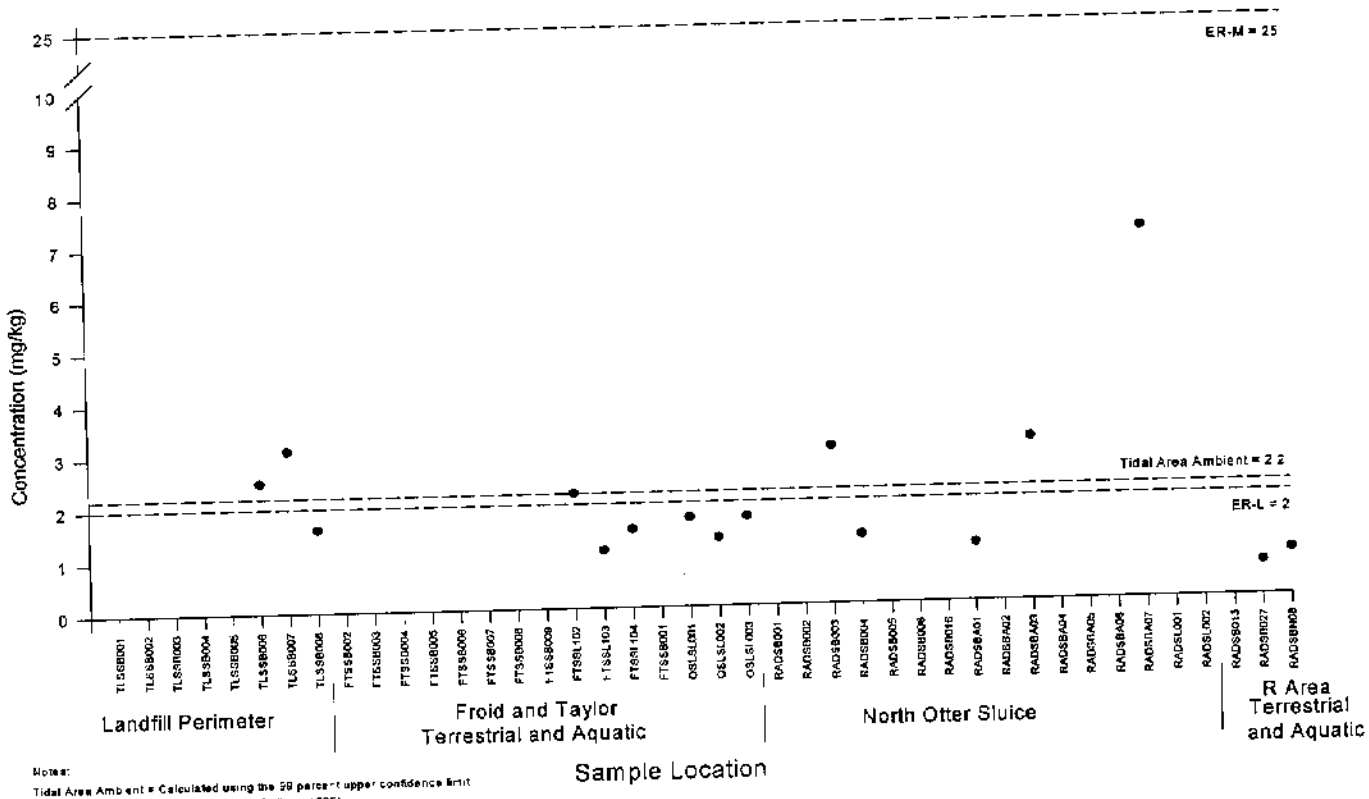
Note
Tidal Area Ambient = Calculated using the 99 percent upper confidence limit

FIGURE 6-1C
DETECTED CONCENTRATIONS OF ALUMINUM IN THE WOOD HOGGER TERRESTRIAL AND SOUTH OTTER SLUICE AQUATIC UNITS, SOIL AND SEDIMENT TIDAL AREA QEA, NWS SBD CONCORD



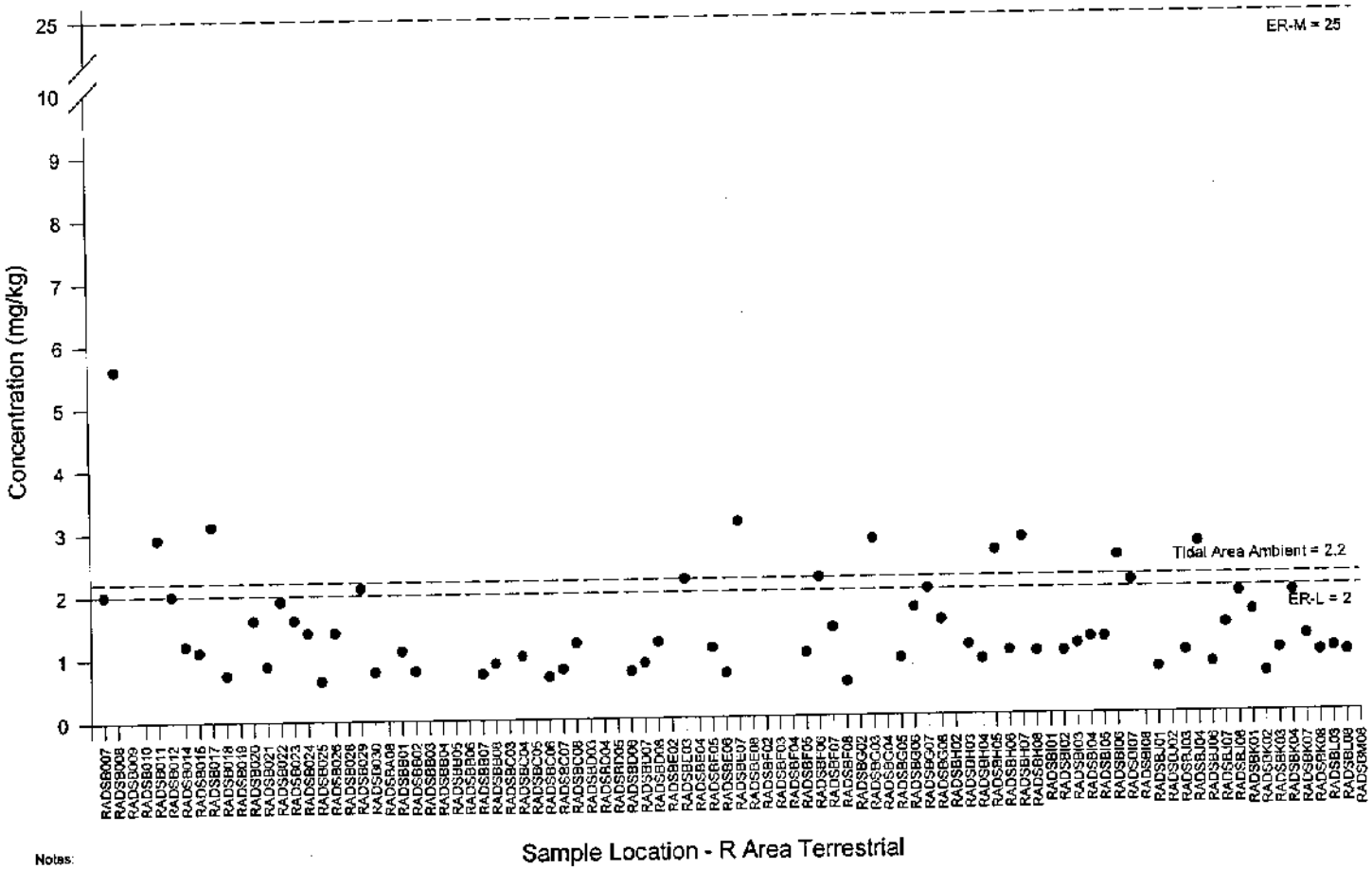
Note:
Tidal Area Ambient = Calculated using the 99 percent upper confidence limit

FIGURE 6-2A
DETECTED CONCENTRATIONS OF ANTIMONY IN THE LANDFILL PERIMETER TERRESTRIAL, FROID AND TAYLOR TERRESTRIAL, FROID AND TAYLOR AQUATIC, R AREA TERRESTRIAL AND AQUATIC, AND NORTH OTTER SLUICE AQUATIC UNITS, SOIL AND SEDIMENT
TIDAL AREA QEA, NWS SBD CONCORD



Notes:
Tidal Area Ambient = Calculated using the 95 percent upper confidence limit
ER-M = Effects range median (Long and others 1995)
ER-L = Effects range low (Long and others 1995)

FIGURE 6-2B
DETECTED CONCENTRATIONS OF ANTIMONY IN THE R AREA TERRESTRIAL UNIT, SOIL AND SEDIMENT
TIDAL AREA QEA, NWS SBD CONCORD



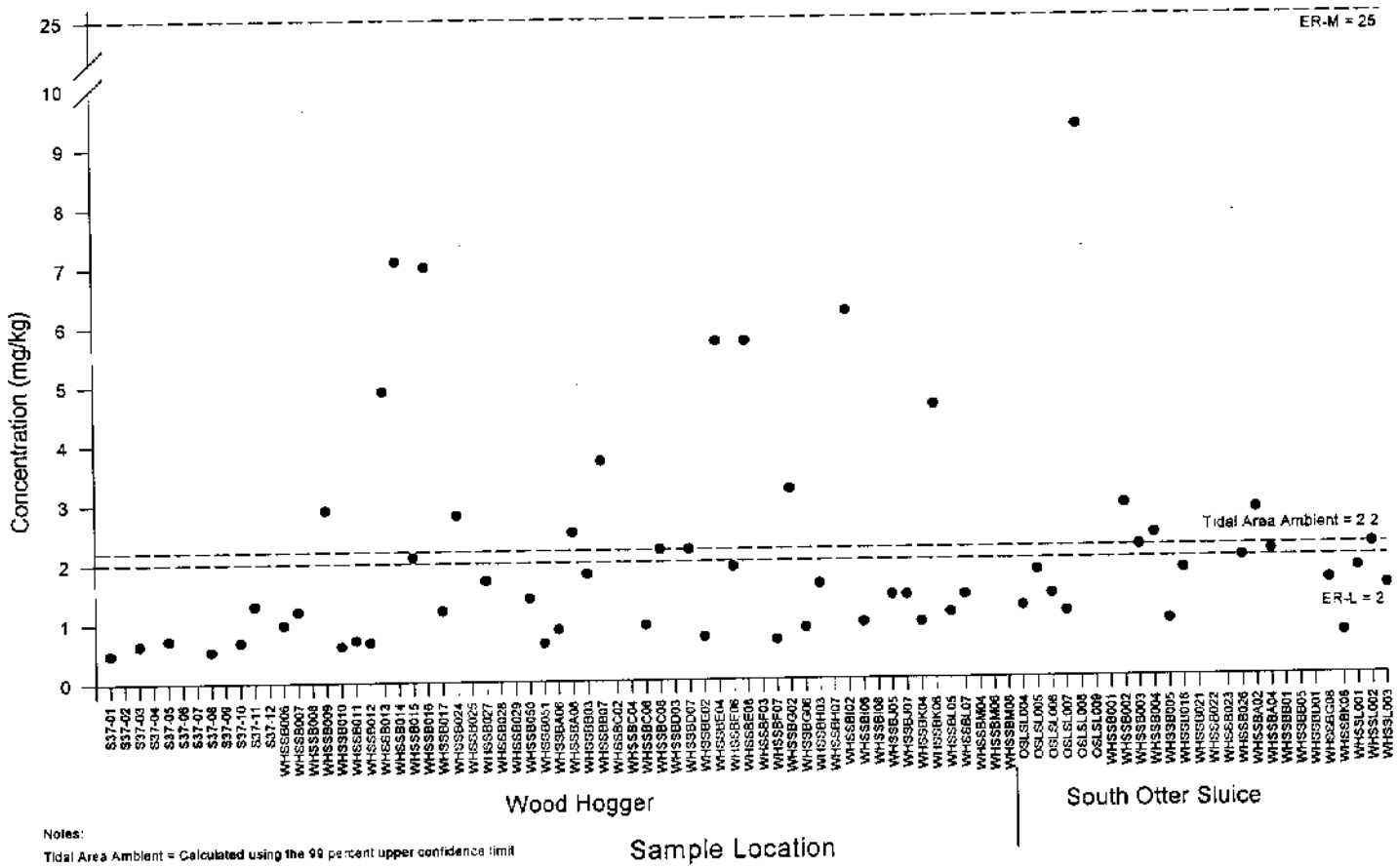
Notes:

Tidal Area Ambient = Calculated using the 95 percent upper confidence limit

ER-M = Effects range median (Long and others 1995)

ER-L = Effects range low (Long and others 1995)

FIGURE 6-2C
DETECTED CONCENTRATIONS OF ANTIMONY IN THE WOOD HOGGER TERRESTRIAL AND SOUTH OTTER SLUICE AQUATIC UNITS, SOIL AND SEDIMENT TIDAL AREA QEA, NWS SBD CONCORD



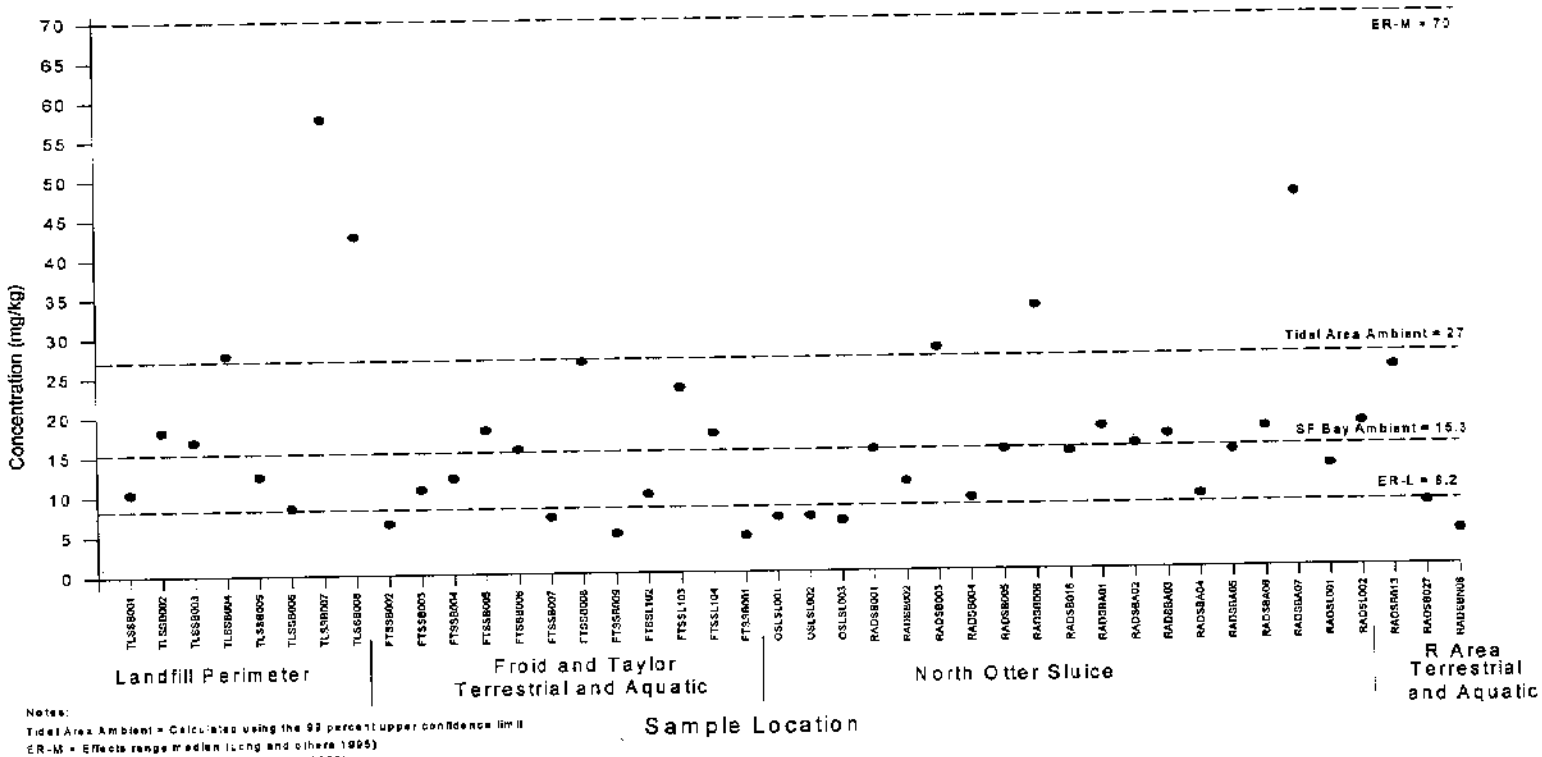
Notes:

Tidal Area Ambient = Calculated using the 99 percent upper confidence limit

ER-M = Effects range median (Long and others 1995)

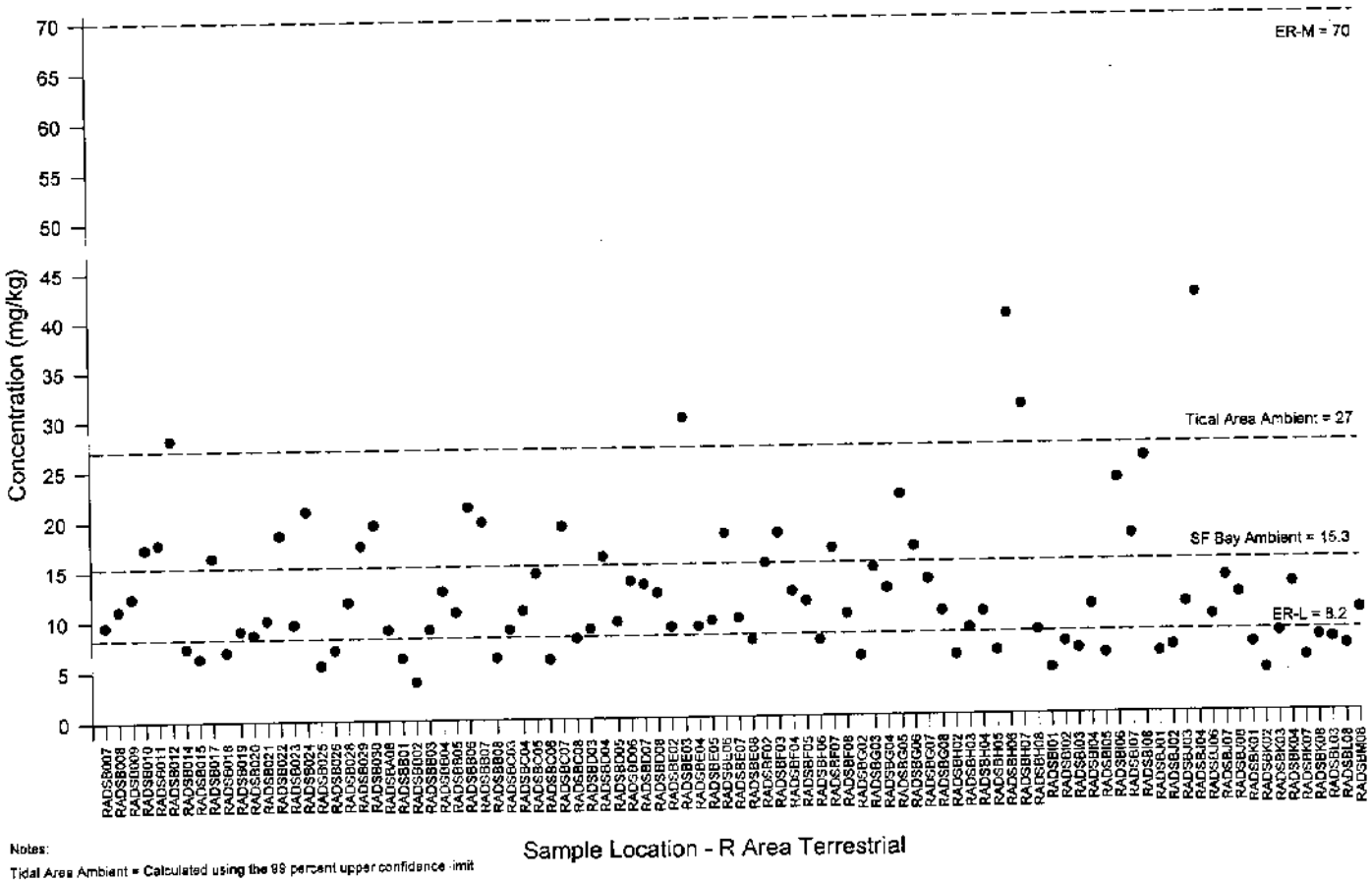
ER-L = Effects range low (Long and others 1995)

FIGURE 6-3A
DETECTED CONCENTRATIONS OF ARSENIC IN THE LANDFILL PERIMETER TERRESTRIAL, FROID AND TAYLOR TERRESTRIAL, FROID AND TAYLOR AQUATIC, R AREA TERRESTRIAL AND AQUATIC, AND NORTH OTTER SLUICE AQUATIC UNITS, SOIL AND SEDIMENT
TIDAL AREA QEA, NWS SBD CONCORD



Notes:
Tidal Area Ambient = Calculated using the 99 percent upper confidence limit
ER-M = Effects range median (Long and others 1995)
ER-L = Effects range low (Long and others 1995)
SF Bay Ambient = San Francisco Bay ambient value (RWQCB 1995)

FIGURE 6-3B
DETECTED CONCENTRATIONS OF ARSENIC IN THE R AREA TERRESTRIAL UNIT, SOIL AND SEDIMENT TIDAL AREA QEA, NWS SBD CONCORD



Notes:

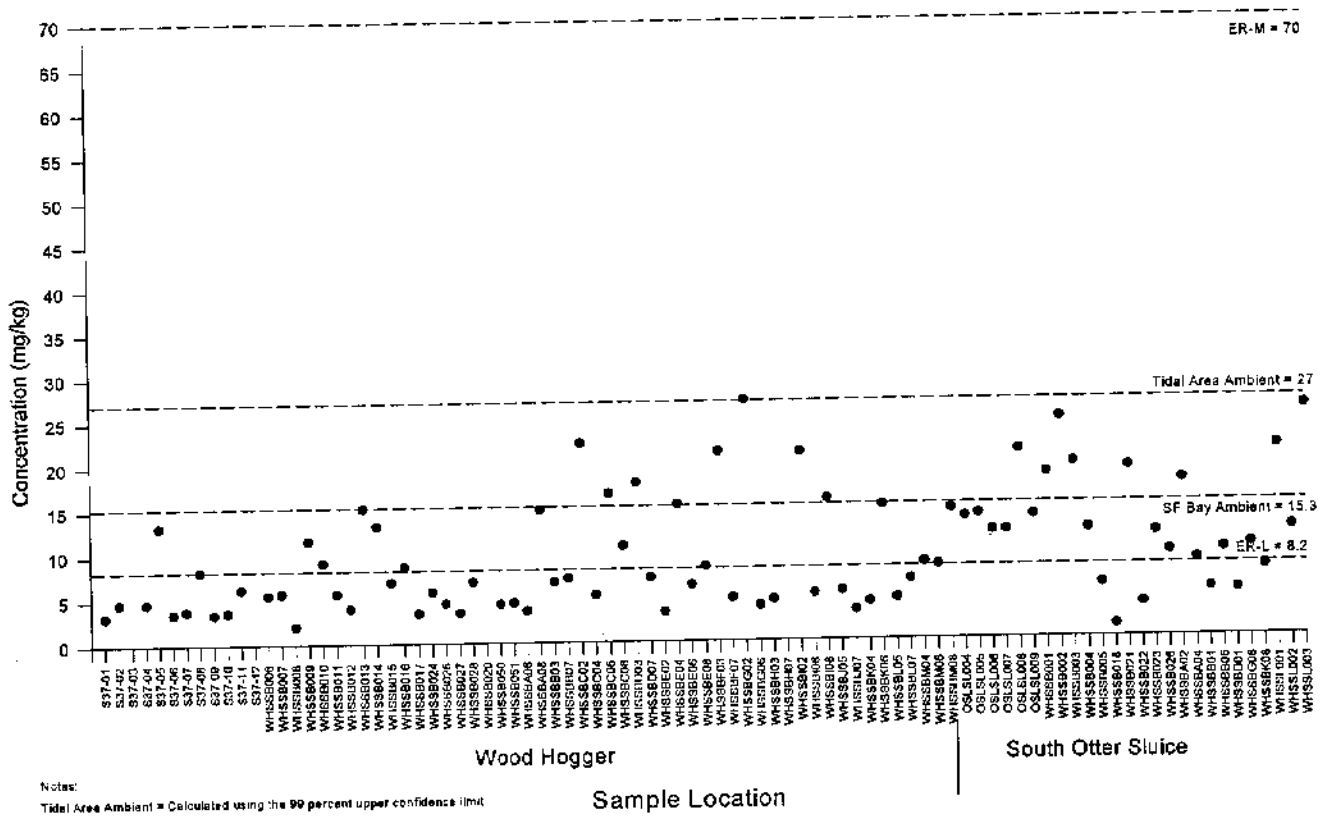
Tidal Area Ambient = Calculated using the 99 percent upper confidence limit

ER-M = Effects range median (Long and others 1995)

ER-L = Effects range low (Long and others 1995)

SF Bay Ambient = San Francisco Bay ambient value (RWQCB 1998)

FIGURE 6-3C
DETECTED CONCENTRATIONS OF ARSENIC IN THE WOOD HOGGER TERRESTRIAL AND SOUTH OTTER SLUICE AQUATIC UNITS, SOIL AND SEDIMENT TIDAL AREA QEA, NWS SBD CONCORD



Notes:
Tidal Area Ambient = Calculated using the 99 percent upper confidence limit
SF Bay Ambient = San Francisco Bay ambient value (RWQCB 1995)
ER-L = Effects range low (Long and others 1995)
ER-M = Effects range median (Long and others 1995)

FIGURE 6-4A
DETECTED CONCENTRATIONS OF BARIUM IN THE LANDFILL PERIMETER TERRESTRIAL, FROID AND TAYLOR TERRESTRIAL, FROID AND TAYLOR AQUATIC, R AREA TERRESTRIAL AND AQUATIC, AND NORTH OTTER SLUICE AQUATIC UNITS, SOIL AND SEDIMENT
TIDAL AREA QEA, NWS SBD CONCORD

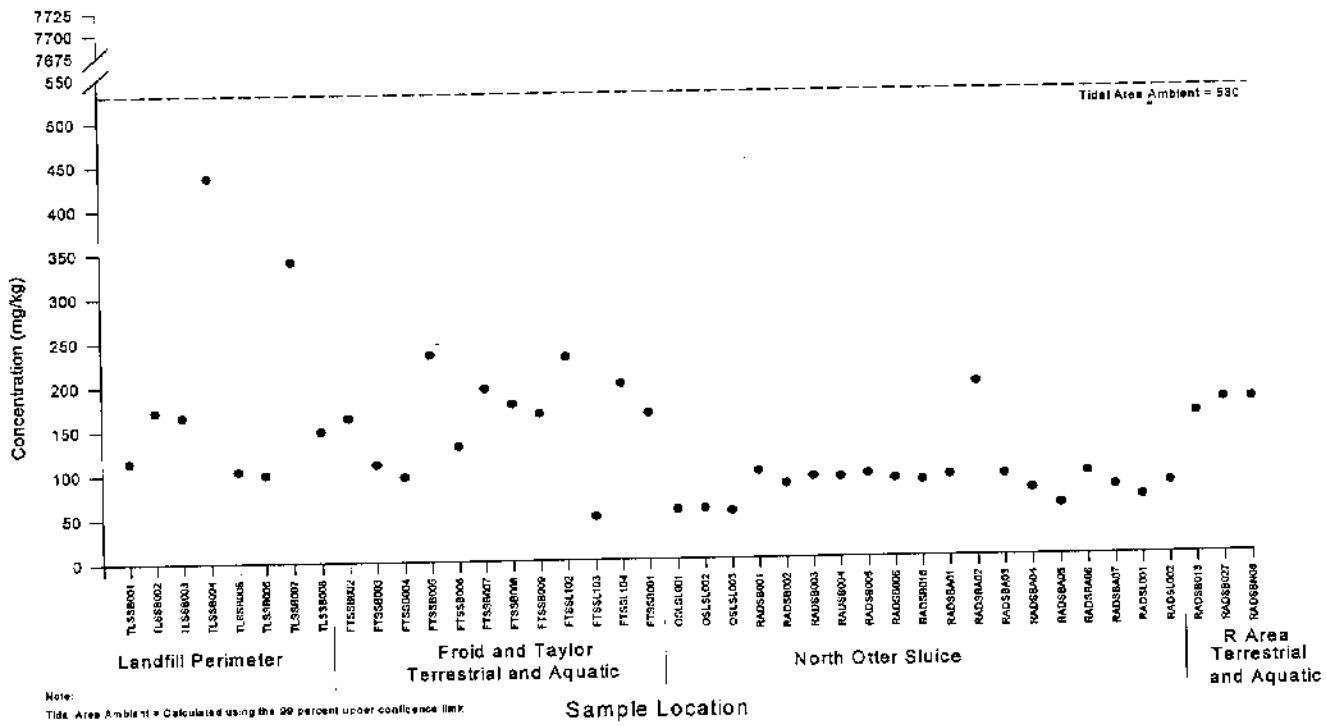
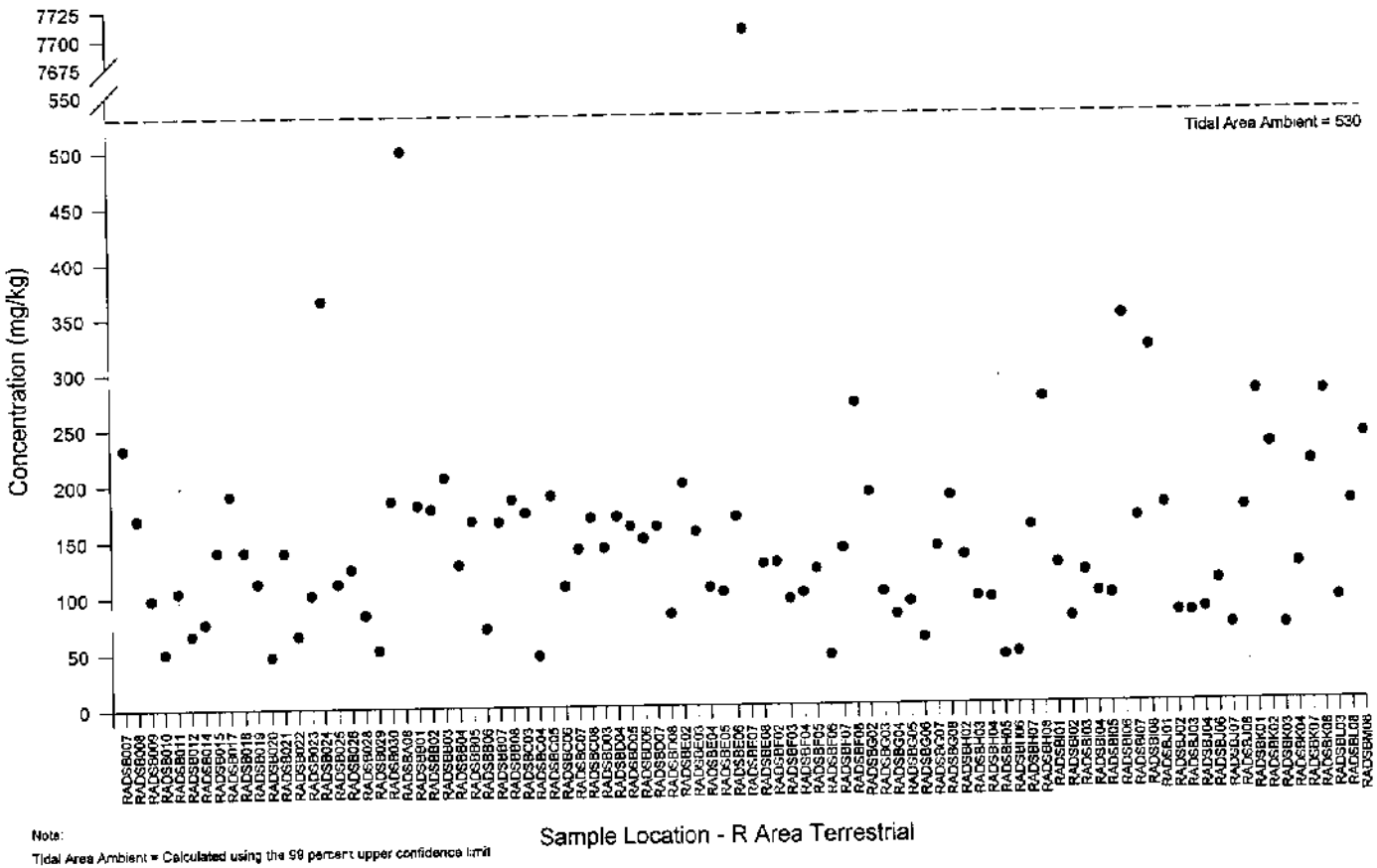
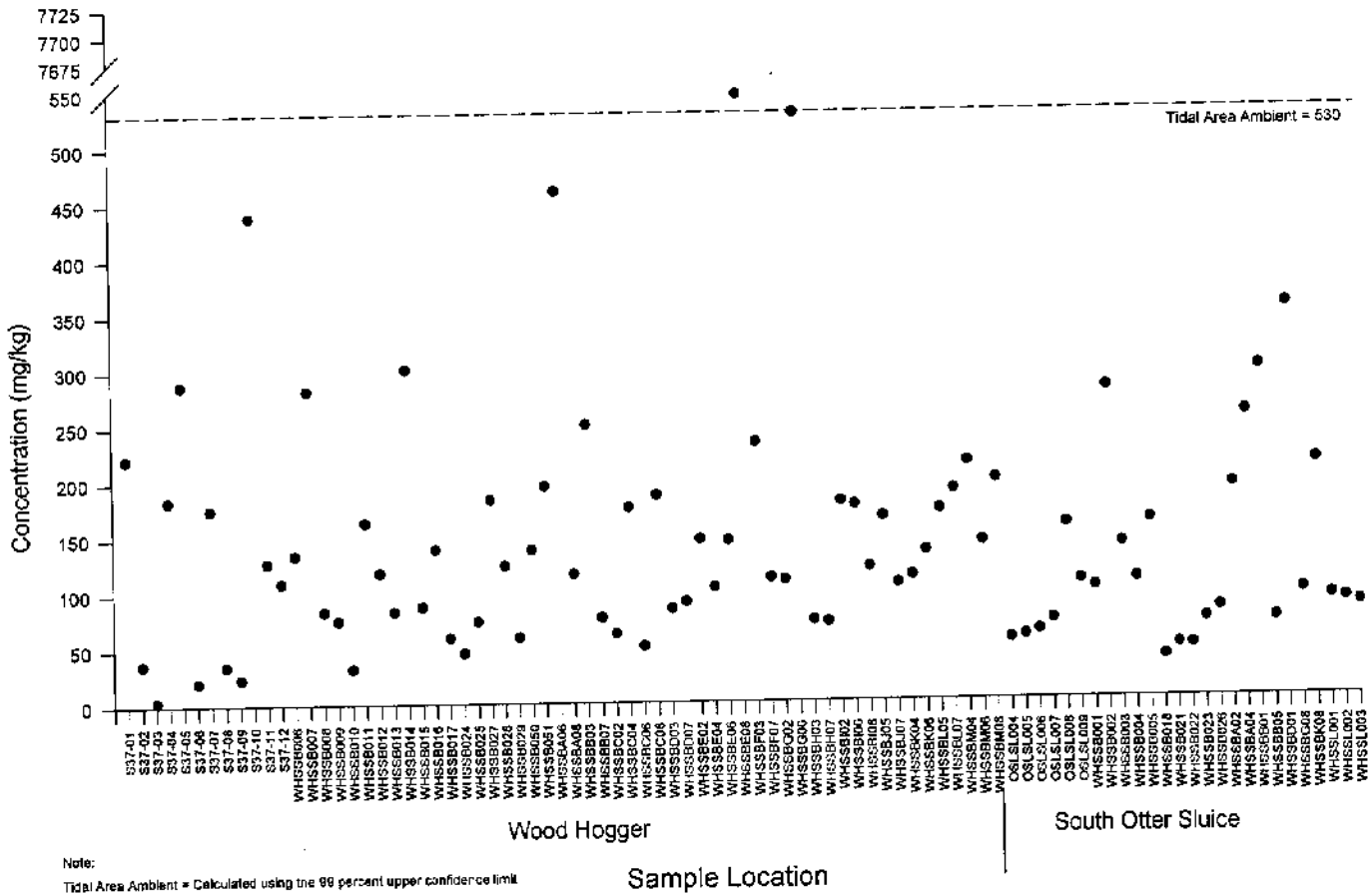


FIGURE 6-4B
DETECTED CONCENTRATIONS OF BARIUM IN THE R AREA TERRESTRIAL UNIT, SOIL AND SEDIMENT TIDAL AREA QEA, NWS SBD CONCORD



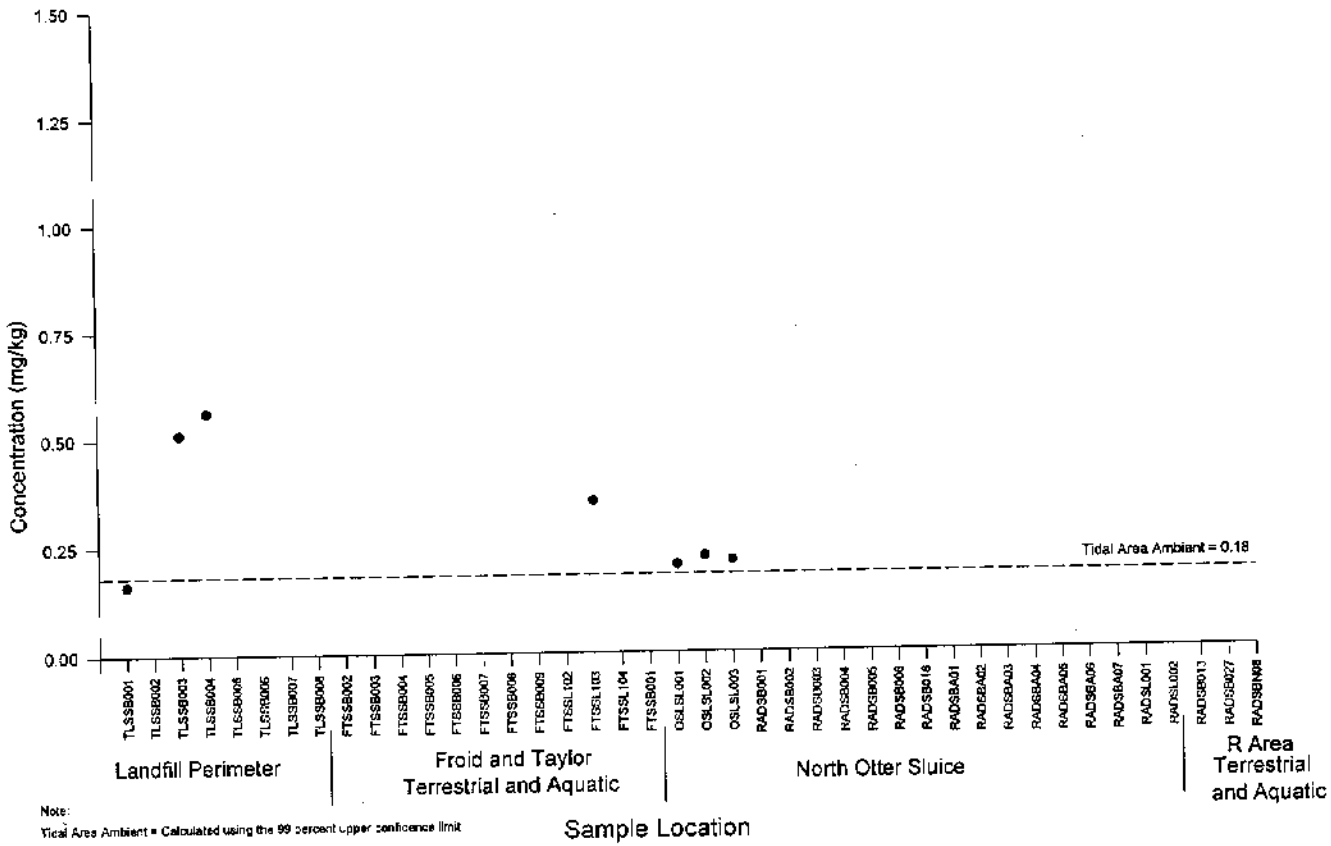
Note:
Tidal Area Ambient = Calculated using the 99 percent upper confidence limit

FIGURE 6-4C
DETECTED CONCENTRATIONS OF BARIUM IN THE WOOD HOGGER TERRESTRIAL AND SOUTH OTTER SLUICE AQUATIC UNITS, SOIL AND SEDIMENT TIDAL AREA QEA, NWS SBD CONCORD



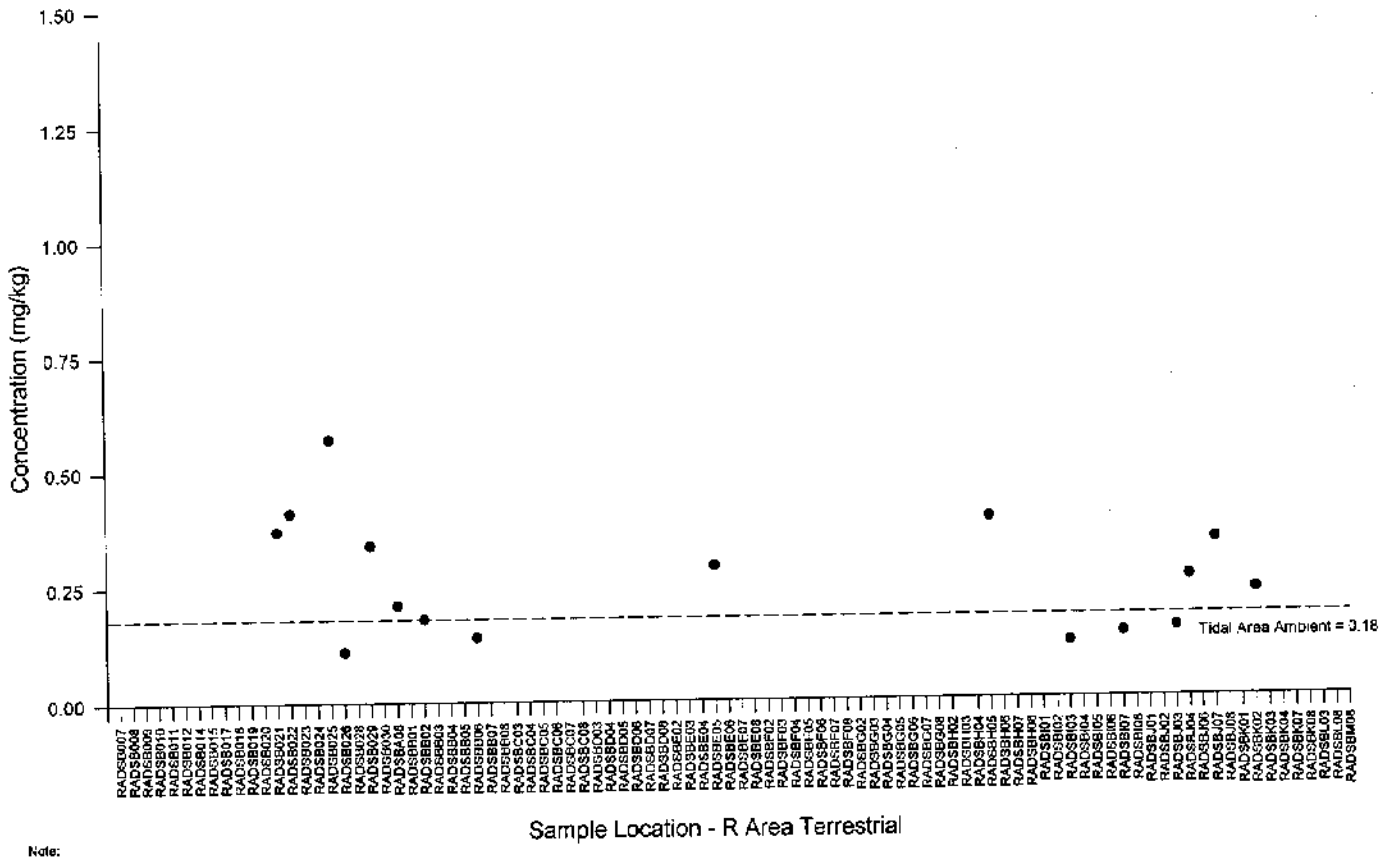
Note:
Tidal Area Ambient = Calculated using the 99 percent upper confidence limit

FIGURE 6-5A
DETECTED CONCENTRATIONS OF BERYLLIUM IN THE LANDFILL PERIMETER TERRESTRIAL, FROID AND TAYLOR TERRESTRIAL, FROID AND TAYLOR AQUATIC, R AREA TERRESTRIAL AND AQUATIC, AND NORTH OTTER SLUICE AQUATIC UNITS, SOIL AND SEDIMENT
TIDAL AREA QEA, NWS SBD CONCORD



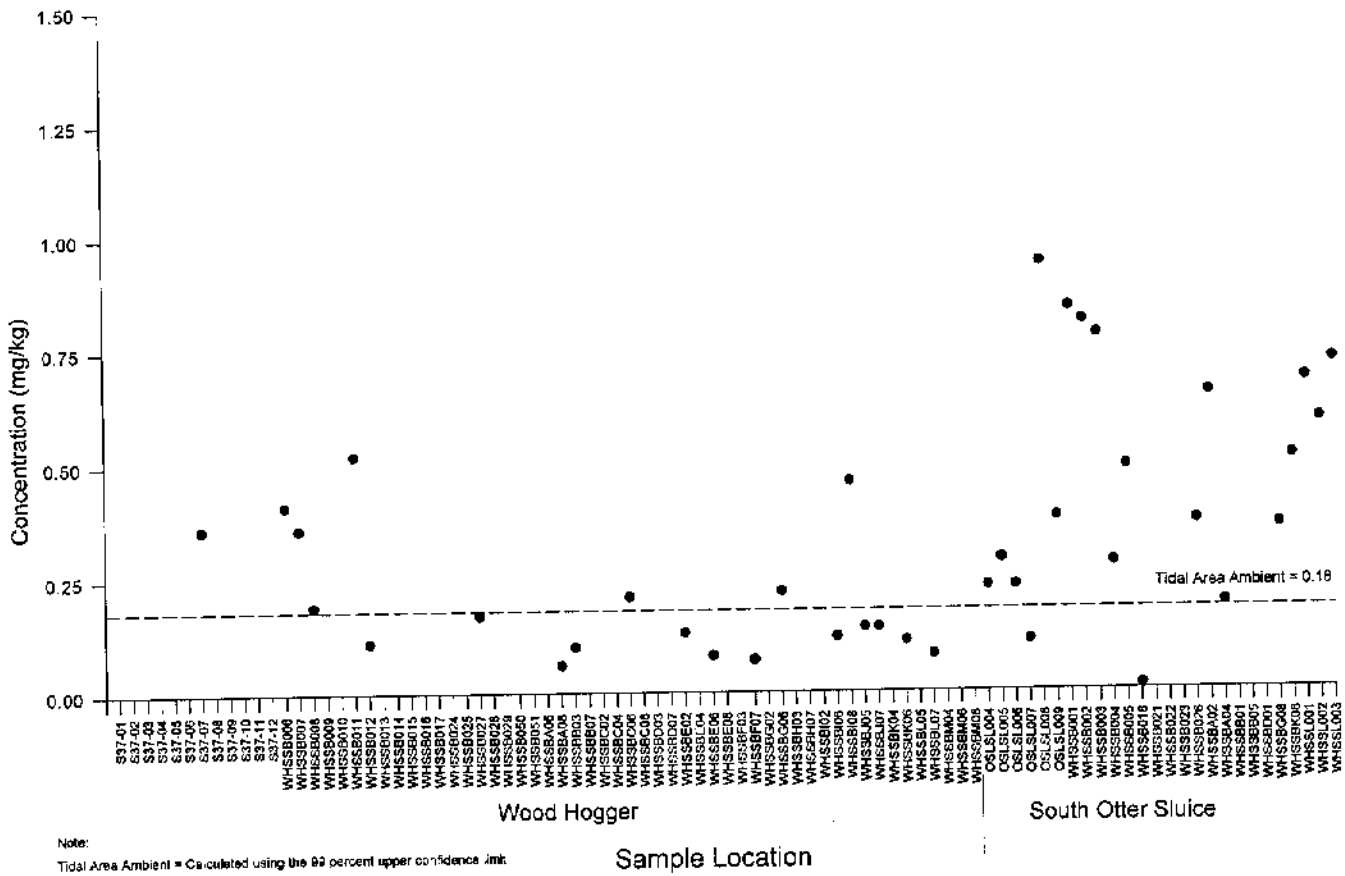
Note:
Tidal Area Ambient = Calculated using the 99 percent upper confidence limit

FIGURE 6-5B
DETECTED CONCENTRATIONS OF BERYLLIUM IN THE R AREA TERRESTRIAL UNIT, SOIL AND SEDIMENT TIDAL AREA QEA, NWS SBD CONCORD



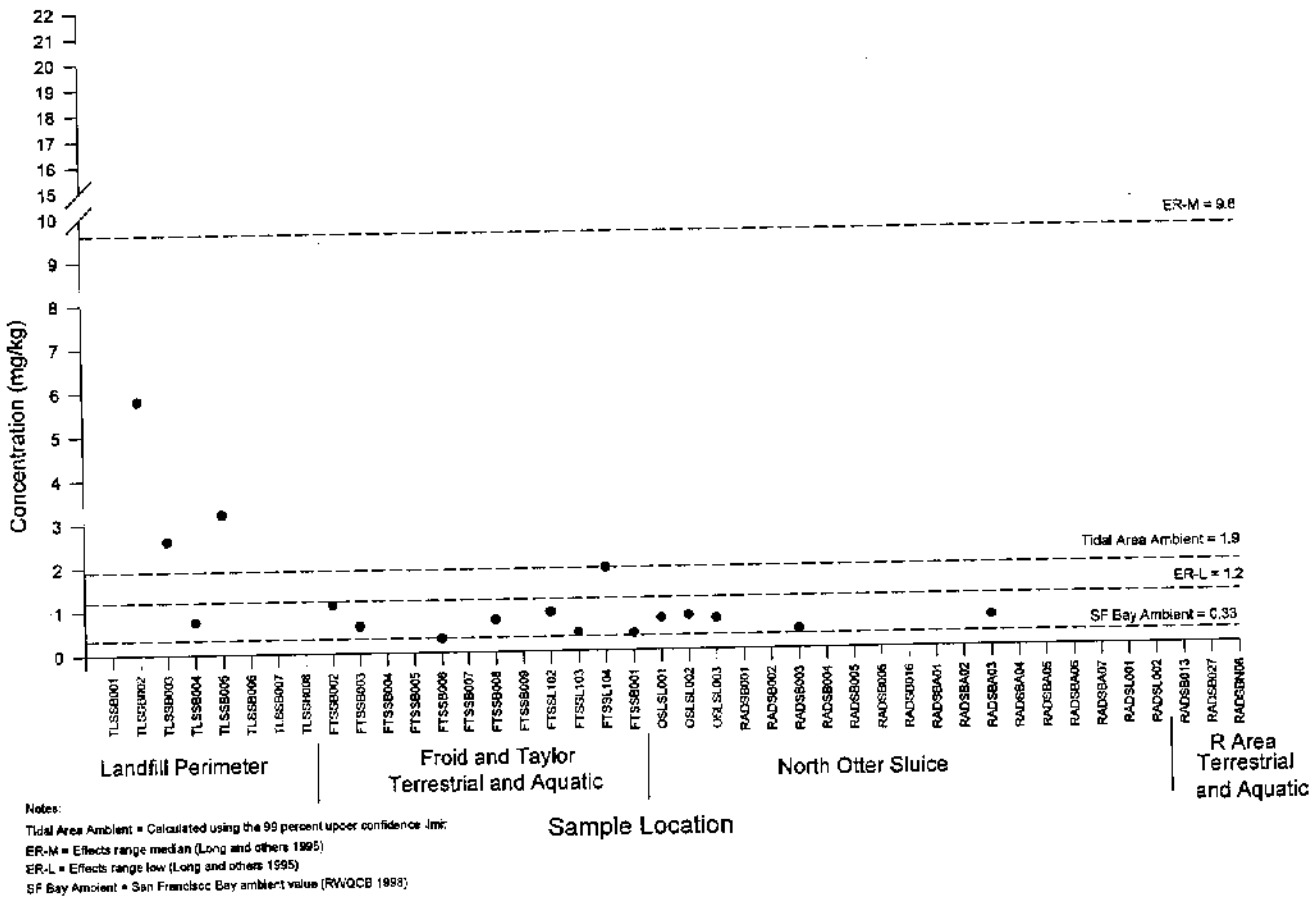
Note:
Tidal Area Ambient = Calculated using the 99 percent upper confidence limit

FIGURE 6-5C
DETECTED CONCENTRATIONS OF BERYLLIUM IN THE WOOD HOGGER TERRESTRIAL AND SOUTH OTTER SLUICE AQUATIC UNITS, SOIL AND SEDIMENT TIDAL AREA QEA, NWS SBD CONCORD



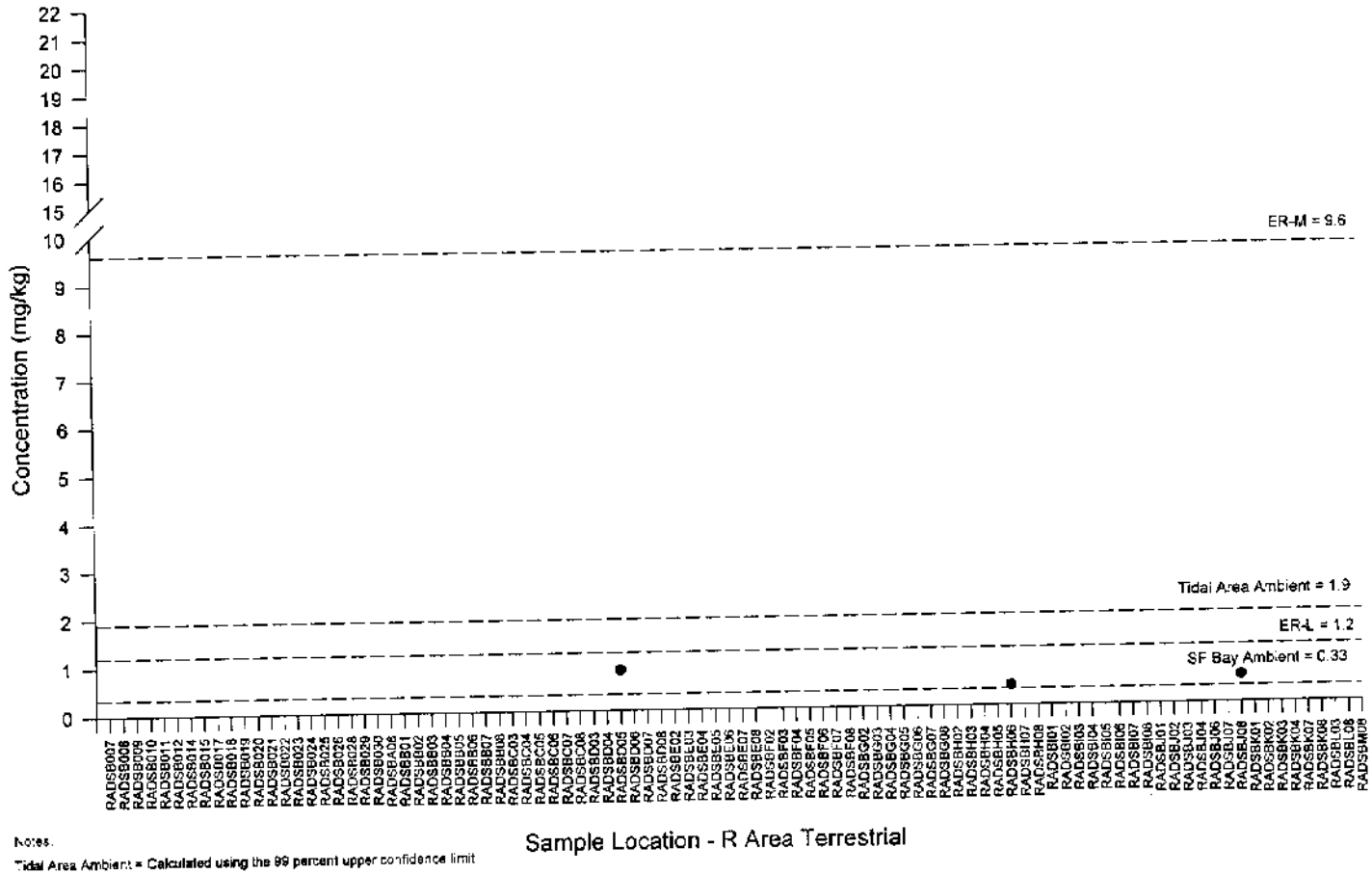
Note:
Tidal Area Ambient = Calculated using the 99 percent upper confidence limit

FIGURE 6-6A
DETECTED CONCENTRATIONS OF CADMIUM IN THE LANDFILL PERIMETER TERRESTRIAL, FROID AND TAYLOR TERRESTRIAL, FROID AND TAYLOR AQUATIC, R AREA TERRESTRIAL AND AQUATIC, AND NORTH OTTER SLUICE AQUATIC UNITS, SOIL AND SEDIMENT
TIDAL AREA QEA, NWS SBD CONCORD



Notes:
Tidal Area Ambient = Calculated using the 99 percent upper confidence limit
ER-M = Effects range median (Long and others 1995)
ER-L = Effects range low (Long and others 1995)
SF Bay Ambient = San Francisco Bay ambient value (RWQCB 1998)

FIGURE 6-6B
DETECTED CONCENTRATIONS OF CADMIUM IN THE R AREA TERRESTRIAL UNIT, SOIL AND SEDIMENT
TIDAL AREA QEA, NWS SBD CONCORD



Notes:

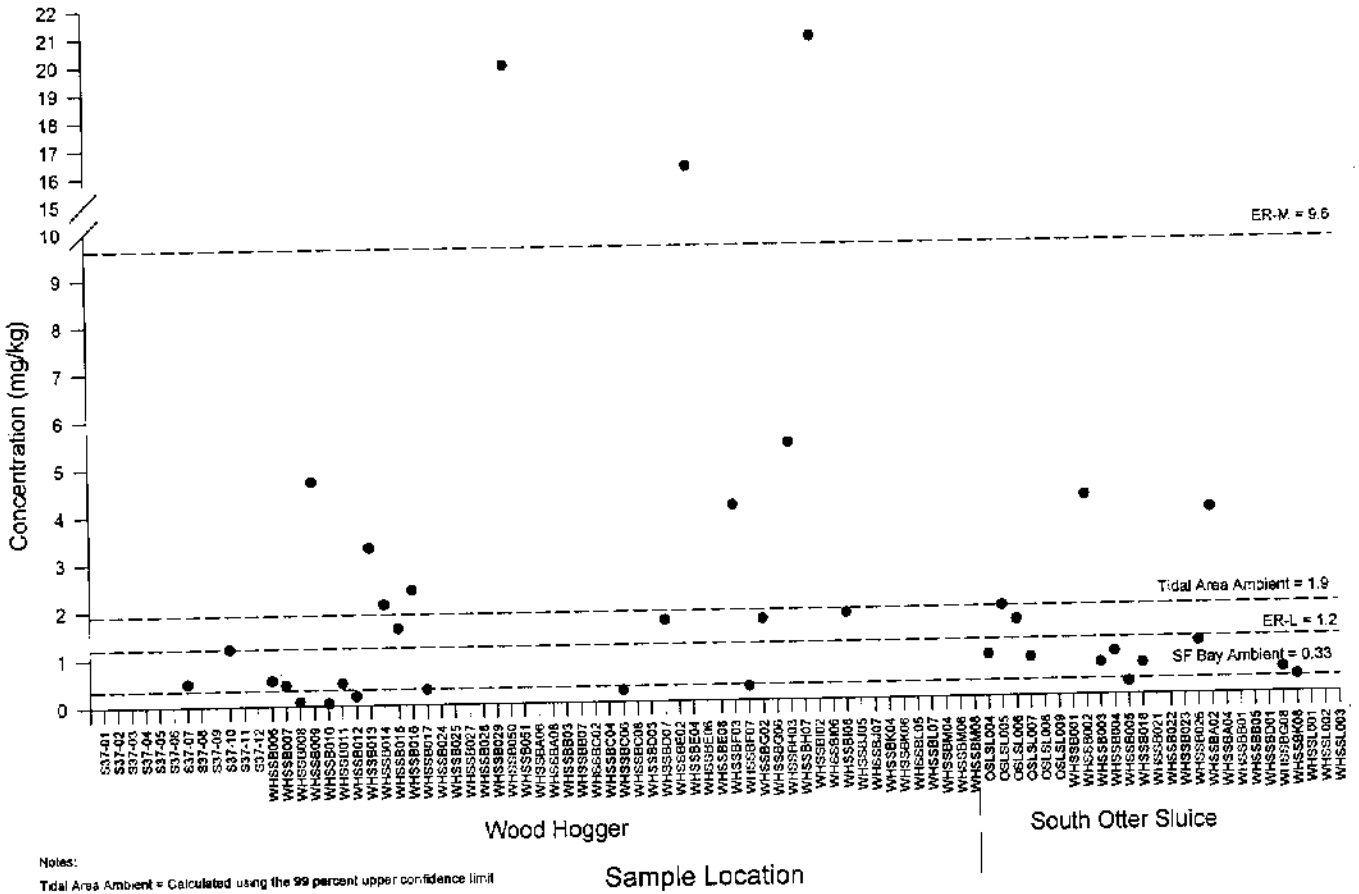
Tidal Area Ambient = Calculated using the 99 percent upper confidence limit

ER-M = Effects range median (Long and others 1995)

ER-L = Effects range low (Long and others 1995)

SF Bay Ambient = San Francisco Bay ambient value (RWQCB 1998)

FIGURE 6-6C
DETECTED CONCENTRATIONS OF CADMIUM IN THE WOOD HOGGER TERRESTRIAL AND SOUTH OTTER SLUICE AQUATIC UNITS, SOIL AND SEDIMENT TIDAL AREA QEA, NWS SBD CONCORD



Notes:

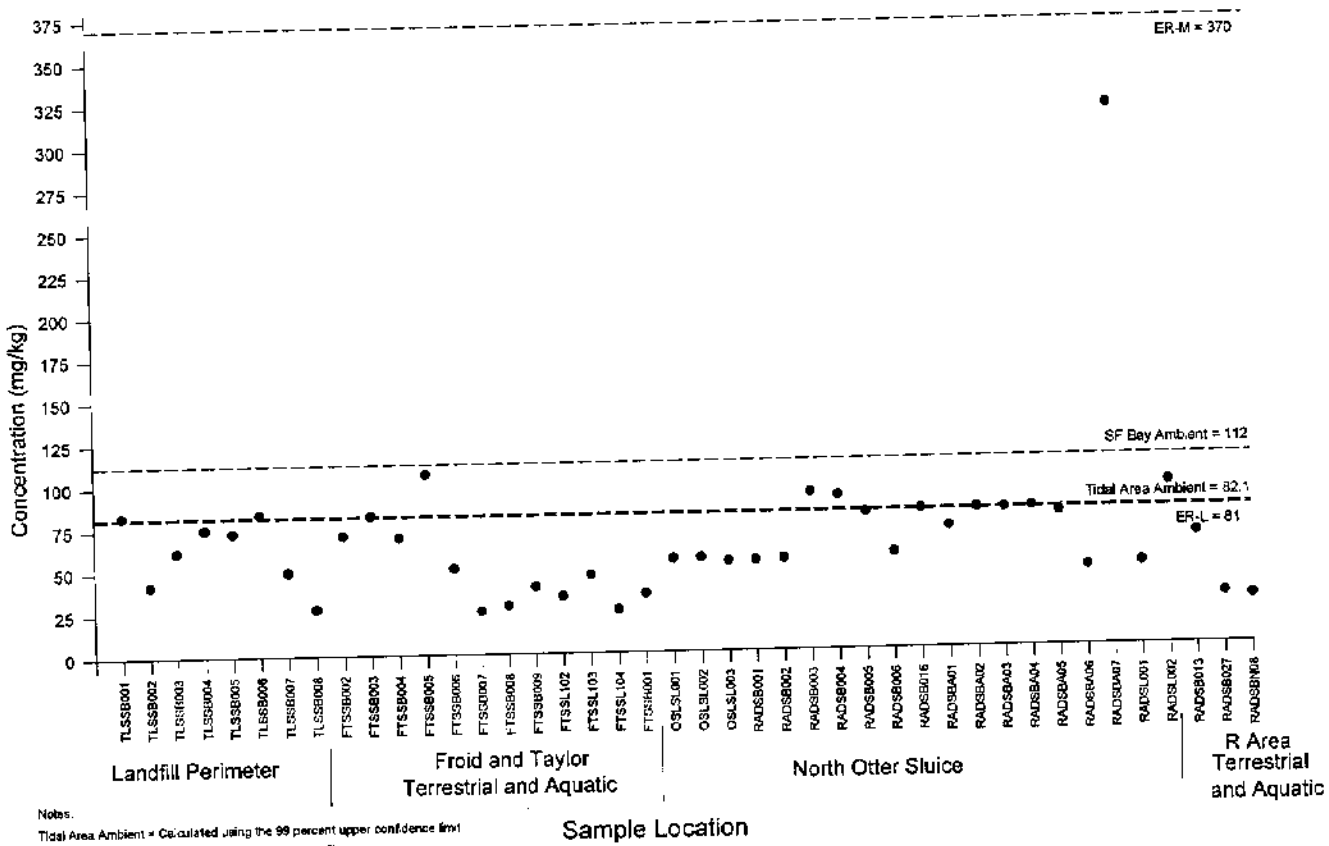
Tidal Area Ambient = Calculated using the 99 percent upper confidence limit

ER-M = Effects range median (Long and others 1995)

ER-L = Effects range low (Long and others 1995)

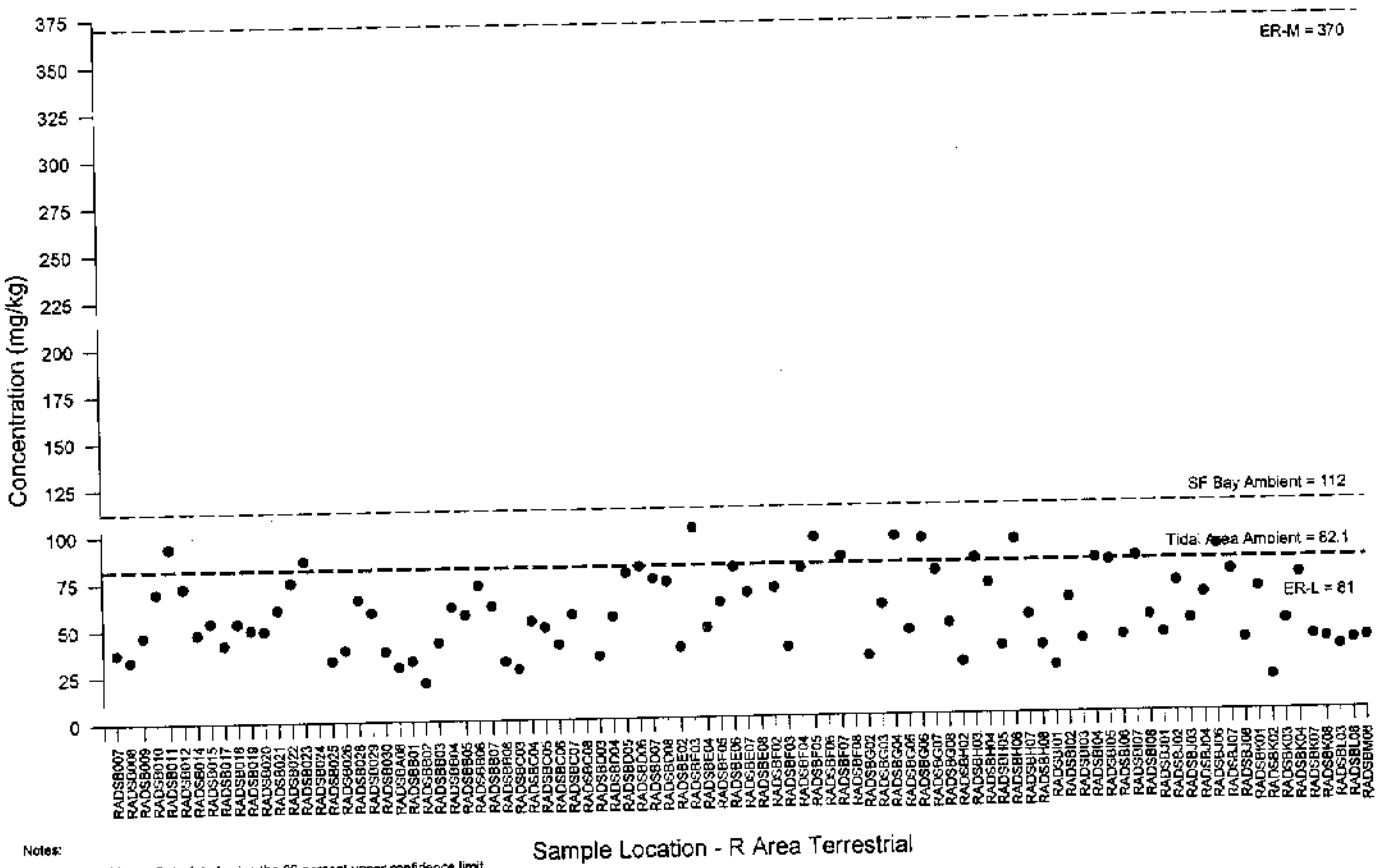
SF Bay Ambient = San Francisco Bay ambient value (RWQCB 1998)

FIGURE 6-7A
DETECTED CONCENTRATIONS OF CHROMIUM IN THE LANDFILL PERIMETER TERRESTRIAL, FROID AND TAYLOR TERRESTRIAL, FROID AND TAYLOR AQUATIC, R AREA TERRESTRIAL AND AQUATIC, AND NORTH OTTER SLUICE AQUATIC UNITS, SOIL AND SEDIMENT
TIDAL AREA QEA, NWS SBD CONCORD



Notes:
Tidal Area Ambient = Calculated using the 99 percent upper confidence limit
ER-M = Effects range median (Long and others 1995)
ER-L = Effects range low (Long and others 1995)
SF Bay Ambient = San Francisco Bay ambient value (RWQCB 1998)

FIGURE 6-7B
DETECTED CONCENTRATIONS OF CHROMIUM IN THE R AREA TERRESTRIAL UNIT, SOIL AND SEDIMENT
TIDAL AREA QEA, NWS SBD CONCORD



Notes:

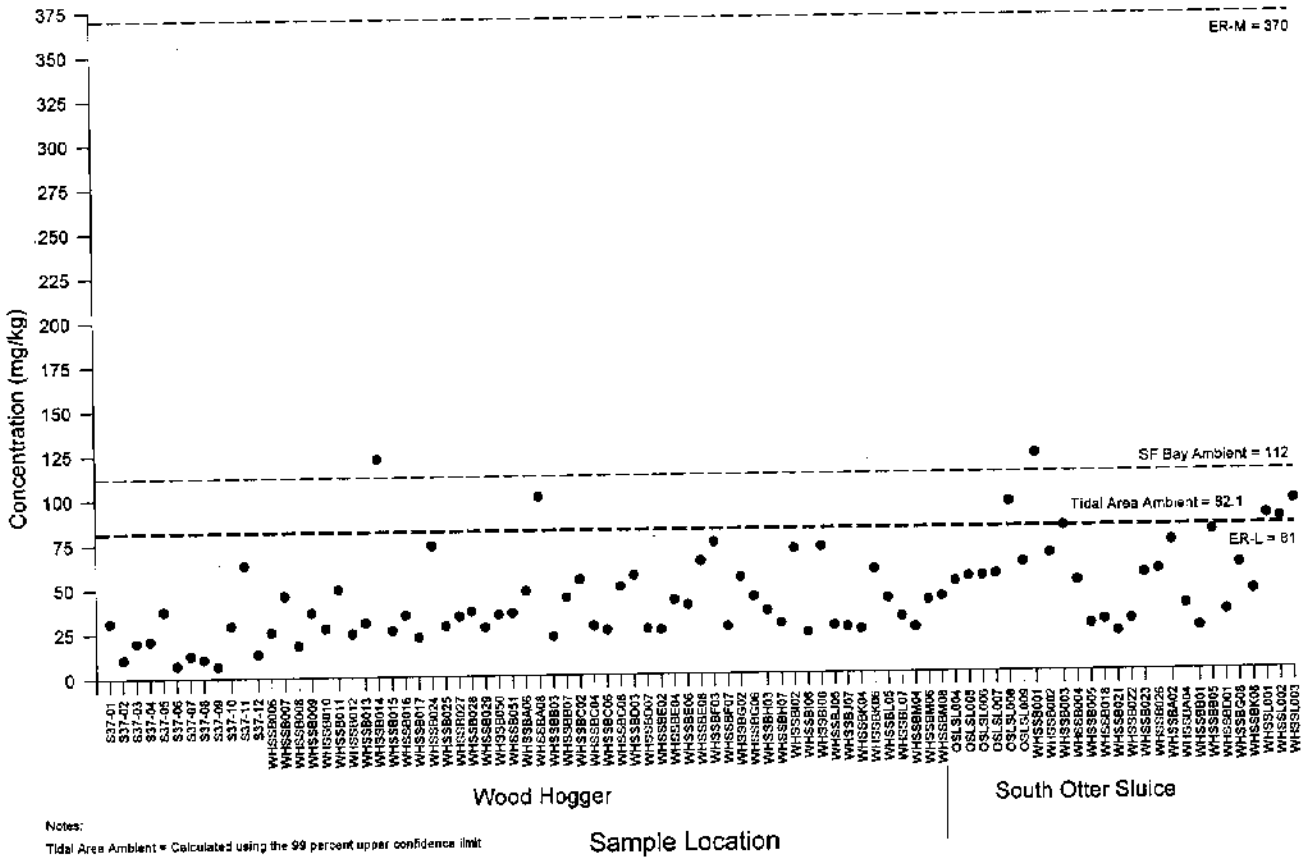
Tidal Area Ambient = Calculated using the 99 percent upper confidence limit

ER-M = Effects range median (Long and others 1995)

ER-L = Effects range low (Long and others 1995)

SF Bay Ambient = San Francisco Bay ambient value (RWQCB 1998)

FIGURE 6-7C
DETECTED CONCENTRATIONS OF CHROMIUM IN THE WOOD HOGGER TERRESTRIAL AND SOUTH OTTER SLUICE AQUATIC UNITS, SOIL AND SEDIMENT TIDAL AREA QEA, NWS SBD CONCORD



Notes:

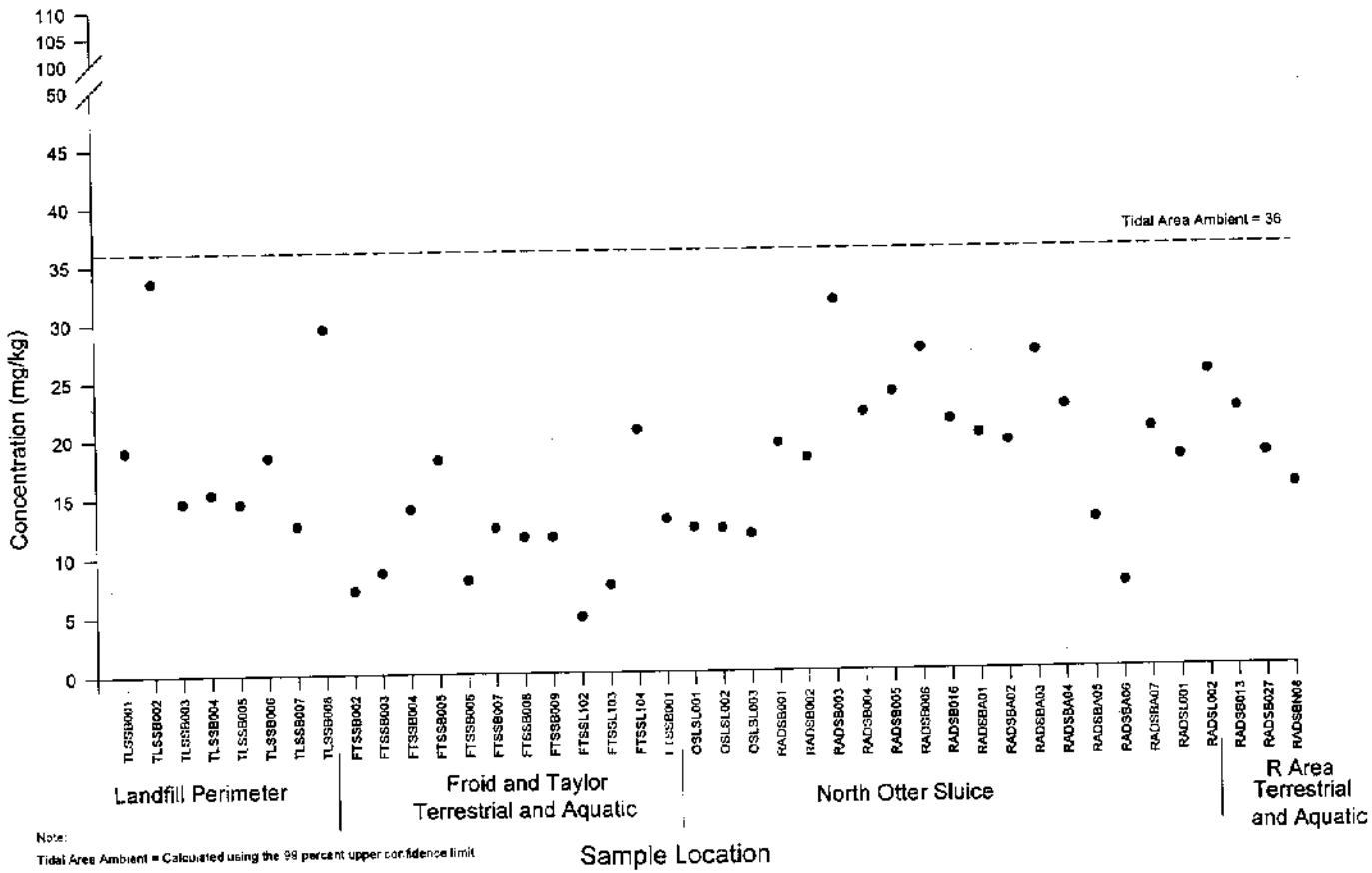
Tidal Area Ambient = Calculated using the 99 percent upper confidence limit

ER-M = Effects range median (Long and others 1995)

ER-L = Effects range low (Long and others 1995)

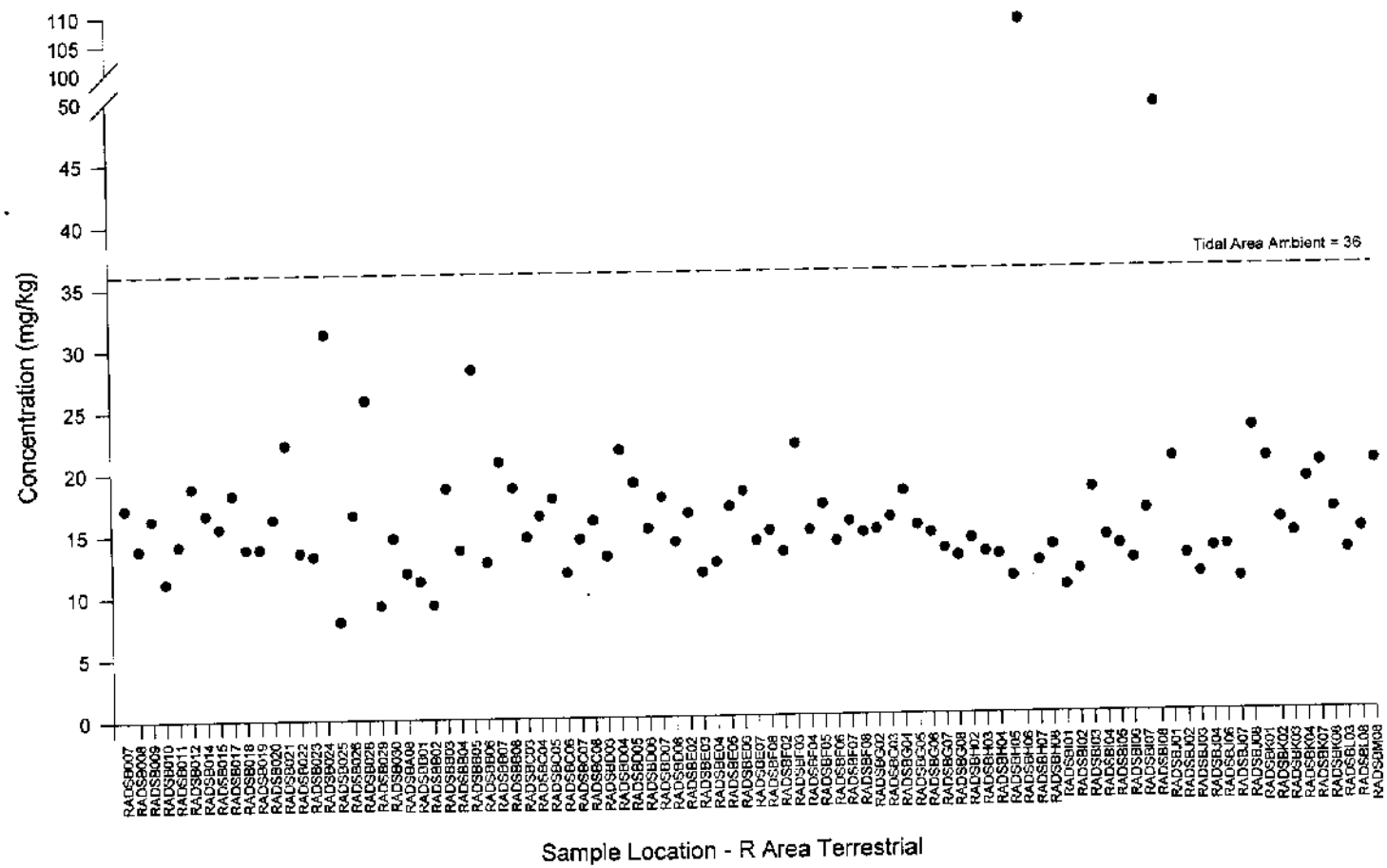
SF Bay Ambient = San Francisco Bay ambient value (RWQCB 1998)

FIGURE 6-8A
DETECTED CONCENTRATIONS OF COBALT IN THE LANDFILL PERIMETER TERRESTRIAL, FROID AND TAYLOR TERRESTRIAL, FROID AND TAYLOR AQUATIC, R AREA TERRESTRIAL AND AQUATIC, AND NORTH OTTER SLUICE AQUATIC UNITS, SOIL AND SEDIMENT
TIDAL AREA QEA, NWS SBD CONCORD



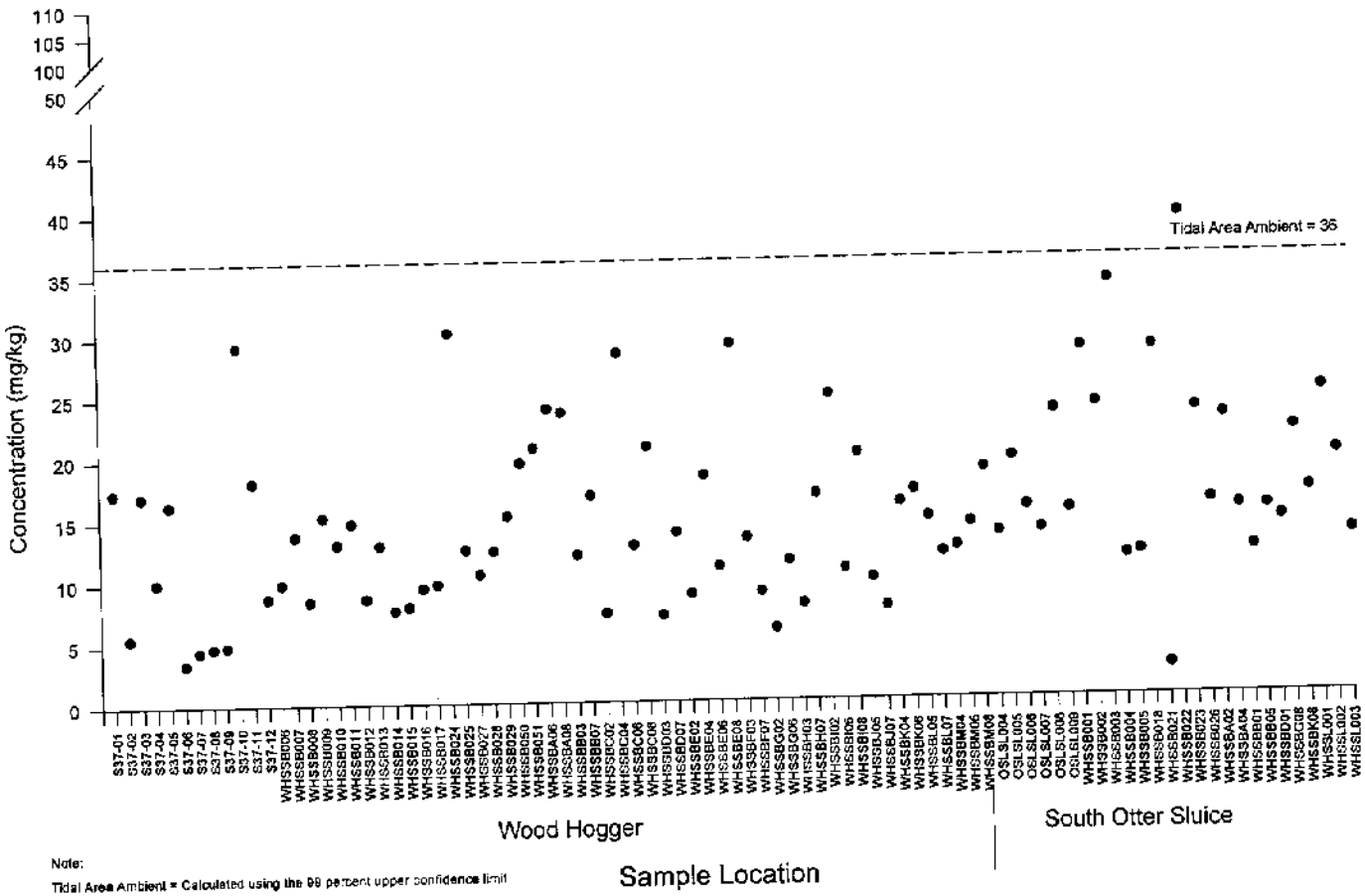
Note:
Tidal Area Ambient = Calculated using the 99 percent upper confidence limit

FIGURE 6-8B
DETECTED CONCENTRATIONS OF COBALT THE R AREA TERRESTRIAL UNIT, SOIL AND SEDIMENT TIDAL AREA QEA, NWS SBD CONCORD



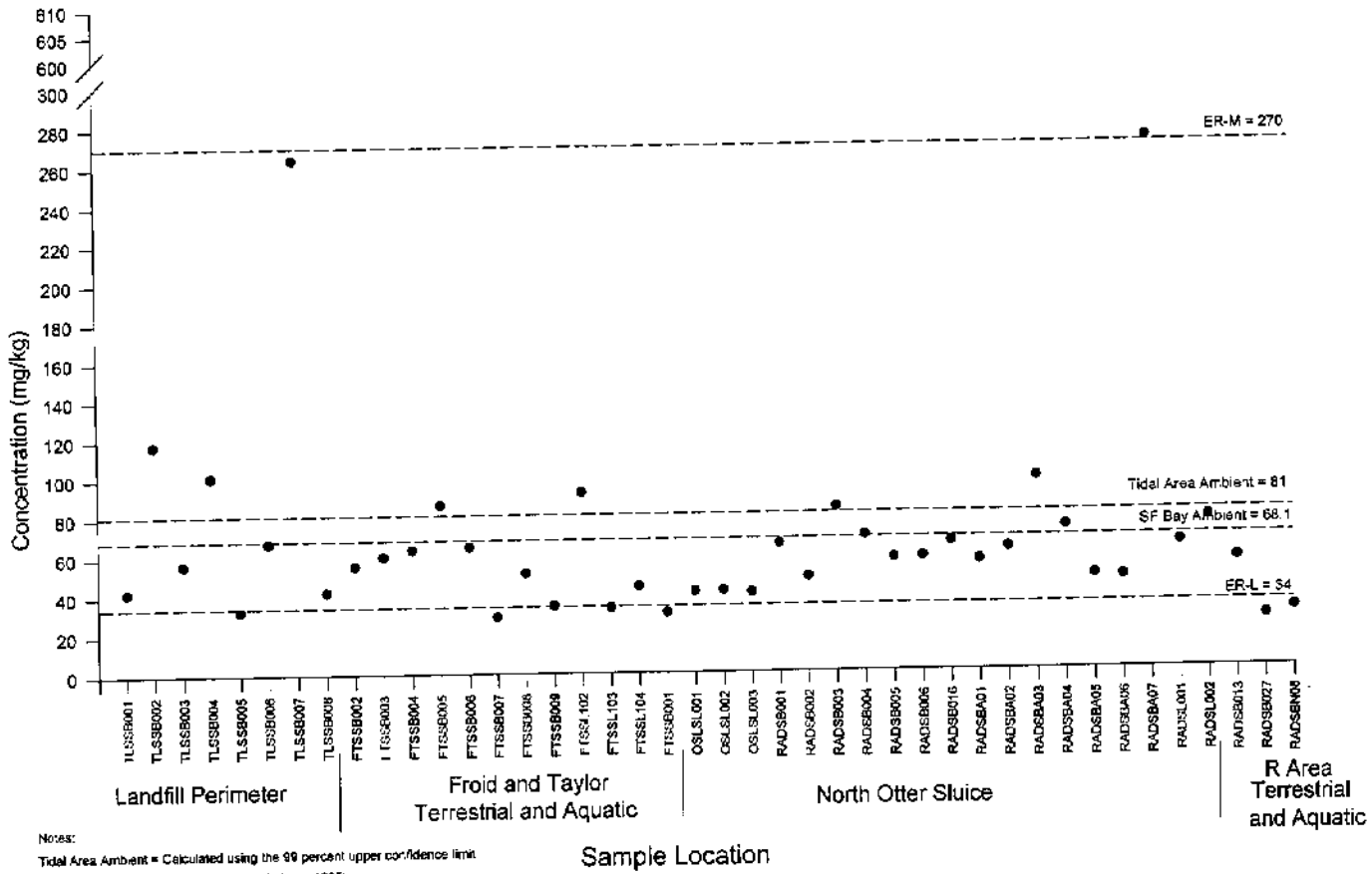
Note:
Tidal Area Ambient = Calculated using the 99 percent upper confidence limit

FIGURE 6-8C
DETECTED CONCENTRATIONS OF COBALT IN THE WOOD HOGGER TERRESTRIAL AND SOUTH OTTER SLUICE AQUATIC UNITS, SOIL AND SEDIMENT TIDAL AREA QEA, NWS SBD CONCORD



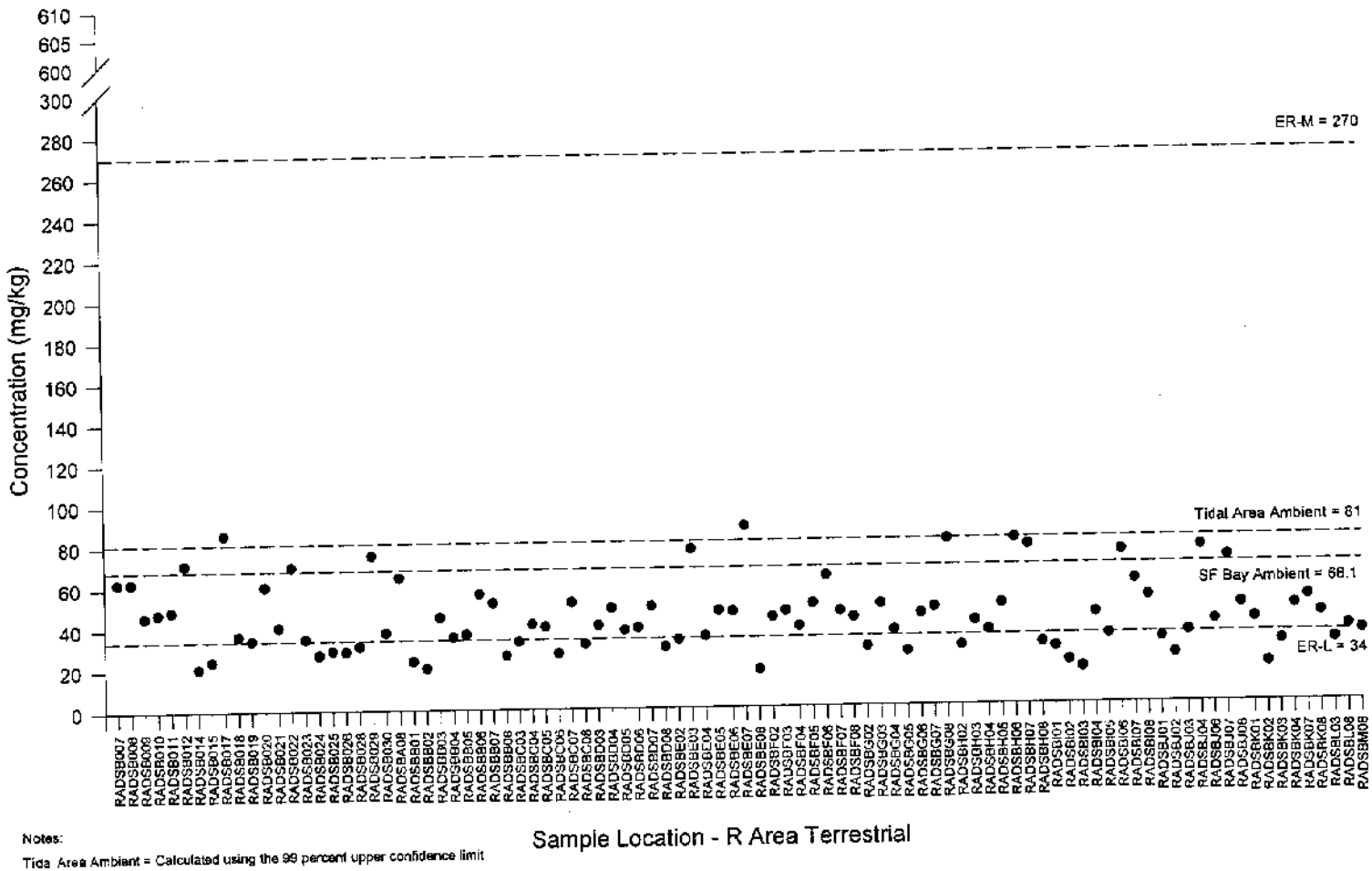
Note:
Tidal Area Ambient = Calculated using the 99 percent upper confidence limit

FIGURE 6-9A
DETECTED CONCENTRATIONS OF COPPER IN THE LANDFILL PERIMETER TERRESTRIAL, FROID AND TAYLOR TERRESTRIAL, FROID AND TAYLOR AQUATIC, R AREA TERRESTRIAL AND AQUATIC, AND NORTH OTTER SLUICE AQUATIC UNITS, SOIL AND SEDIMENT
TIDAL AREA QEA, NWS SBD CONCORD



Notes:
Tidal Area Ambient = Calculated using the 99 percent upper confidence limit
ER-M = Effects range median (Long and others 1995)
ER-L = Effects range low (Long and others 1995)
SF Bay Ambient = San Francisco Bay ambient value (RWQCB 1998)

FIGURE 6-9B
DETECTED CONCENTRATIONS OF COPPER THE R AREA TERRESTRIAL UNIT, SOIL AND SEDIMENT TIDAL AREA QEA, NWS SBD CONCORD



Notes:

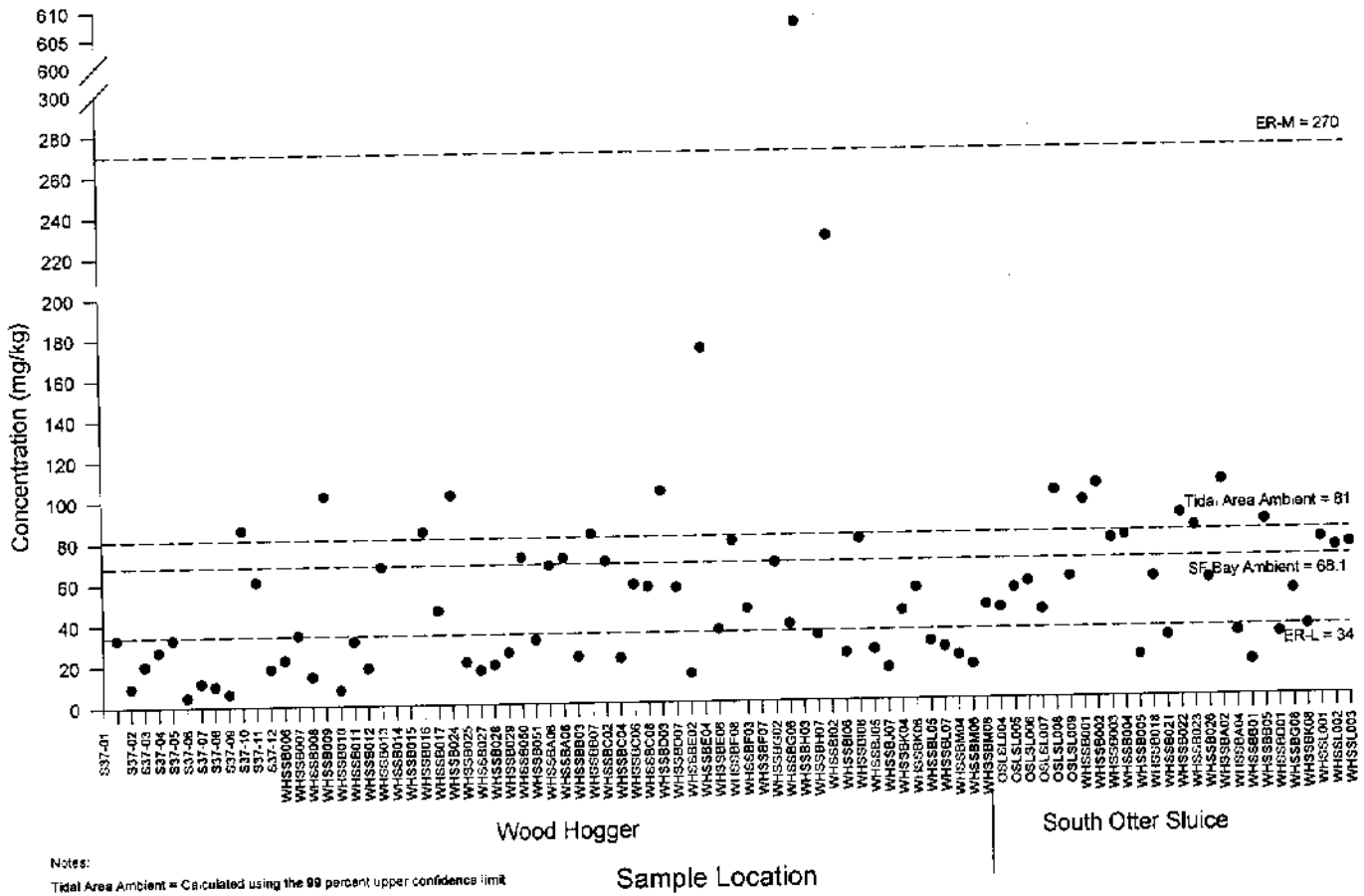
Tida Area Ambient = Calculated using the 99 percent upper confidence limit

ER-M = Effects range median (Long and others 1995)

ER-L = Effects range low (Long and others 1995)

SF Bay Ambient = San Francisco Bay ambient value (RWQCB 1998)

FIGURE 6-9C
DETECTED CONCENTRATIONS OF COPPER IN THE WOOD HOGGER TERRESTRIAL AND SOUTH OTTER SLUICE AQUATIC UNITS, SOIL AND SEDIMENT TIDAL AREA QEA, NWS SBD CONCORD



Notes:

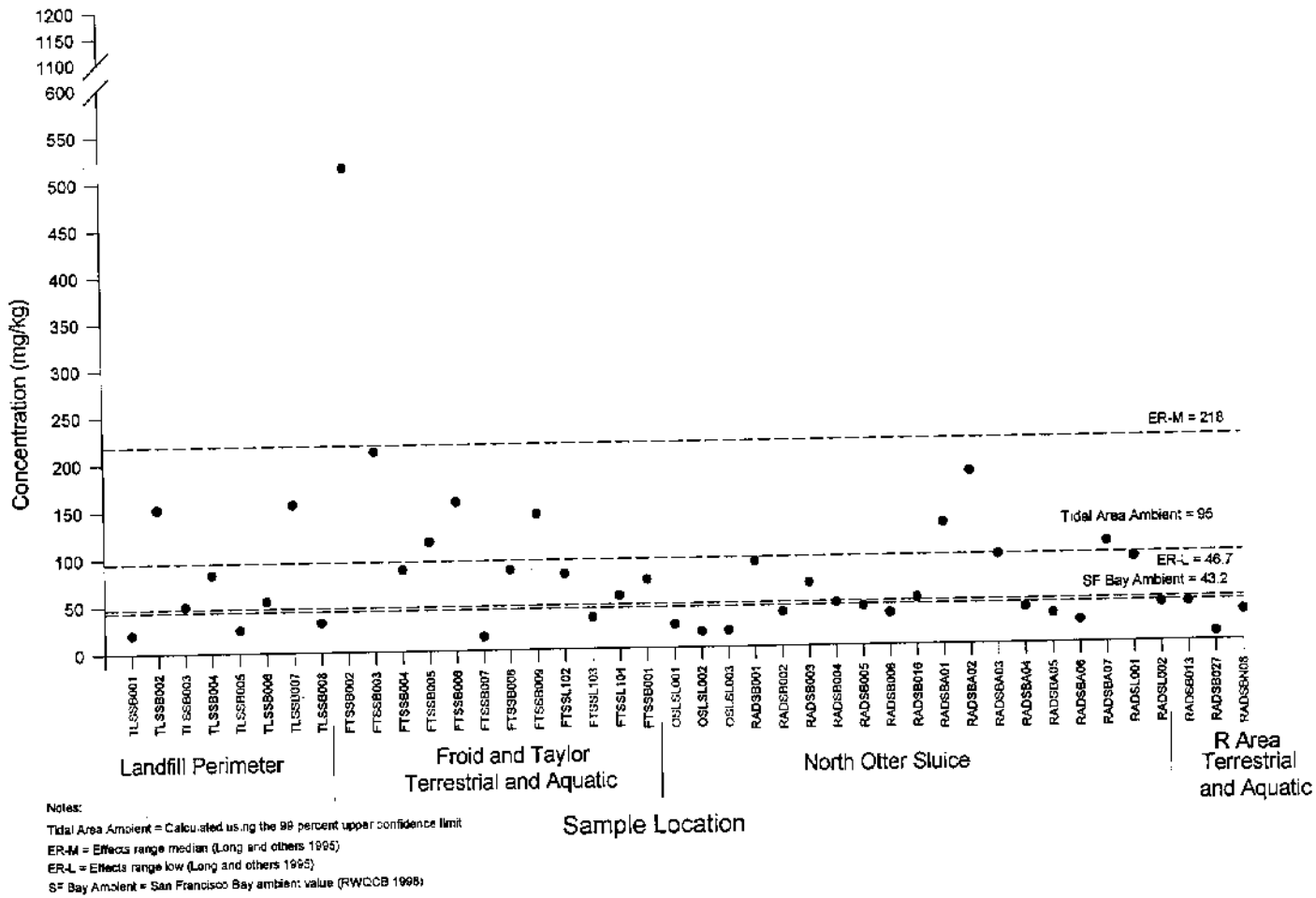
Tidal Area Ambient = Calculated using the 99 percent upper confidence limit

ER-M = Effects range median (Long and others 1995)

ER-L = Effects range low (Long and others 1995)

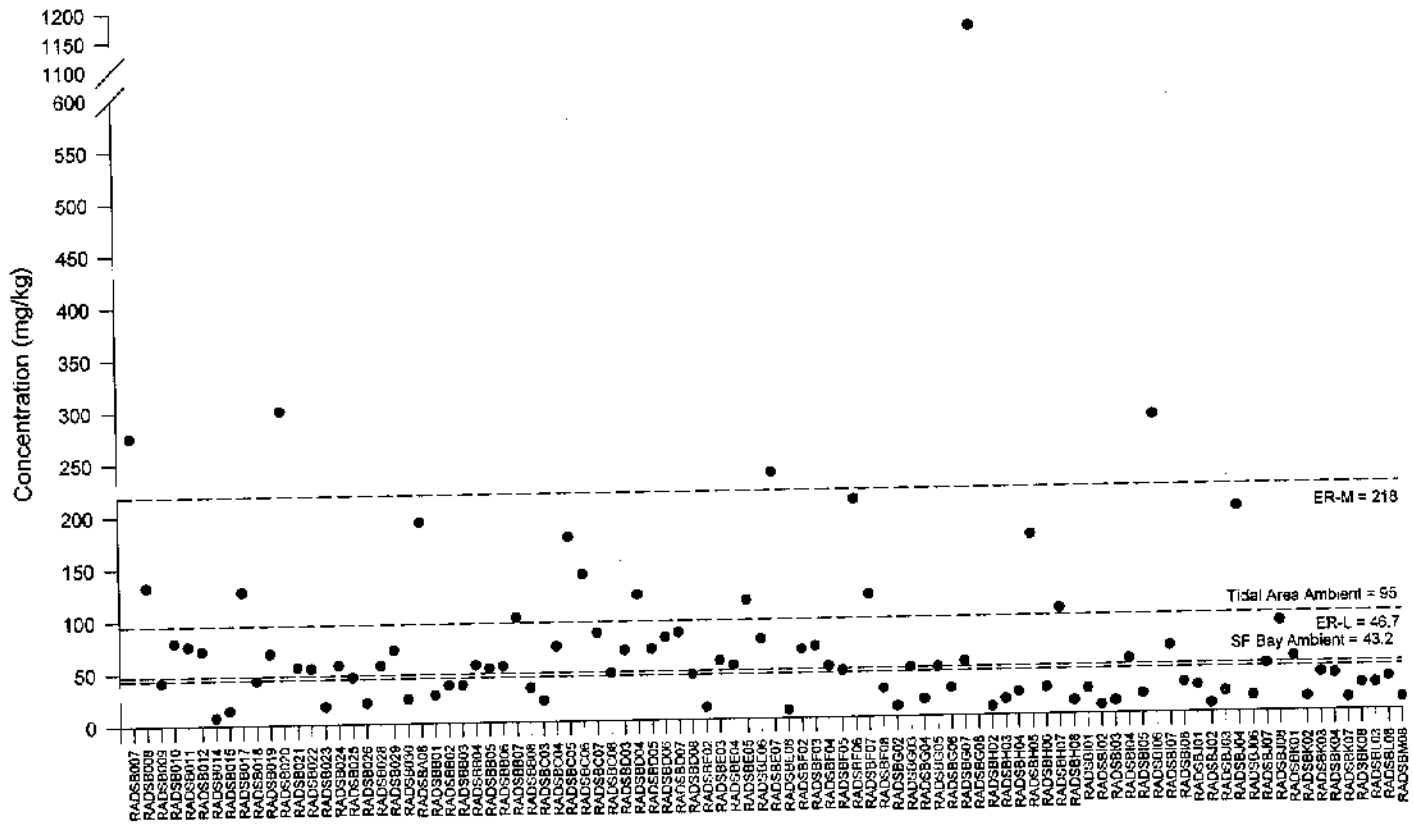
SF Bay Ambient = San Francisco Bay ambient value (RWQCB 1998)

FIGURE 6-10A
DETECTED CONCENTRATIONS OF LEAD IN THE LANDFILL PERIMETER TERRESTRIAL, FROID AND TAYLOR TERRESTRIAL, FROID AND TAYLOR AQUATIC, R AREA TERRESTRIAL AND AQUATIC, AND NORTH OTTER SLUICE AQUATIC UNITS, SOIL AND SEDIMENT
TIDAL AREA QEA, NWS SBD CONCORD



Notes:
Tidal Area Ambient = Calculated using the 99 percent upper confidence limit
ER-M = Effects range median (Long and others 1995)
ER-L = Effects range low (Long and others 1995)
SF Bay Ambient = San Francisco Bay ambient value (RWQCB 1995)

FIGURE 6-10B
DETECTED CONCENTRATIONS OF LEAD THE R AREA TERRESTRIAL UNIT, SOIL AND SEDIMENT TIDAL AREA QEA, NWS SBD CONCORD



Notes:

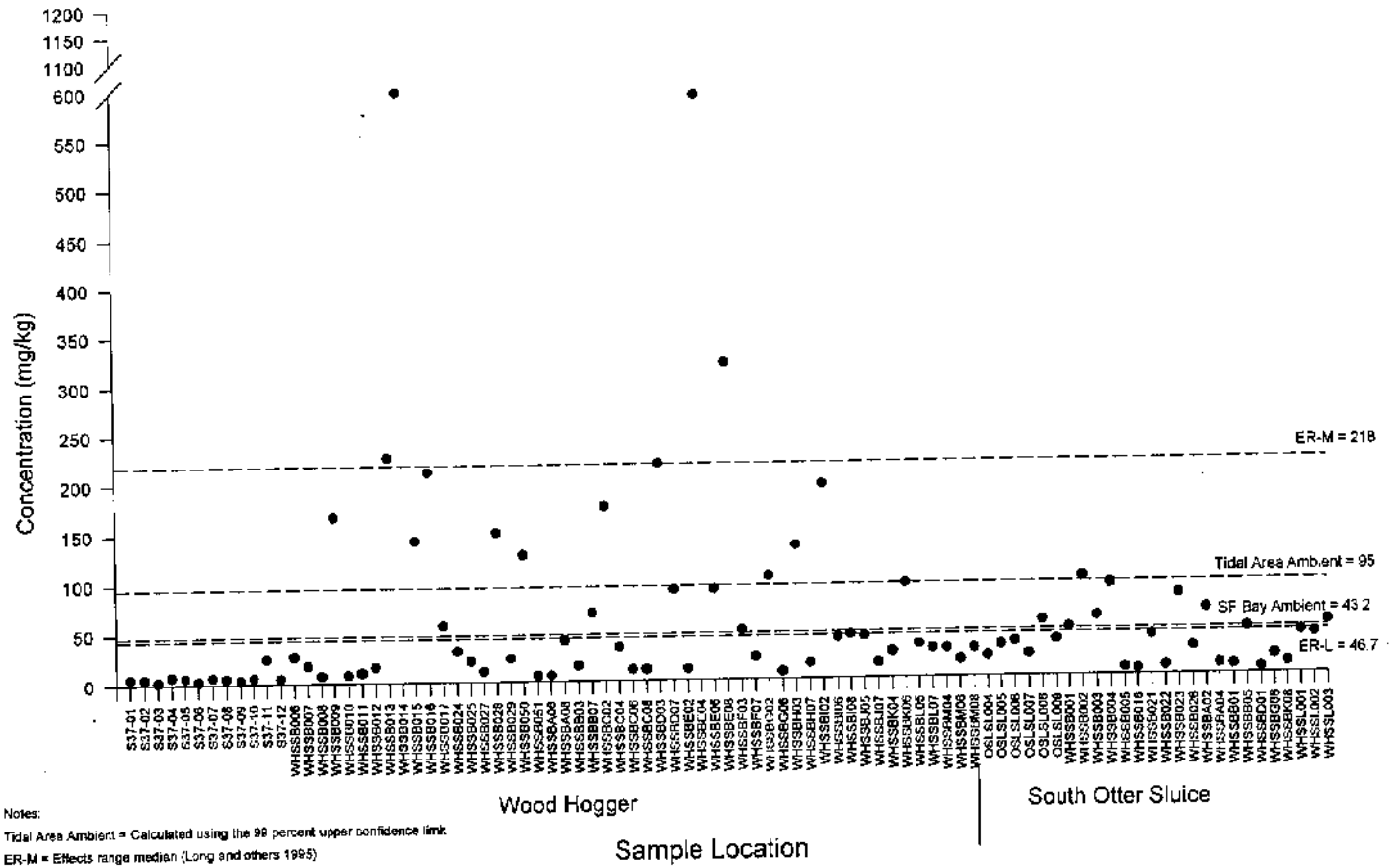
Tidal Area Ambient = Calculated using the 99 percent upper confidence limit

ER-M = Effects range median (Long and others 1995)

ER-L = Effects range low (Long and others 1995)

SF Bay Ambient = San Francisco Bay ambient value (RWQCB 1998)

FIGURE 6-10C
DETECTED CONCENTRATIONS OF LEAD IN THE WOOD HOGGER TERRESTRIAL AND SOUTH OTTER SLUICE AQUATIC UNITS, SOIL AND SEDIMENT TIDAL AREA QEA, NWS SBD CONCORD



Notes:

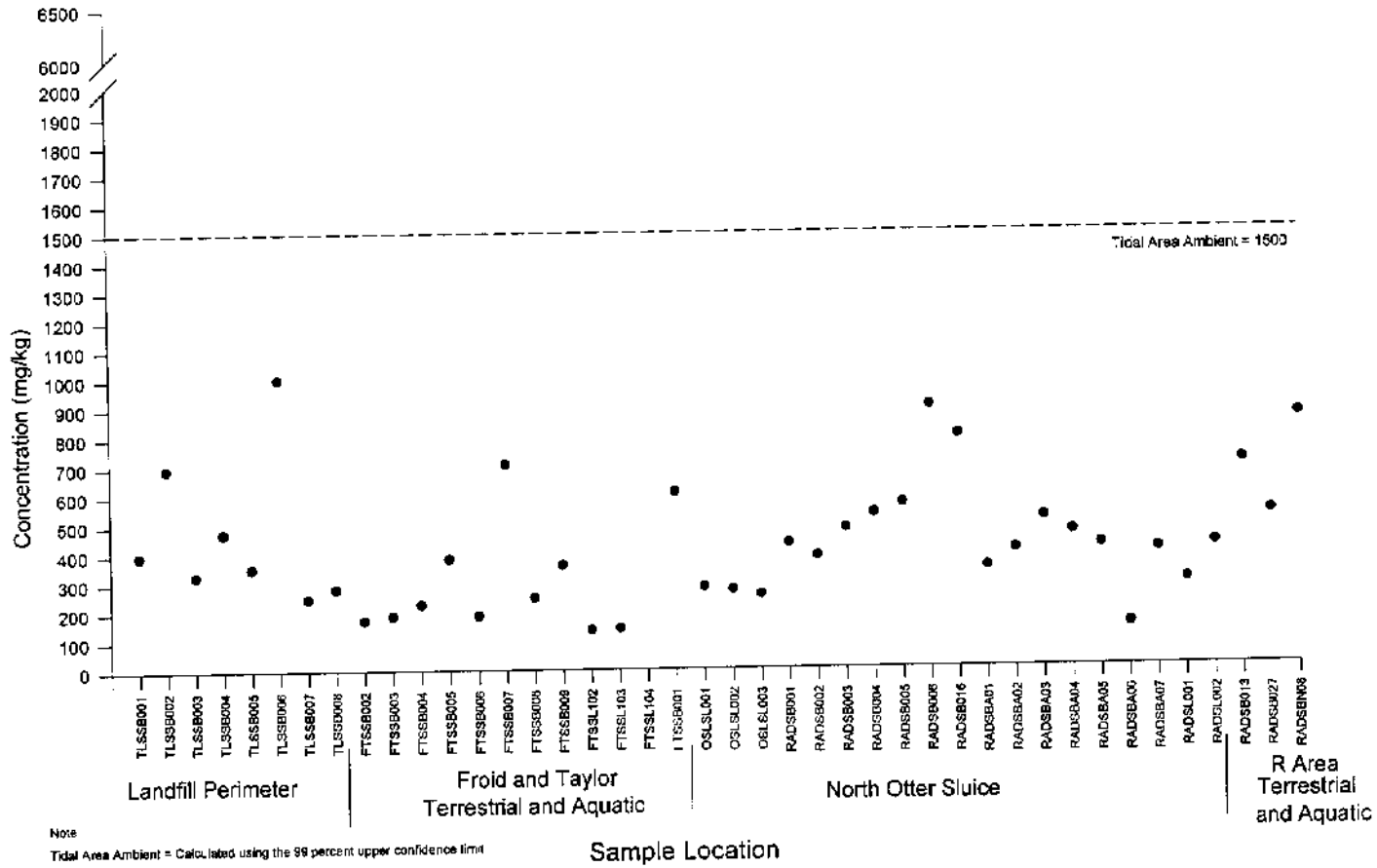
Tidal Area Ambient = Calculated using the 99 percent upper confidence limit.

ER-M = Effects range median (Long and others 1995)

ER-L = Effects range low (Long and others 1995)

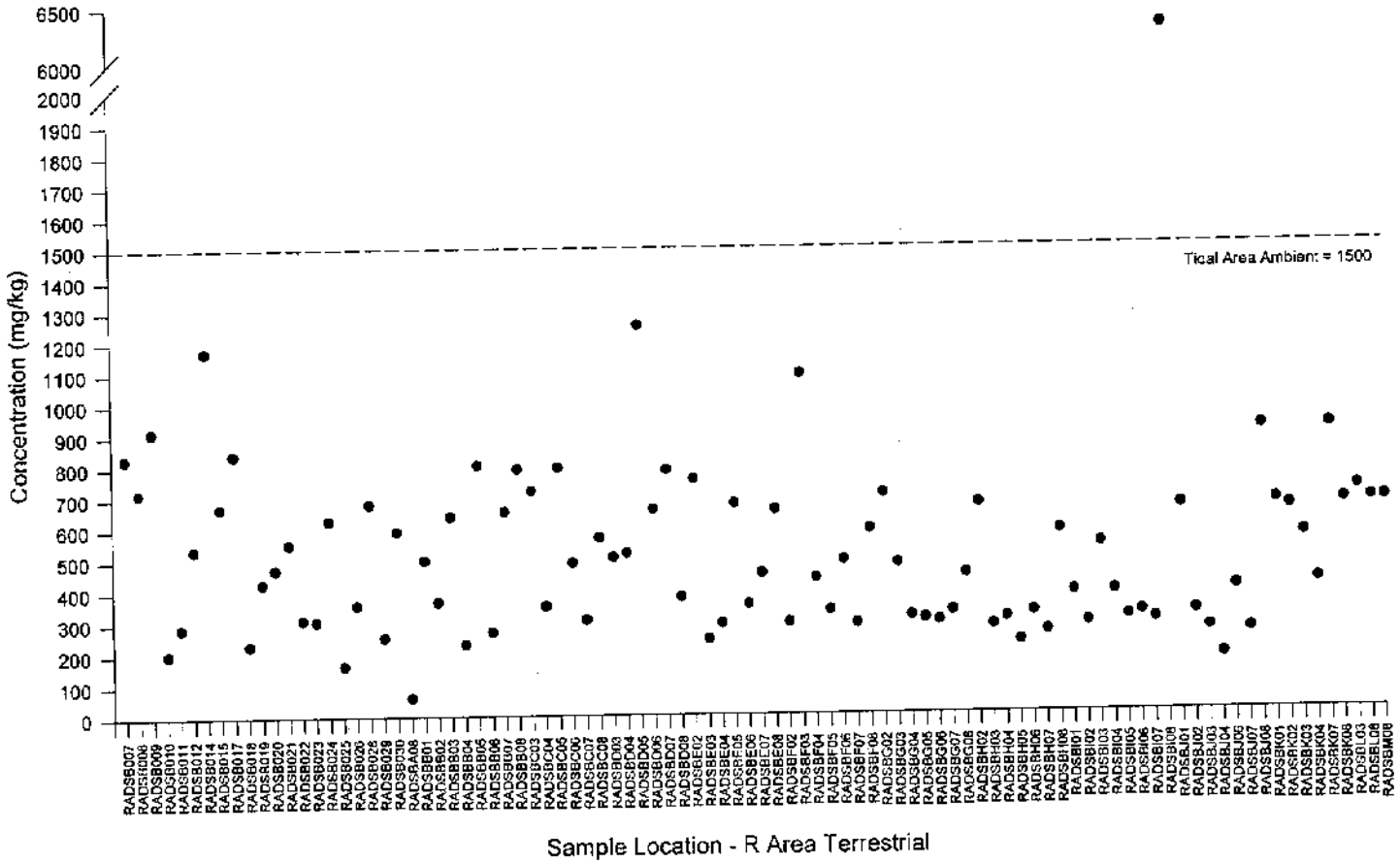
SF Bay Ambient = San Francisco Bay ambient value (RWQCB 1998)

FIGURE 6-11A
DETECTED CONCENTRATIONS OF MANGANESE IN THE LANDFILL PERIMETER TERRESTRIAL, FROID AND TAYLOR TERRESTRIAL, FROID AND TAYLOR AQUATIC, R AREA TERRESTRIAL AND AQUATIC, AND NORTH OTTER SLUICE AQUATIC UNITS, SOIL AND SEDIMENT TIDAL AREA QEA, NWS SBD CONCORD



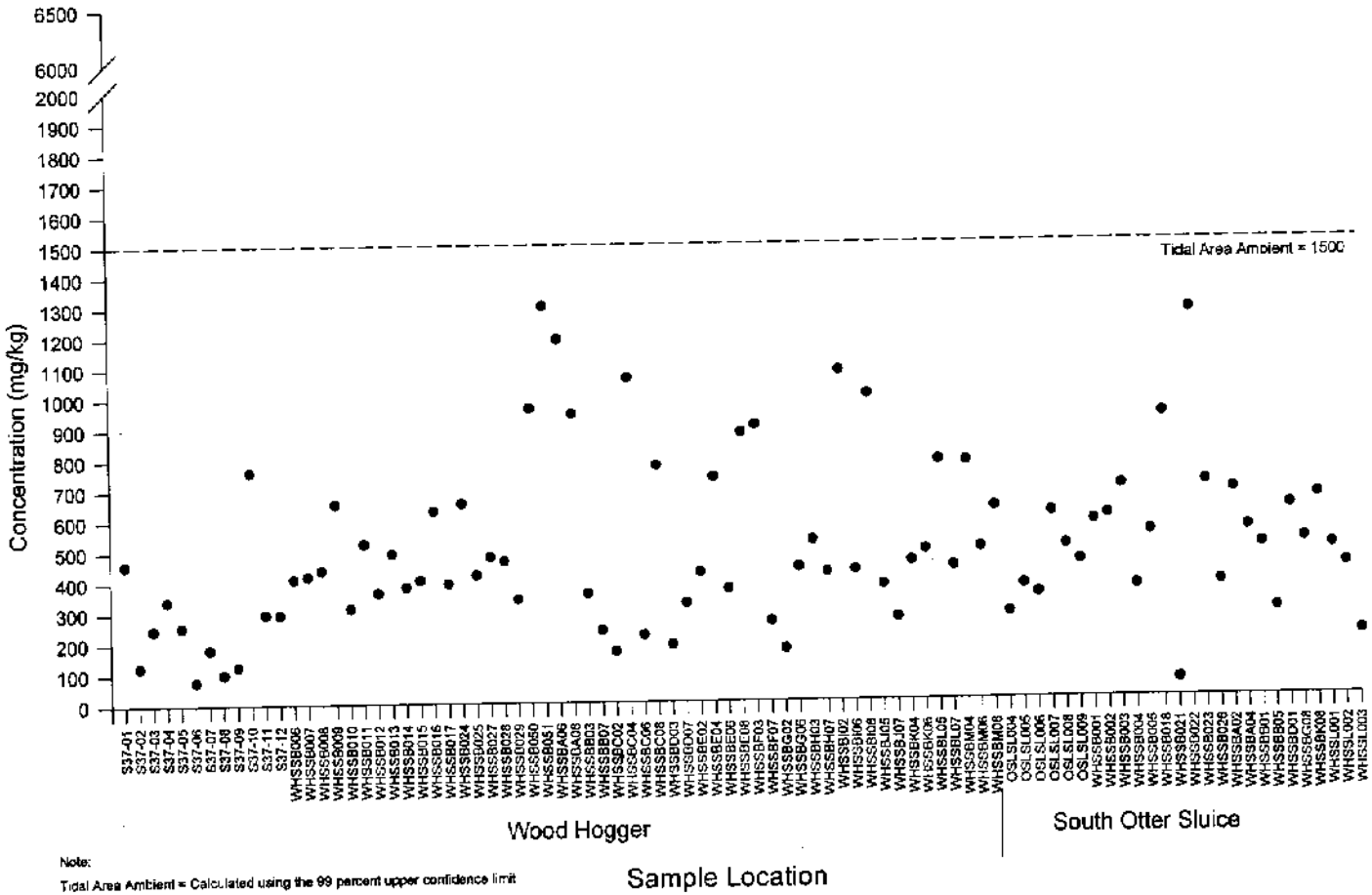
Note
Tidal Area Ambient = Calculated using the 99 percent upper confidence limit

FIGURE 6-11B
DETECTED CONCENTRATIONS OF MANGANESE THE R AREA TERRESTRIAL UNIT, SOIL AND SEDIMENT TIDAL AREA QEA, NWS SBD CONCORD



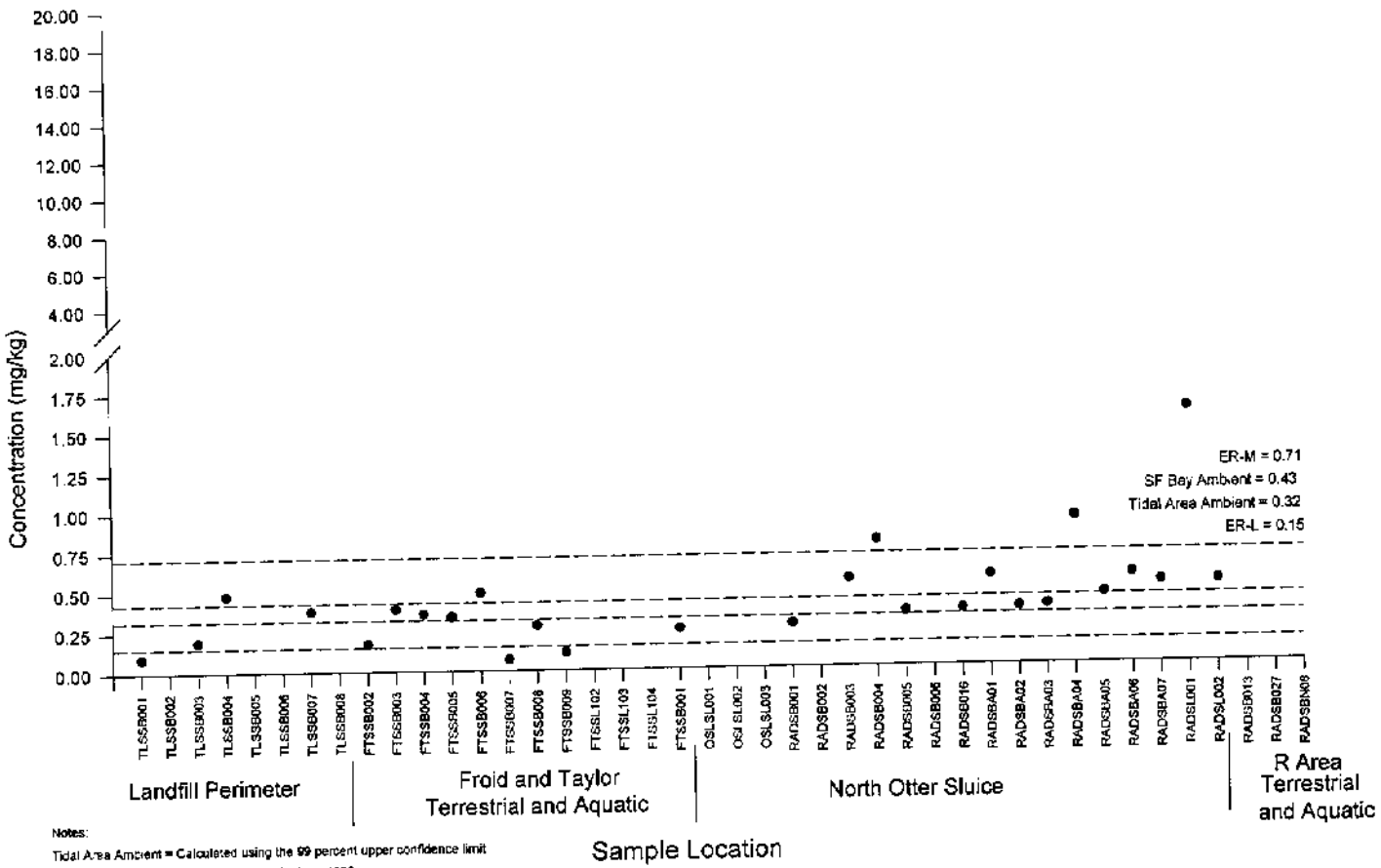
Note:
Tidal Area Ambient = Calculated using the 99 percent upper confidence limit

FIGURE 6-11C
DETECTED CONCENTRATIONS OF MANGANESE IN THE WOOD HOGGER TERRESTRIAL AND SOUTH OTTER SLUICE AQUATIC UNITS, SOIL AND SEDIMENT TIDAL AREA QEA, NWS SBD CONCORD



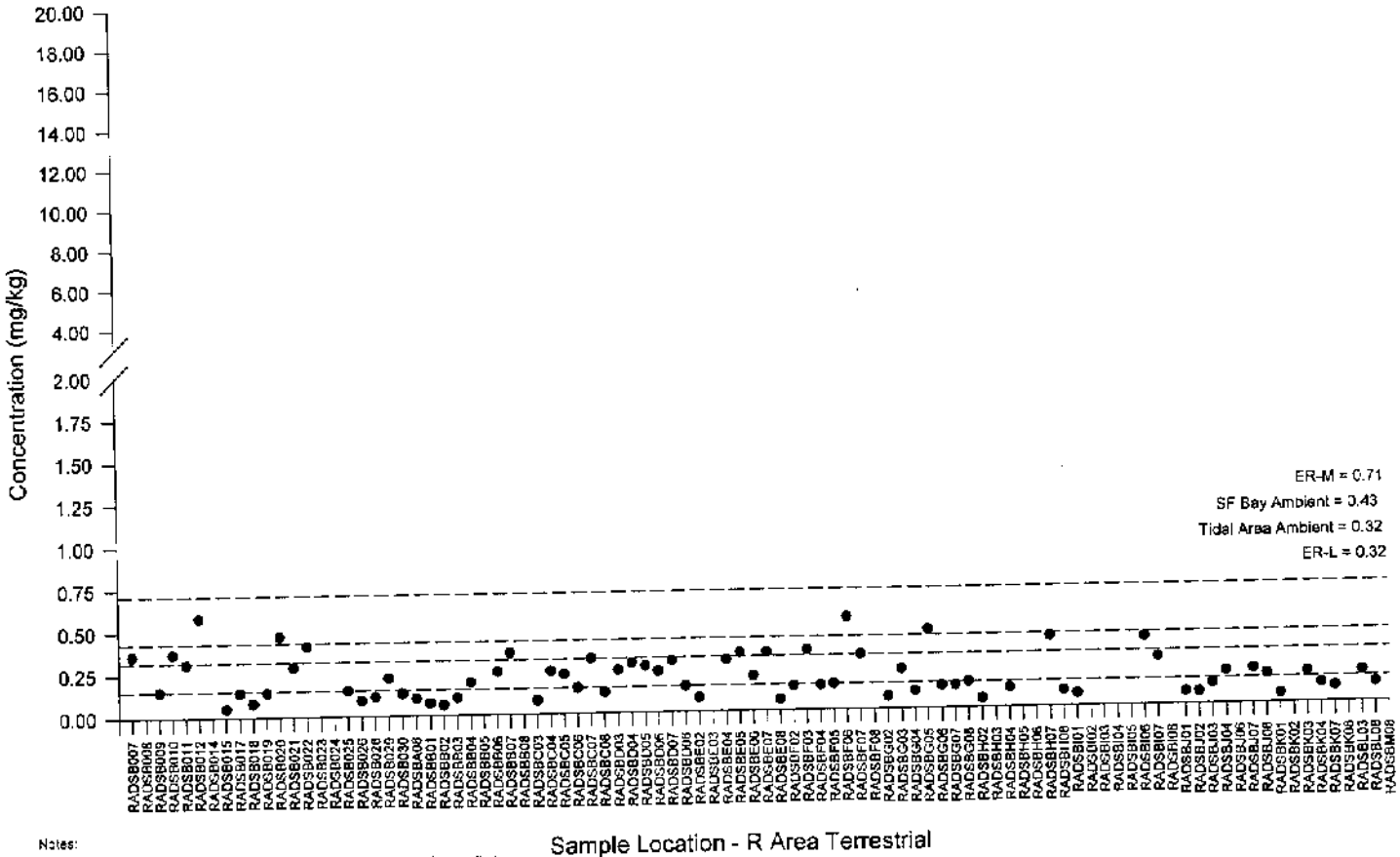
Note:
Tidal Area Ambient = Calculated using the 99 percent upper confidence limit

FIGURE 6-12A
DETECTED CONCENTRATIONS OF MERCURY IN THE LANDFILL PERIMETER TERRESTRIAL, FROID AND TAYLOR TERRESTRIAL, FROID AND TAYLOR AQUATIC, R AREA TERRESTRIAL AND AQUATIC, AND NORTH OTTER SLUICE AQUATIC UNITS, SOIL AND SEDIMENT
TIDAL AREA QEA, NWS SBD CONCORD



Notes:
Tidal Area Ambient = Calculated using the 99 percent upper confidence limit
ER-M = Effects range median (Long and others 1995)
ER-L = Effects range low (Long and others 1995)
SF Bay Ambient = San Francisco Bay ambient value (RWQCB 1996)

FIGURE 6-12B
DETECTED CONCENTRATIONS OF MERCURY THE R AREA TERRESTRIAL UNIT, SOIL AND SEDIMENT TIDAL AREA QEA, NWS SBD CONCORD



Notes:

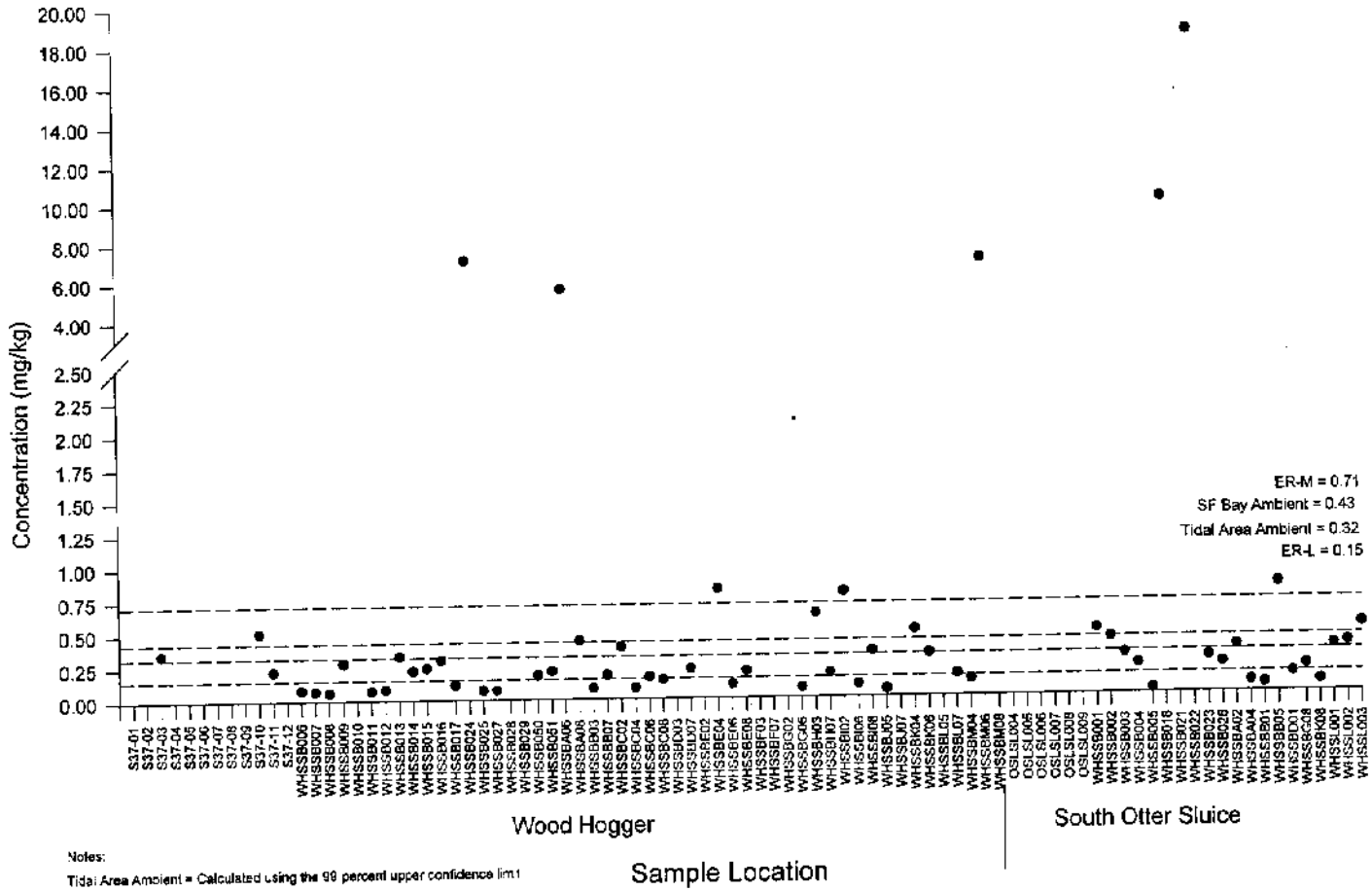
Tidal Area Ambient = Calculated using the 99 percent upper confidence limit

ER-M = Effects range median (Long and others 1995)

ER-L = Effects range low (Long and others 1995)

SF Bay Ambient = San Francisco Bay ambient value (RWQCB 1998)

FIGURE 6-12C
DETECTED CONCENTRATIONS OF MERCURY IN THE WOOD HOGGER TERRESTRIAL AND SOUTH OTTER SLUICE AQUATIC UNITS, SOIL AND SEDIMENT TIDAL AREA QEA, NWS SBD CONCORD



Notes:

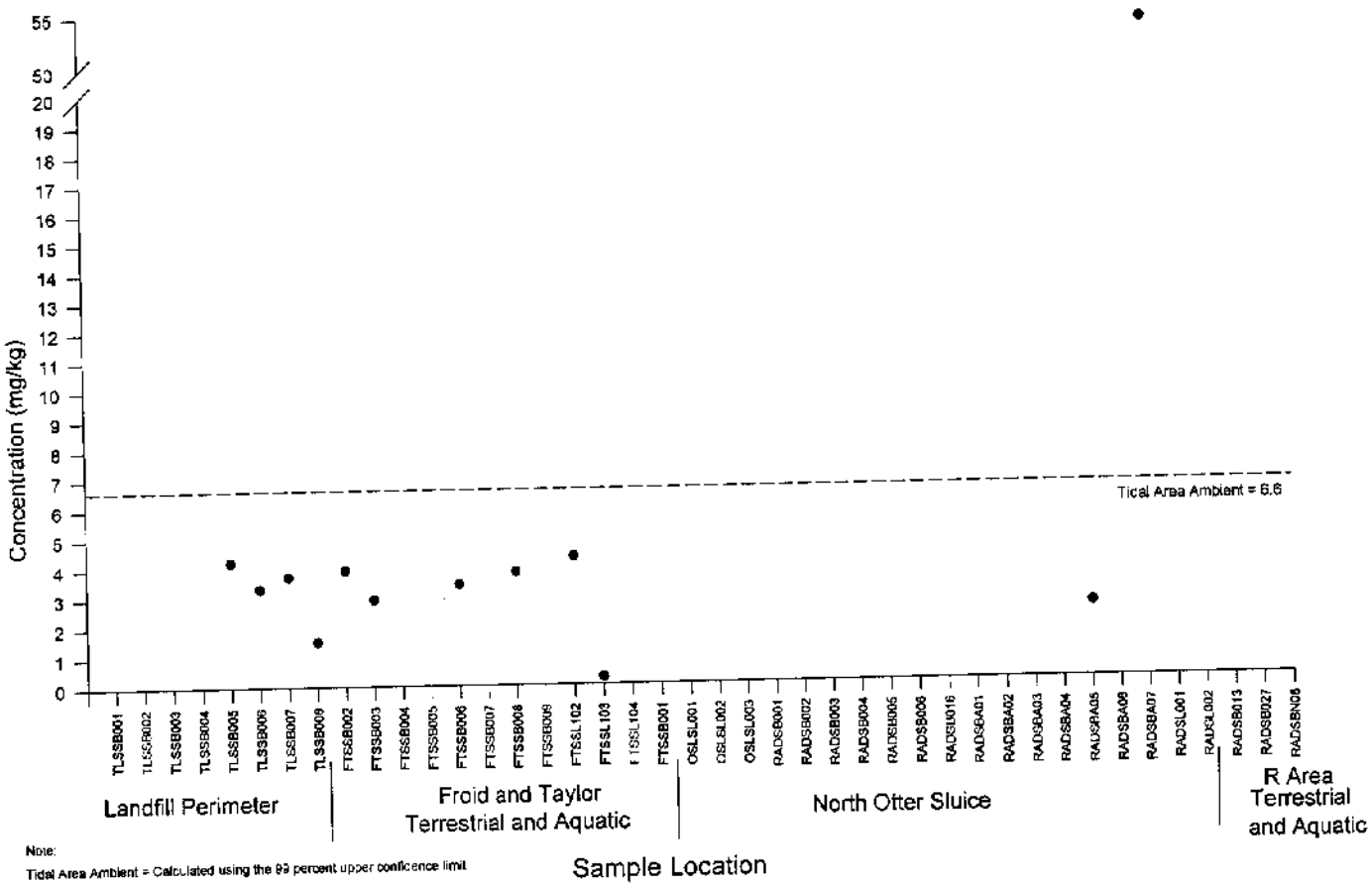
Tidal Area Ambient = Calculated using the 99 percent upper confidence limit

ER-M = Effects range median (Long and others 1995)

ER-L = Effects range low (Long and others 1995)

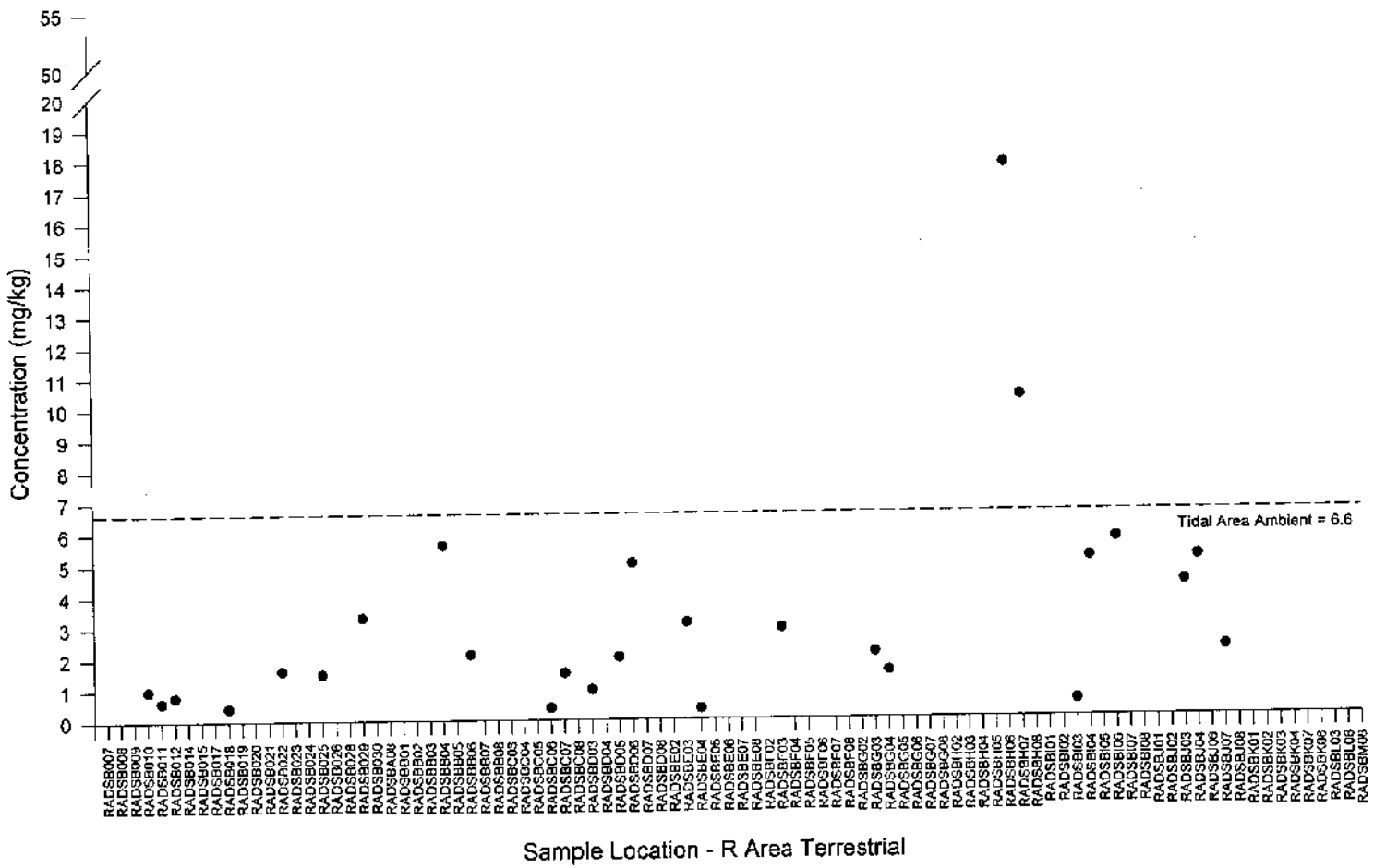
SF Bay Ambient = San Francisco Bay ambient value (RWQCB 1998)

FIGURE 6-13A
DETECTED CONCENTRATIONS OF MOLYBDENUM IN THE LANDFILL PERIMETER TERRESTRIAL, FROID AND TAYLOR TERRESTRIAL, FROID AND TAYLOR AQUATIC, R AREA TERRESTRIAL AND AQUATIC, AND NORTH OTTER SLUICE AQUATIC UNITS, SOIL AND SEDIMENT
TIDAL AREA QEA, NWS SBD CONCORD



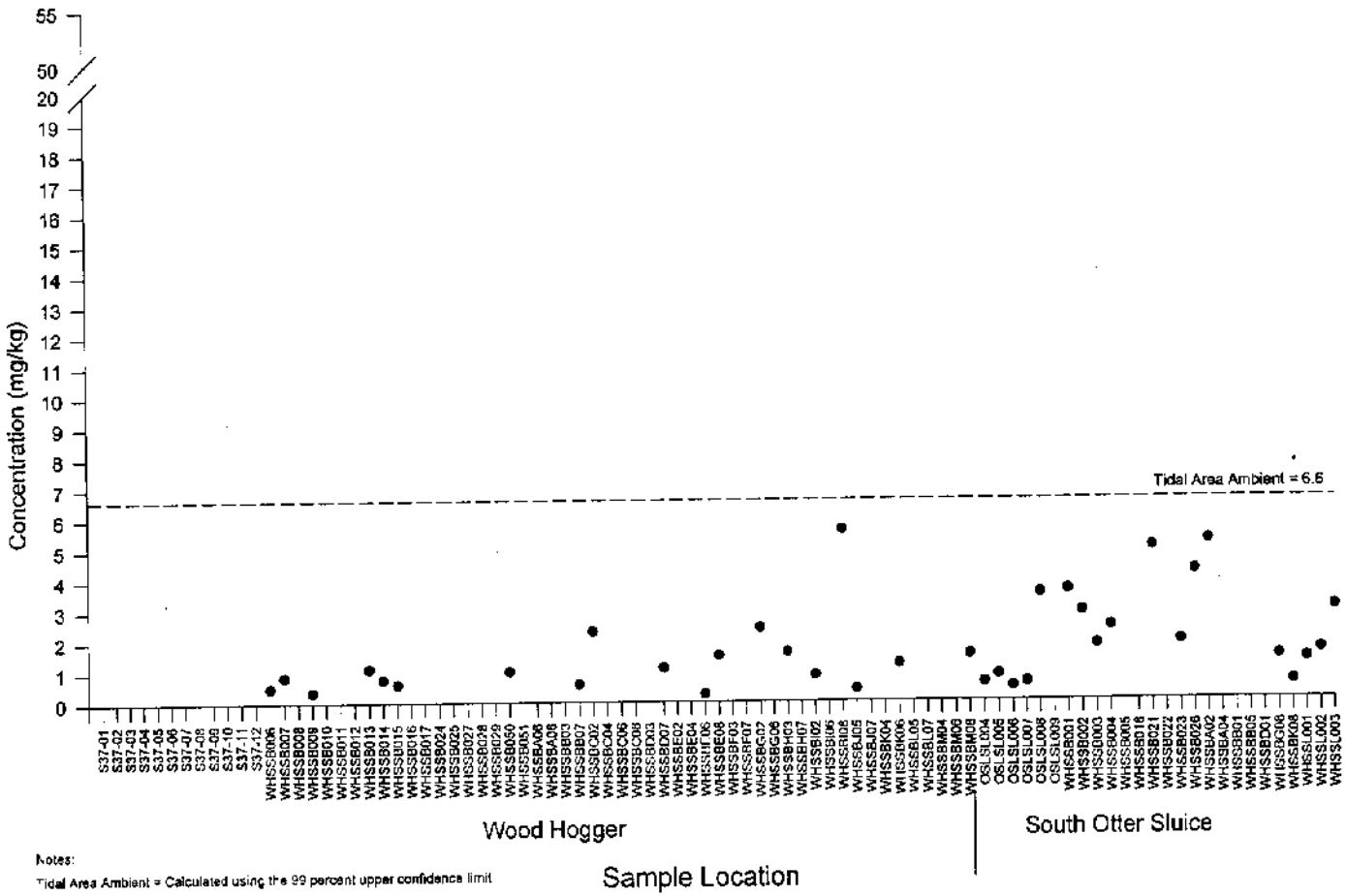
Note:
Tidal Area Ambient = Calculated using the 99 percent upper confidence limit

FIGURE 6-13B
DETECTED CONCENTRATIONS OF MOLYBDENUM THE R AREA TERRESTRIAL UNIT, SOIL AND SEDIMENT
TIDAL AREA QEA, NWS SBD CONCORD



Note:
Tidal Area Ambient = Calculated using the 99 percent upper confidence limit

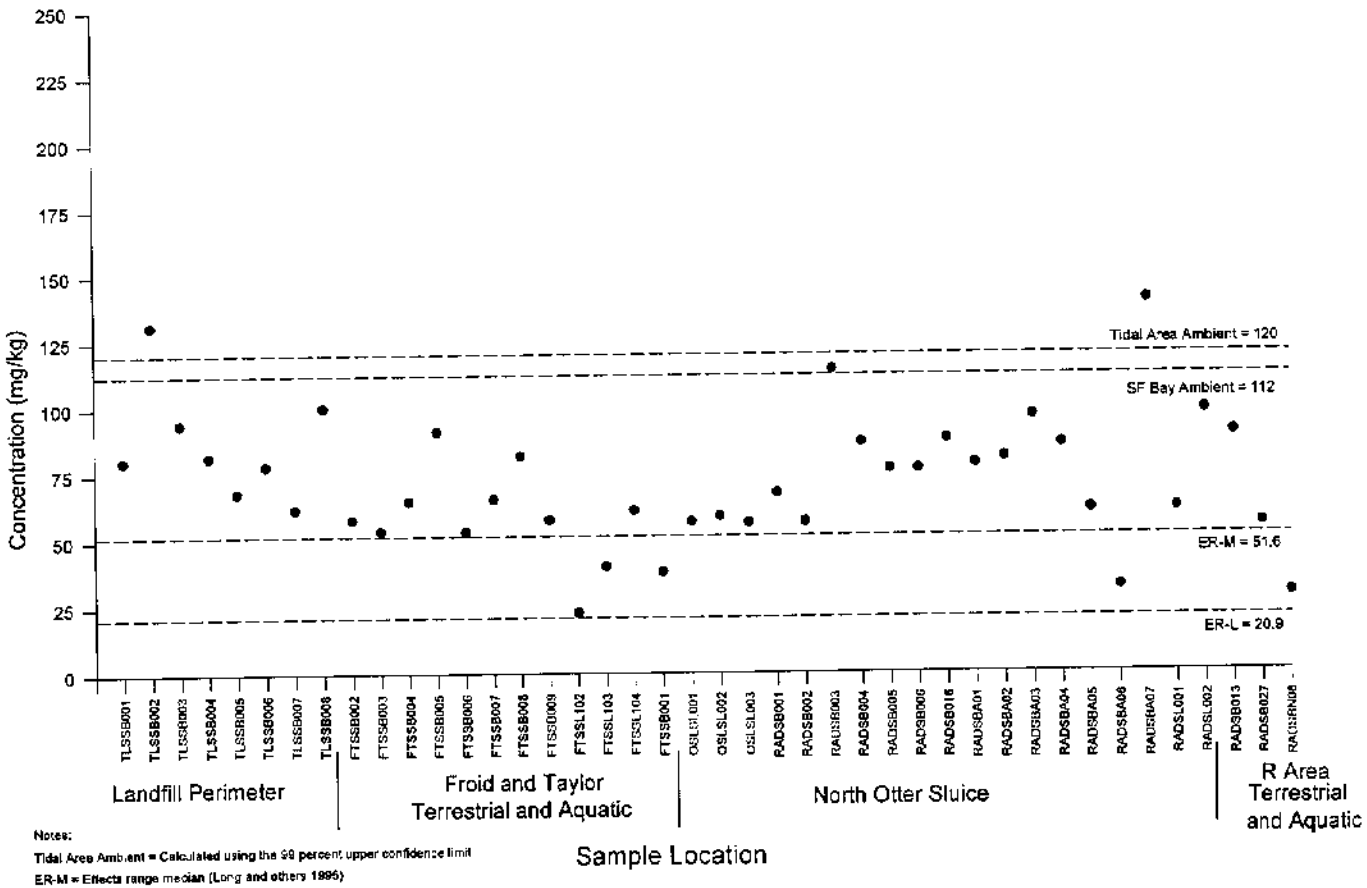
FIGURE 6-13C
DETECTED CONCENTRATIONS OF MOLYBDENUM IN THE WOOD HOGGER TERRESTRIAL AND SOUTH OTTER SLUICE AQUATIC UNITS, SOIL AND SEDIMENT TIDAL AREA QEA, NWS SBD CONCORD



Notes:

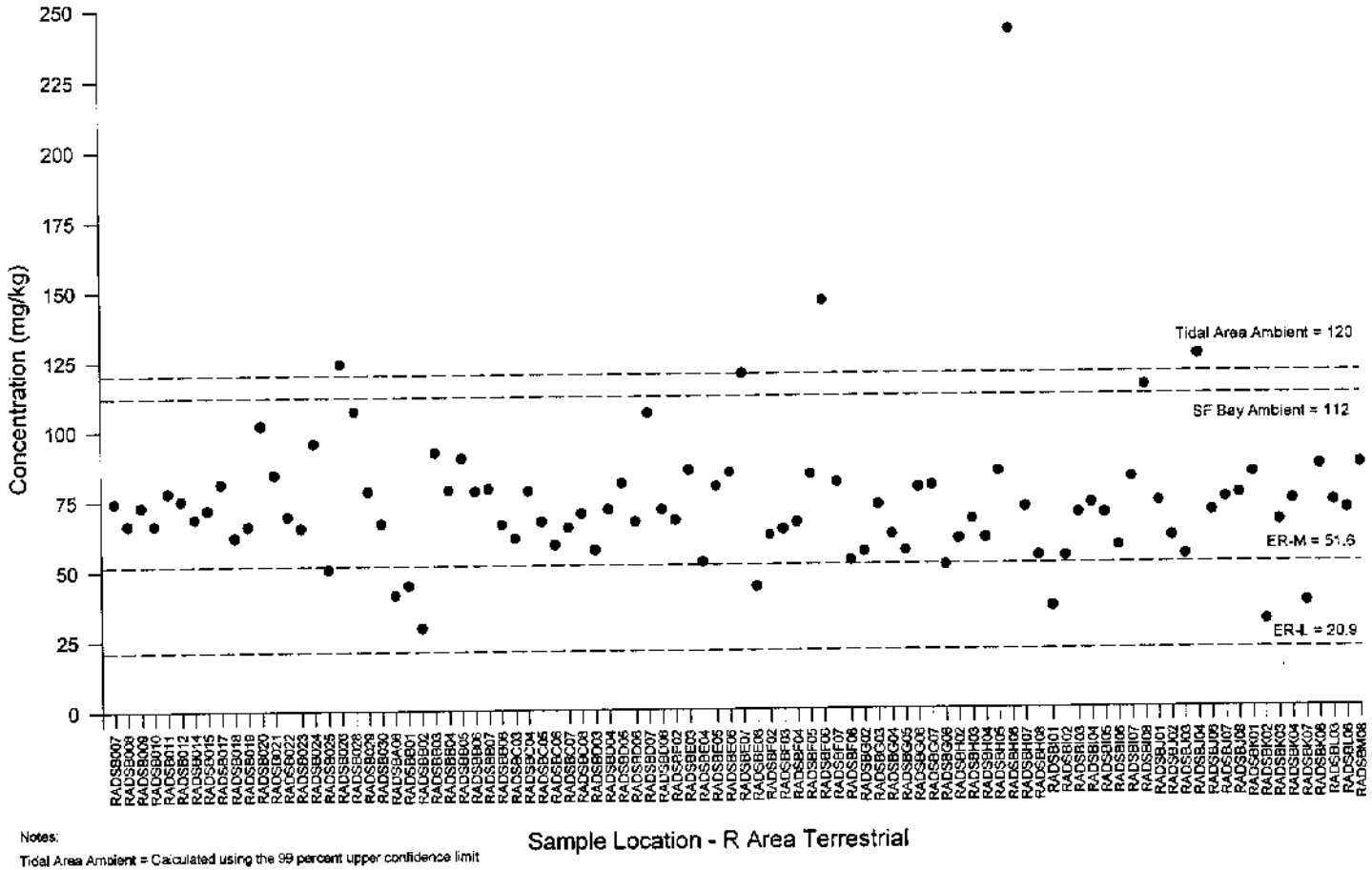
Tidal Area Ambient = Calculated using the 99 percent upper confidence limit

FIGURE 6-14A
DETECTED CONCENTRATIONS OF NICKEL IN THE LANDFILL PERIMETER TERRESTRIAL, FROID AND TAYLOR TERRESTRIAL, FROID AND TAYLOR AQUATIC, R AREA TERRESTRIAL AND AQUATIC, AND NORTH OTTER SLUICE AQUATIC UNITS, SOIL AND SEDIMENT
TIDAL AREA QEA, NWS SBD CONCORD



Notes:
Tidal Area Ambient = Calculated using the 99 percent upper confidence limit
ER-M = Effects range median (Long and others 1995)
ER-L = Effects range low (Long and others 1995)
SF Bay Ambient = San Francisco Bay ambient value (RWQCB 1995)

FIGURE 6-14B
DETECTED CONCENTRATIONS OF NICKEL THE R AREA TERRESTRIAL UNIT, SOIL AND SEDIMENT TIDAL AREA QEA, NWS SBD CONCORD



Notes:

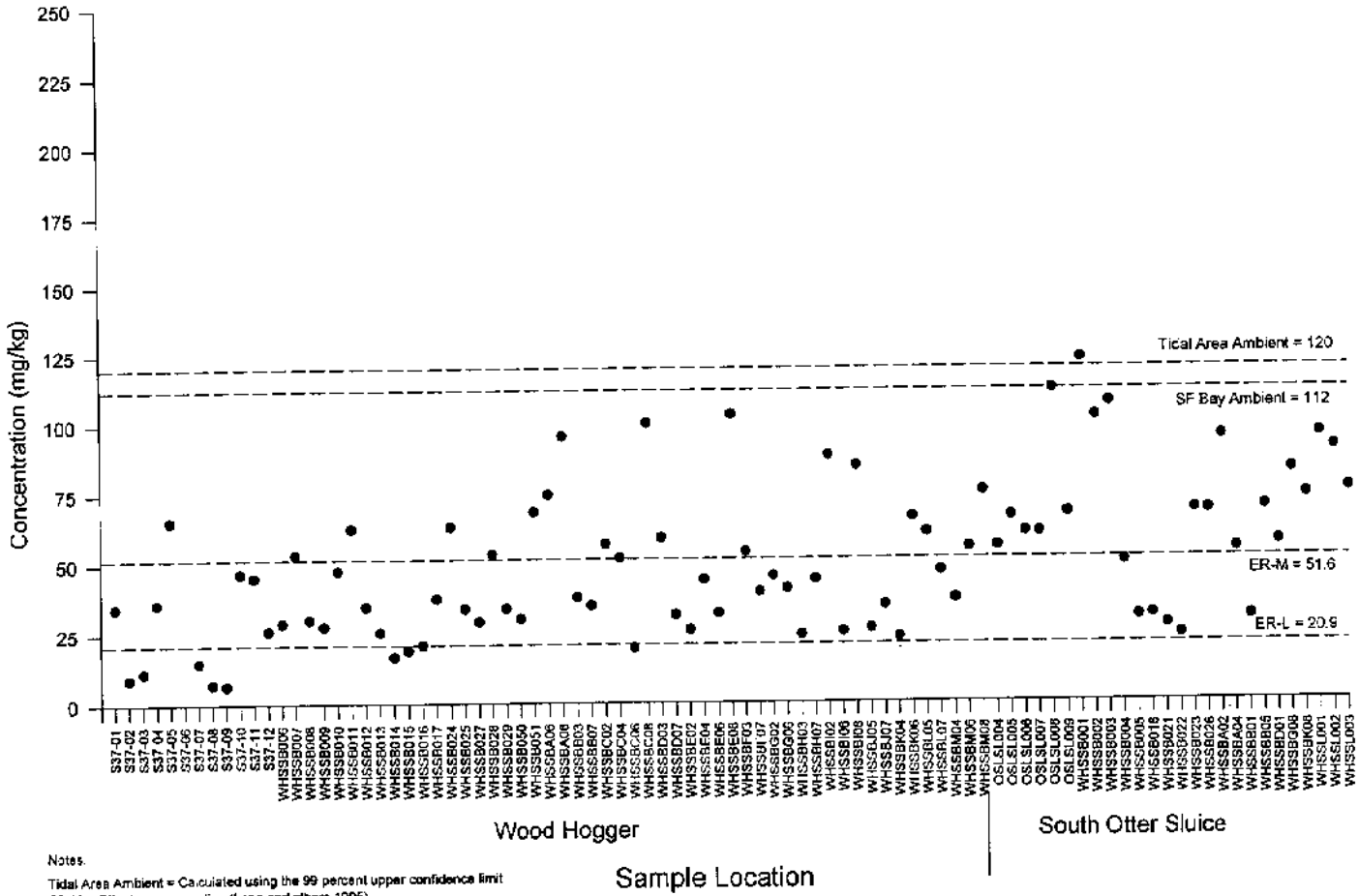
Tidal Area Ambient = Calculated using the 99 percent upper confidence limit

ER-M = Effects range median (Long and others 1995)

ER-L = Effects range low (Long and others 1995)

SF Bay Ambient = San Francisco Bay ambient value (RWQCB 1998)

FIGURE 6-14C
DETECTED CONCENTRATIONS OF NICKEL IN THE WOOD HOGGER TERRESTRIAL AND SOUTH OTTER SLUICE AQUATIC UNITS, SOIL AND SEDIMENT TIDAL AREA QEA, NWS SBD CONCORD



Notes:

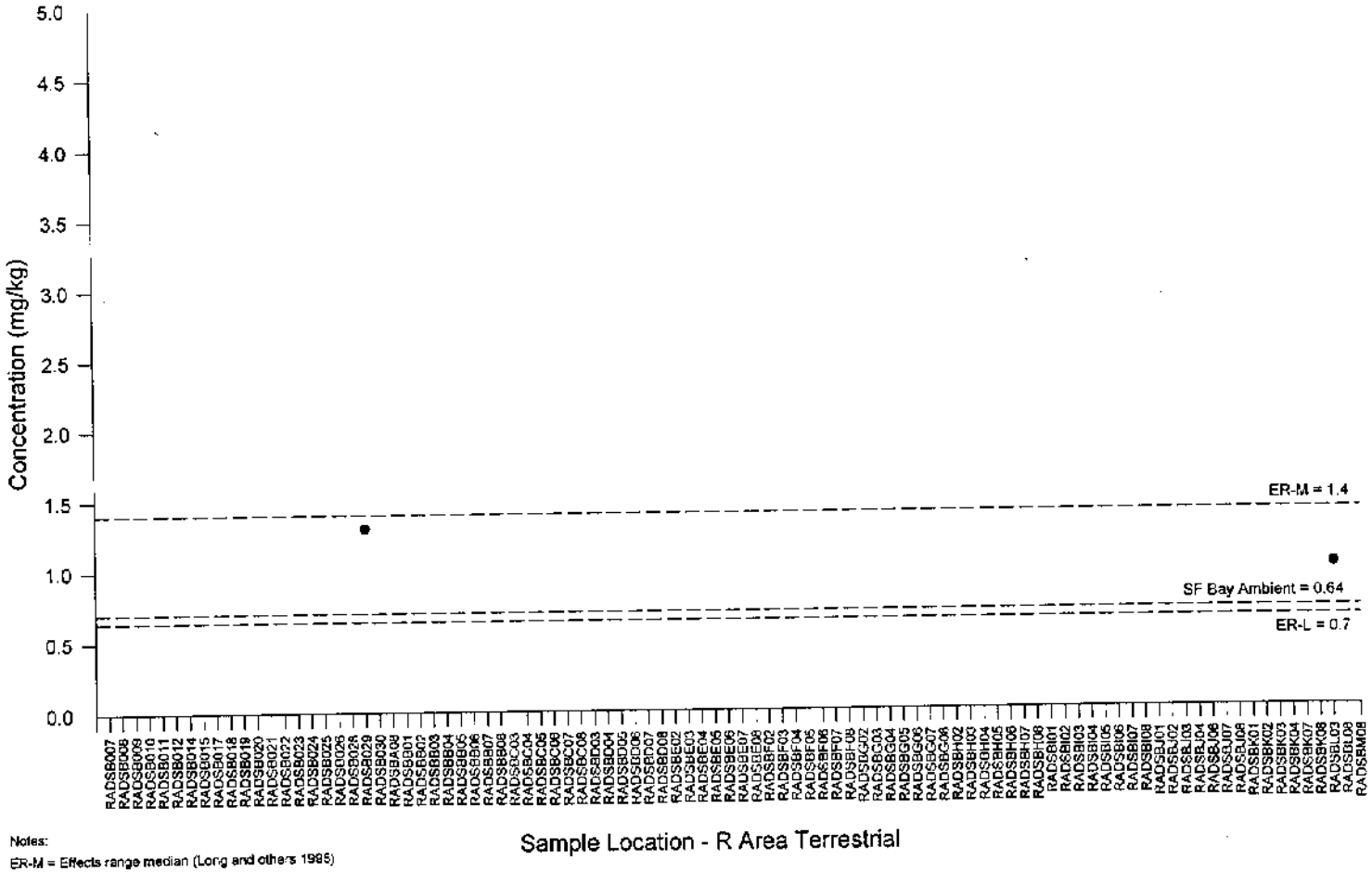
Tidal Area Ambient = Calculated using the 99 percent upper confidence limit

ER-M = Effects range median (Long and others 1995)

ER-L = Effects range low (Long and others 1995)

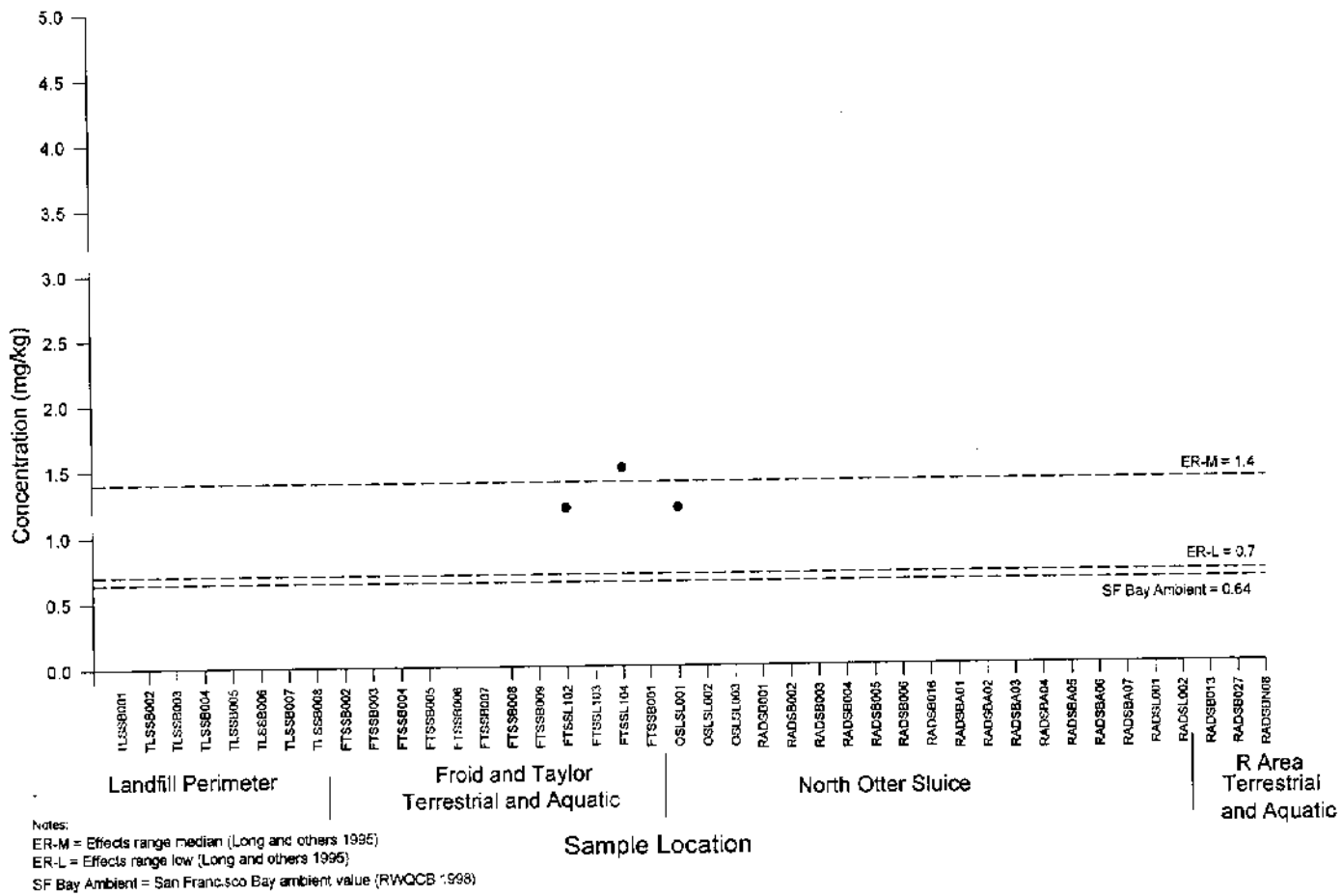
SF Bay Ambient = San Francisco Bay ambient value (RWQCB 1998)

FIGURE 6-15A
DETECTED CONCENTRATIONS OF SELENIUM IN THE LANDFILL PERIMETER TERRESTRIAL, FROID AND TAYLOR TERRESTRIAL, FROID AND TAYLOR AQUATIC, R AREA TERRESTRIAL AND AQUATIC, AND NORTH OTTER SLUICE AQUATIC UNITS, SOIL AND SEDIMENT TIDAL AREA QEA, NWS SBD CONCORD



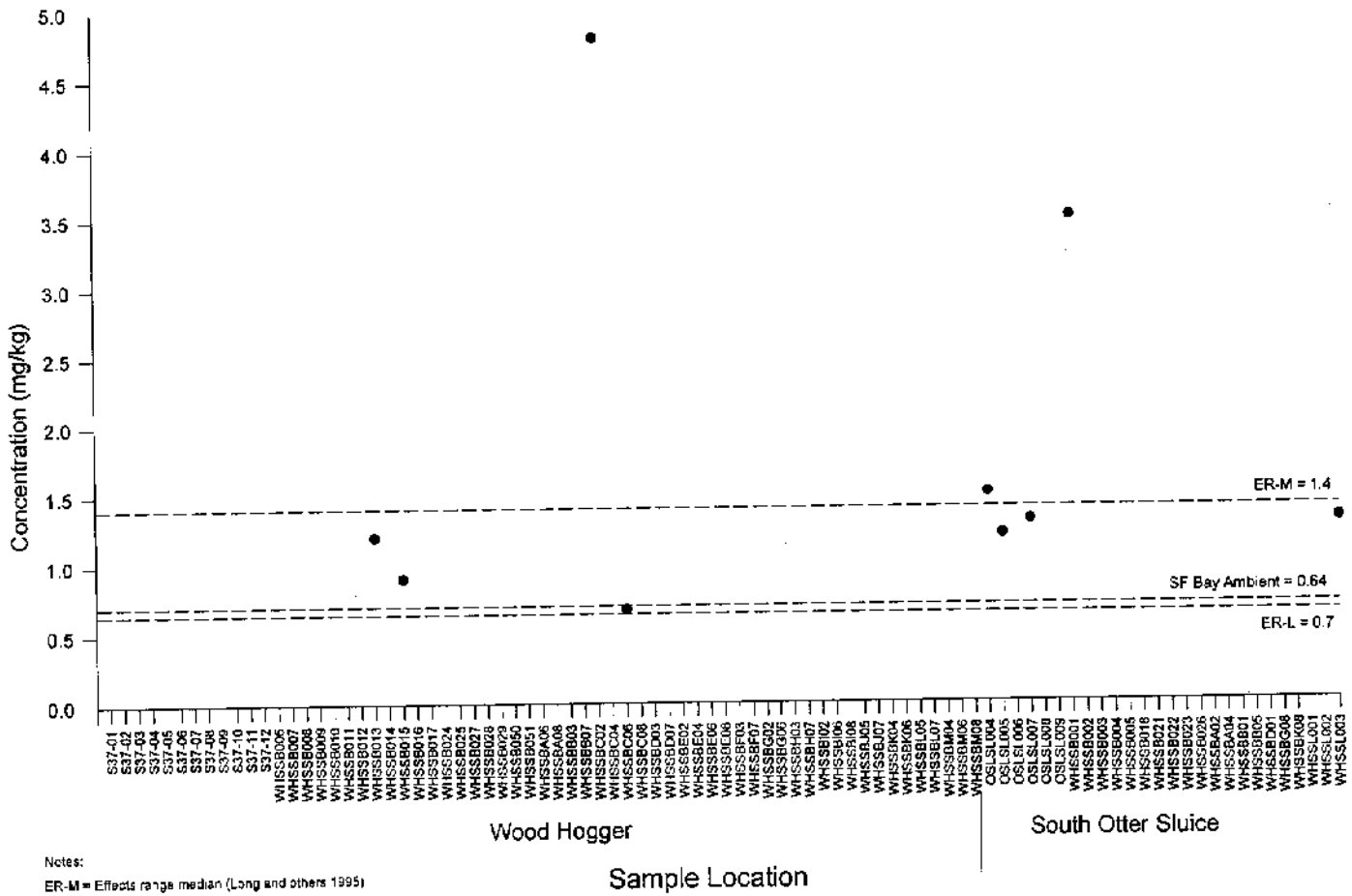
Notes:
ER-M = Effects range median (Long and others 1995)
ER-L = Effects range low (Long and others 1995)
SF Bay Ambient = San Francisco Bay ambient value (RWQCB 1998)

FIGURE 6-15B
DETECTED CONCENTRATIONS OF SELENIUM THE R AREA TERRESTRIAL UNIT, SOIL AND SEDIMENT TIDAL AREA QEA, NWS SBD CONCORD



Notes:
ER-M = Effects range median (Long and others 1995)
ER-L = Effects range low (Long and others 1995)
SF Bay Ambient = San Francisco Bay ambient value (RWQCB 1998)

FIGURE 6-15C
DETECTED CONCENTRATIONS OF SELENIUM IN THE WOOD HOGGER TERRESTRIAL AND SOUTH OTTER SLUICE AQUATIC UNITS, SOIL AND SEDIMENT TIDAL AREA QEA, NWS SBD CONCORD



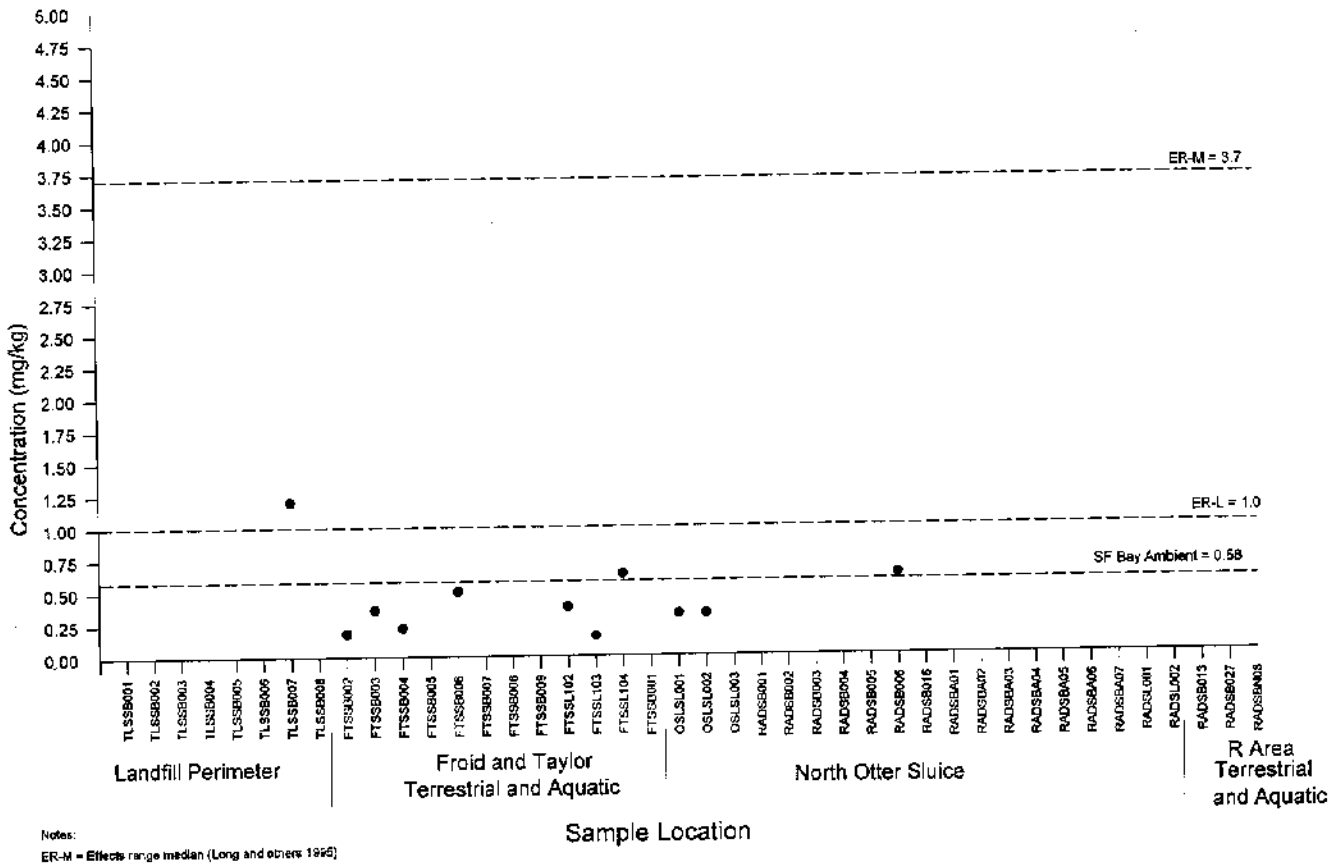
Notes:

ER-M = Effects range median (Long and others 1995)

ER-L = Effects range low (Long and others 1995)

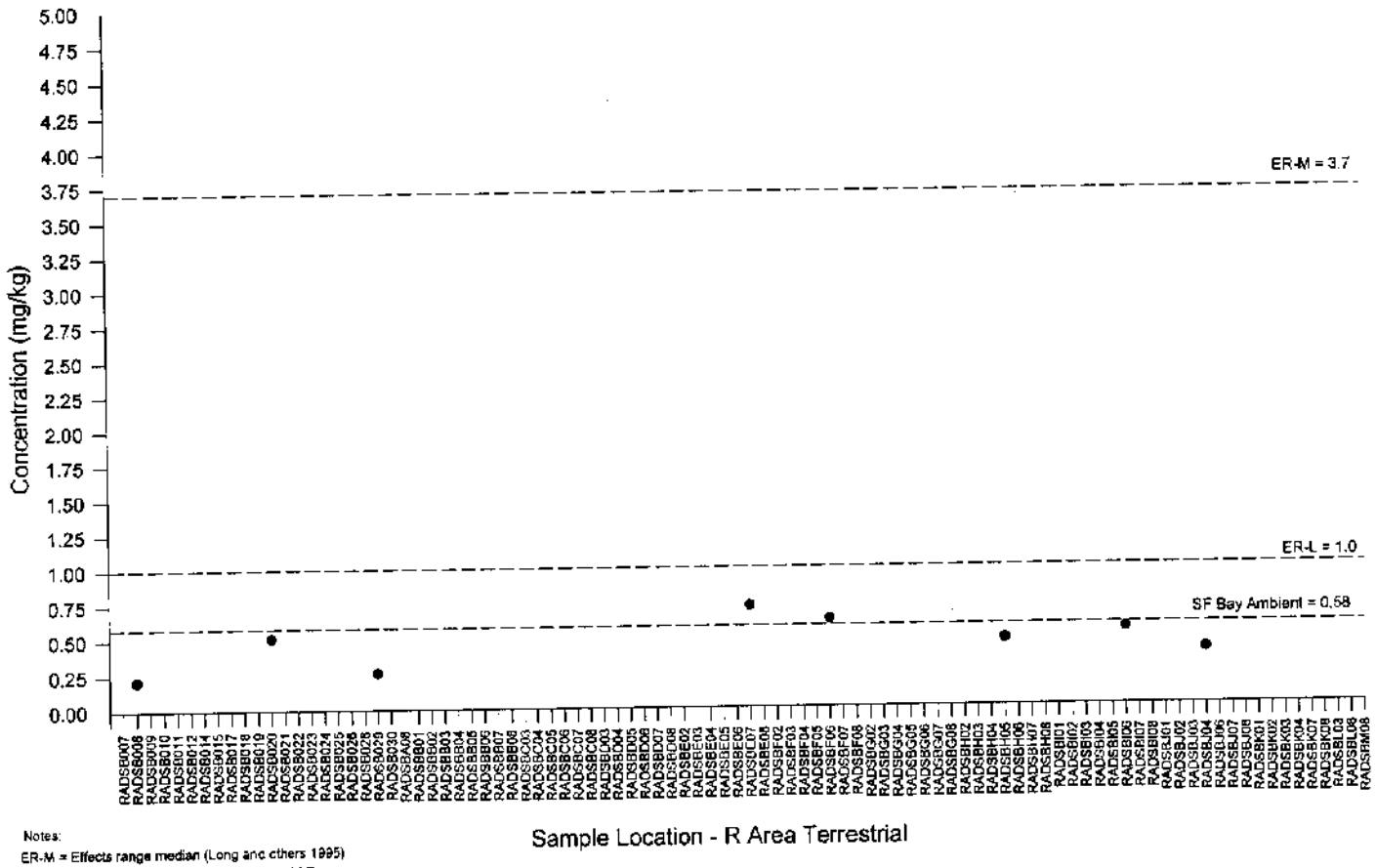
SF Bay Ambient = San Francisco Bay ambient value (RWQCB 1998)

FIGURE 6-16A
DETECTED CONCENTRATIONS OF SILVER IN THE LANDFILL PERIMETER TERRESTRIAL, FROID AND TAYLOR TERRESTRIAL, FROID AND TAYLOR AQUATIC, NORTH OTTER SLUICE AQUATIC, AND R AREA TERRESTRIAL AND AQUATIC UNITS, SOIL AND SEDIMENT
TIDAL AREA QEA, NWS SBD CONCORD



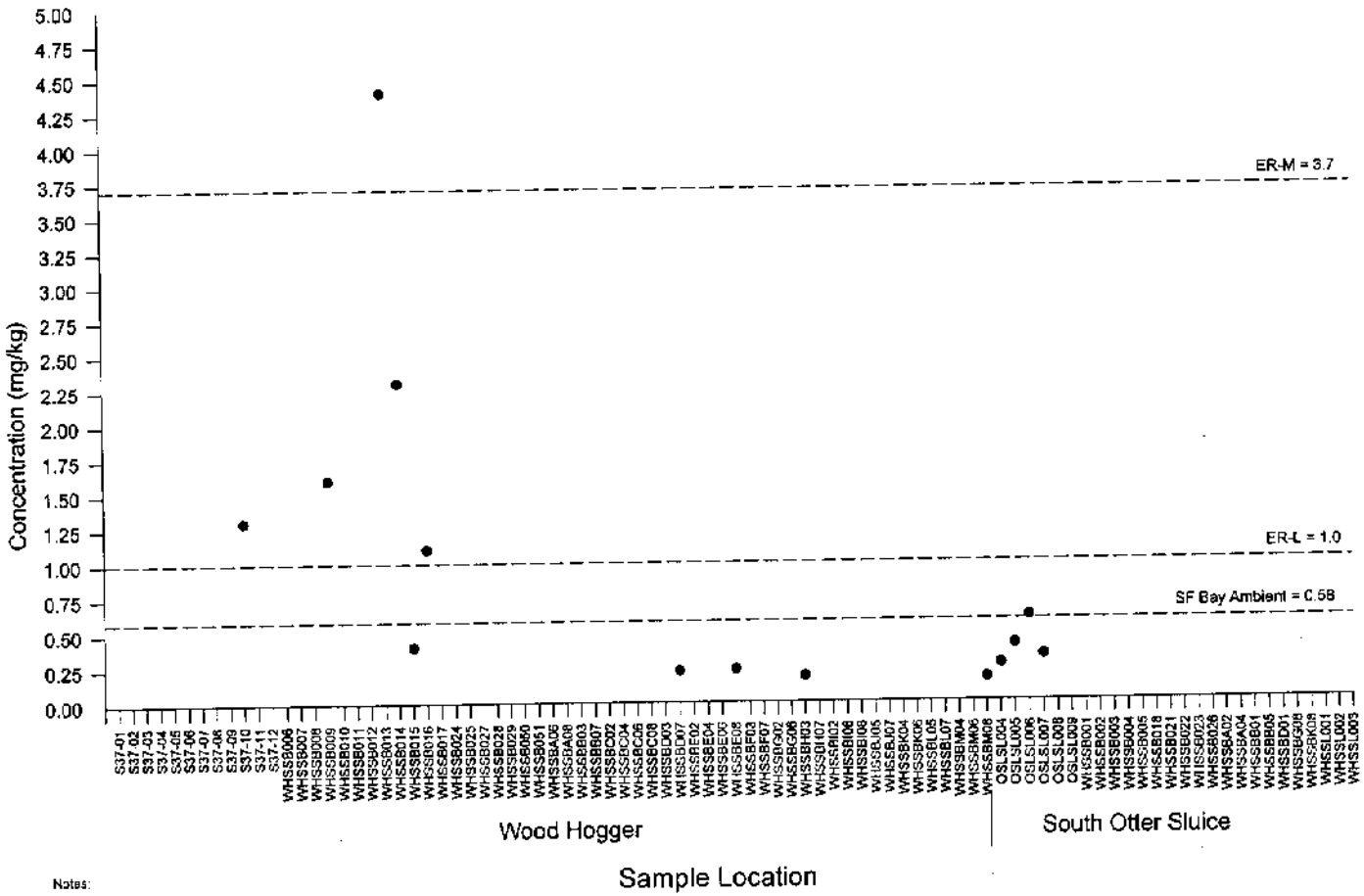
Notes:
ER-M = Effects range median (Long and others 1995)
ER-L = Effects range low (Long and others 1995)
SF Bay Ambient = San Francisco Bay ambient value (RWQCB 1998)

FIGURE 6-16B
DETECTED CONCENTRATIONS OF SILVER IN R AREA TERRESTRIAL UNIT, SOIL AND SEDIMENT TIDAL AREA QEA, NWS SBD CONCORD



Notes:
ER-M = Effects range median (Long and others 1995)
ER-L = Effects range low (Long and others 1995)
SF Bay Ambient = San Francisco Bay ambient value (RWQCB 1998)

FIGURE 6-16C
DETECTED CONCENTRATIONS OF SILVER IN WOOD HOGGER TERRESTRIAL AND SOUTH OTTER SLUICE AQUATIC UNITS, TIDAL AREA QEA, NWS SBD CONCORD



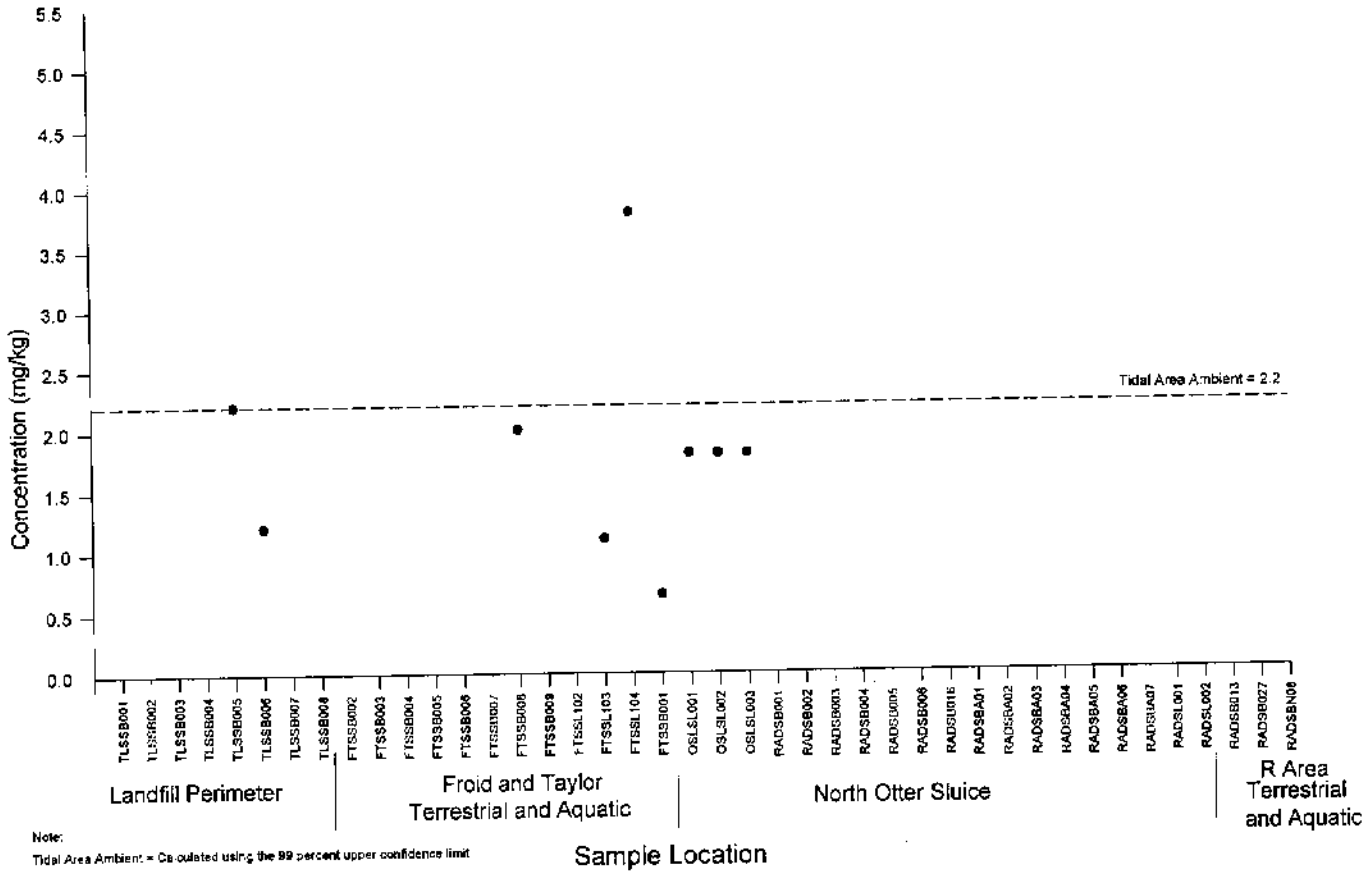
Notes:

ER-M = Effects range median (Long and others 1995)

ER-L = Effects range low (Long and others 1995)

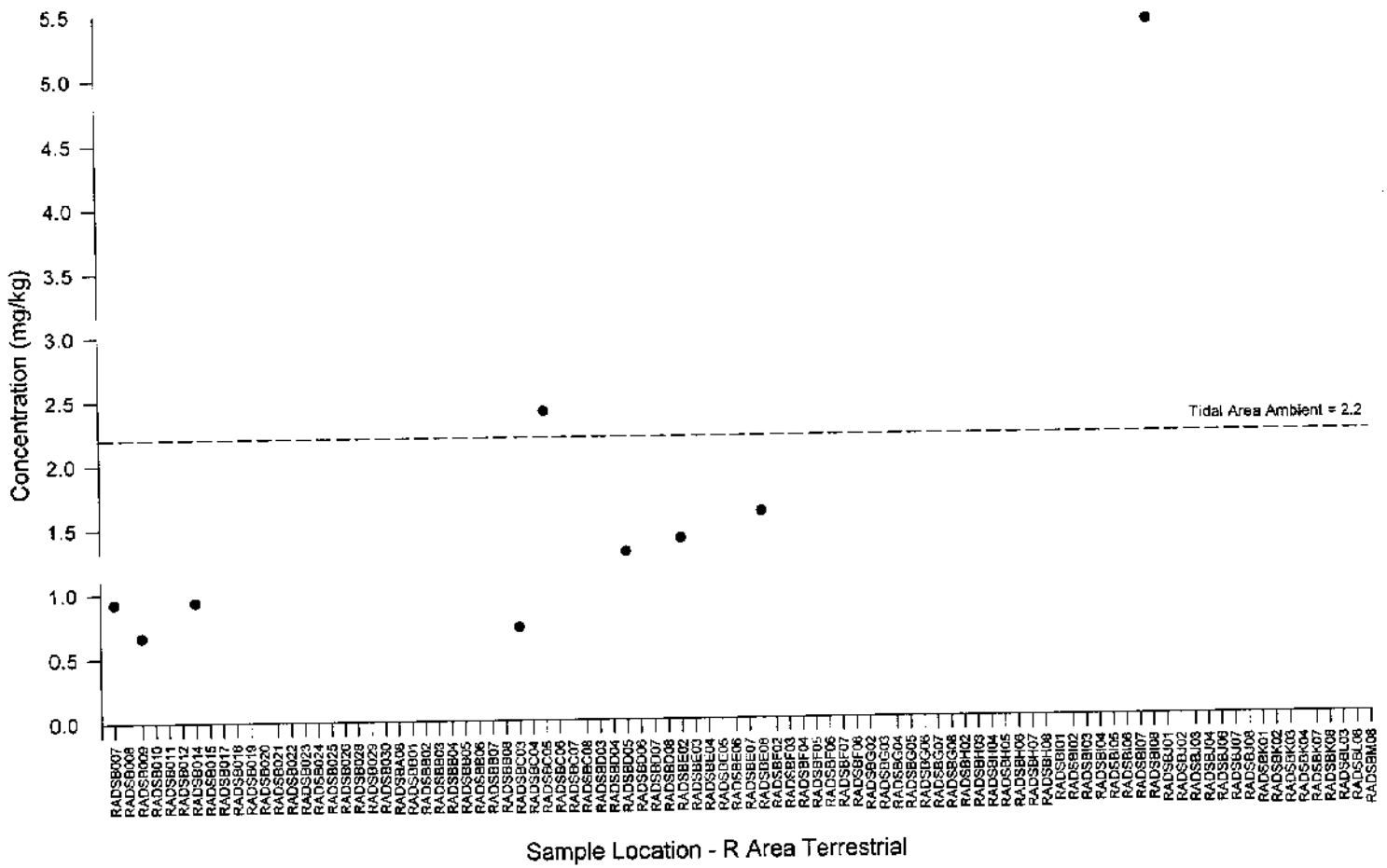
SF Bay Ambient = San Francisco Bay ambient value (RWQCB 1998)

FIGURE 6-17A
DETECTED CONCENTRATIONS OF THALLIUM IN THE LANDFILL PERIMETER TERRESTRIAL, FROID AND TAYLOR TERRESTRIAL, FROID AND TAYLOR AQUATIC, NORTH OTTER SLUICE AQUATIC, AND R AREA TERRESTRIAL AND AQUATIC UNITS, SOIL AND SEDIMENT
TIDAL AREA QEA, NWS SBD CONCORD



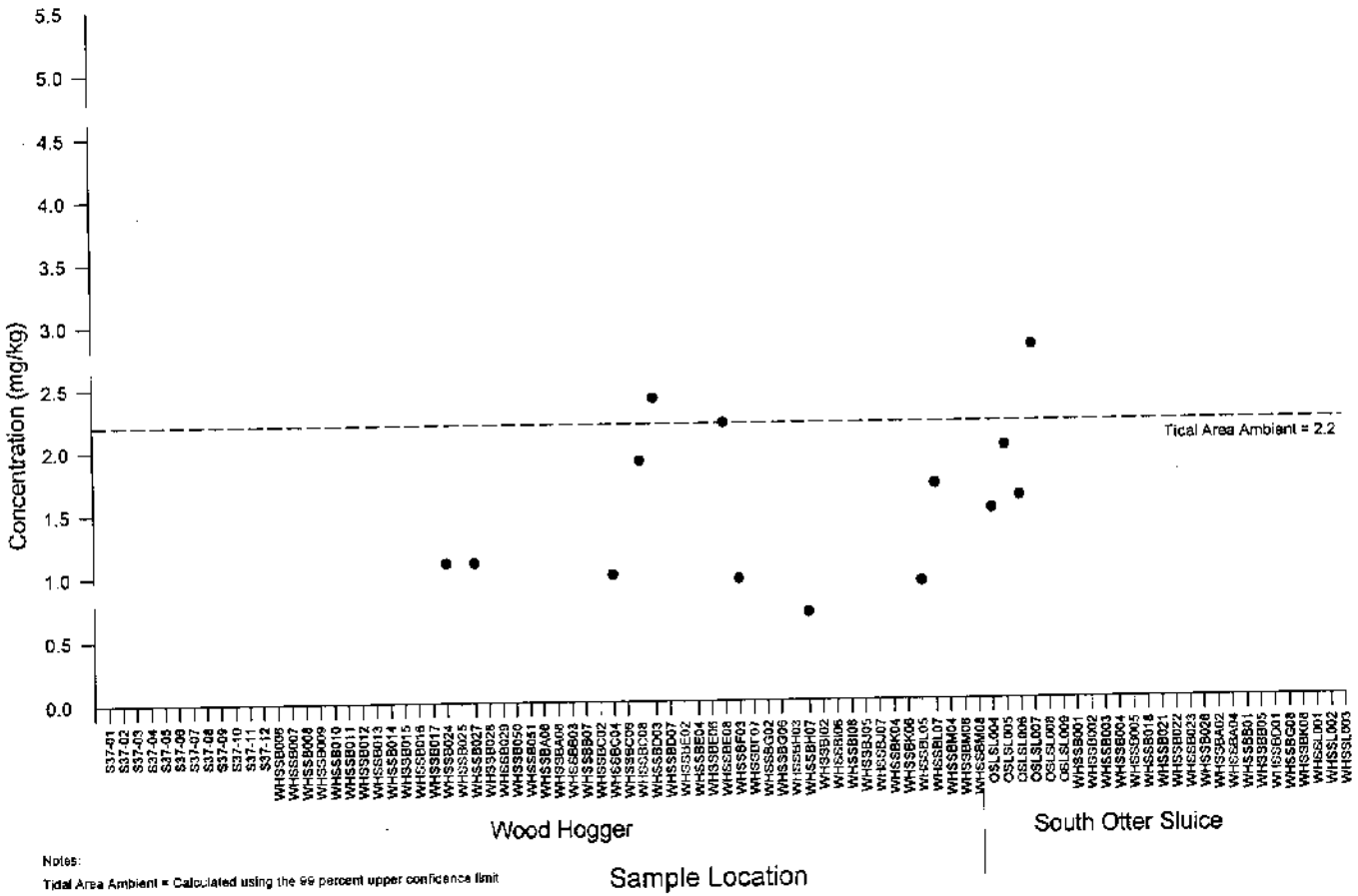
Note:
Tidal Area Ambient = Calculated using the 99 percent upper confidence limit

FIGURE 6-17B
DETECTED CONCENTRATIONS OF THALLIUM IN R AREA TERRESTRIAL UNIT, SOIL AND SEDIMENT TIDAL AREA QEA, NWS SBD CONCORD



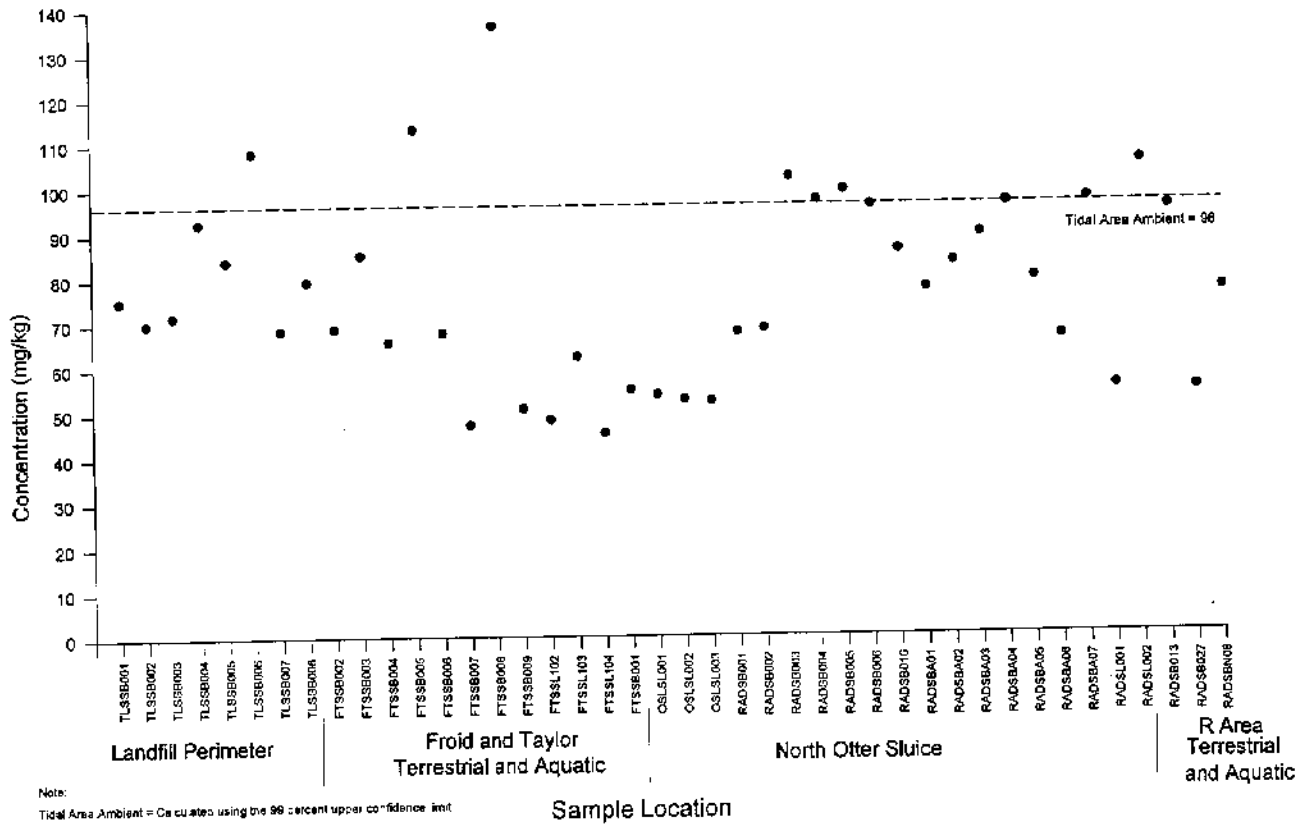
Note:
Tidal Area Ambient = Calculated using the 99 percent upper confidence limit

FIGURE 6-17C
DETECTED CONCENTRATIONS OF THALLIUM IN WOOD HOGGER TERRESTRIAL AND SOUTH OTTER SLUICE AQUATIC UNITS, TIDAL AREA QEA, NWS SBD CONCORD



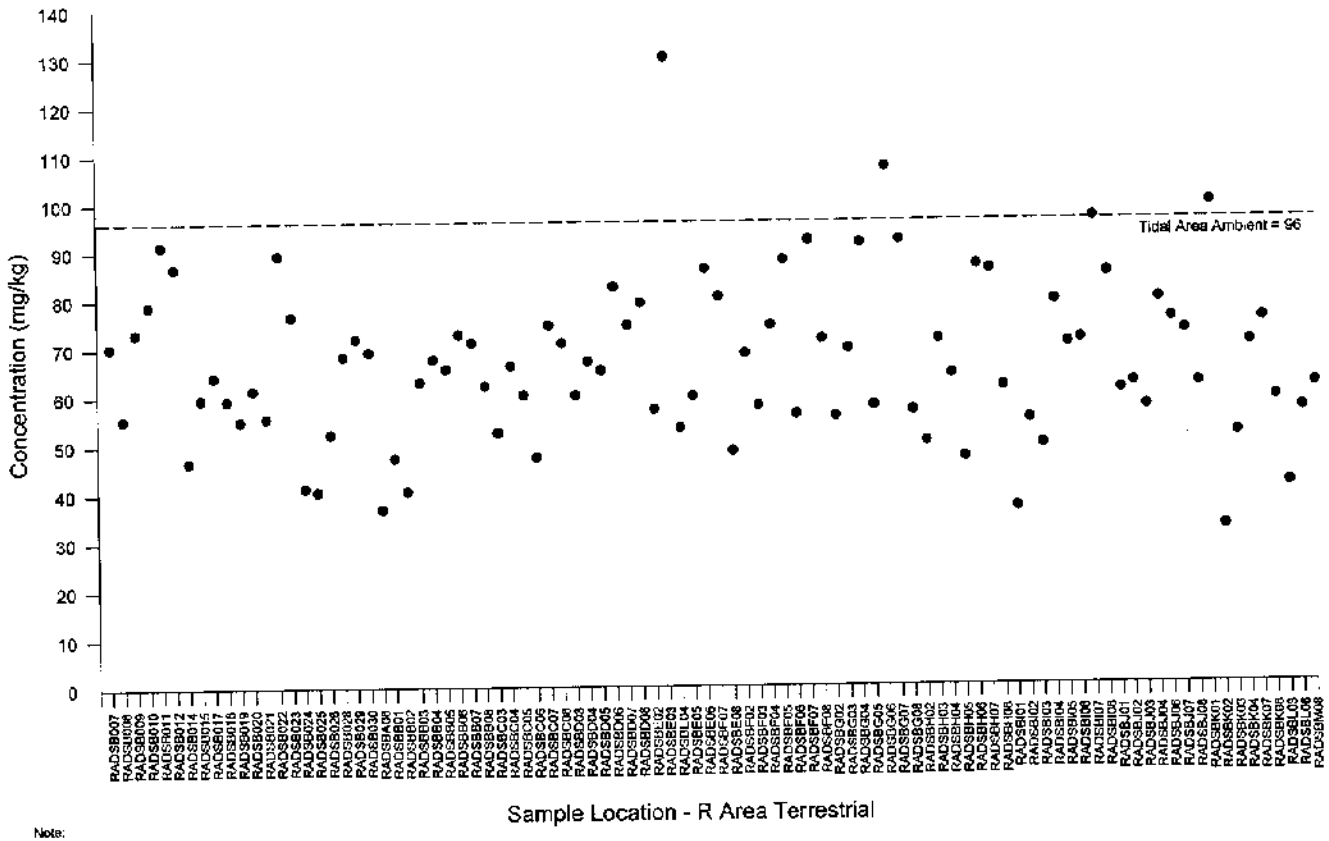
Notes:
Tidal Area Ambient = Calculated using the 99 percent upper confidence limit

FIGURE 6-18A
DETECTED CONCENTRATIONS OF VANADIUM IN THE LANDFILL PERIMETER TERRESTRIAL, FROID AND TAYLOR TERRESTRIAL, FROID AND TAYLOR AQUATIC, NORTH OTTER SLUICE AQUATIC, AND R AREA TERRESTRIAL AND AQUATIC UNITS, SOIL AND SEDIMENT
TIDAL AREA QEA, NWS SBD CONCORD



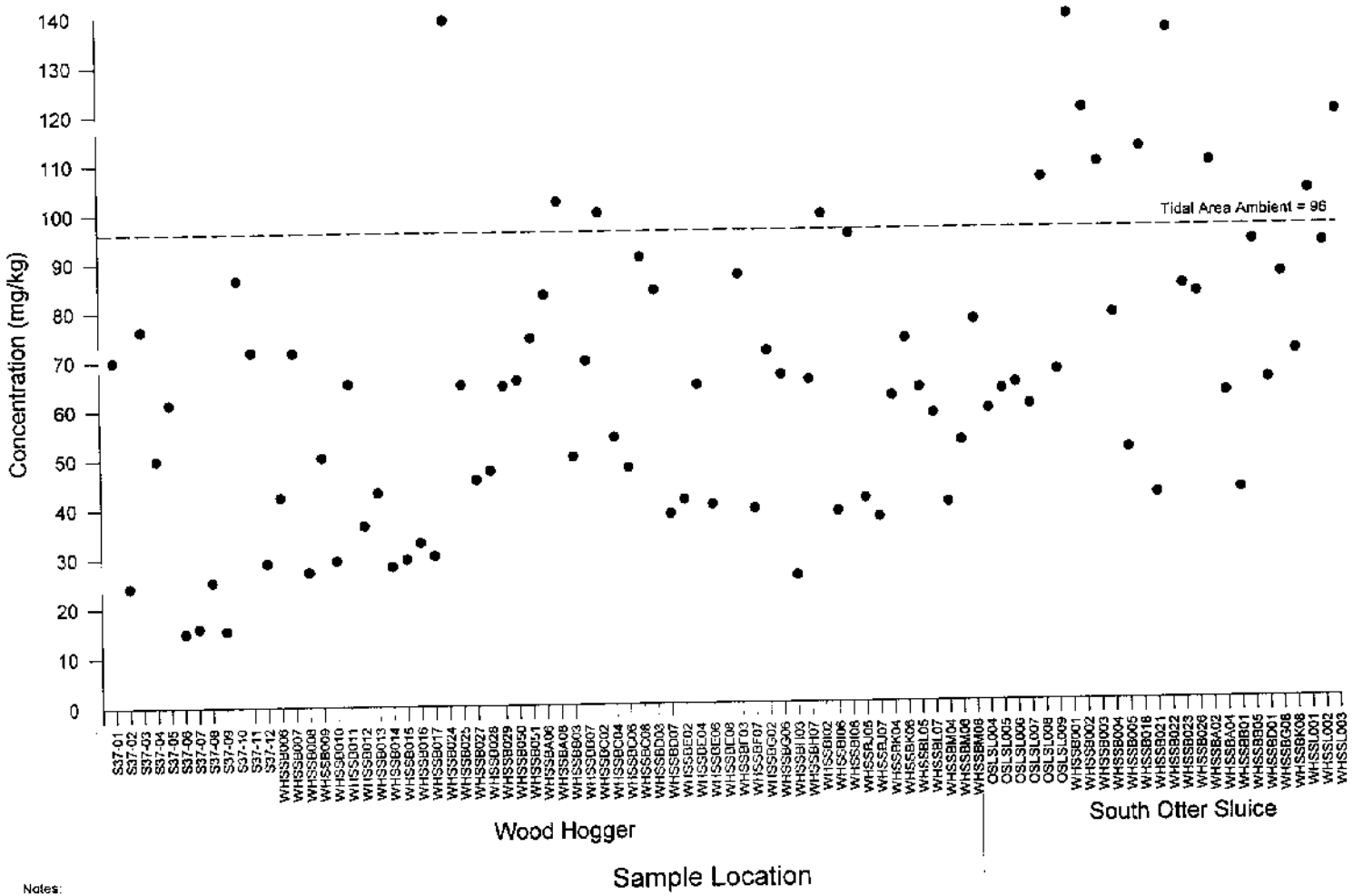
Note:
Tidal Area Ambient = Calculated using the 99 percent upper confidence limit

FIGURE 6-18B
DETECTED CONCENTRATIONS OF VANADIUM IN R AREA TERRESTRIAL UNIT, SOIL AND SEDIMENT
TIDAL AREA QEA, NWS SBD CONCORD



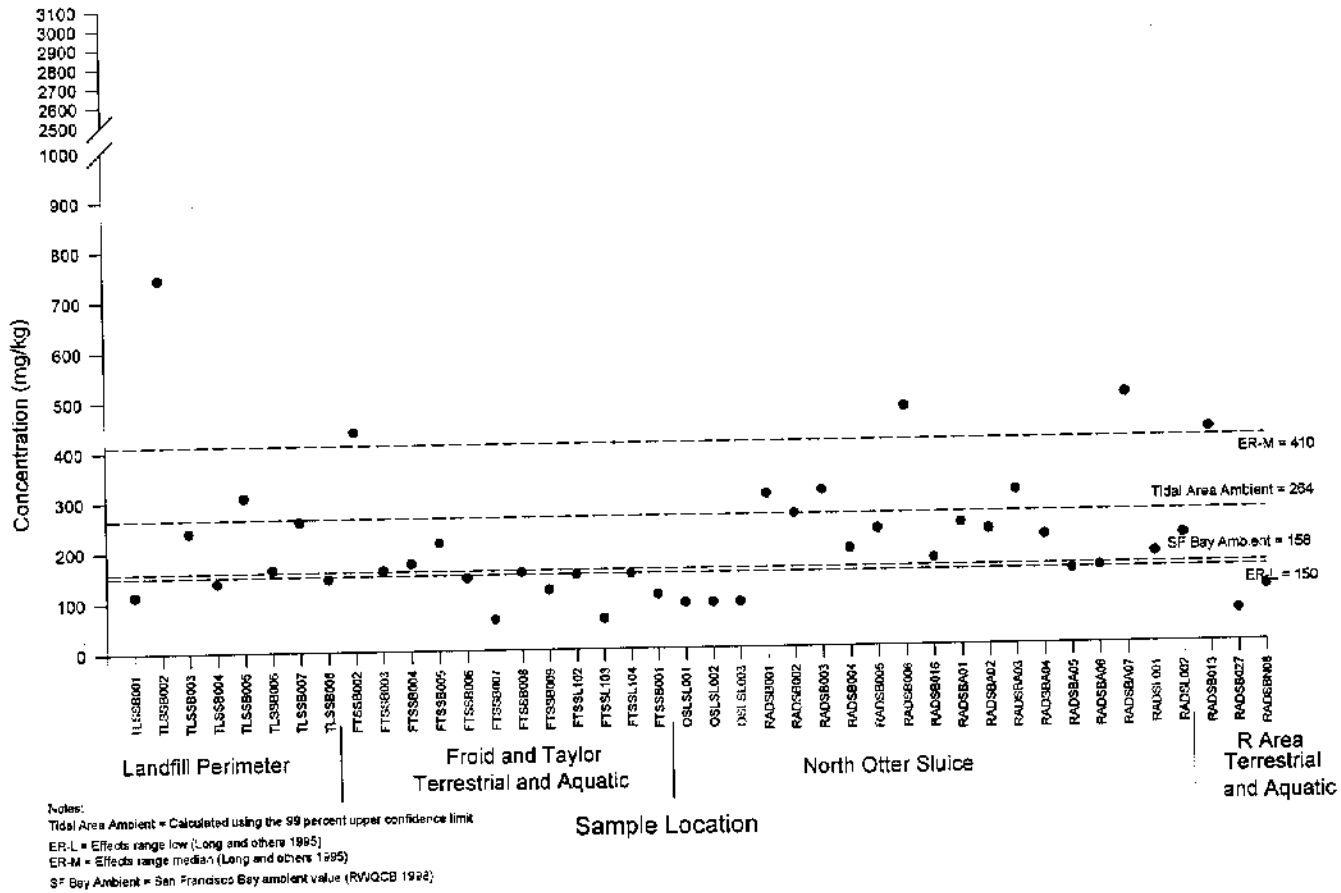
Note:
Tidal Area Ambient = Calculated using the 89 percent upper confidence limit

FIGURE 6-18C
DETECTED CONCENTRATIONS OF VANADIUM IN WOOD HOGGER TERRESTRIAL AND SOUTH OTTER SLUICE AQUATIC UNITS, SOIL AND SEDIMENT TIDAL AREA QEA, NWS SBD CONCORD



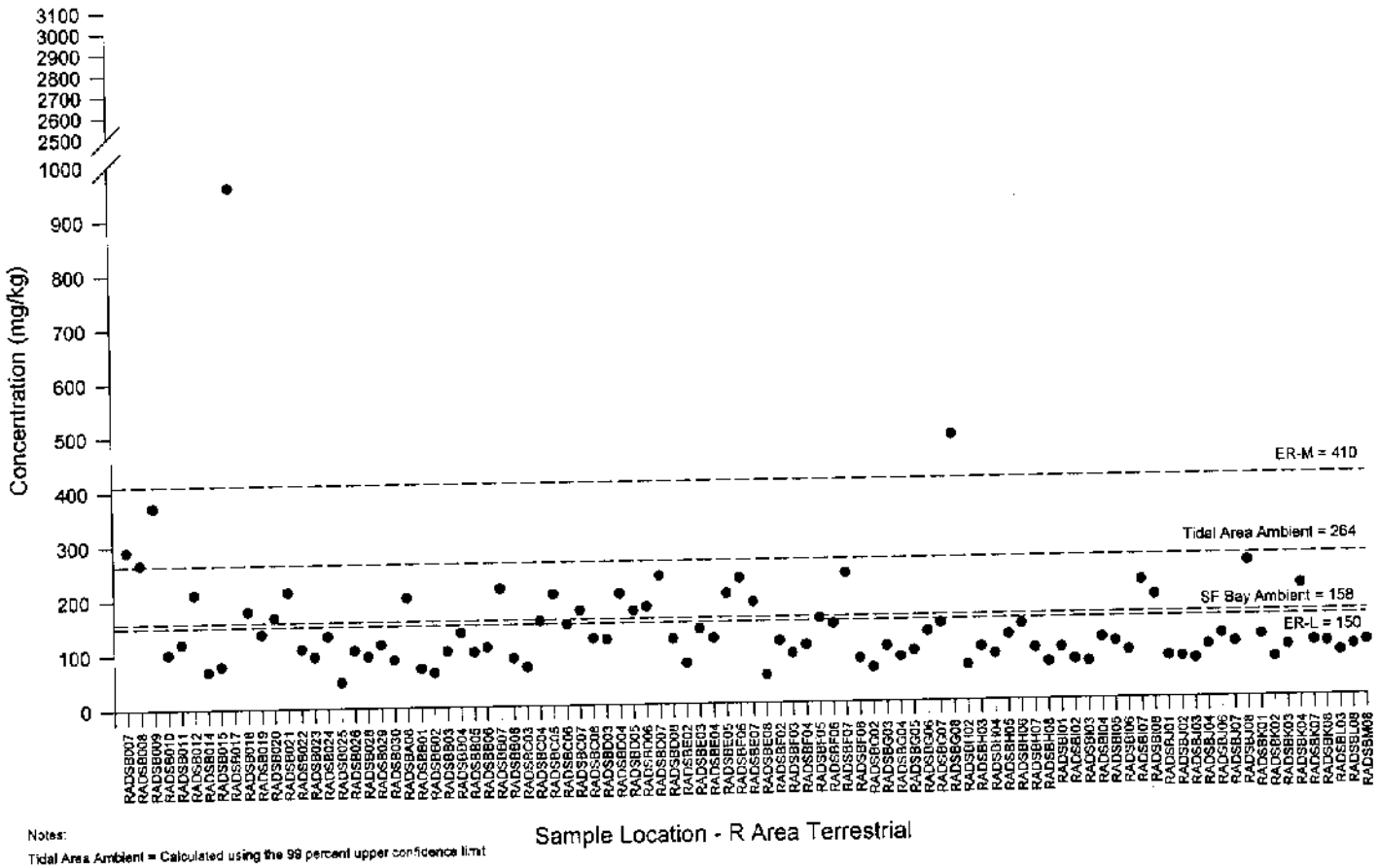
Notes:
Tidal Area Ambient = Calculated using the 99 percent upper confidence limit

FIGURE 6-19A
DETECTED CONCENTRATIONS OF ZINC IN THE LANDFILL PERIMETER TERRESTRIAL, FROID AND TAYLOR TERRESTRIAL, FROID AND TAYLOR AQUATIC, NORTH OTTER SLUICE AQUATIC, AND R AREA TERRESTRIAL AND AQUATIC UNITS, SOIL AND SEDIMENT
TIDAL AREA QEA, NWS SBD CONCORD



Notes:
Tidal Area Ambient = Calculated using the 99 percent upper confidence limit
ER-L = Effects range low (Long and others 1995)
ER-M = Effects range median (Long and others 1995)
SF Bay Ambient = San Francisco Bay ambient value (RWQCB 1992)

FIGURE 6-19B
DETECTED CONCENTRATIONS OF ZINC IN R AREA TERRESTRIAL UNIT, SOIL AND SEDIMENT TIDAL AREA QEA, NWS SBD CONCORD



Notes:

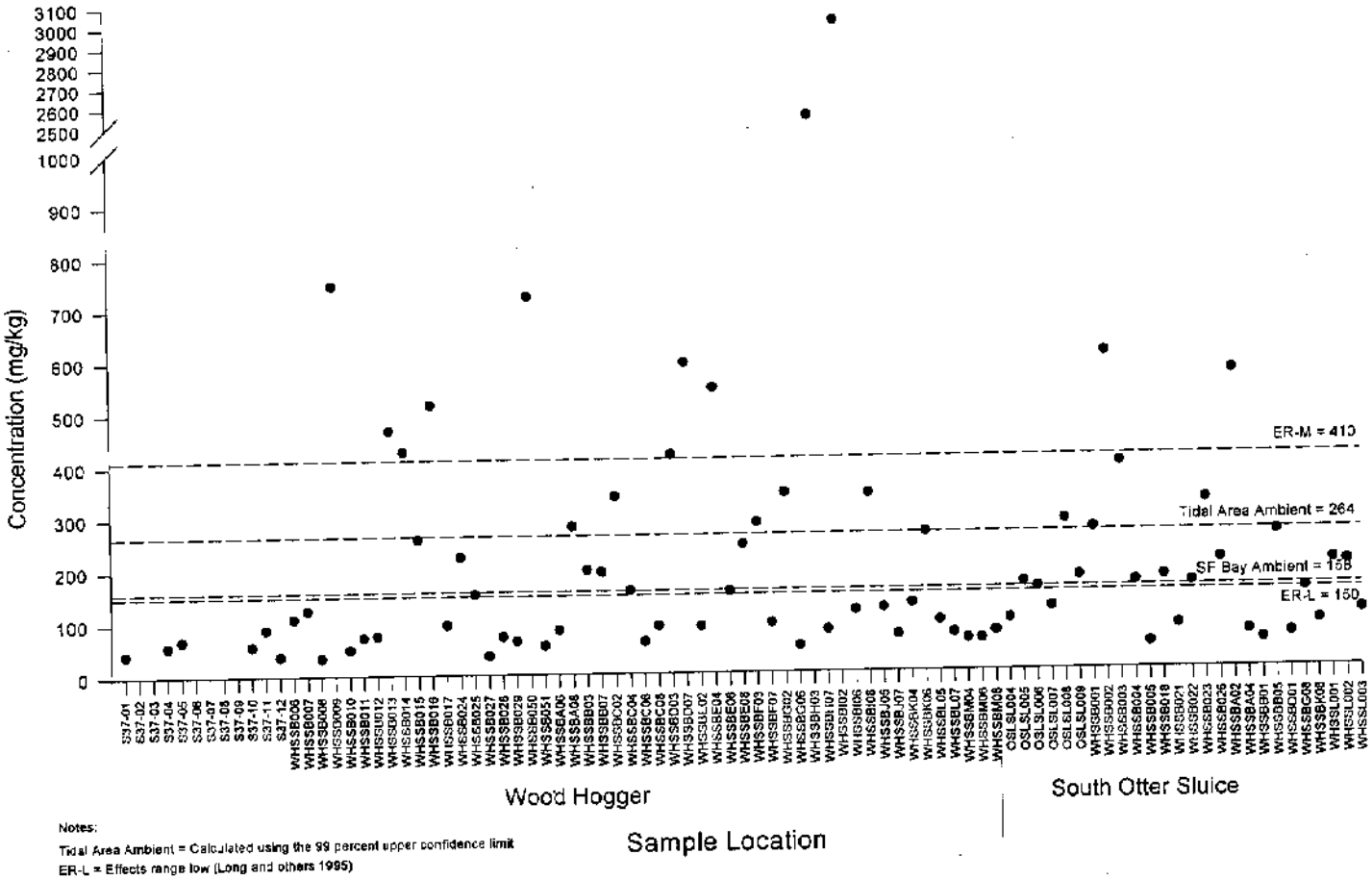
Tidal Area Ambient = Calculated using the 99 percent upper confidence limit

ER-M = Effects range median (Long and others 1995)

ER-L = Effects range low (Long and others 1995)

SF Bay Ambient = San Francisco Bay ambient value (RWQCB 1995)

FIGURE 6-19C
DETECTED CONCENTRATIONS OF ZINC IN WOOD HOGGER TERRESTRIAL AND SOUTH OTTER SLUICE AQUATIC UNITS, TIDAL AREA QEA, NWS SBD CONCORD



Notes:

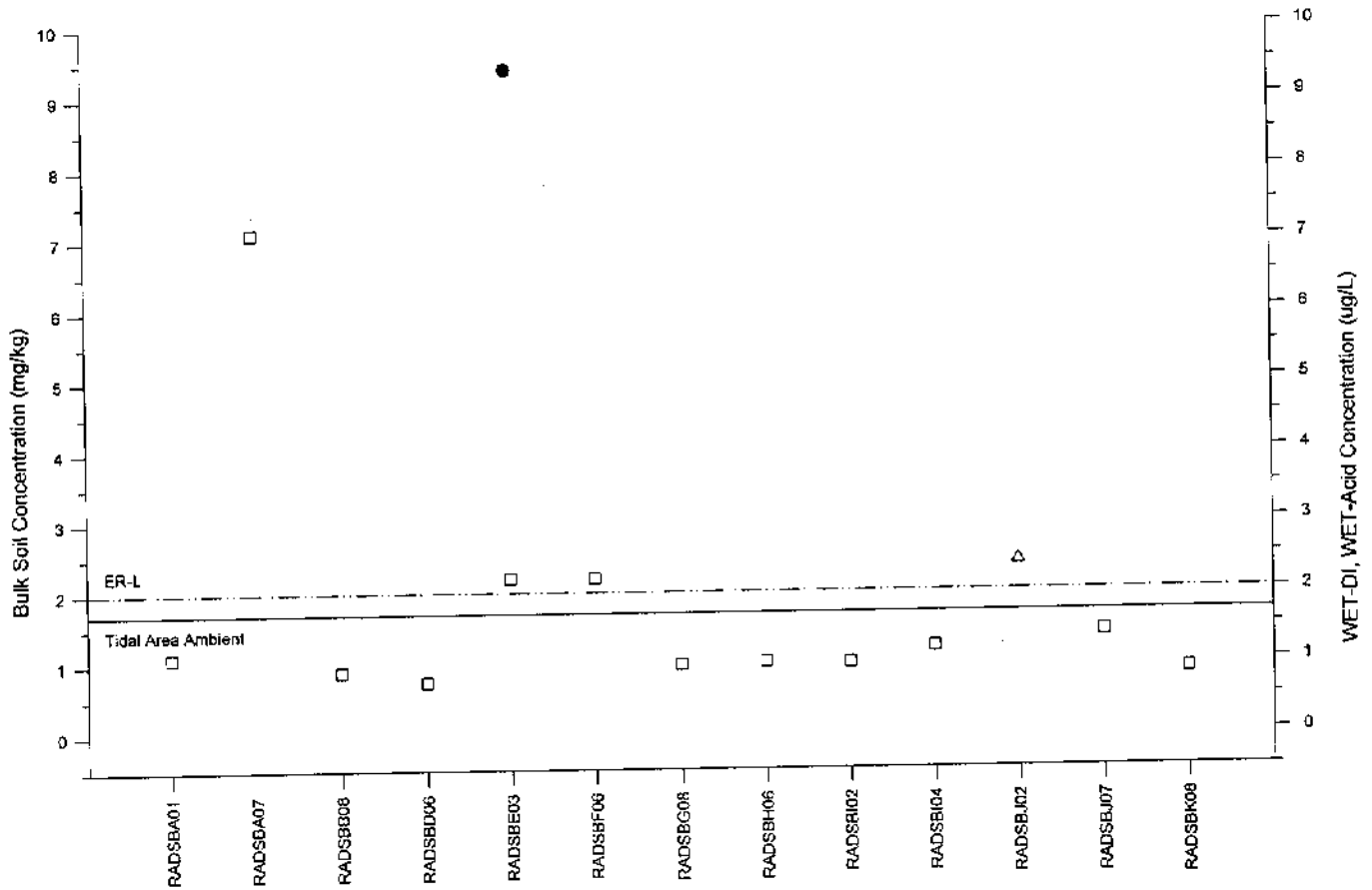
Tidal Area Ambient = Calculated using the 99 percent upper confidence limit

ER-L = Effects range low (Long and others 1995)

ER-M = Effects range median (Long and others 1995)

SF Bay Ambient = San Francisco Bay ambient value (RWQCB 1998)

FIGURE 6-20A
ANTIMONY IN R AREA DISPOSAL SITE SOIL AND SEDIMENT SAMPLES: BULK CHEMISTRY AND EXTRACTIONS
TIDAL AREA QEA, NWS SBD CONCORD



Notes:

Tidal Area Ambient = Calculated using the 99 percent upper confidence limit

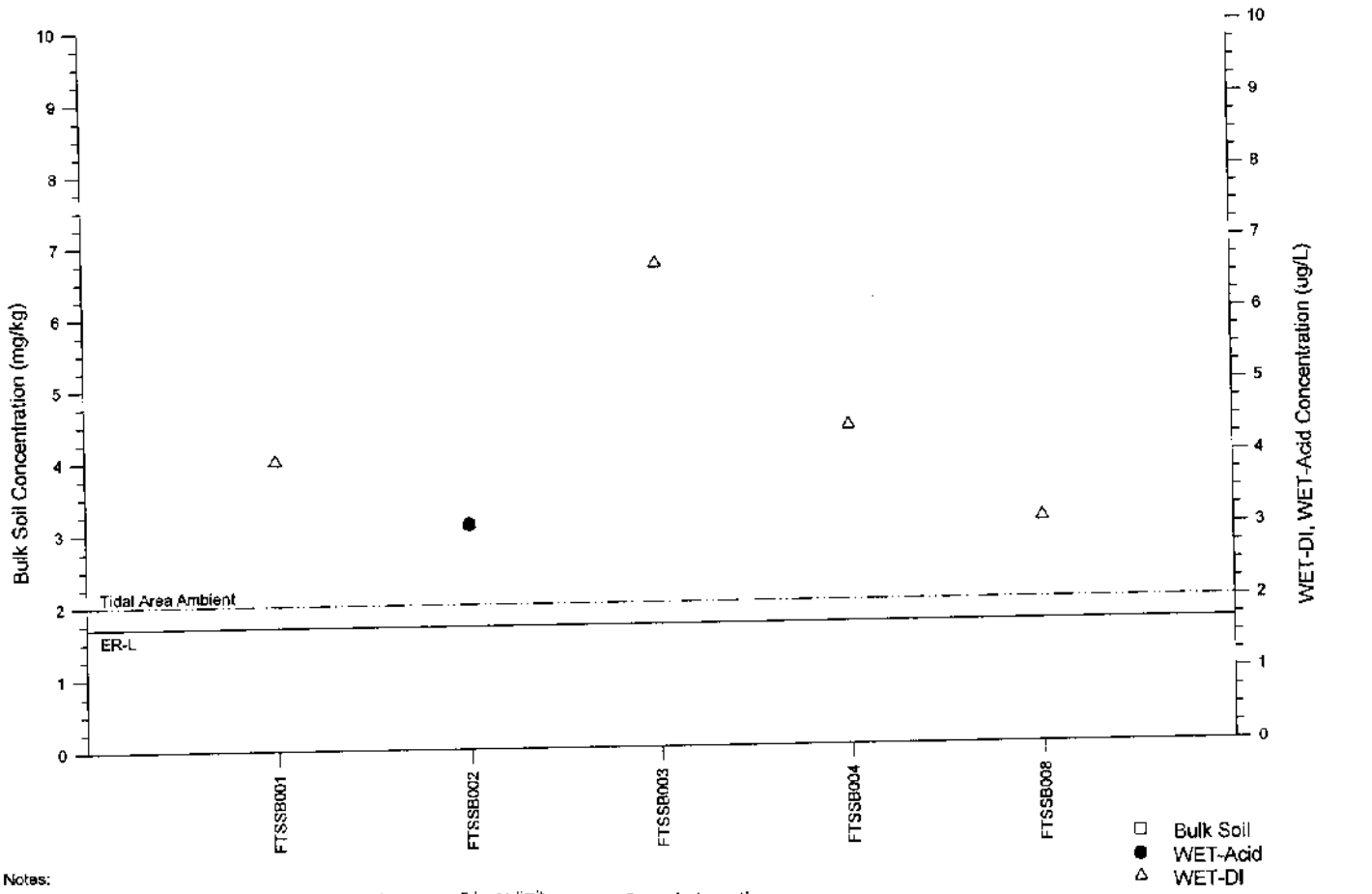
ER-L = Effects Range Low (Long and others 1995)

ER-L and ambient values are used for evaluating bulk soil data.

□ Bulk Soil
● WET-Acid
△ WET-DI

Only detected concentrations are shown.

FIGURE 6-20B
ANTIMONY IN FROID AND TAYLOR ROADS SITE SOIL SAMPLES: BULK CHEMISTRY AND EXTRACTIONS
TIDAL AREA QEA, NWS SBD CONCORD



Notes:

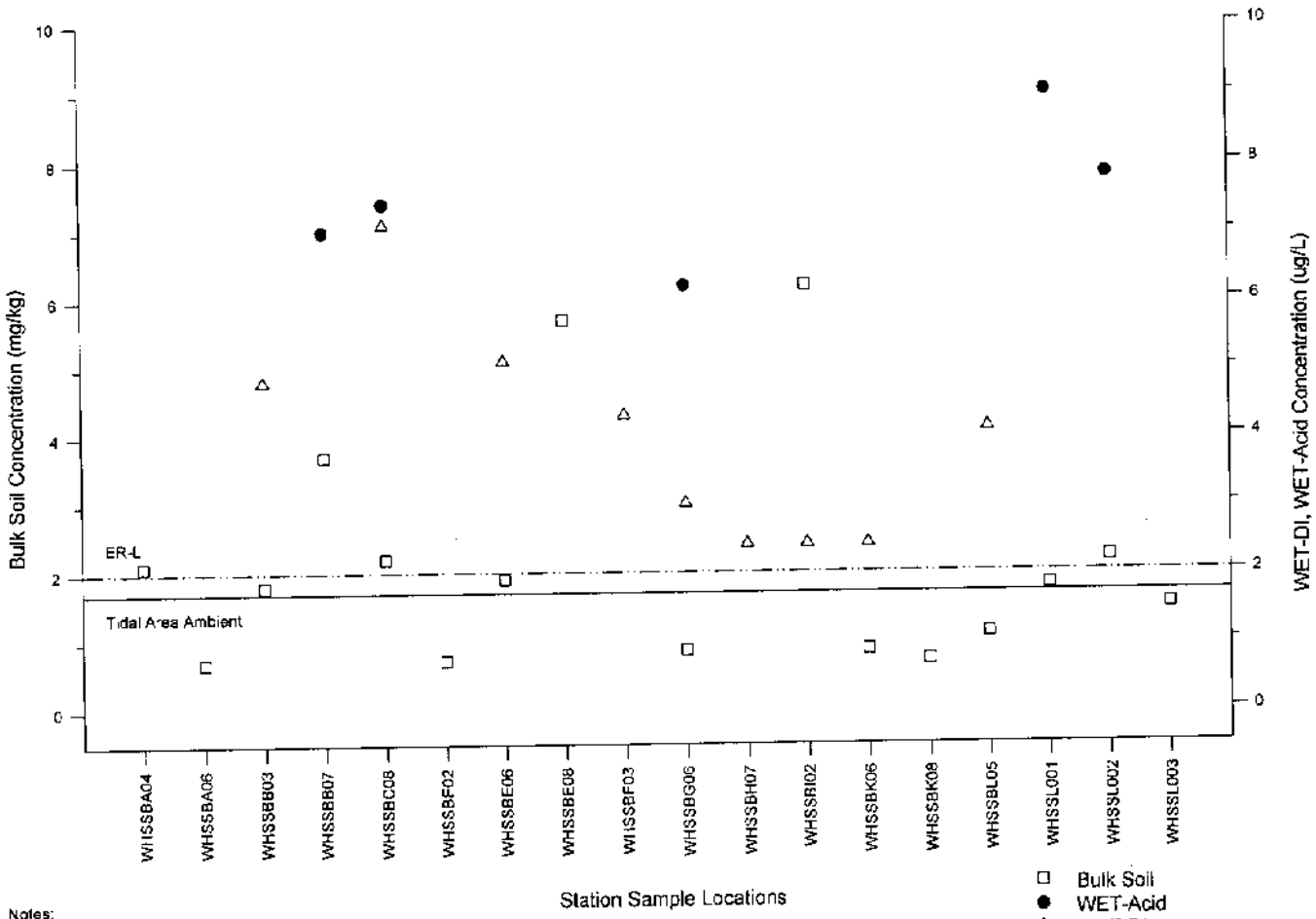
Tidal Area Ambient = Calculated using the 99 percent upper confidence limit

ER-L = Effects Range Low (Long and others 1995)

ER-L and ambient values are used for evaluating bulk soil data.

Only detected concentrations are shown.

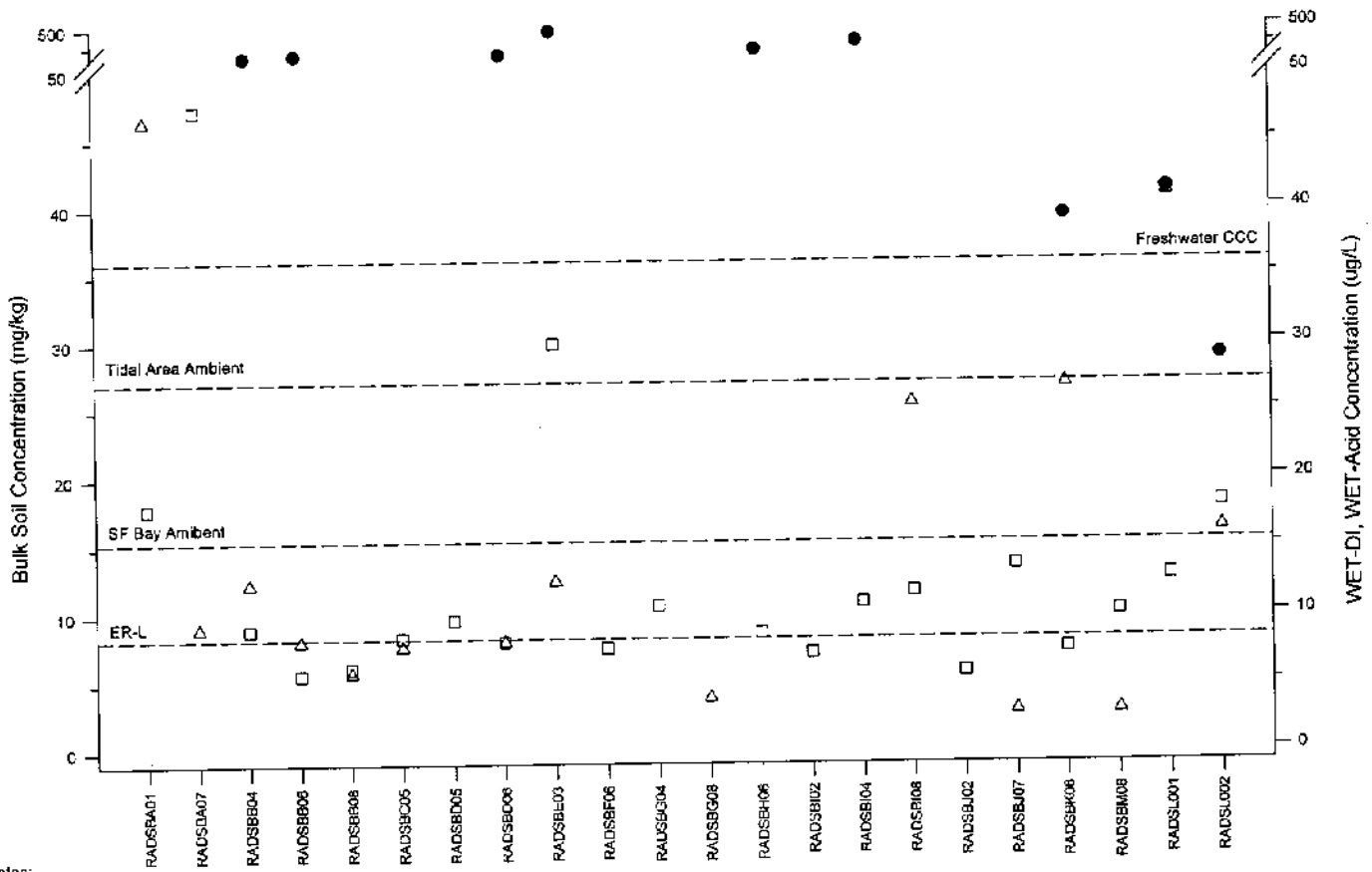
FIGURE 6-20C
ANTIMONY IN WOOD HOGGER SITE SOIL AND SEDIMENT SAMPLES: BULK CHEMISTRY AND EXTRACTIONS
TIDAL AREA QEA, NWS SBD CONCORD



Notes:
Tidal Area Ambient = Calculated using the 99 percent upper confidence limit
ER-L = Effects Range Low (Long et al. 1995)
WHSSL001, WHSSL002, and WHSSL003 are sediment samples; all others are soil samples.
ER-L and ambient values are used for evaluating bulk soil data.

Only detected concentrations are shown.

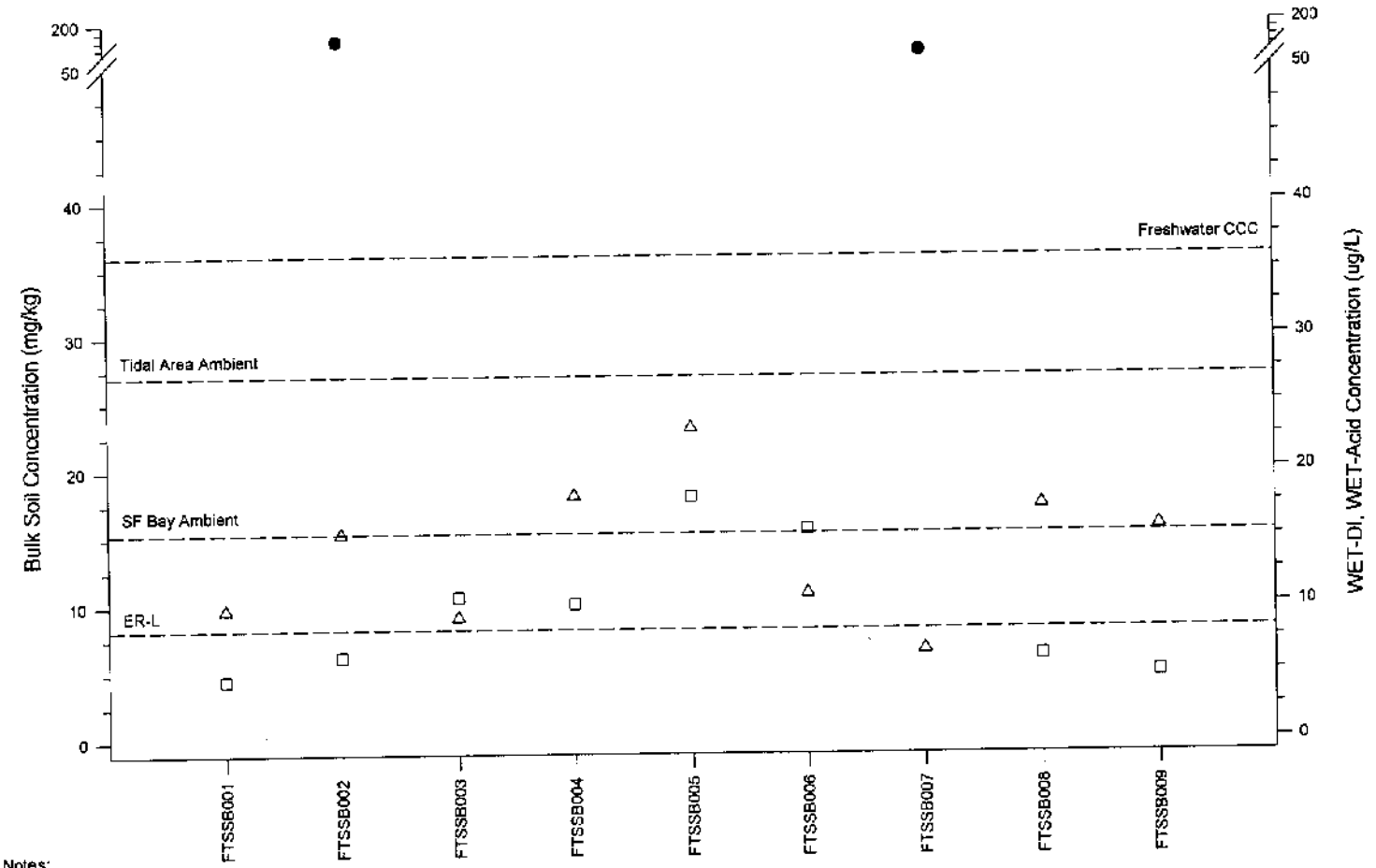
FIGURE 6-21A
ARSENIC IN R AREA DISPOSAL SITE SOIL AND SEDIMENT SAMPLES: BULK CHEMISTRY AND EXTRACTIONS
TIDAL AREA QEA, NWS SBD CONCORD



Notes:
Tidal Area Ambient = Calculated using the 99 percent upper confidence limit
Freshwater CCC = Criteria continuous concentration (EPA 1998)
SF Bay Ambient = San Francisco Bay ambient (RWQCB 1998)
ER-L = Effects Range Low (Long and others 1995)
RADSL001 and RADS_002 are sediment samples; all others are soil samples.
CCC value is used for evaluating WET data; ER-L and ambient values are used for evaluating bulk soil data.

Only detected concentrations are shown.

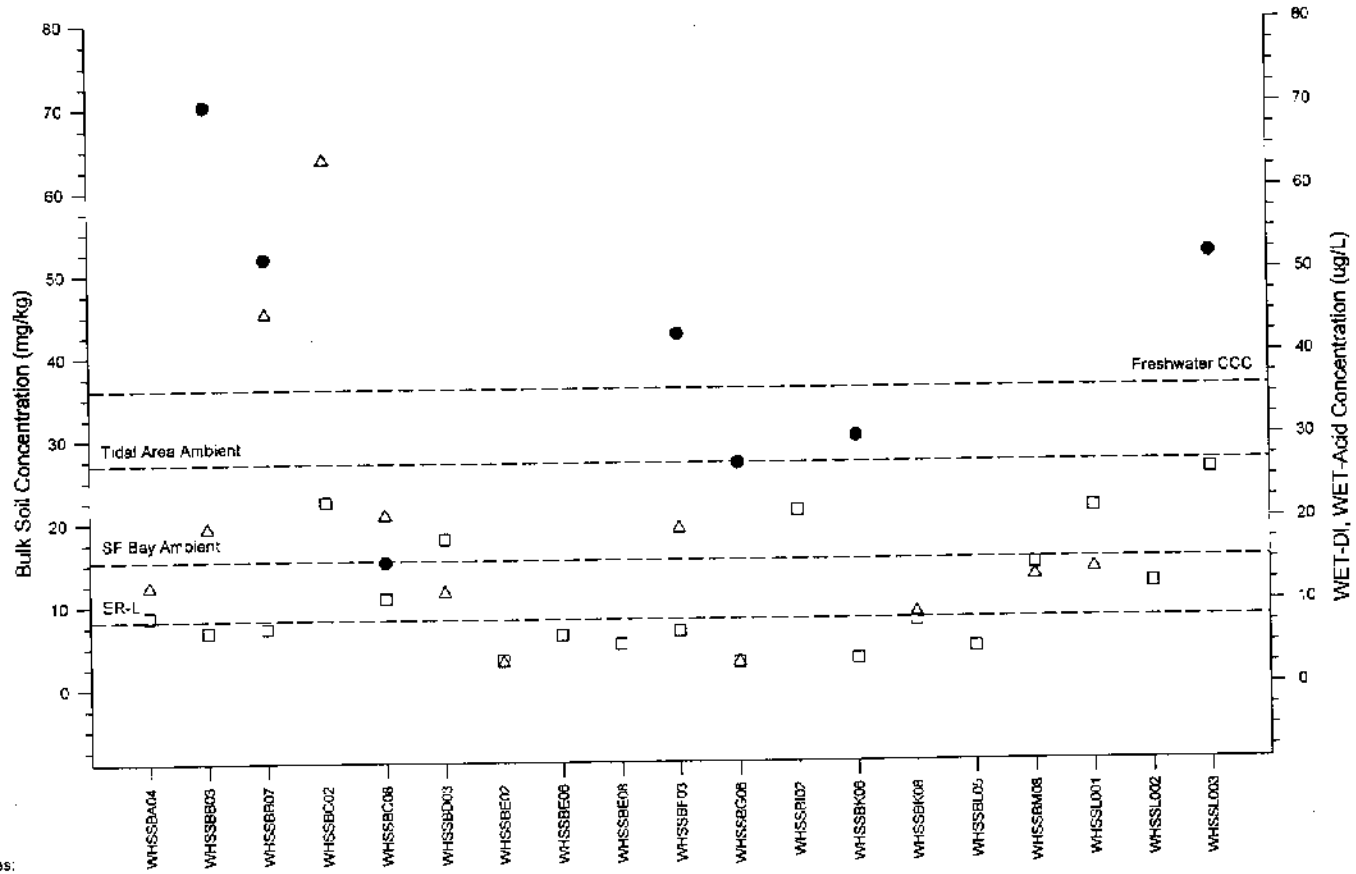
FIGURE 6-21B
ARSENIC IN FROID AND TAYLOR ROADS SITE SOIL SAMPLES: BULK CHEMISTRY AND EXTRACTIONS
TIDAL AREA QEA, NWS SBD CONCORD



Notes:
Tidal Area Ambient = Calculated using the 99 percent upper confidence limit
Freshwater CCC = Criteria continuous concentration (EPA 1998)
SF Bay Ambient = San Francisco Bay ambient (RWQCB 1998)
ER-L = Effects Range Low (Long and others 1995)
CCC value is used for evaluating WET data; ER-L and ambient values are used for evaluating bulk soil data.

Only detected concentrations are shown.

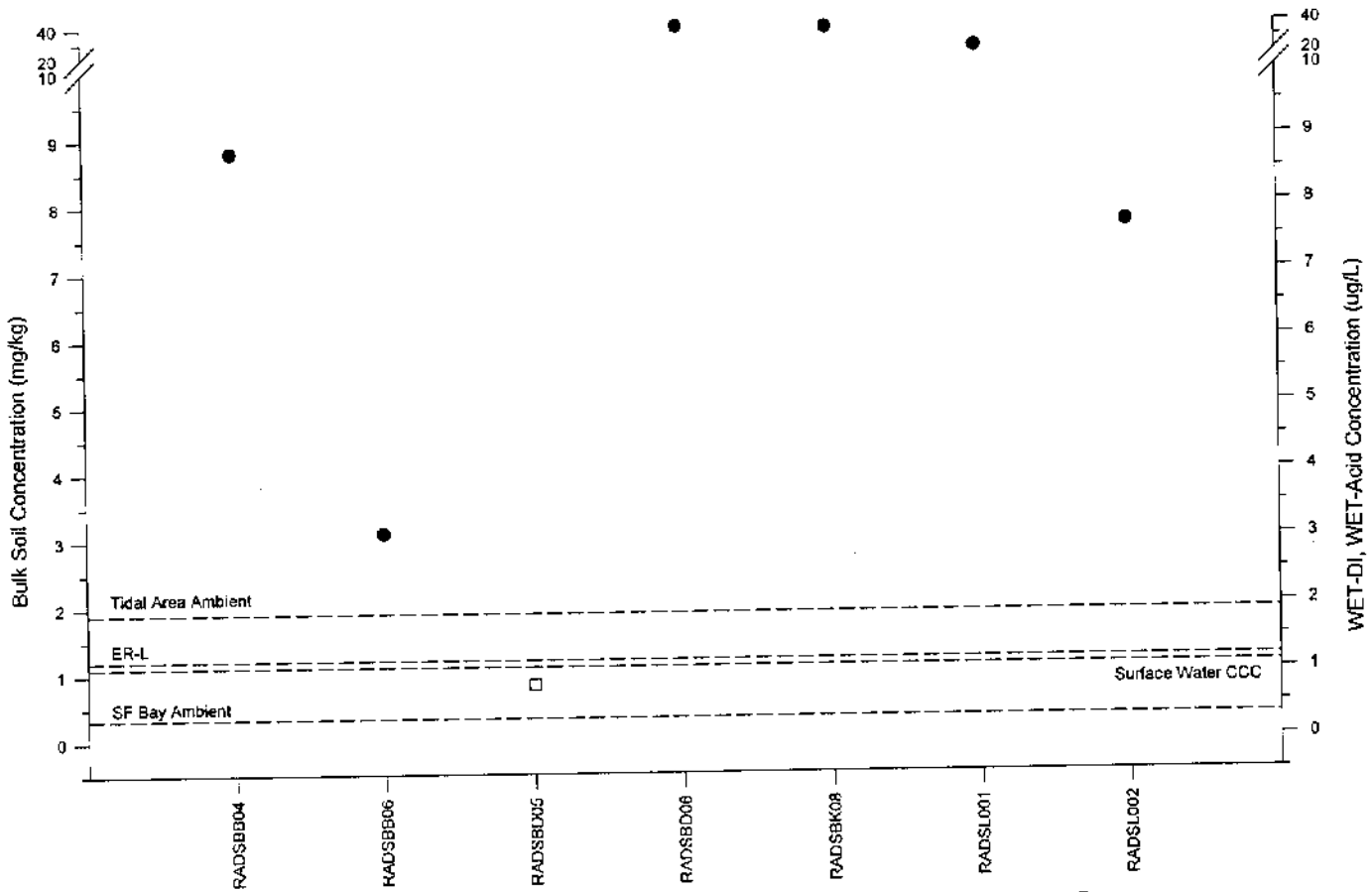
FIGURE 6-21C
ARSENIC IN WOOD HOGGER SITE SOIL AND SEDIMENT SAMPLES: BULK CHEMISTRY AND EXTRACTIONS
TIDAL AREA QEA, NWS SBD CONCORD



Only detected concentrations are shown.

Notes:
Tidal Area Ambient = Calculated using the 95 percent upper confidence limit
Freshwater CCC = Criteria continuous concentration (EPA 1998)
SF Bay Ambient = San Francisco Bay ambient (RWQCB 1998)
ER-L = Effects Range Low (Long and others 1995)
RADSL001 and RADSL002 are sediment samples; all others are soil samples.
CCC value is used for evaluating WET data; ER-L and ambient values are used for evaluating bulk soil data.
WHSSL001, WHSSL002, and WHSSL003 are sediment samples; all others are soil samples.

FIGURE 6-22A
CADMIUM IN R AREA DISPOSAL SITE SOIL AND SEDIMENT SAMPLES: BULK CHEMISTRY AND EXTRACTIONS
TIDAL AREA QEA, NWS SBD CONCORD

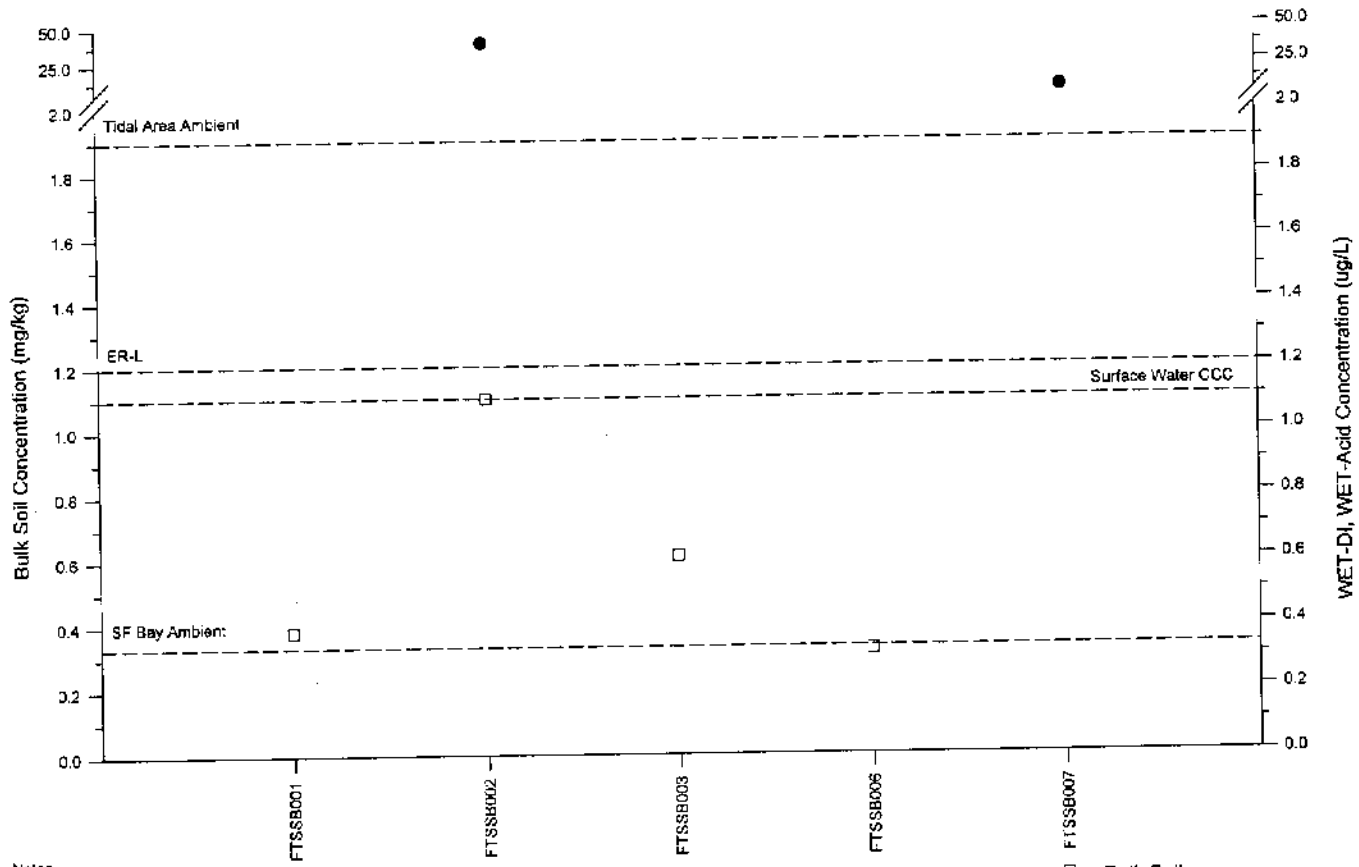


Notes:

SF Bay Ambient = San Francisco Bay ambient (RWQCB 1998)
Surface Water CCC = Criteria continuous concentration (Bay Basin Plan 1986)
Tidal Area Ambient = Calculated using the upper 99 percent upper confidence limit
ER-L = Effects Range Low (Long and others 1995)
CCC value is used for evaluating WET data; ER-L and ambient values are used for evaluating bulk soil data
RADSL001 and RADSL002 are sediment samples; all others are soil samples.

Only detected concentrations are shown.

FIGURE 6-22B
CADMIUM IN FROID AND TAYLOR ROADS SITE SOIL SAMPLES: BULK CHEMISTRY AND EXTRACTIONS
TIDAL AREA QEA, NWS SBD CONCORD

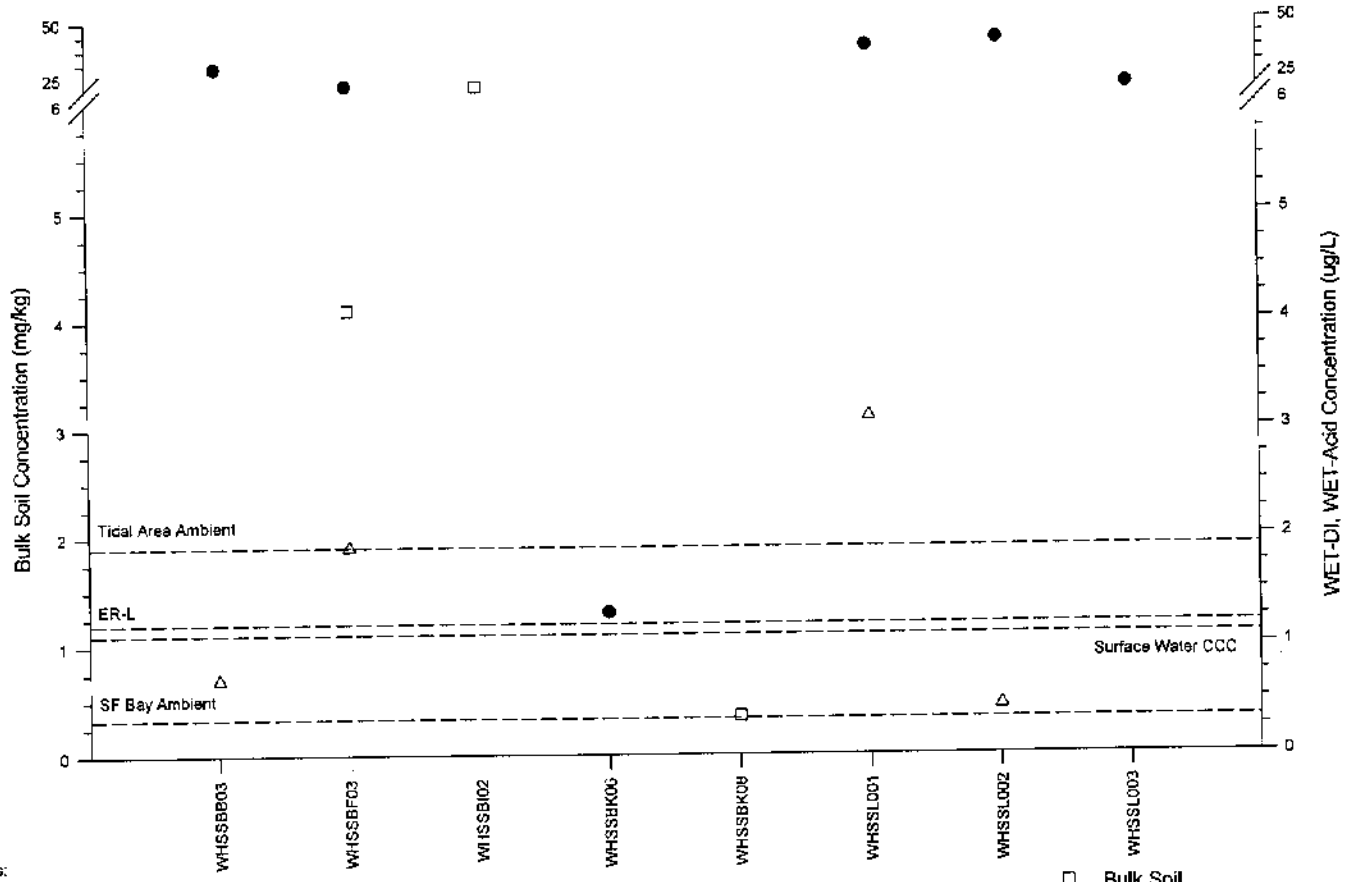


Notes

SF Bay Ambient = San Francisco Bay ambient (RWQCB 1998)
Surface Water CCC = Criteria continuous concentration (Bay Basin Plan 1986)
Tidal Area Ambient = Calculated using the upper 99 percent upper confidence limit
ER-L = Effects Range Low (Long and others 1995)
CCC value is used for evaluating WET data. ER-L and ambient values are used for evaluating bulk soil data.

Only detected concentrations are shown.

FIGURE 6-22C
CADMIUM IN WOOD HOGGER SITE SOIL AND SEDIMENT SAMPLES: BULK CHEMISTRY AND EXTRACTIONS
TIDAL AREA QEA, NWS SBD CONCORD

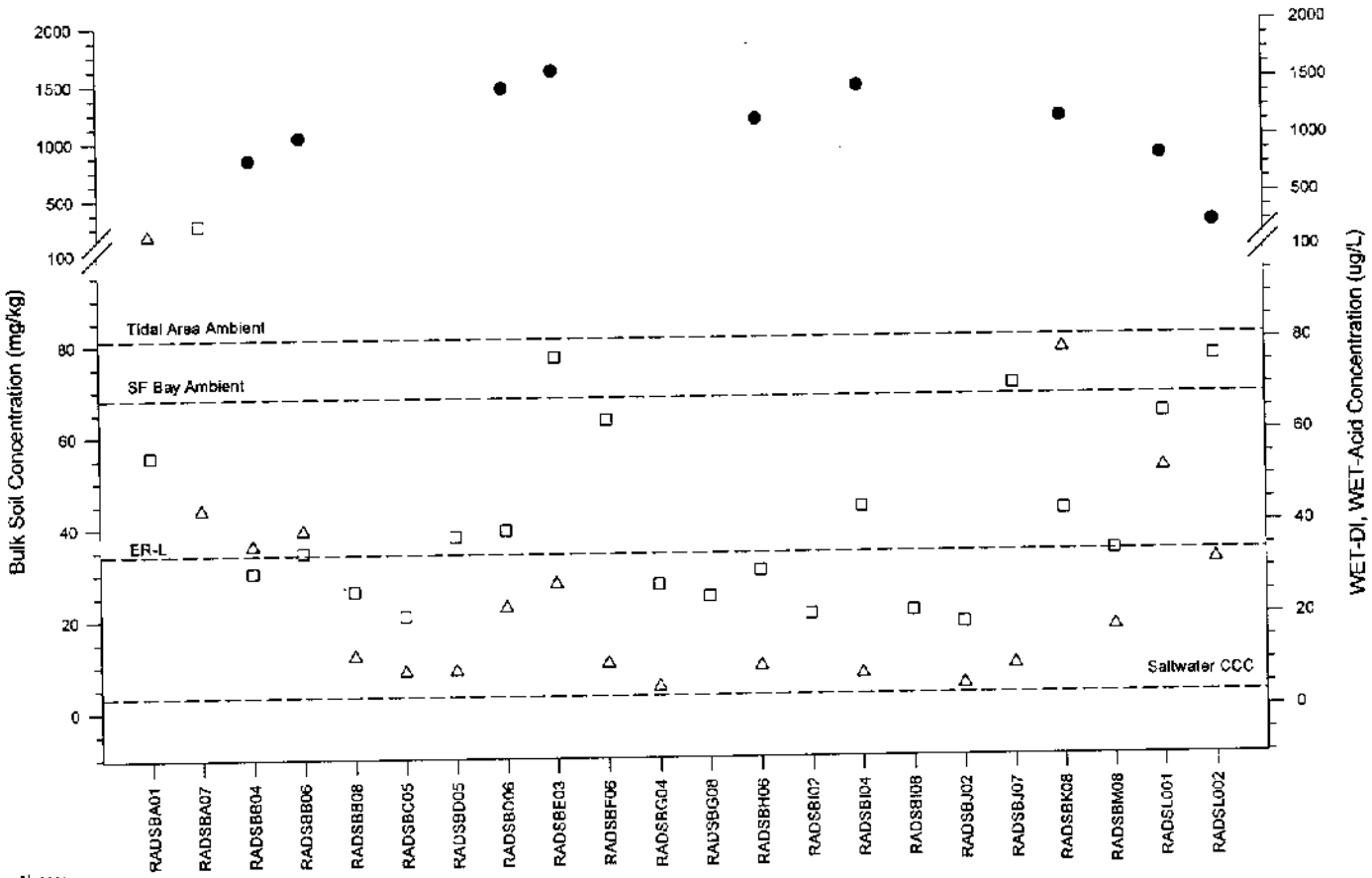


Notes:

SF Bay Ambient = San Francisco Bay ambient (RWQCB 1998)
Surface Water CCC = Criteria continuous concentration (Bay Basin Plan 1986)
Tidal Area Ambient = Calculated using the upper 99 percent upper confidence limit
ER-L = Effects Range Low (Long and others 1995)
CCC value is used for evaluating WET data; ER-L and ambient values are used for evaluating bulk soil data.
WHSSL001, WHSSL002, and WHSSL003 are sediment samples; all others are soil samples.

Only detected concentrations are shown.

FIGURE 6-23A
COPPER IN R AREA DISPOSAL SITE SOIL AND SEDIMENT SAMPLES: BULK CHEMISTRY AND EXTRACTIONS
TIDAL AREA QEA, NWS SBD CONCORD

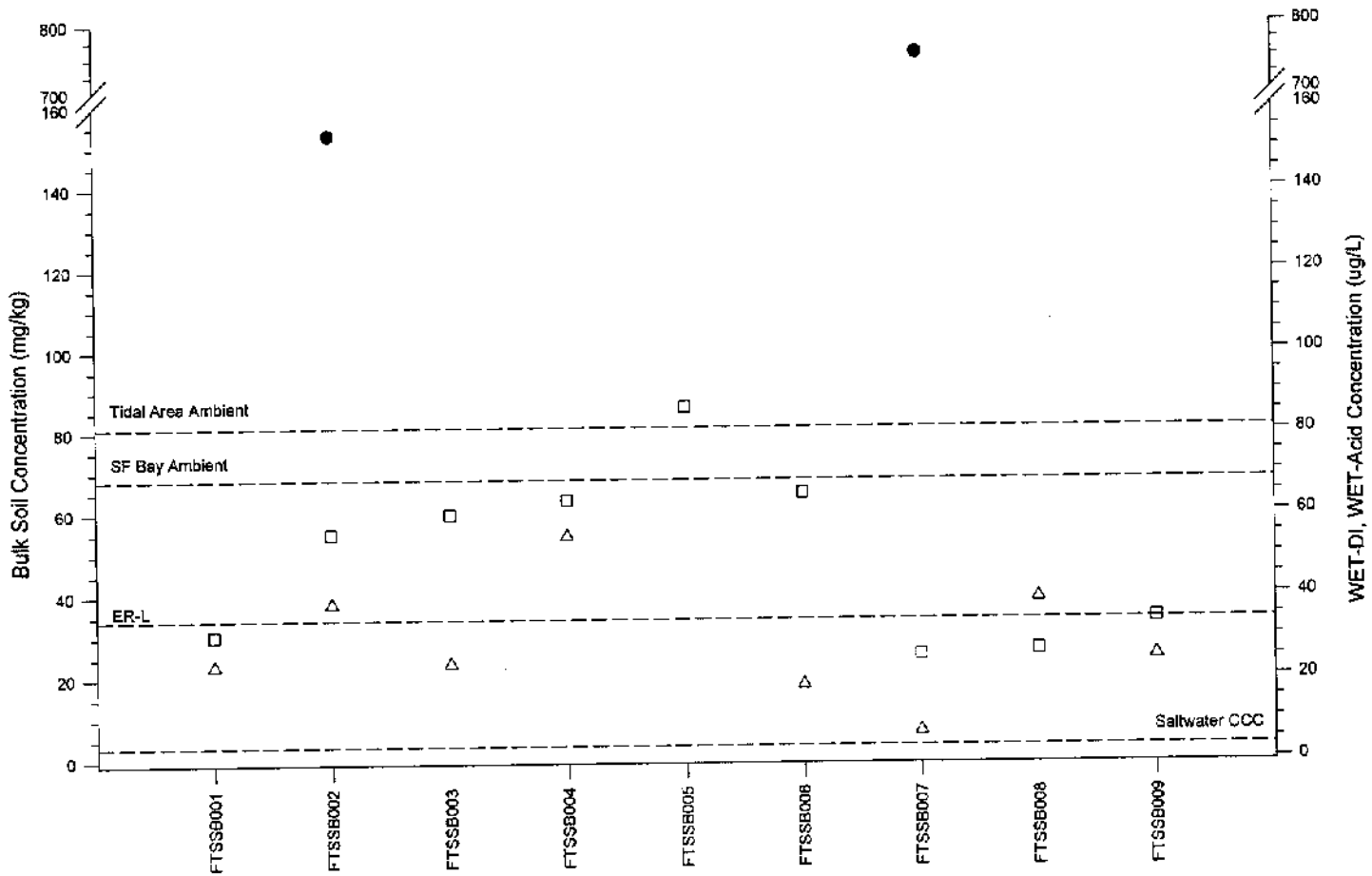


Notes:

SF Bay Ambient = San Francisco Bay ambient (RWQCB 1998)
Saltwater CCC = Criteria continuous concentration (EPA 1998)
Tidal Area Ambient = Calculated using the upper 99 percent upper confidence limit
ER-L = Effects Range Low (Long and others 1995)
CCC value is used for evaluating WET data; ER-L and ambient values are used for evaluating bulk soil data.
RADSL001 and RADSL002 are sediment samples; all others are soil samples.

Only detected concentrations are shown.

FIGURE 6-23B
COPPER IN FROID AND TAYLOR ROADS SITE SOIL SAMPLES: BULK CHEMISTRY AND EXTRACTIONS
TIDAL AREA QEA, NWS SBD CONCORD

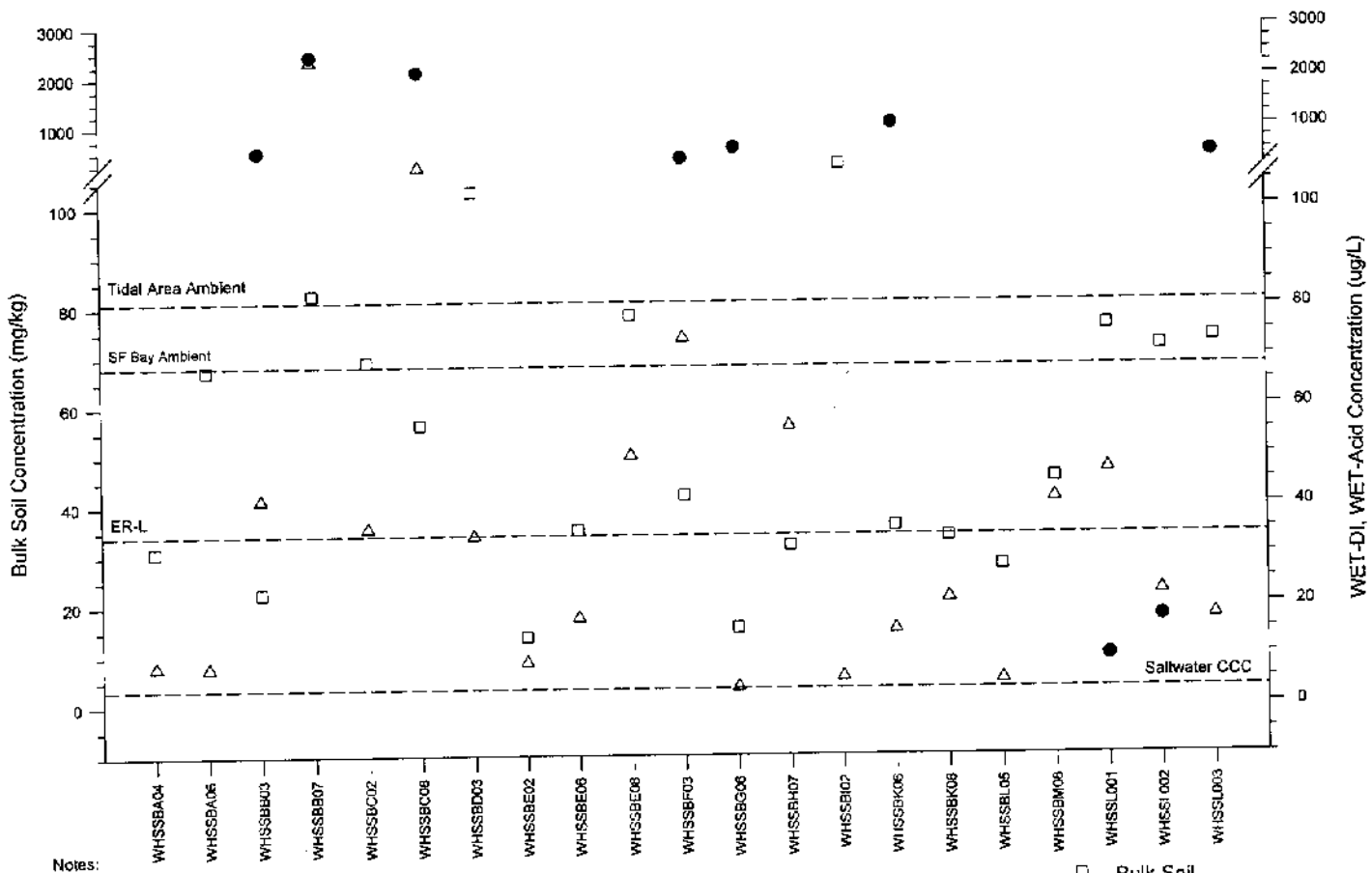


Notes:

SF Bay Ambient = San Francisco Bay ambient (RWQCB 1998)
Saltwater CCC = Criteria continuous concentration (EPA 1998)
Tidal Area Ambient = Calculated using the upper 99 percent upper confidence limit
ER-L = Effects Range Low (Long and others 1995)
CCC value is used for evaluating WET data; ER-L and ambient values are used for evaluating bulk soil data.

Only detected concentrations are shown.

FIGURE 6-23C
COPPER IN WOOD HOGGER SITE SOIL AND SEDIMENT SAMPLES: BULK CHEMISTRY AND EXTRACTIONS
TIDAL AREÀ QEA, NWS SBD CONCORD

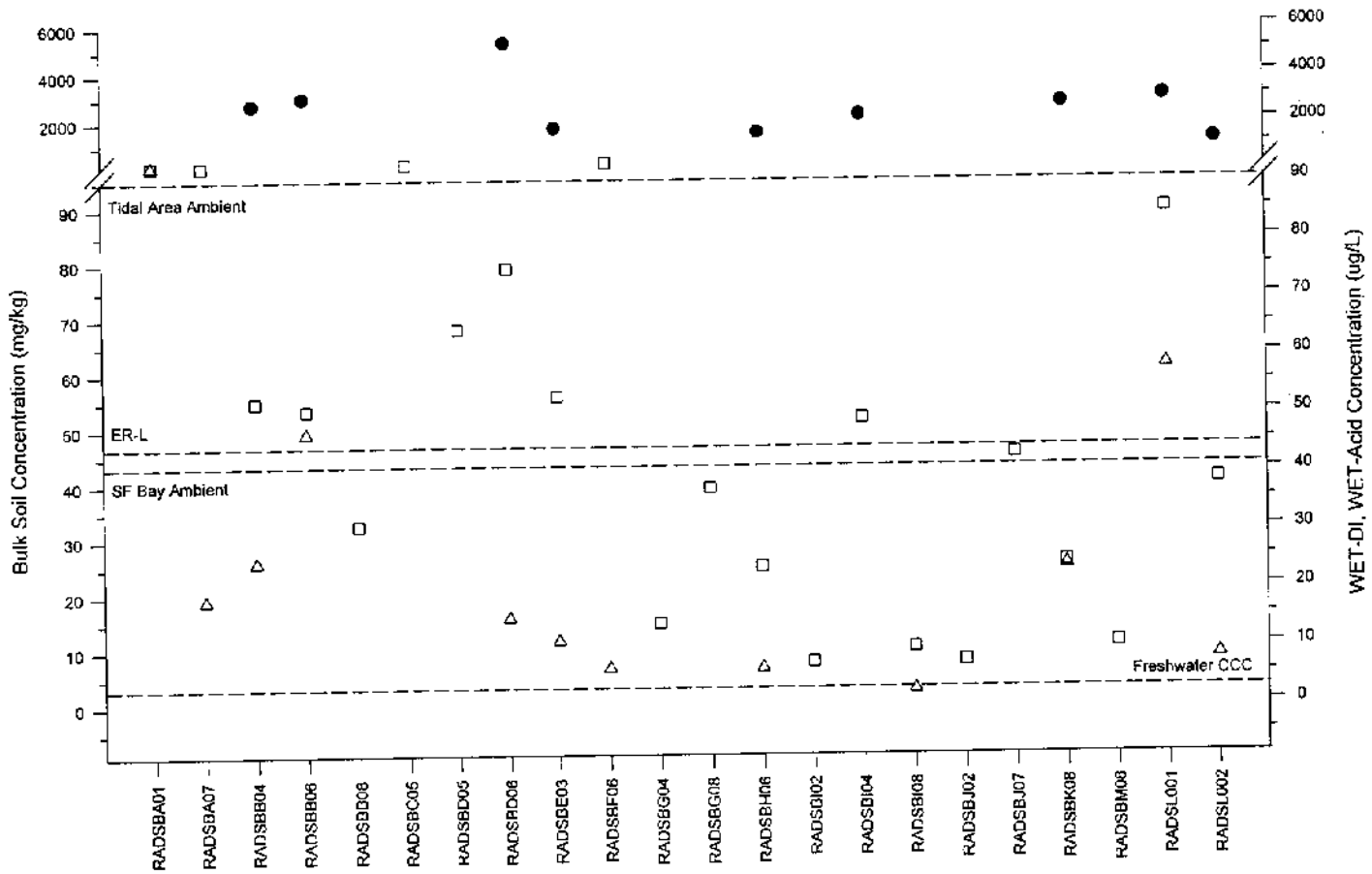


Notes:

SF Bay Ambient = San Francisco Bay ambient (RWQCB 1998)
Saltwater CCC = Criteria continuous concentration (EPA 1998)
Tidal Area Ambient = Calculated using the upper 99 percent upper confidence limit
ER-L = Effects Range Low (Long and others 1995)
CCC value is used for evaluating WET data; ER-L, cover and ambient values are used for evaluating bulk soil data.
WHSSL001, WHSSL002, and WHSSL003 are sediment samples; all others are soil samples.

Only detected concentrations are shown.

FIGURE 6-24A
LEAD IN R AREA DISPOSAL SITE SOIL AND SEDIMENT SAMPLES: BULK CHEMISTRY AND EXTRACTIONS
TIDAL AREA QEA, NWS SBD CONCORD

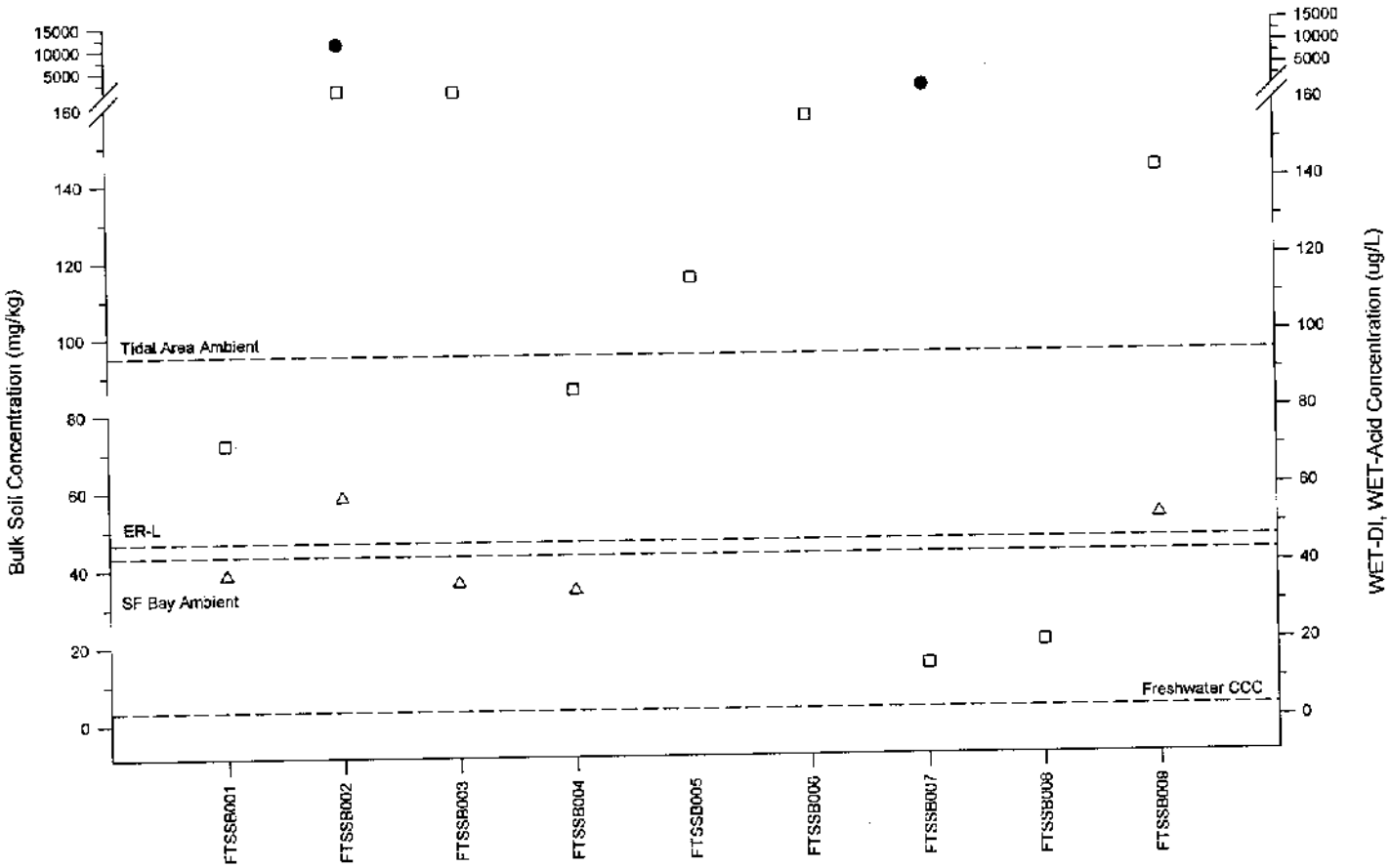


Notes:

SF Bay Ambient = San Francisco Bay ambient (RWQCB 1998)
Freshwater CCC = Criteria continuous concentration (EPA 1998)
Tidal Area Ambient = Calculated using the upper 99 percent upper confidence limit
ER-L = Effects Range Low (Long and others 1995)
CCC value is used for evaluating WET data; ER-L and ambient values are used for evaluating bulk soil data.
RADSL001 and RADSL002 are sediment samples; all others are soil samples.

Only detected concentrations are shown.

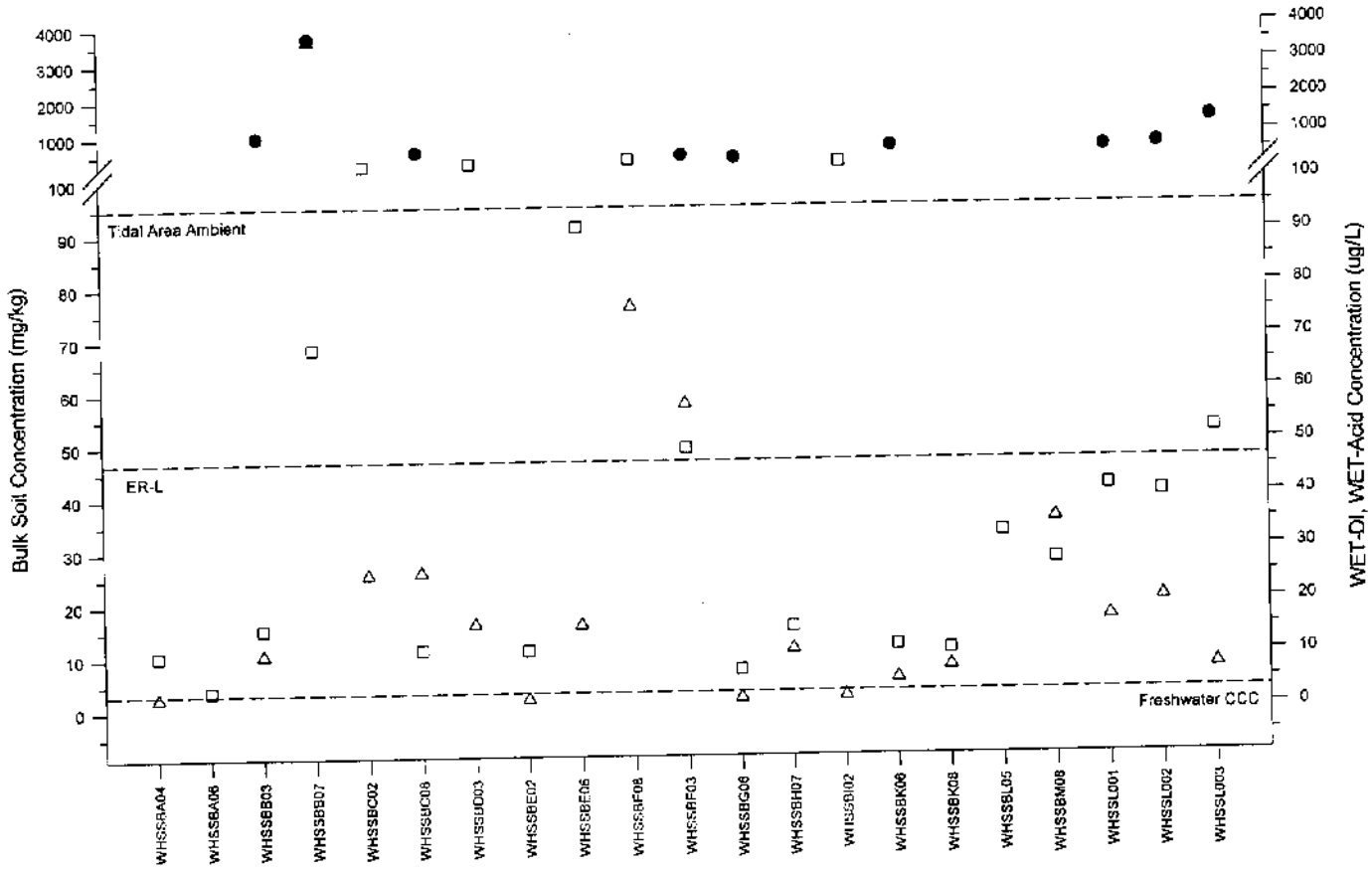
FIGURE 6-24B
LEAD IN FROID AND TAYLOR ROADS SITE SOIL SAMPLES: BULK CHEMISTRY AND EXTRACTIONS
TIDAL AREA QEA, NWS SBD CONCORD



Notes:
SF Bay Ambient = San Francisco Bay ambient (RWQCB 1998)
Freshwater CCC = Criteria continuous concentration (EPA 1998)
Tidal Area Ambient = Calculated using the upper 99 percent upper confidence limit
ER-L = Effects Range Low (Long and others 1995)
CCC value is used for evaluating WET data; ER-L and ambient values are used for evaluating bulk soil data.

Only detected concentrations are shown.

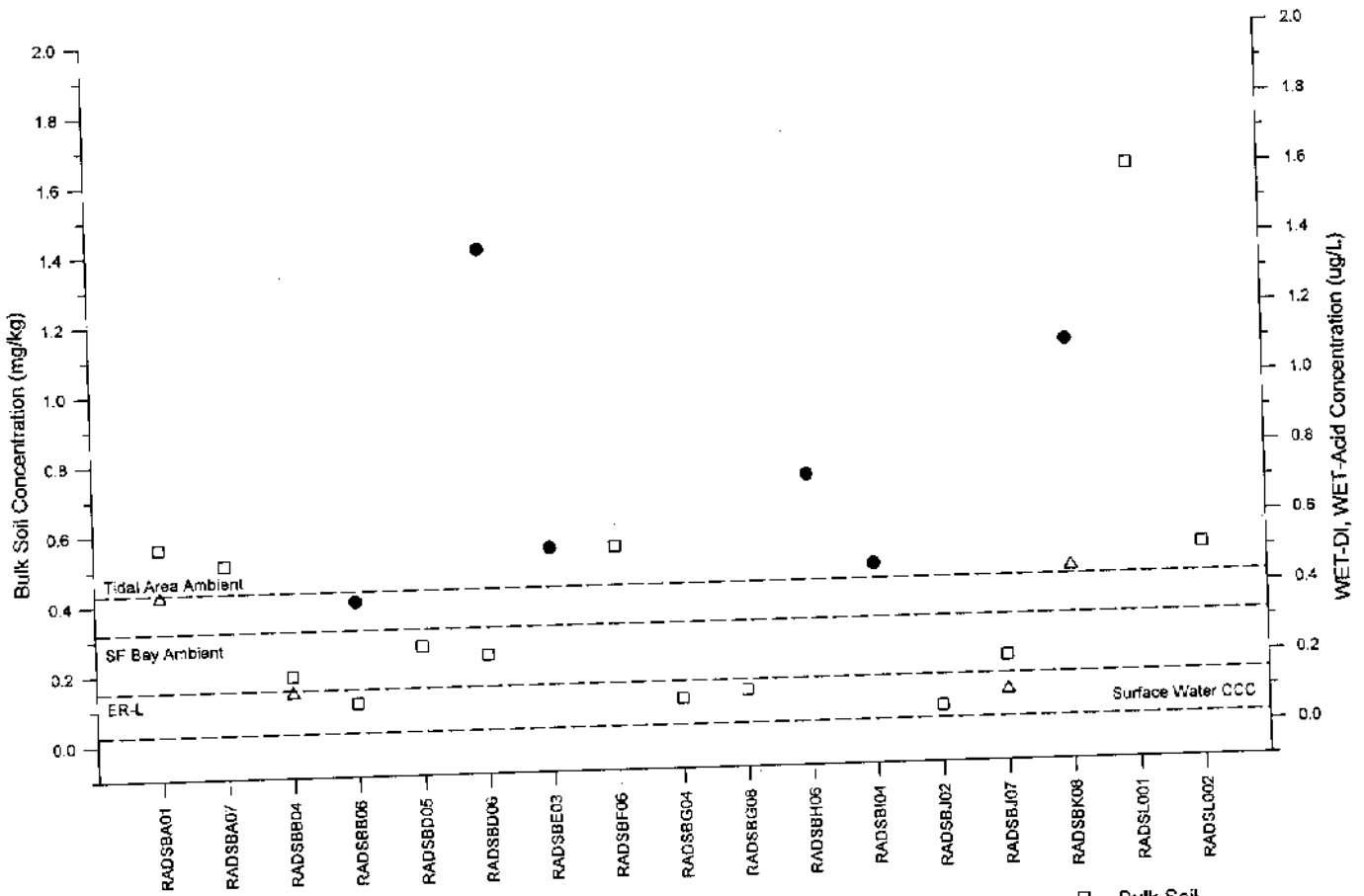
FIGURE 6-24C
LEAD IN WOOD HOGGER SITE SOIL AND SEDIMENT SAMPLES: BULK CHEMISTRY AND EXTRACTIONS
TIDAL AREA QEA, NWS SBD CONCORD



Notes:
SF Bay Ambient = San Francisco Bay ambient (RWQCB 1998)
Tidal Area Ambient = Calculated using the upper 99 percent upper confidence limit
Freshwater CCC = Criteria continuous concentration (EPA 1998)
ER-L = Effects Range Low (Long and others 1995)
WHSSL001, WHSSL002, and WHSSL003 are sediment samples; all others are soil samples.
CCC value is used for evaluating WET data; ER-L and ambient values are used for evaluating bulk soil data.

Only detected concentrations are shown.

FIGURE 6-25A
MERCURY IN R AREA DISPOSAL SITE SOIL AND SEDIMENT SAMPLES: BULK CHEMISTRY AND EXTRACTIONS
TIDAL AREA QEA, NWS SBD CONCORD



Only detected concentrations are shown.

Notes:

SF Bay Ambient = San Francisco Bay ambient (RWQCB 1998)

Surface Water CCC = Criteria continuous concentration (Bay Basin Plan 1986)

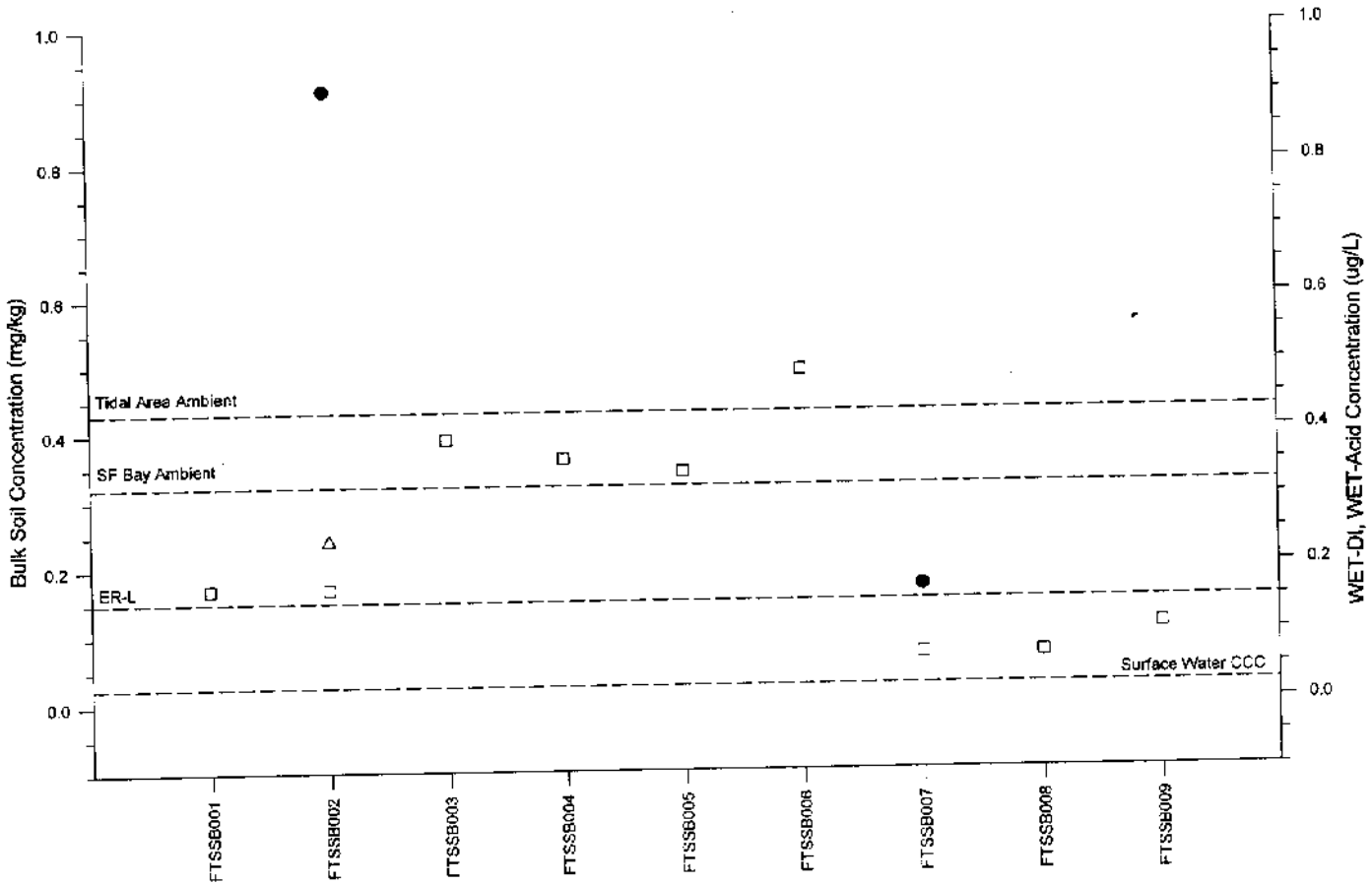
Tical Area Ambient = Calculated using the upper 99 percent upper confidence limit

ER-L = Effects Range Low (Long and others 1995)

CCC value is used for evaluating WET data; ER-L and ambient values are used for evaluating bulk soil data.

RADSL001 and RADSL002 are sediment samples; all others are soil samples.

FIGURE 6-25B
MERCURY IN FROID AND TAYLOR ROADS SITE SOIL SAMPLES: BULK CHEMISTRY AND EXTRACTIONS
TIDAL AREA QEA, NWS SBD CONCORD

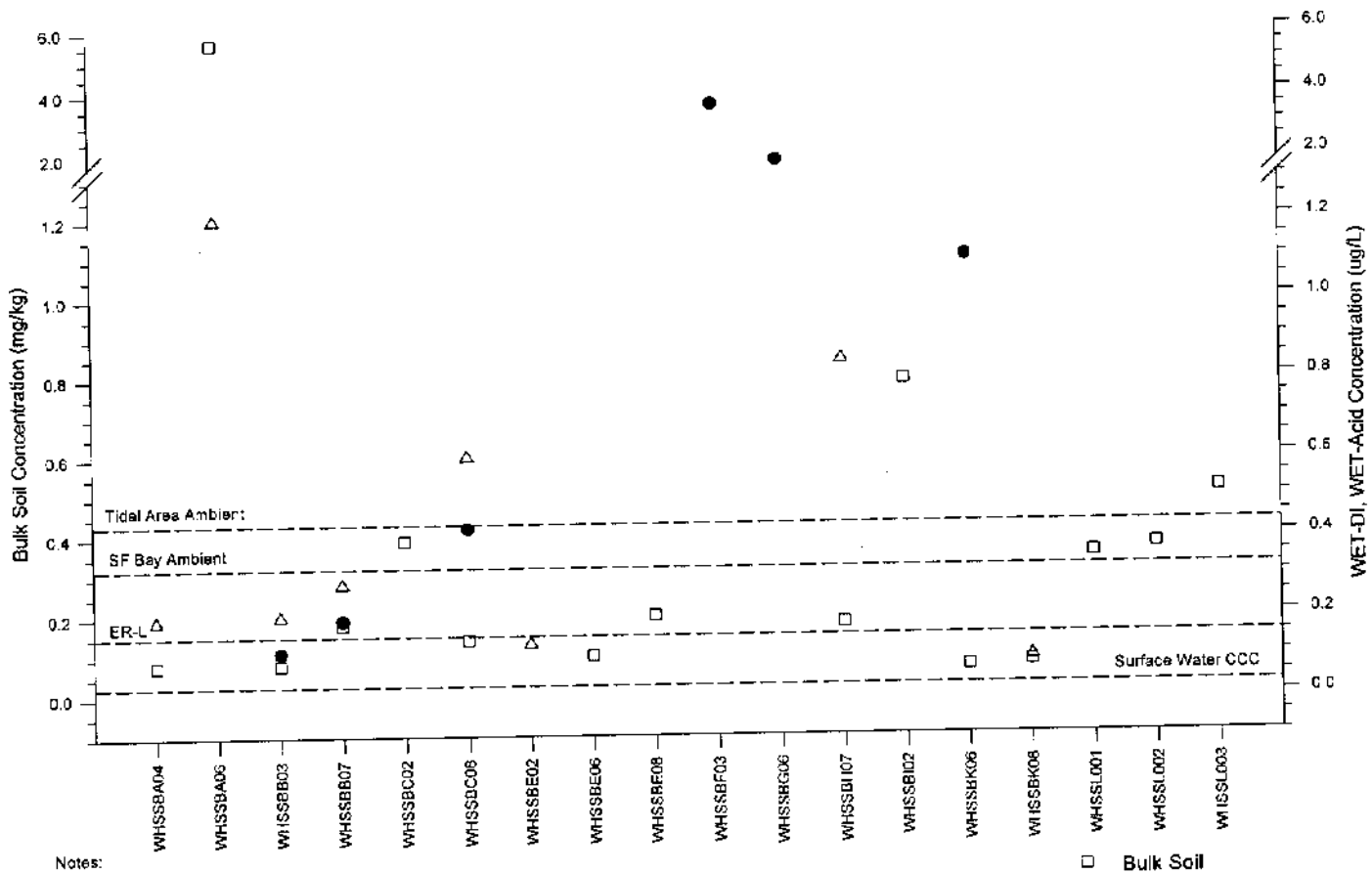


Notes:

SF Bay Ambient = San Francisco Bay ambient (RWQCB 1998)
Surface Water CCC = Criteria continuous concentration (Bay Basin Plan 1986)
Tidal Area Ambient = Calculated using the upper 99 percent upper confidence limit
ER-L = Effects Range Low (Long and others 1995)
CCC value is used for evaluating WET data; ER-L and ambient values are used for evaluating bulk soil data.

Only detected concentrations are shown.

FIGURE 6-25C
MERCURY IN WOOD HOGGER SITE SOIL AND SEDIMENT SAMPLES: BULK CHEMISTRY AND EXTRACTIONS
TIDAL AREA QEA, NWS SBD CONCORD

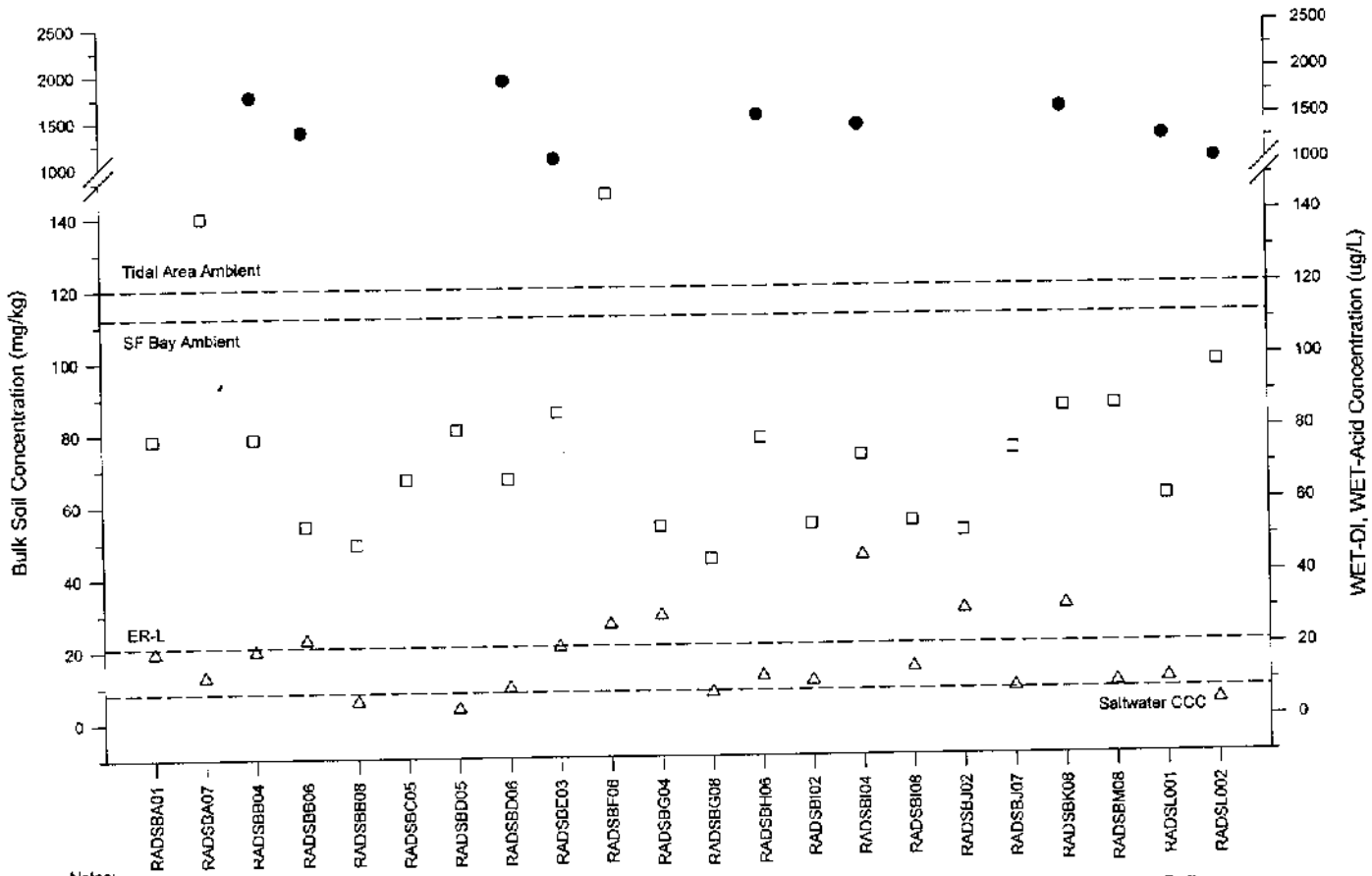


Notes:

SF Bay Ambient = San Francisco Bay ambient (RWQCB 1998)
Surface Water CCC = Criteria continuous concentration (Bay Basin Plan 1988)
Tidal Area Ambient = Calculated using the upper 99 percent upper confidence limit
ER-L = Effects Range Low (Long and others 1995)
CCC value is used for evaluating WET data; ER-L and ambient values are used for evaluating bulk soil data.
WHSSL001, WHSSL002, and WHSSL003 are sediment samples; all others are soil samples.

Only detected concentrations are shown.

FIGURE 6-26A
NICKEL IN R AREA DISPOSAL SITE SOIL AND SEDIMENT SAMPLES: BULK CHEMISTRY AND EXTRACTIONS
TIDAL AREA QEA, NWS SBD CONCORD

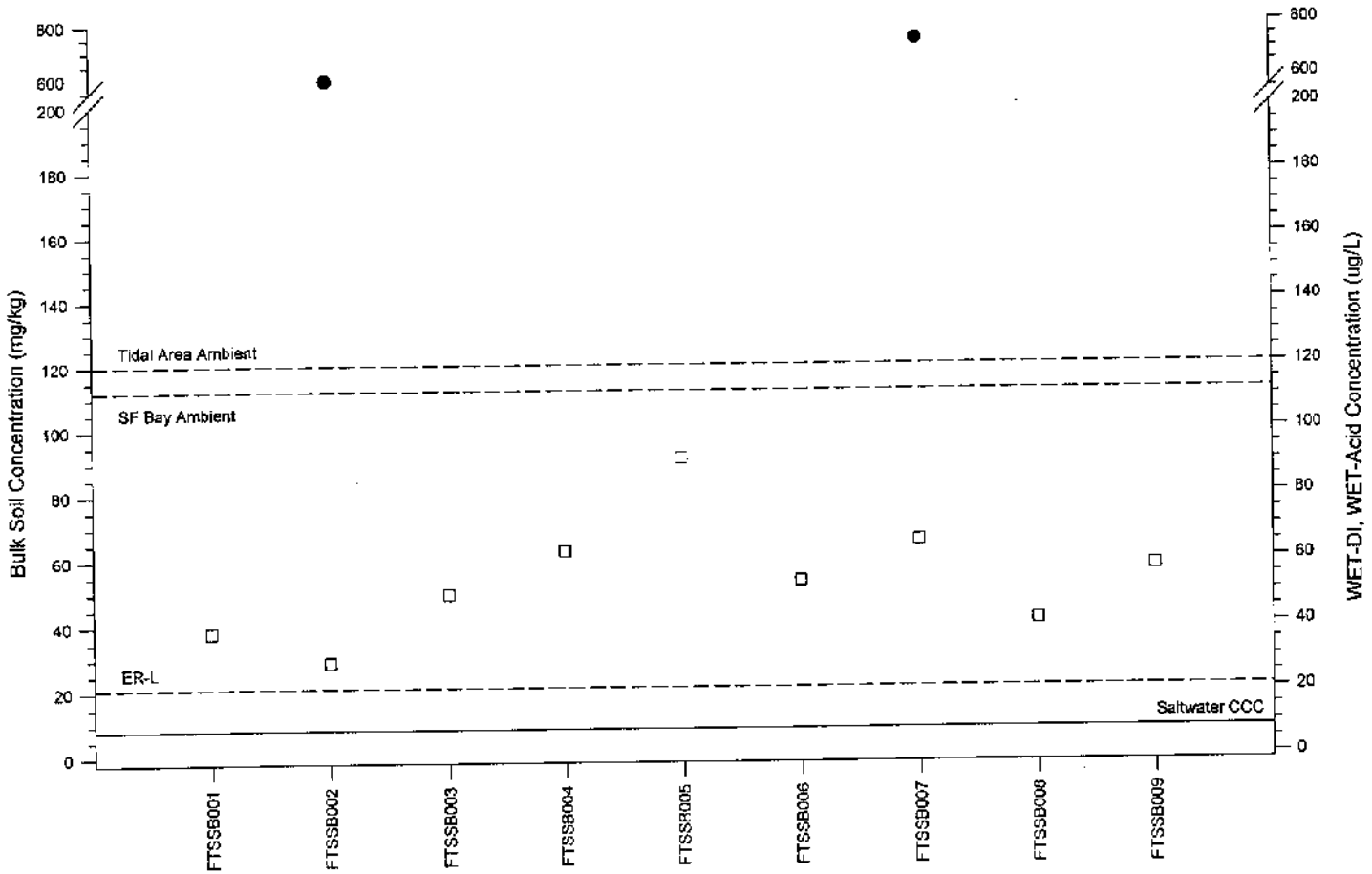


Notes:

SF Bay Ambient = San Francisco Bay ambient (RWQCB 1998)
Saltwater CCC = Criteria continuous concentration (EPA 1998)
Tidal Area Ambient = Calculated using the upper 99 percent upper confidence limit
ER-L = Effects Range Low (Long and others 1995)
CCC value is used for evaluating WET data; ER-L and ambient values are used for evaluating bulk soil data.
RADSL001 and RADSL002 are sediment samples, all others are soil samples.

Only detected concentrations are shown.

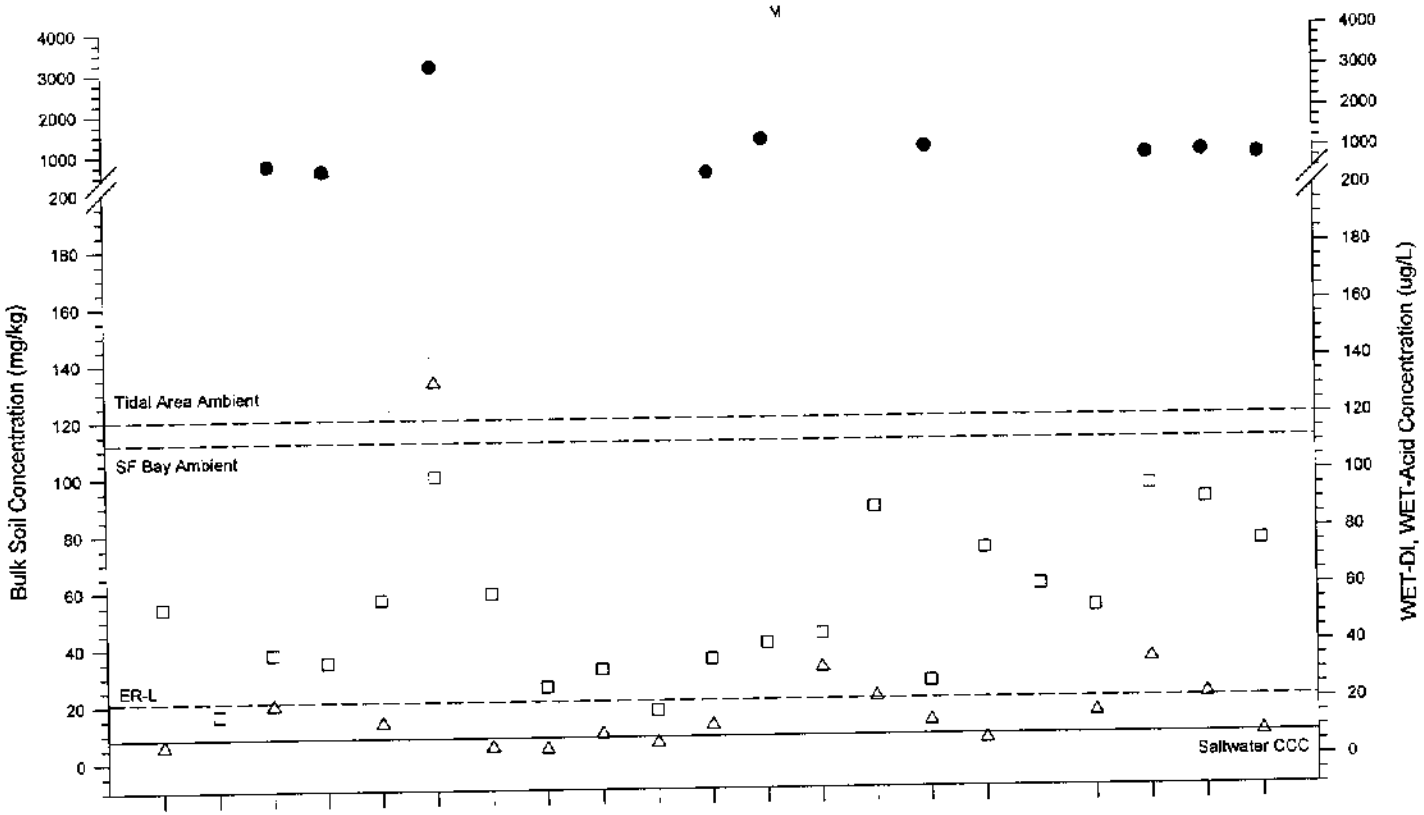
FIGURE 6-26B
NICKEL IN FROID AND TAYLOR ROADS SITE SOIL SAMPLES: BULK CHEMISTRY AND EXTRACTIONS
TIDAL AREA QEA, NWS SBD CONCORD



Notes:
SF Bay Ambient = San Francisco Bay ambient (RWQCB 1998)
Saltwater CCC = Criteria continuous concentration (EPA 1998)
Tidal Area Ambient = Calculated using the upper 99 percent upper confidence limit
ER-L = Effects Range Low (Long and others 1995)
CCC value is used for evaluating WET data; ER-L and ambient values are used for evaluating bulk soil data

Only detected concentrations are shown.

FIGURE 6-26C
NICKEL IN WOOD HOGGER SITE SOIL AND SEDIMENT SAMPLES: BULK CHEMISTRY AND EXTRACTIONS
TIDAL AREA QEA, NWS SBD CONCORD



Notes:

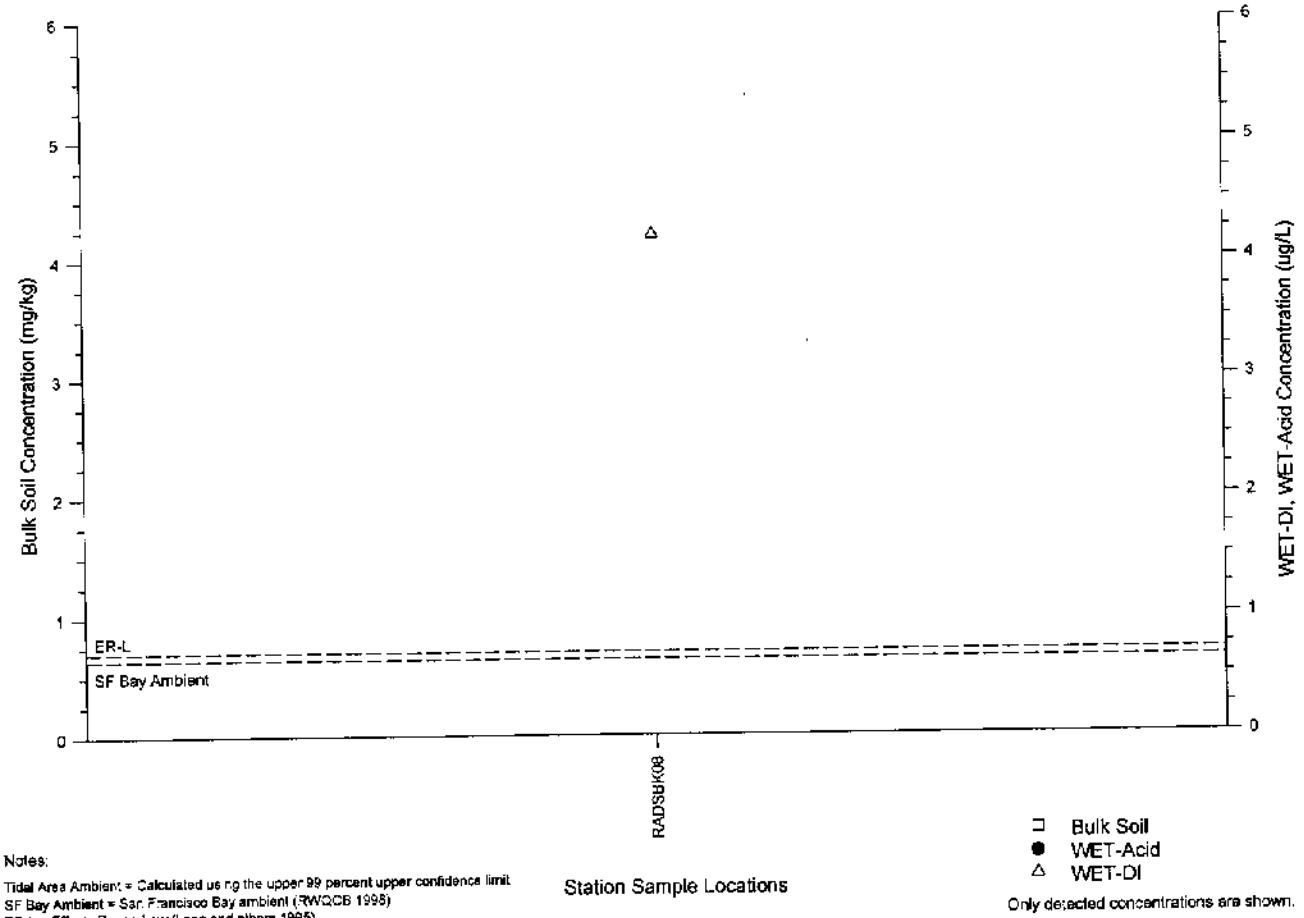
SF Bay Ambient = San Francisco Bay ambient (RWQCB 1998)
Saltwater CCC = Criteria continuous concentration (EPA 1998)
Tidal Area Ambient = Calculated using the upper 95 percent upper confidence limit
ER-L = Effects Range Low (Long and others 1995)
CCC value is used for evaluating WET data; ER-L and ambient values are used for evaluating bulk soil data
WHSSL001, WHSSL002, and WHSSL003 are sediment samples; all others are soil samples.

Station Sample Locations

- □ Bulk Soil
- ● WET-Acid
- △ WET-DI

Only detected concentrations are shown.

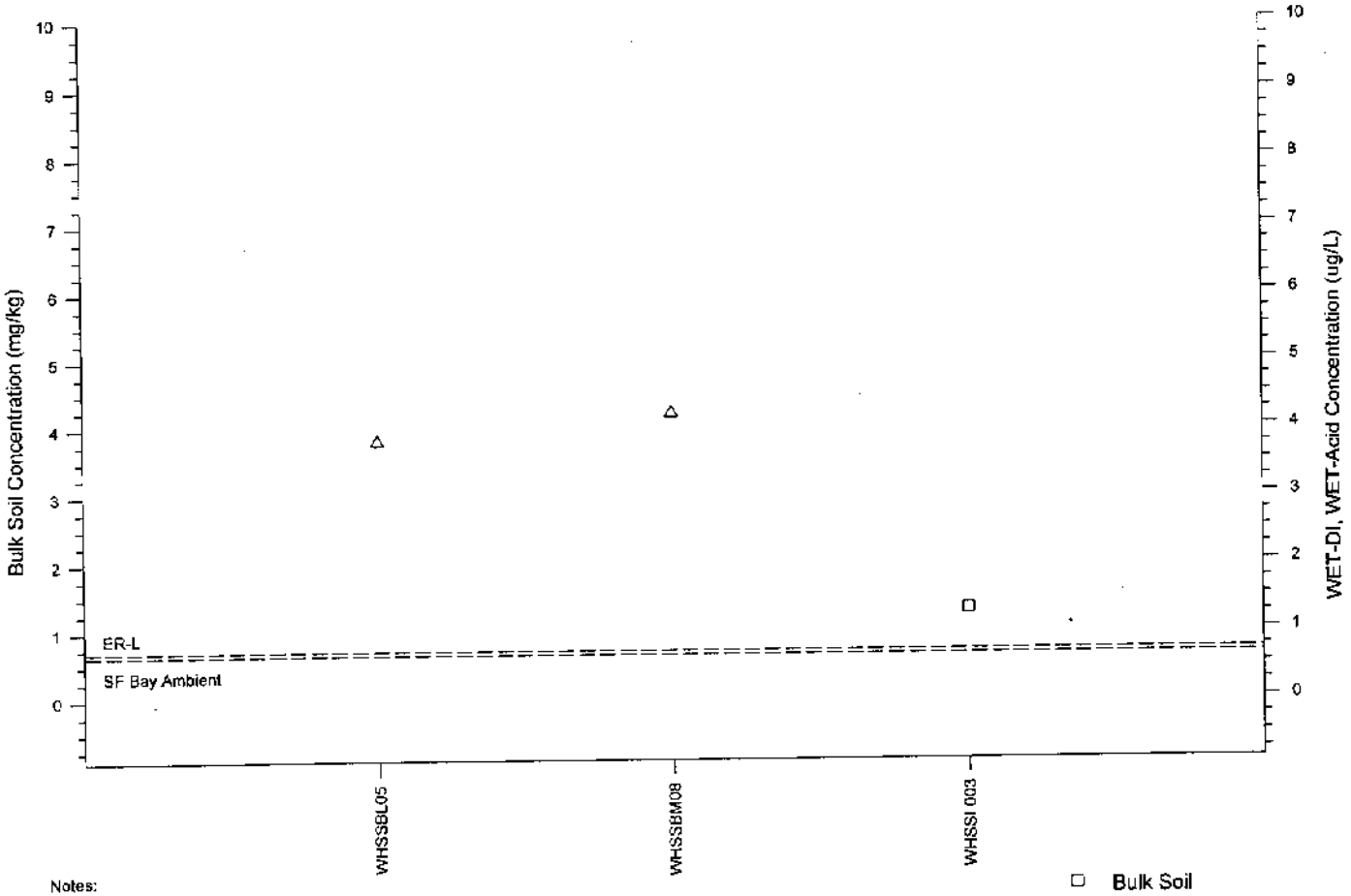
FIGURE 6-27A
SELENIUM IN R AREA DISPOSAL SITE SOIL AND SEDIMENT SAMPLES: BULK CHEMISTRY AND EXTRACTIONS
TIDAL AREA QEA, NWS SBD CONCORD



Notes:

Tidal Area Ambient = Calculated using the upper 99 percent upper confidence limit
SF Bay Ambient = San Francisco Bay ambient (RWQCB 1998)
ER-L = Effects Range Low (Long and others 1995)
ER-L and ambient values are used for evaluating bulk soil data.

FIGURE 6-27B
SELENIUM IN FROID AND TAYLOR ROADS SITE SOIL SAMPLES: BULK CHEMISTRY AND EXTRACTIONS
TIDAL AREA QEA, NWS SBD CONCORD

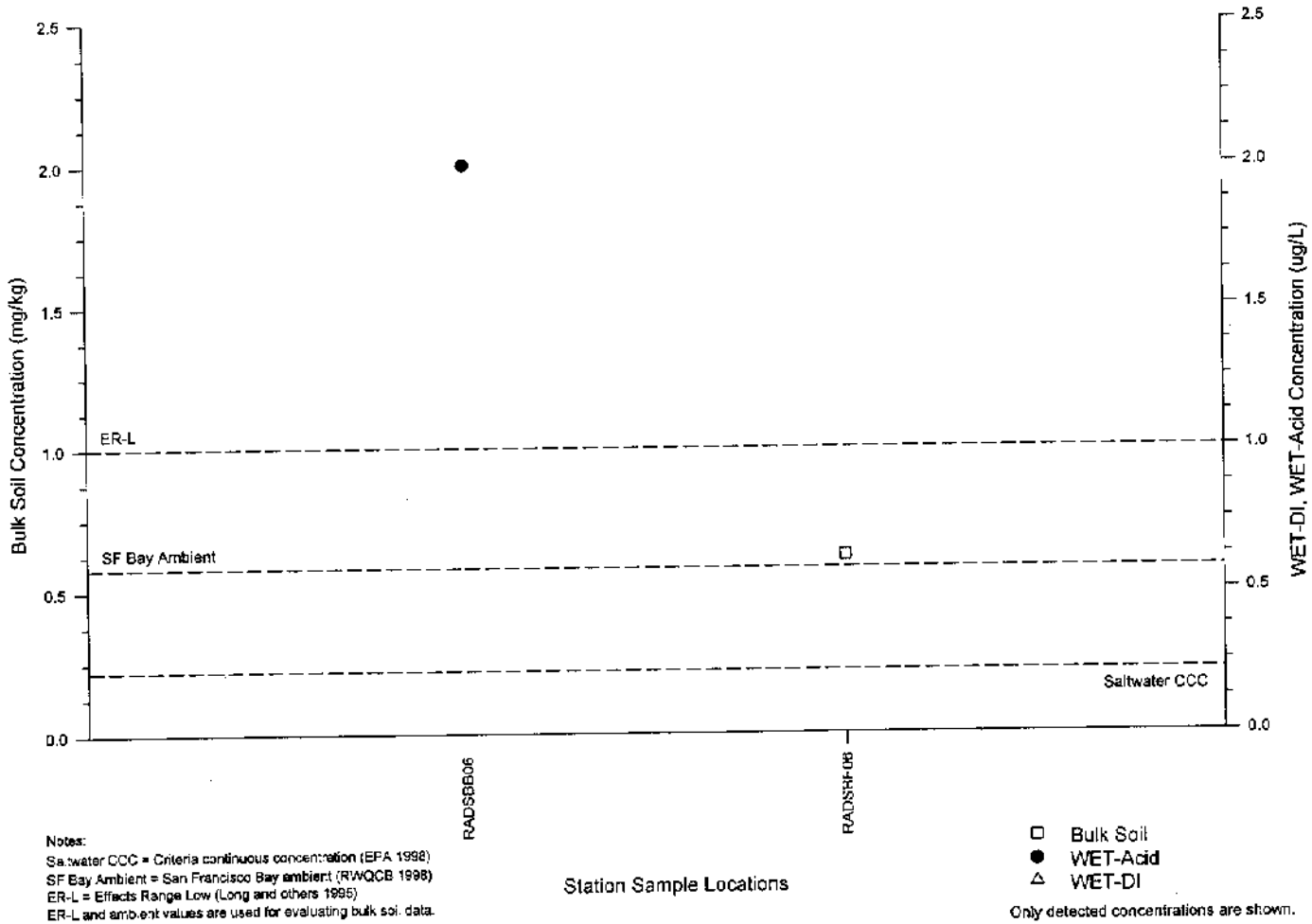


Notes:

SF Bay Ambient = San Francisco Bay ambient (RWQCB 1998)
Tidal Area Ambient = Calculated using the upper 99 percent upper confidence limit
ER-L = Effects Range Low (Long and others 1995)
ER-L and ambient values are used for evaluating bulk soil data.
WHSSL003 is a sediment sample: all others are soil samples.

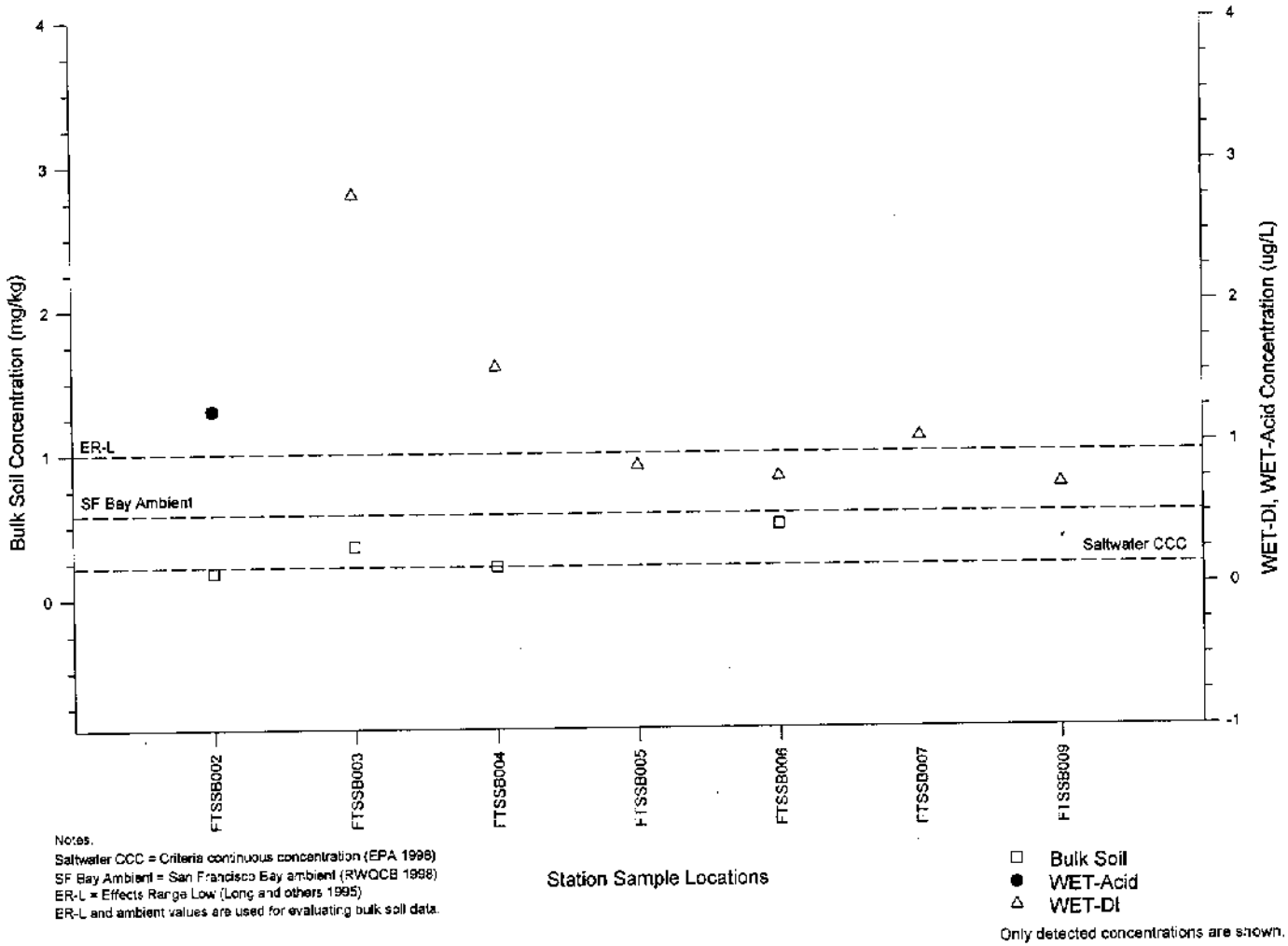
Only detected concentrations are shown.

FIGURE 6-28A
SILVER IN R AREA DISPOSAL SITE SOIL AND SEDIMENT SAMPLES: BULK CHEMISTRY AND EXTRACTIONS
TIDAL AREA QEA, NWS SBD CONCORD



Notes:
Saltwater CCC = Criteria continuous concentration (EPA 1998)
SF Bay Ambient = San Francisco Bay ambient (RWQCB 1998)
ER-L = Effects Range Low (Long and others 1995)
ER-L and ambient values are used for evaluating bulk soil data.

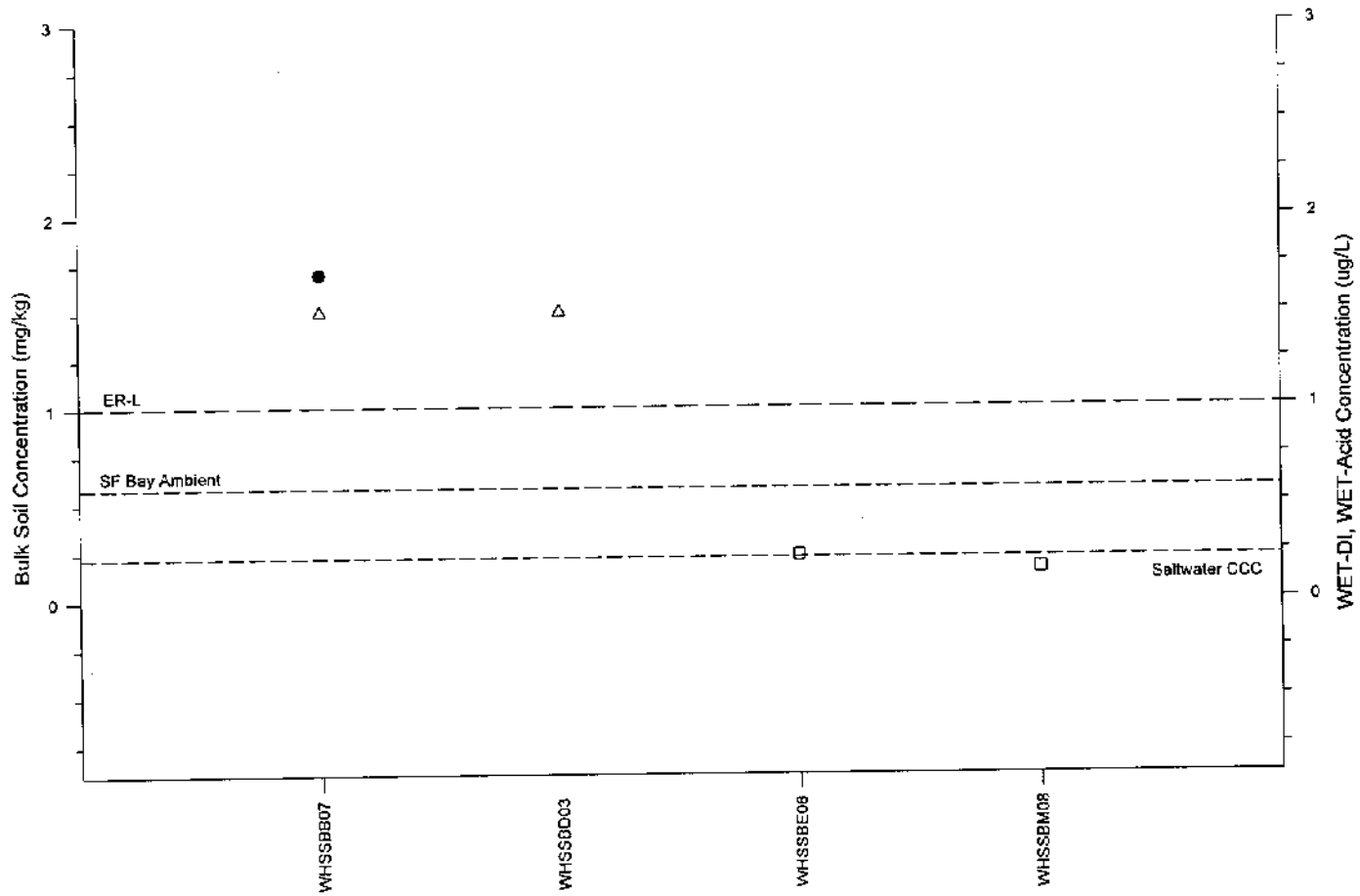
FIGURE 6-28B
SILVER IN FROID AND TAYLOR ROADS SITE SOIL SAMPLES: BULK CHEMISTRY AND EXTRACTIONS
TIDAL AREA QEA, NWS SBD CONCORD



Notes:
Saltwater CCC = Criteria continuous concentration (EPA 1998)
SF Bay Ambient = San Francisco Bay ambient (RWQCB 1998)
ER-L = Effects Range Low (Long and others 1995)
ER-L and ambient values are used for evaluating bulk soil data.

Only detected concentrations are shown.

FIGURE 6-28C
SILVER IN WOOD HOGGER SITE SOIL AND SEDIMENT SAMPLES: BULK CHEMISTRY AND EXTRACTIONS
TIDAL AREA QEA, NWS SBD CONCORD

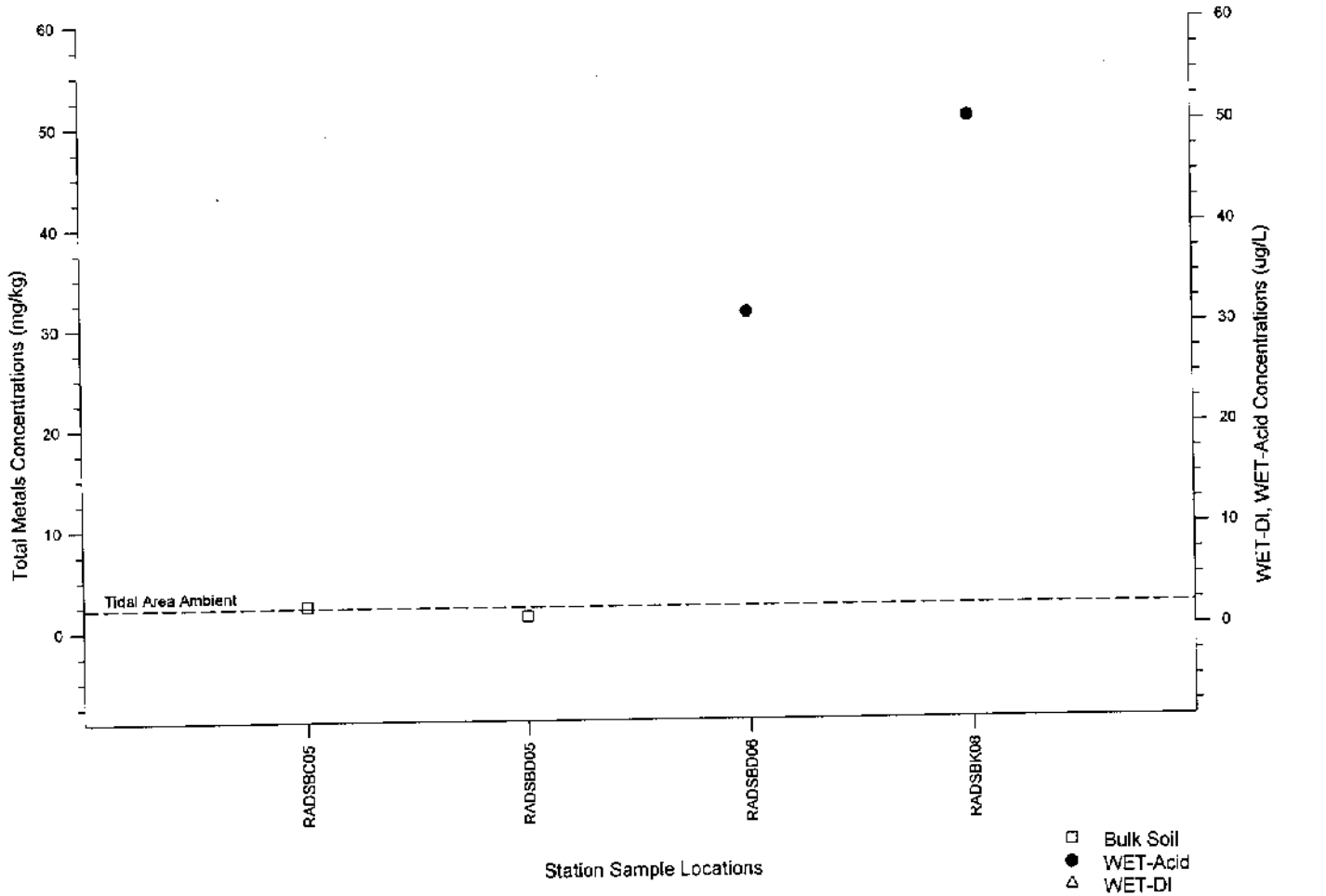


Notes:
Saltwater CCC = Criteria continuous concentration (EPA 1998)
SF Bay Ambient = San Francisco Bay ambient (RWQCB 1998)
ER-L = Effects Range Low (Long and others 1995)
ER-L and ambient values are used for evaluating bulk soil data.

□ Bulk Soil
● WET-Acid
△ WET-DI

Only detected concentrations are shown.

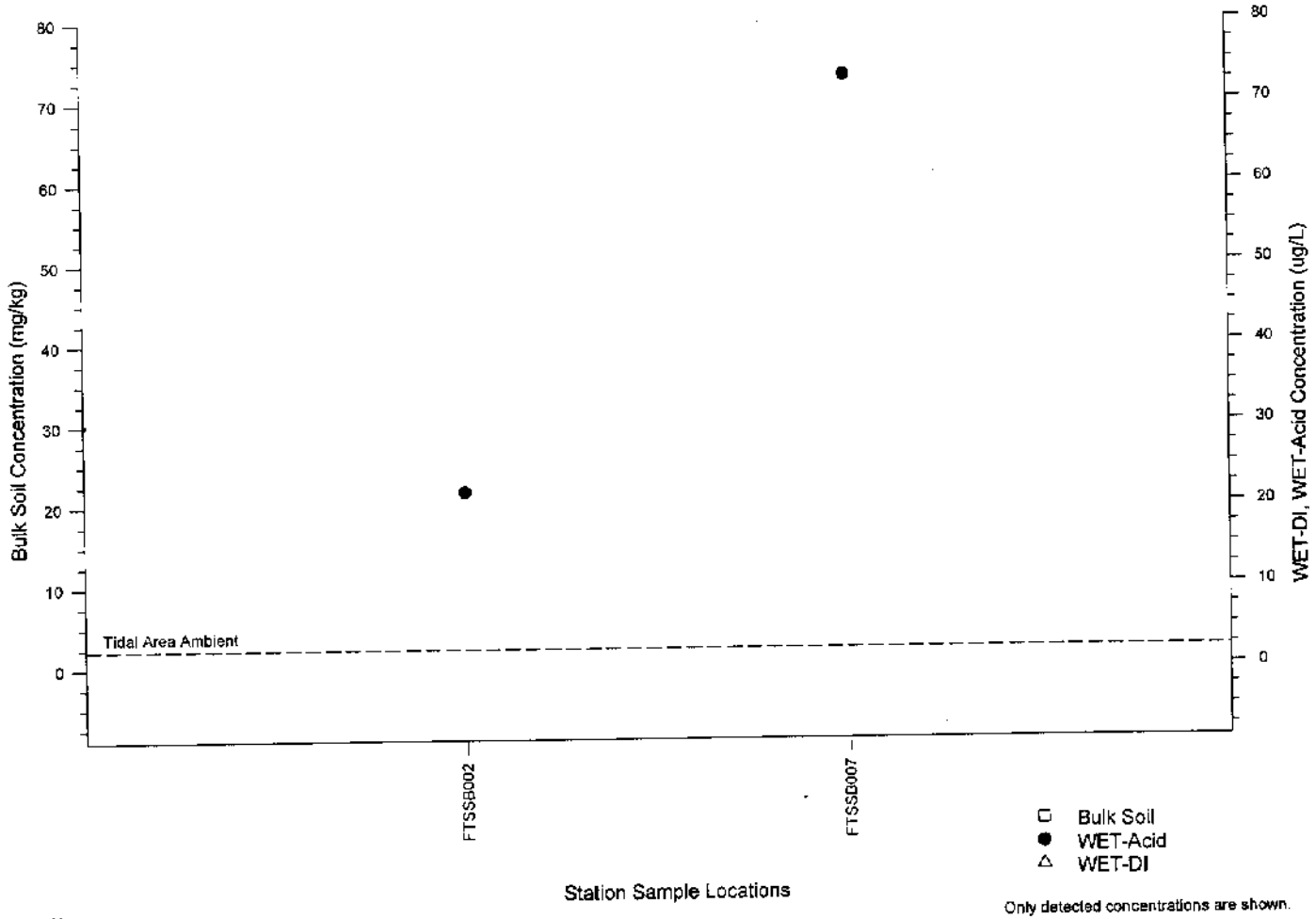
FIGURE 6-29A
THALLIUM IN R AREA DISPOSAL SITE SOIL AND SEDIMENT SAMPLES: BULK CHEMISTRY AND EXTRACTIONS
TIDAL AREA QEA, NWS SBD CONCORD



Note:
Tidal Area Ambient = Calculated using the upper 99 percent upper confidence limit

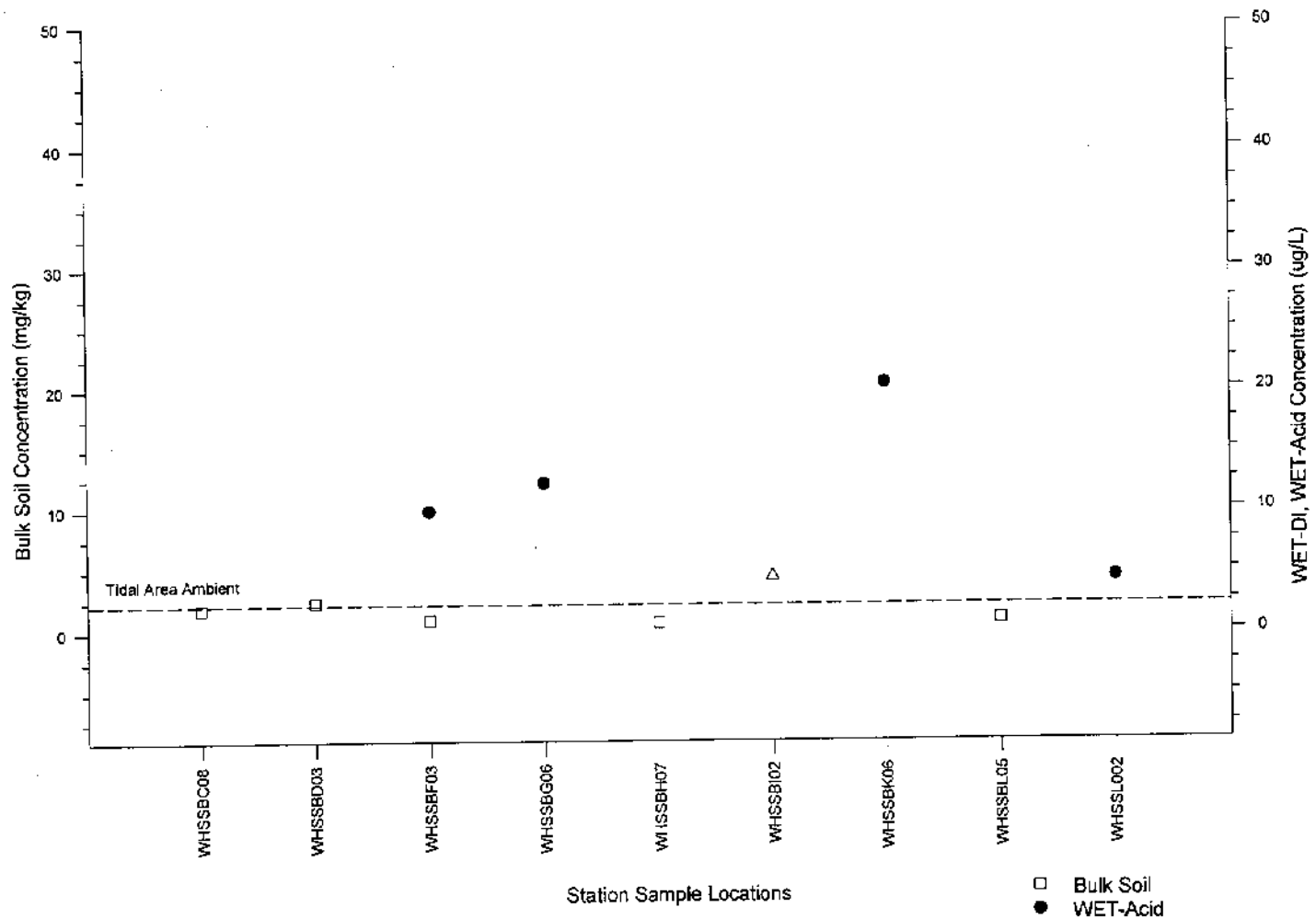
Only detected concentrations are shown.

FIGURE 6-29B
THALLIUM IN FROID AND TAYLOR ROADS SITE SOIL SAMPLES: BULK CHEMISTRY AND EXTRACTIONS
TIDAL AREA QEA, NWS SBD CONCORD



Note:
Tidal Area Ambient = Calculated using the upper 99 percent upper confidence limit

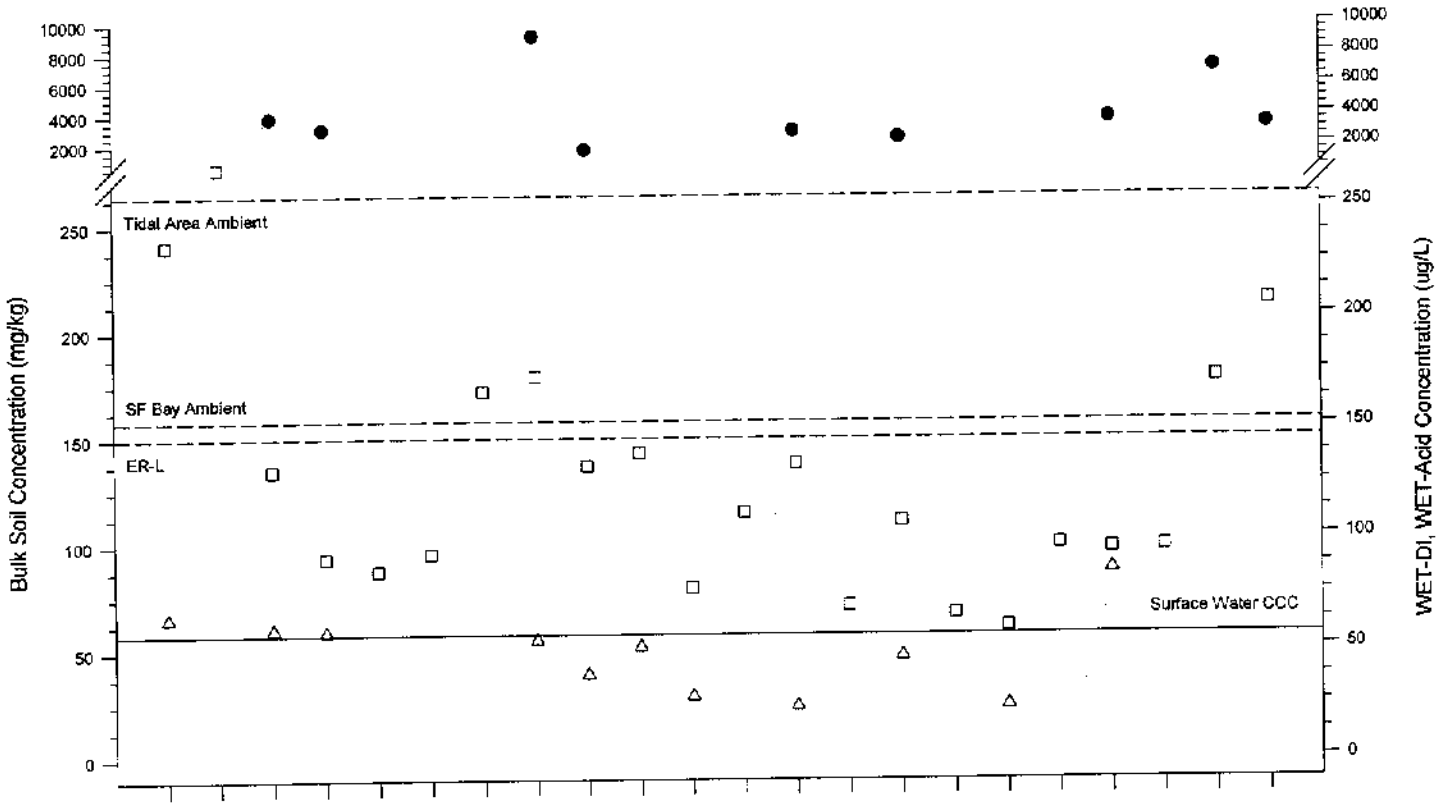
FIGURE 6-29C
THALLIUM IN WOOD HOGGER SITE SOIL AND SEDIMENT SAMPLES: BULK CHEMISTRY AND EXTRACTIONS
TIDAL AREA QEA, NWS SBD CONCORD



Note:
Tidal Area Ambient = Calculated using the upper 99 percent upper confidence lim :
WHSSL002 is a sediment sample; all others are soil samples.

Only detected concentrations are shown.

FIGURE 6-30A
ZINC IN R AREA DISPOSAL SITE SOIL AND SEDIMENT SAMPLES: BULK CHEMISTRY AND EXTRACTIONS
TIDAL AREA QEA, NWS SBD CONCORD



Notes.

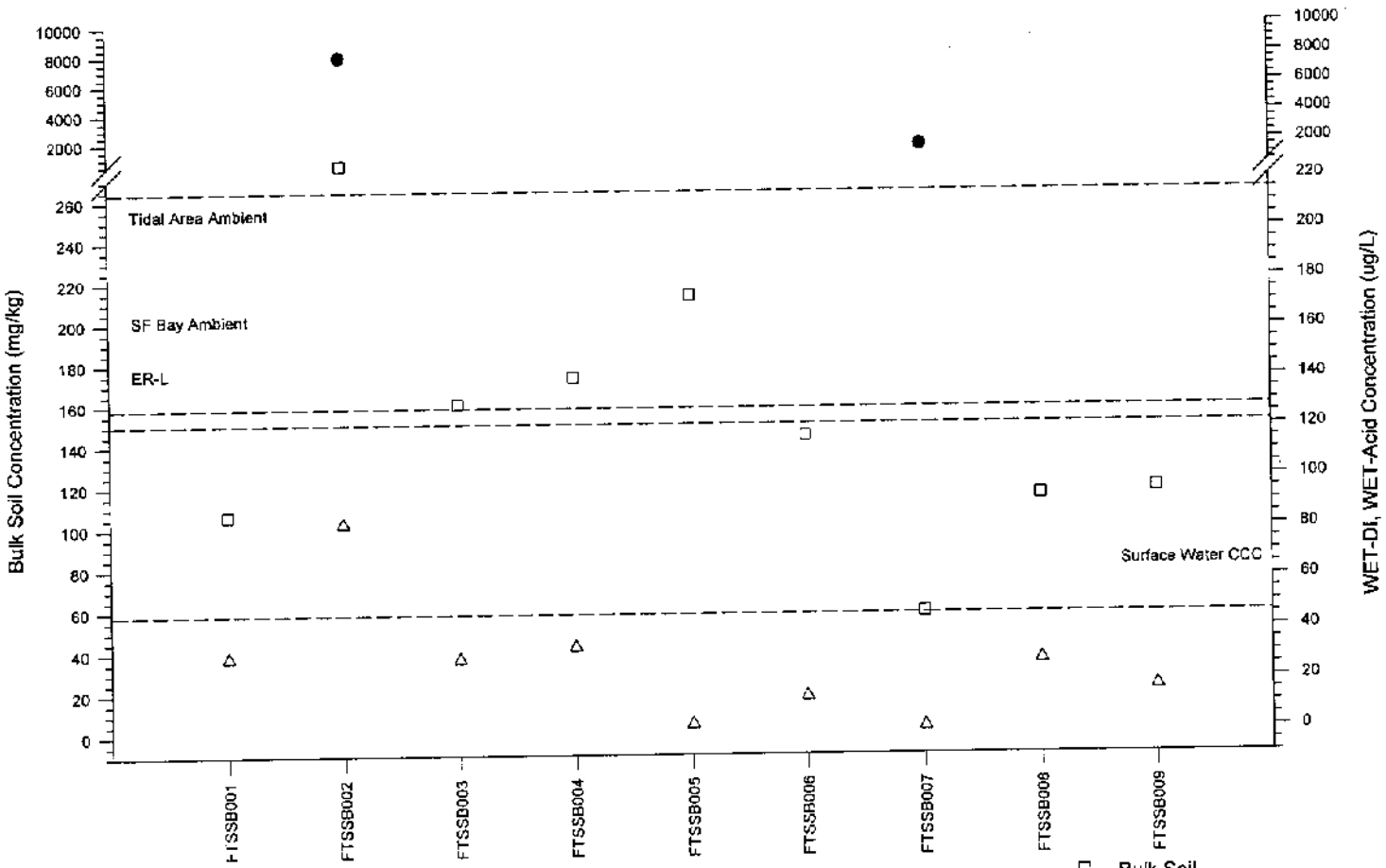
SF Bay Ambient = San Francisco Bay ambient (RWQCB 1998)
Surface Water CCC = Criteria continuous concentration (Bay Basin Plan 1986)
Tidal Area Ambient = Calculated using the upper 99 percent upper confidence limit
ER-L = Effects Range Low (Long and others 1995)
CCC value is used for evaluating WET data; ER-L and ambient values are used for evaluating bulk soil data.
RADSL001 and RADSL002 are sediment samples; all others are soil samples.

Station Sample Locations

- □ Bulk Soil
- ● WET-Acid
- △ WET-DI

Only detected concentrations are shown.

FIGURE 6-30B
ZINC IN FROID AND TAYLOR ROADS SITE SOIL SAMPLES: BULK CHEMISTRY AND EXTRACTIONS
TIDAL AREA QEA, NWS SBD CONCORD

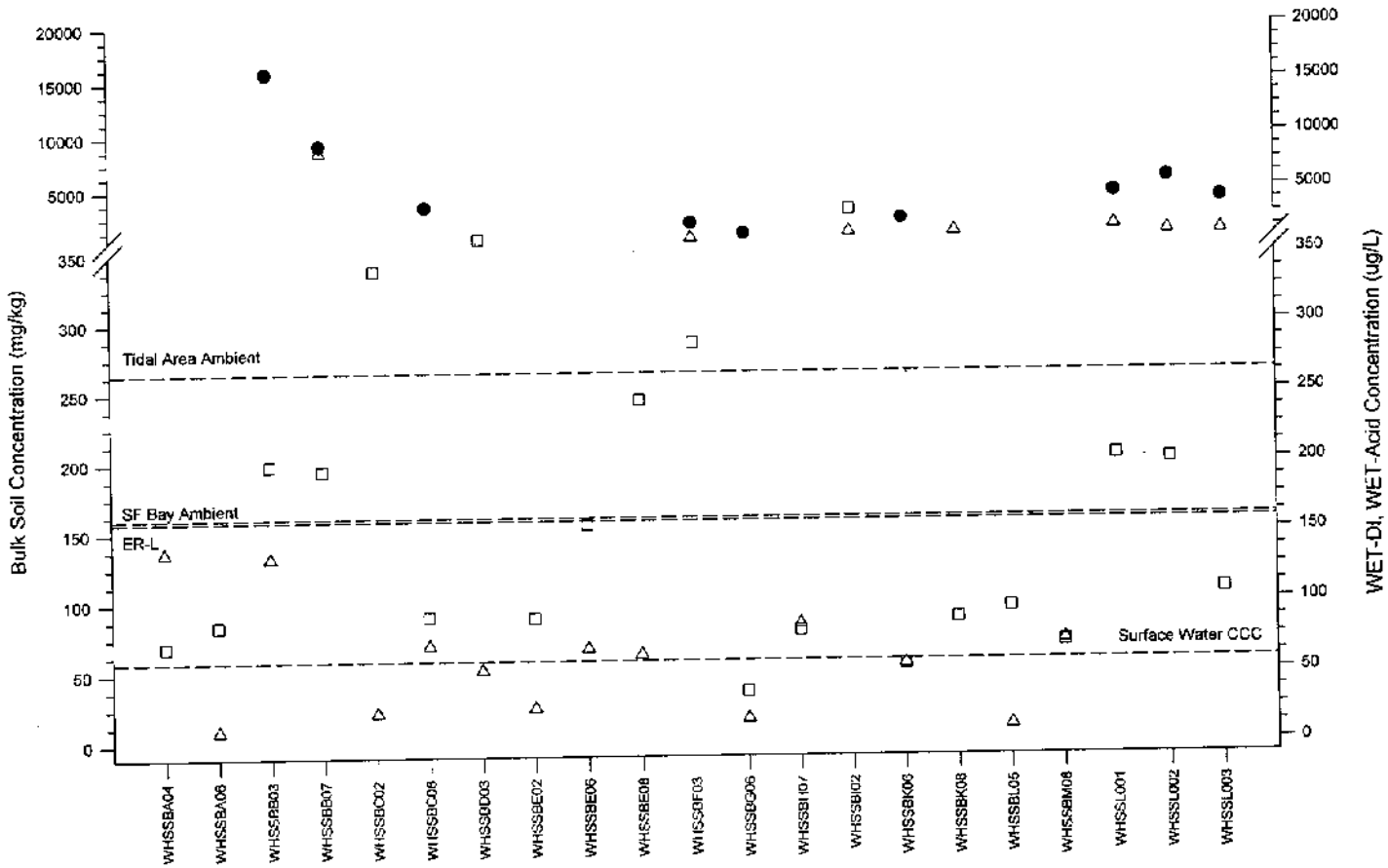


Notes:

SF Bay Ambient = San Francisco Bay ambient (RWQCB 1998)
Surface Water CCC = Criteria continuous concentration (Bay Basin Plan 1986)
Tidal Area Ambient = Calculated using the upper 99 percent upper confidence limit
ER-L = Effects Range Low (Long and others 1995)
CCC value is used for evaluating WET data; ER-L and ambient values are used for evaluating bulk soil data

Only detected concentrations are shown.

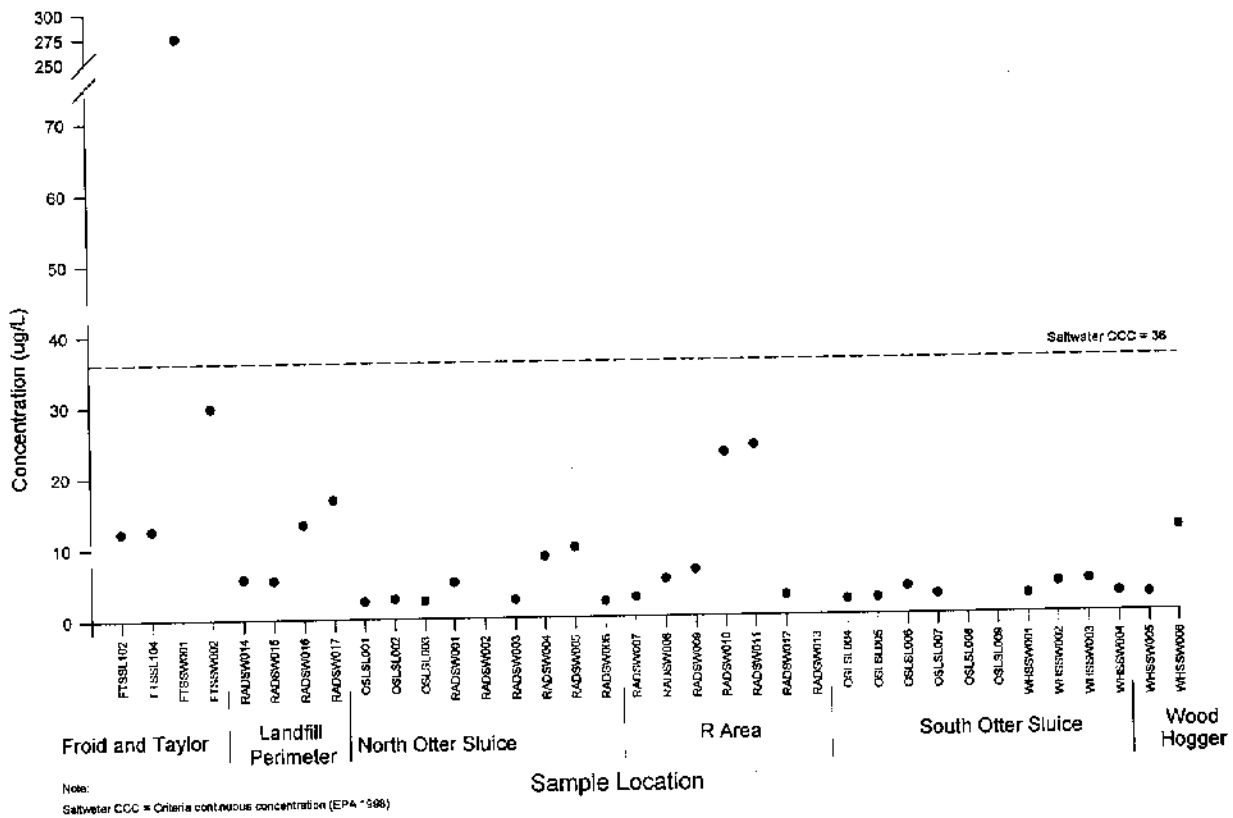
FIGURE 6-30C
ZINC IN WOOD HOGGER SITE SOIL AND SEDIMENT SAMPLES: BULK CHEMISTRY AND EXTRACTIONS
TIDAL AREA QEA, NWS SBD CONCORD



Notes:

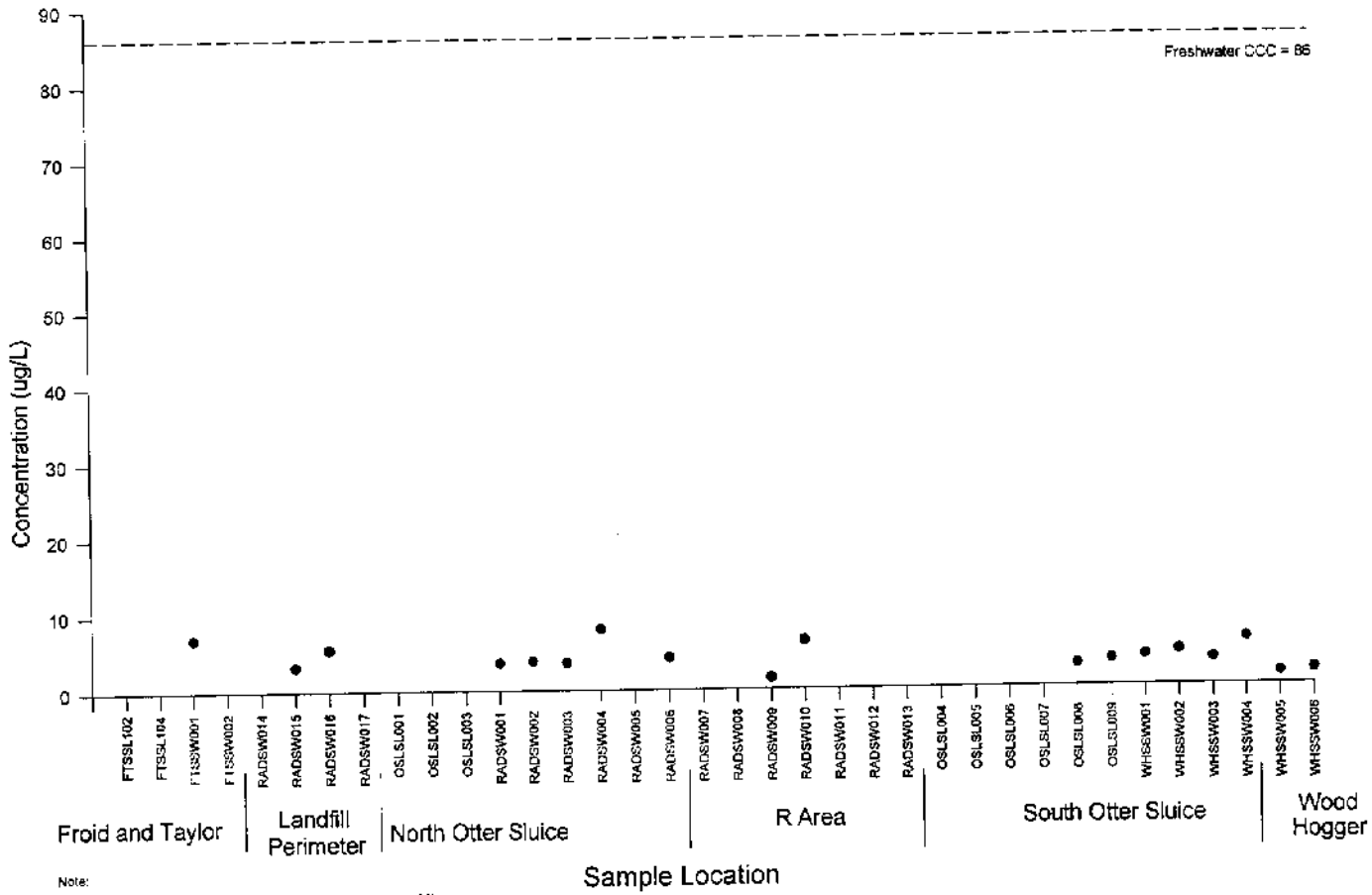
SF Bay Ambient = San Francisco Bay ambient (RWQCB 1998)
Surface Water CCC = Criteria continuous concentration (Bay Basin Plan 1986)
Tidal Area Ambient = Calculated using the upper 99 percent upper confidence limit
ER-L = Effects Range Low (Long and others 1995)
CCC value is used for evaluating WET data; ER-L and ambient values are used for evaluating bulk soil data.

FIGURE 6-31
DETECTED CONCENTRATIONS OF ARSENIC IN SURFACE WATER
TIDAL AREA QEA, NWS SBD CONCORD



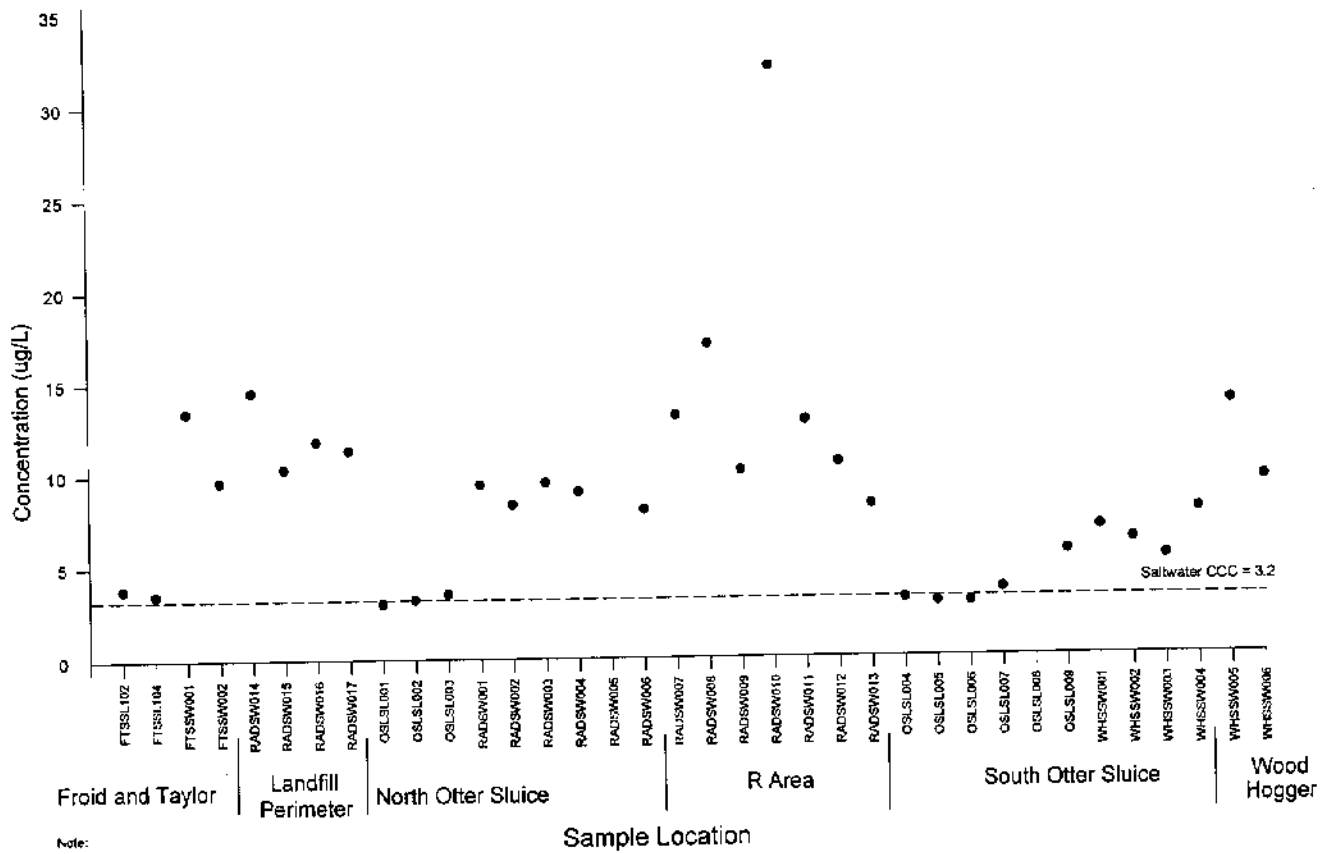
Note:
Saltwater CCC = Criteria continuous concentration (EPA 1998)

FIGURE 6-32
DETECTED CONCENTRATIONS OF CHROMIUM IN SURFACE WATER
TIDAL AREA QEA, NWS SBD CONCORD



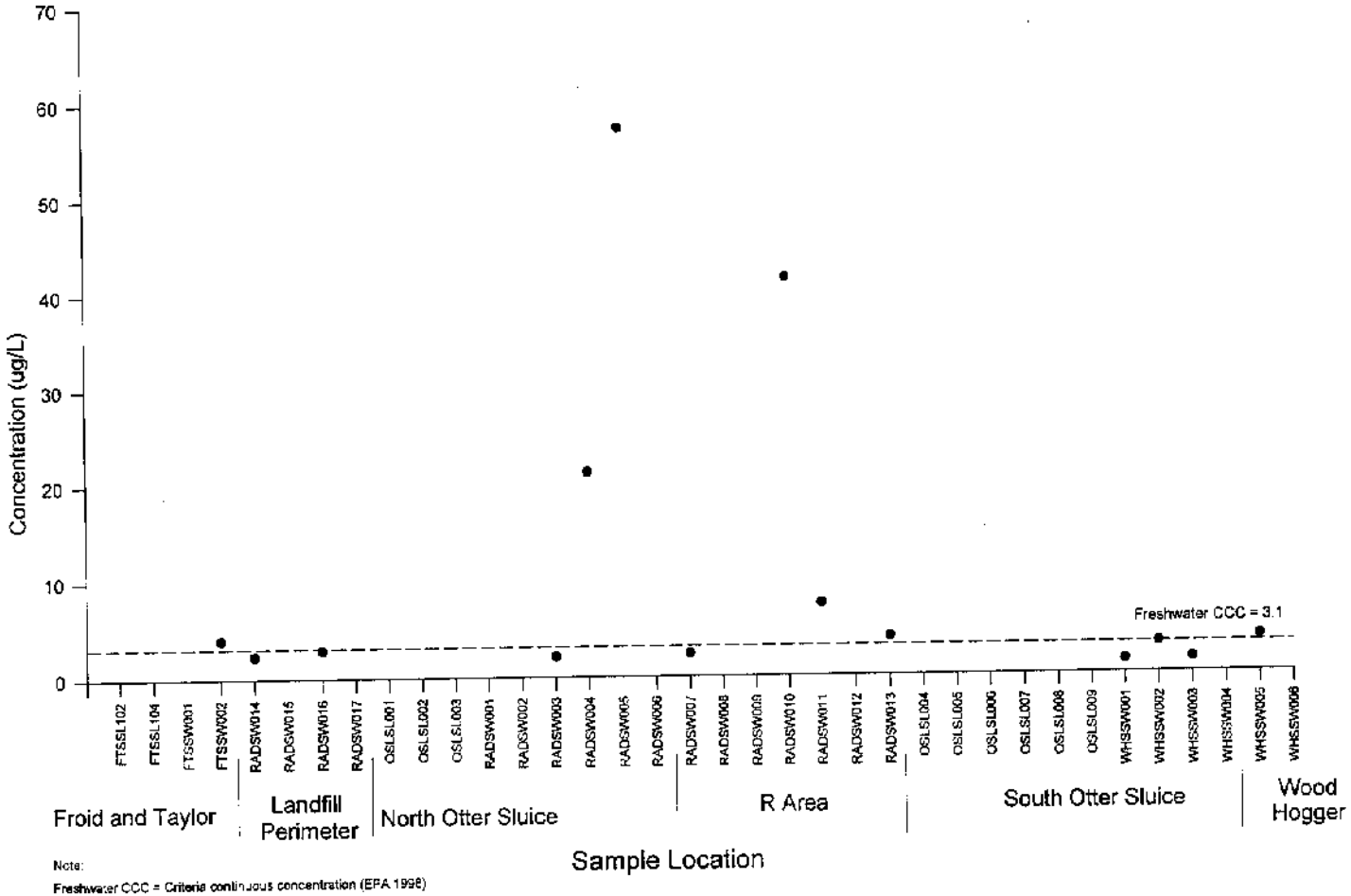
Note:
Freshwater CCC = Criteria continuous concentration (EPA 1998)

FIGURE 6-33
DETECTED CONCENTRATIONS OF COPPER IN SURFACE WATER
TIDAL AREA QEA, NWS SBD CONCORD



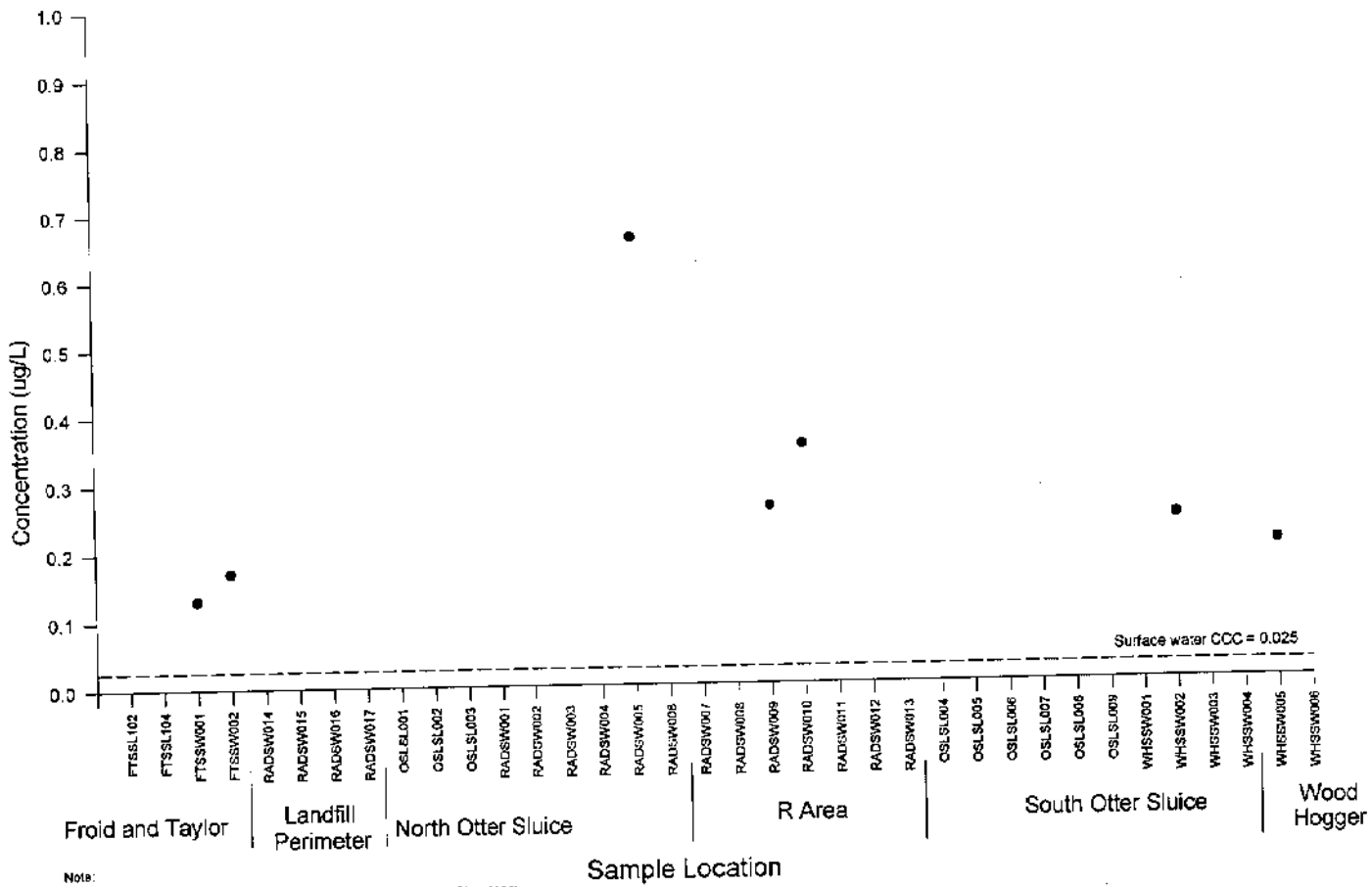
Note:
Saltwater CCC = Criteria continuous concentration (EPA 1995)

FIGURE 6-34
DETECTED CONCENTRATIONS OF LEAD IN SURFACE WATER
TIDAL AREA QEA, NWS SBD CONCORD



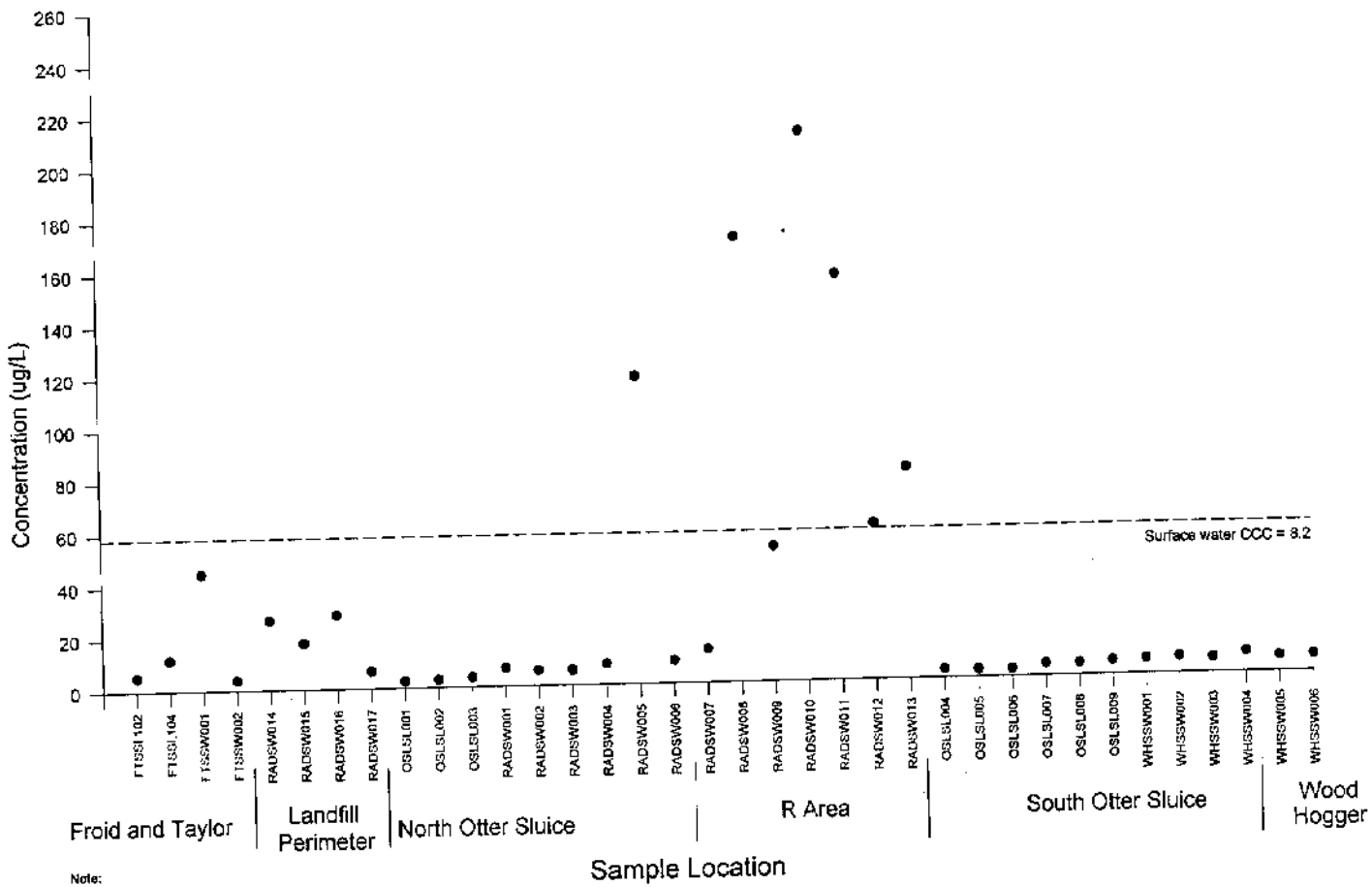
Note:
Freshwater CCC = Criteria continuous concentration (EPA 1998)

FIGURE 6-35
DETECTED CONCENTRATIONS OF MERCURY IN SURFACE WATER
TIDAL AREA QEA, NWS SBD CONCORD



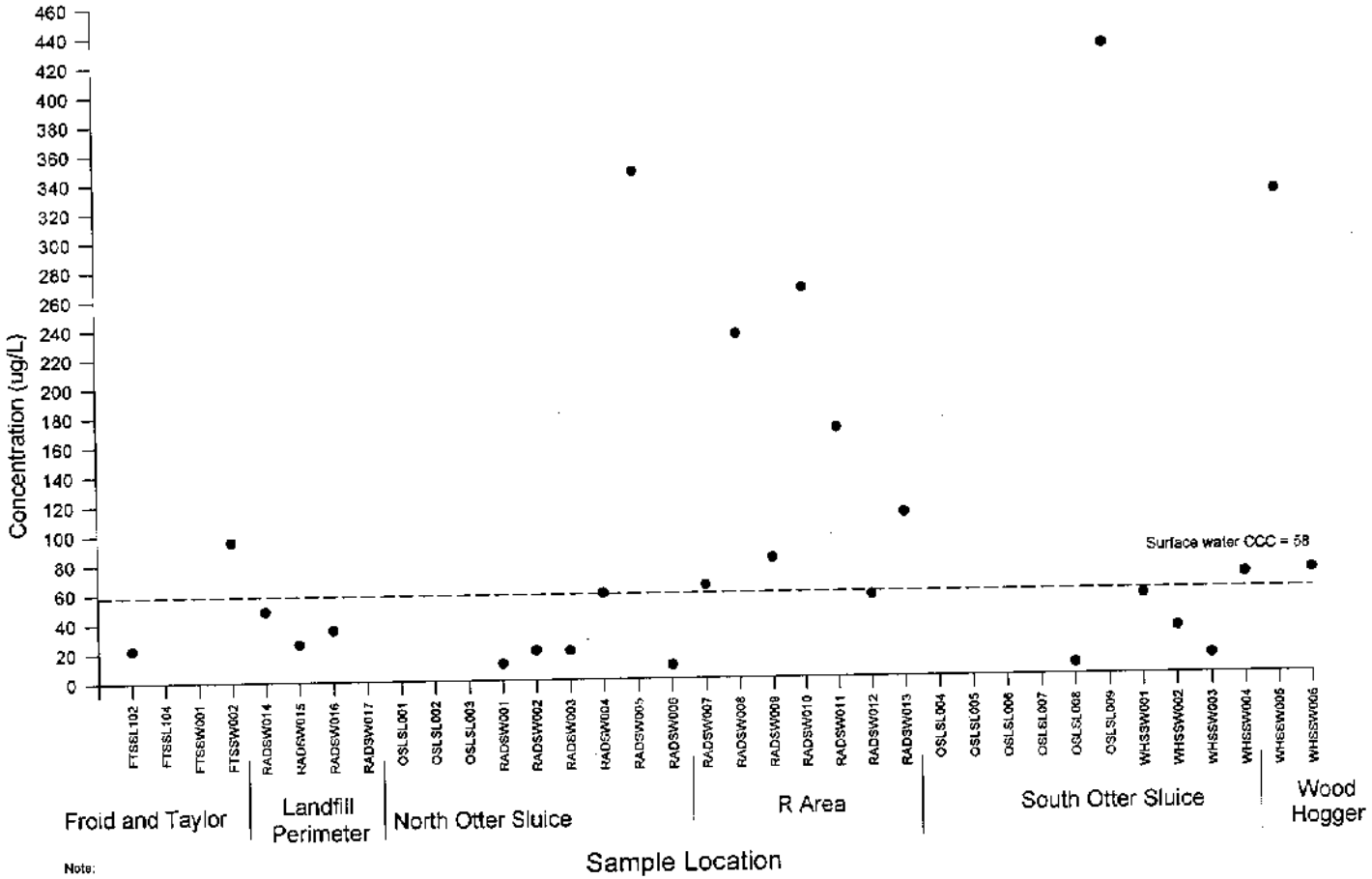
Note:
Surface water CCC = Criteria continuous concentration (Bay Basin Plan 1986)

FIGURE 6-36
DETECTED CONCENTRATIONS OF NICKEL IN SURFACE WATER
TIDAL AREA QEA, NWS SBD CONCORD



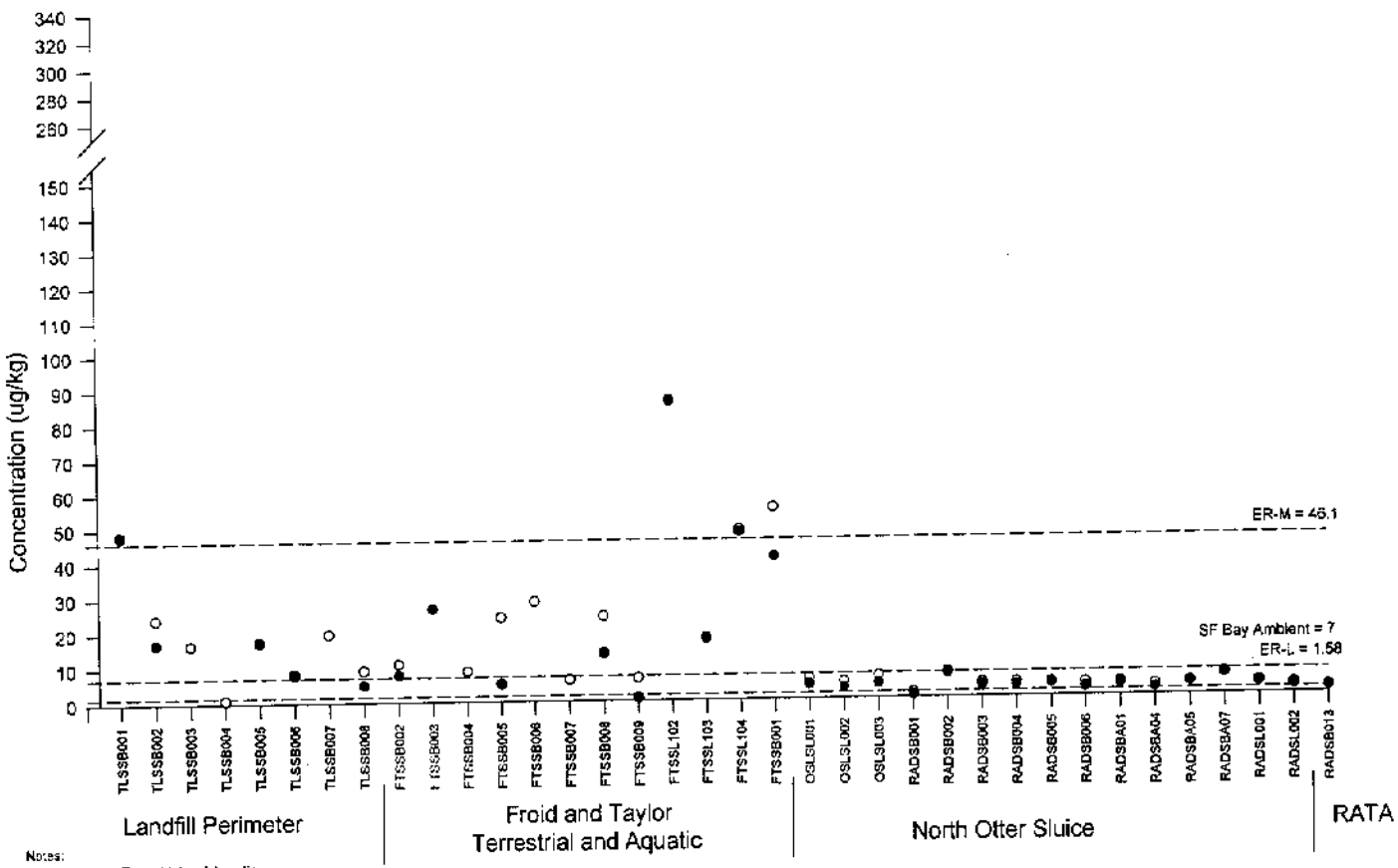
Note:
Surface water CCC = Criteria continuous concentration (Bay Basin Plan 1995)

FIGURE 6-37
DETECTED CONCENTRATIONS OF ZINC IN SURFACE WATER
TIDAL AREA QEA, NWS SBD CONCORD



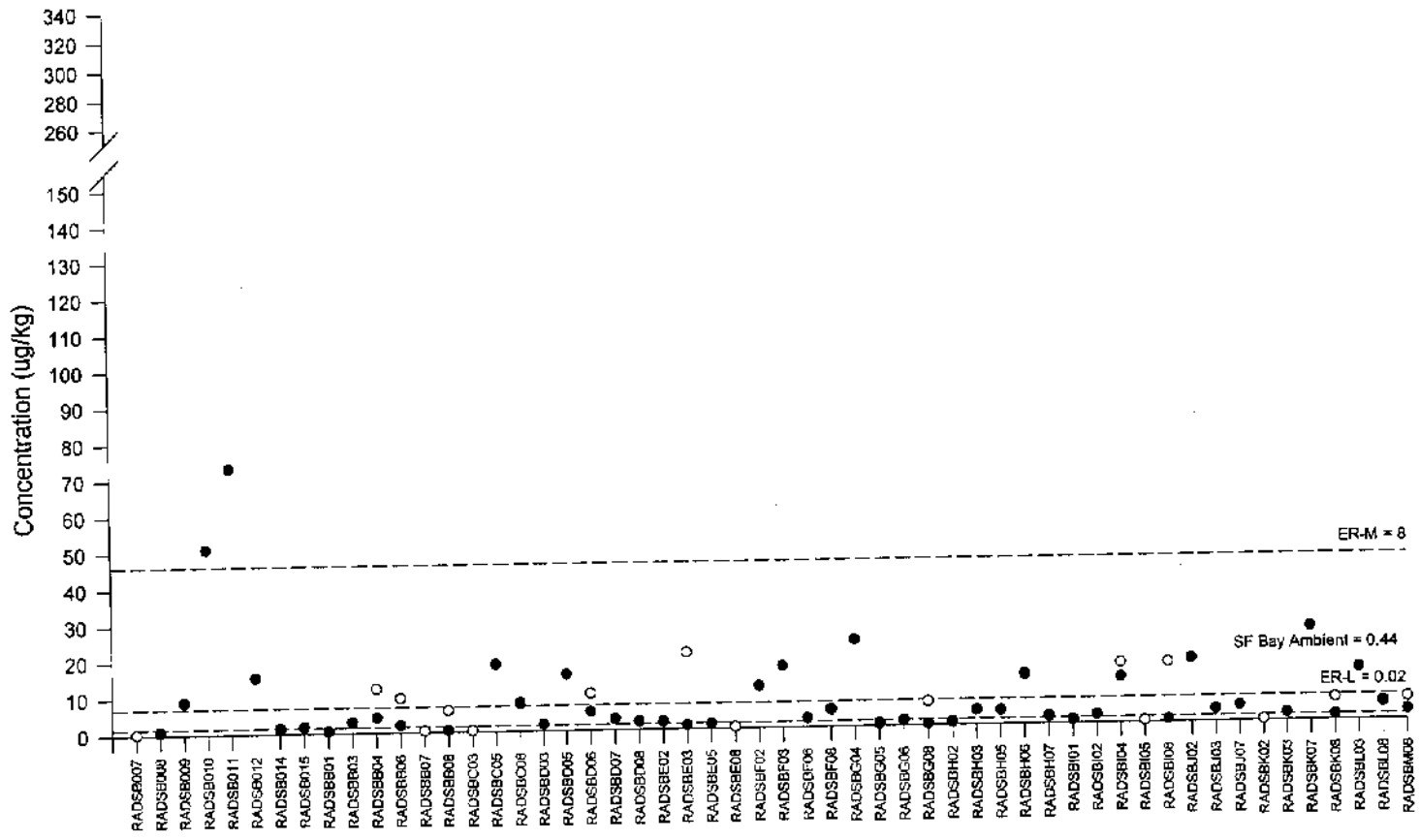
Note:
Surface water CCC = Criteria continuous concentration (Bay Basin Plan 1986)

FIGURE 6-38A
DETECTED CONCENTRATIONS OF TOTAL DDTs IN THE LANDFILL PERIMETER TERRESTRIAL, FROID AND TAYLOR TERRESTRIAL, FROID AND TAYLOR AQUATIC, NORTH OTTER SLUICE AQUATIC, AND R AREA TERRESTRIAL AND AQUATIC UNITS, SOIL AND SEDIMENT TIDAL AREA QEA, NWS SBD CONCORD



Notes:
RATA = R Area Terrestrial and Aquatic
Tidal Area Ambient = Calculated using the 99 percent upper confidence limit
ER-M = Effects range median (Long and others 1995)
ER-L = Effects range low (Long and others 1995)
SF Bay Ambient = San Francisco Bay ambient value (RWQCB 1998)

FIGURE 6-38B
DETECTED CONCENTRATIONS OF TOTAL DDTs IN R AREA TERRESTRIAL UNIT, SOIL AND SEDIMENT TIDAL AREA QEA, NWS SBD CONCORD



Notes:

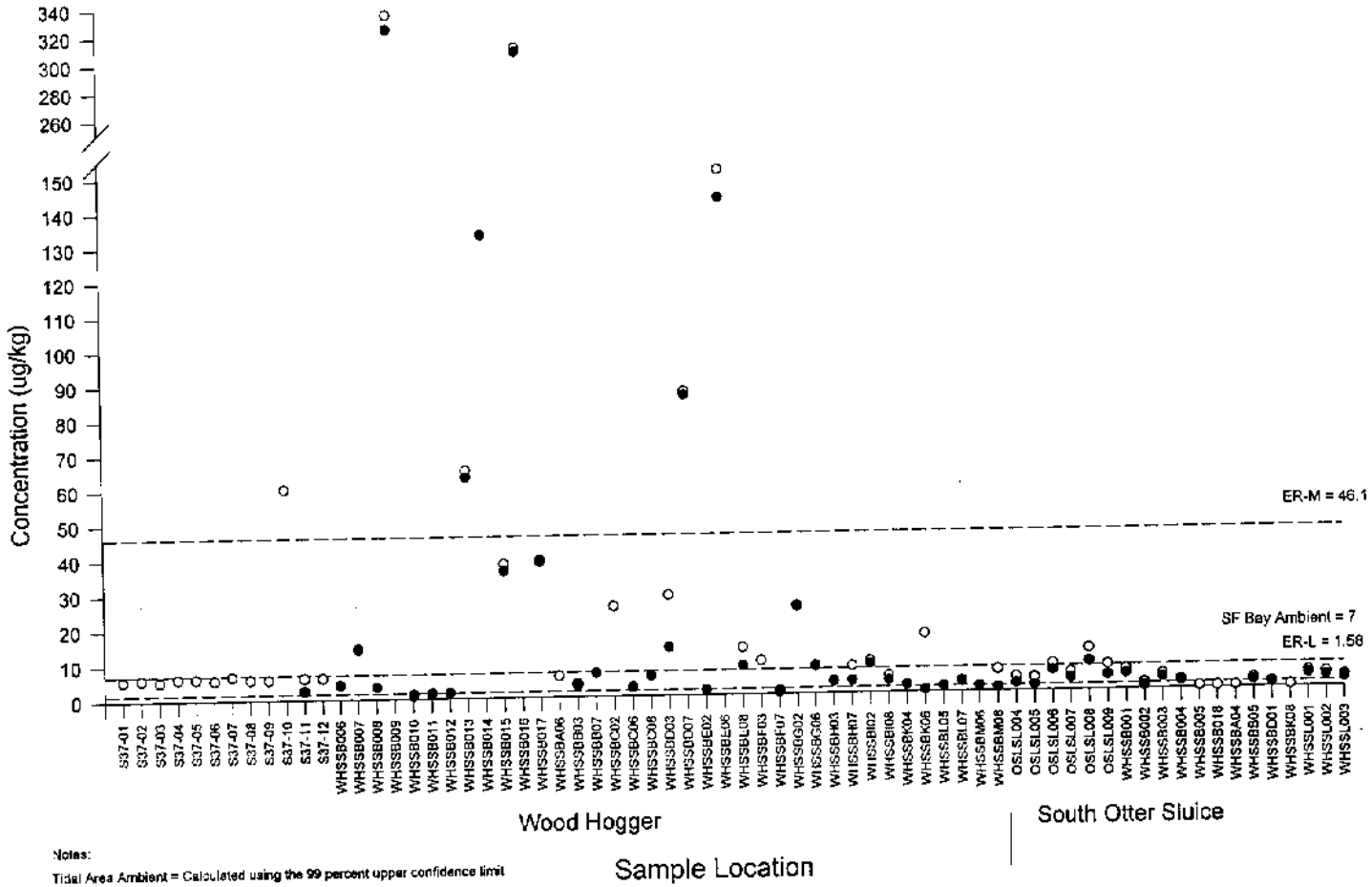
Tidal Area Ambient = Calculated using the 95 percent upper confidence limit

ER-M = Effects range median (Long and others 1995)

ER-L = Effects range low (Long and others 1995)

SF Bay Ambient = San Francisco Bay ambient value (RWQCB 1998)

FIGURE 6-38C
DETECTED CONCENTRATIONS OF TOTAL DDTs IN WOOD HOGGER TERRESRIAL AND SOUTH OTTER SLUICE AQUATIC UNITS, SOIL AND SEDIMENT TIDAL AREA QEA, NWS SBD CONCORD



Notes:

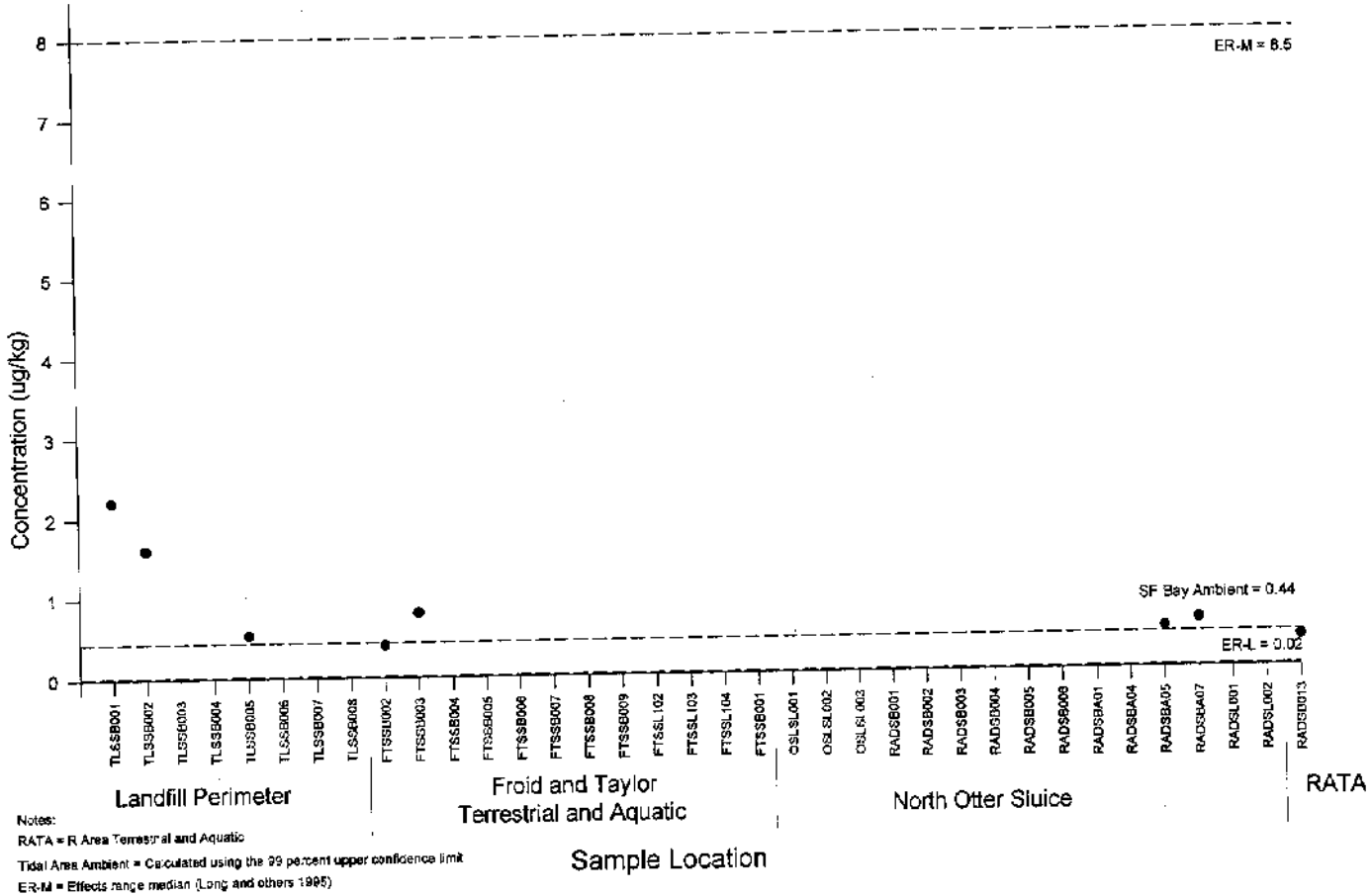
Tidal Area Ambient = Calculated using the 99 percent upper confidence limit

SF Bay Ambient = San Francisco Bay ambient value (RWQCB 1998)

ER-L = Effects range low (Long and others 1995)

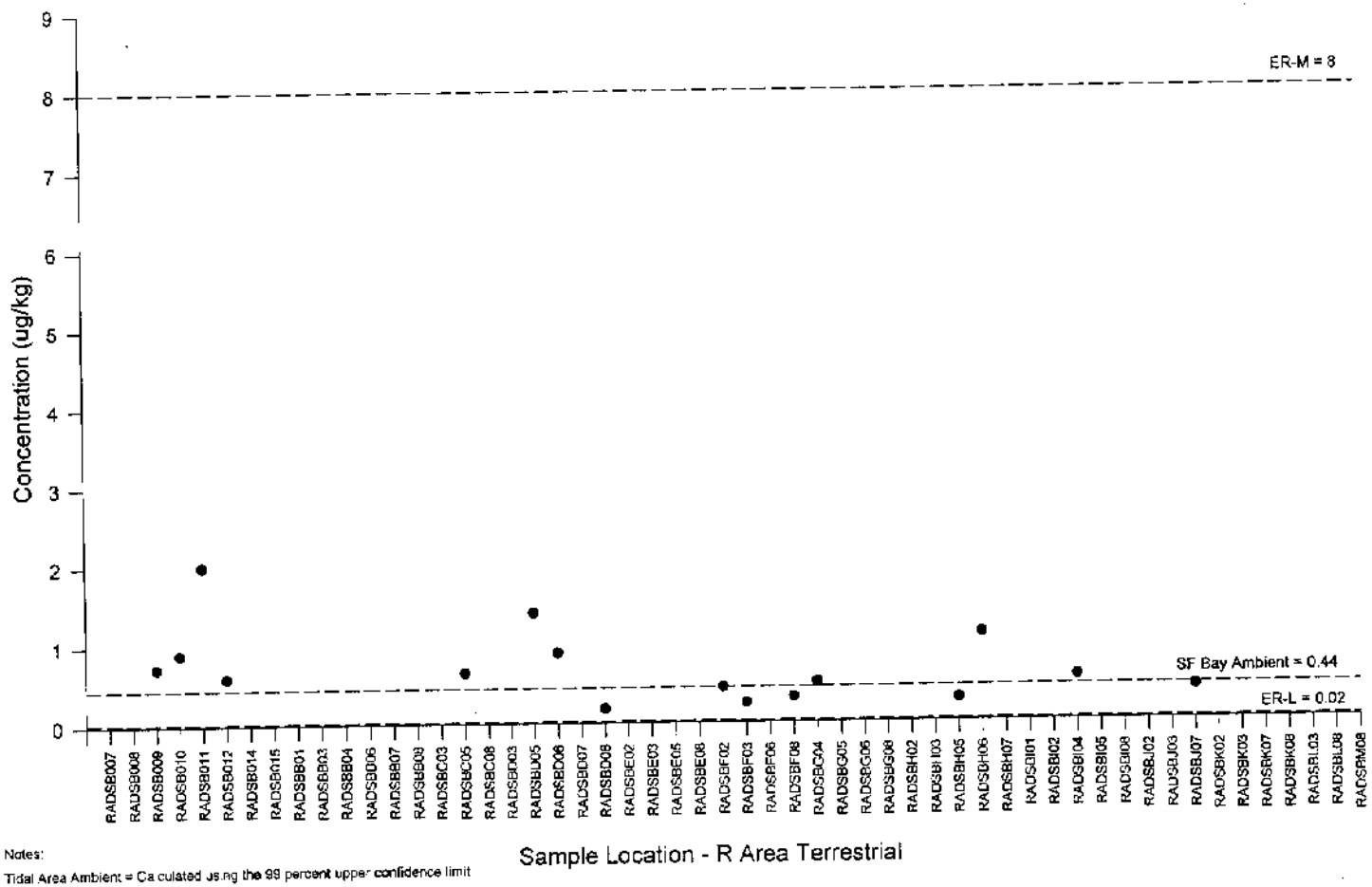
ER-M = Effects range median (Long and others 1995)

FIGURE 6-39A
DETECTED CONCENTRATIONS OF DIELDRIN IN THE LANDFILL PERIMETER TERRESTRIAL, FROID AND TAYLOR TERRESTRIAL, FROID AND TAYLOR AQUATIC, NORTH OTTER SLUICE AQUATIC, AND R AREA TERRESTRIAL AND AQUATIC UNITS, SOIL AND SEDIMENT
TIDAL AREA QEA, NWS SBD CONCORD



Notes:
RATA = R Area Terrestrial and Aquatic
Tidal Area Ambient = Calculated using the 99 percent upper confidence limit
ER-M = Effects range median (Long and others 1995)
ER-L = Effects range low (Long and others 1995)
SF Bay Ambient = San Francisco Bay ambient value (RWQCB 1998)

FIGURE 6-39B
DETECTED CONCENTRATIONS OF DIELDRIN IN R AREA TERRESTRIAL UNIT, SOIL AND SEDIMENT TIDAL AREA QEA, NWS SBD CONCORD



Notes:

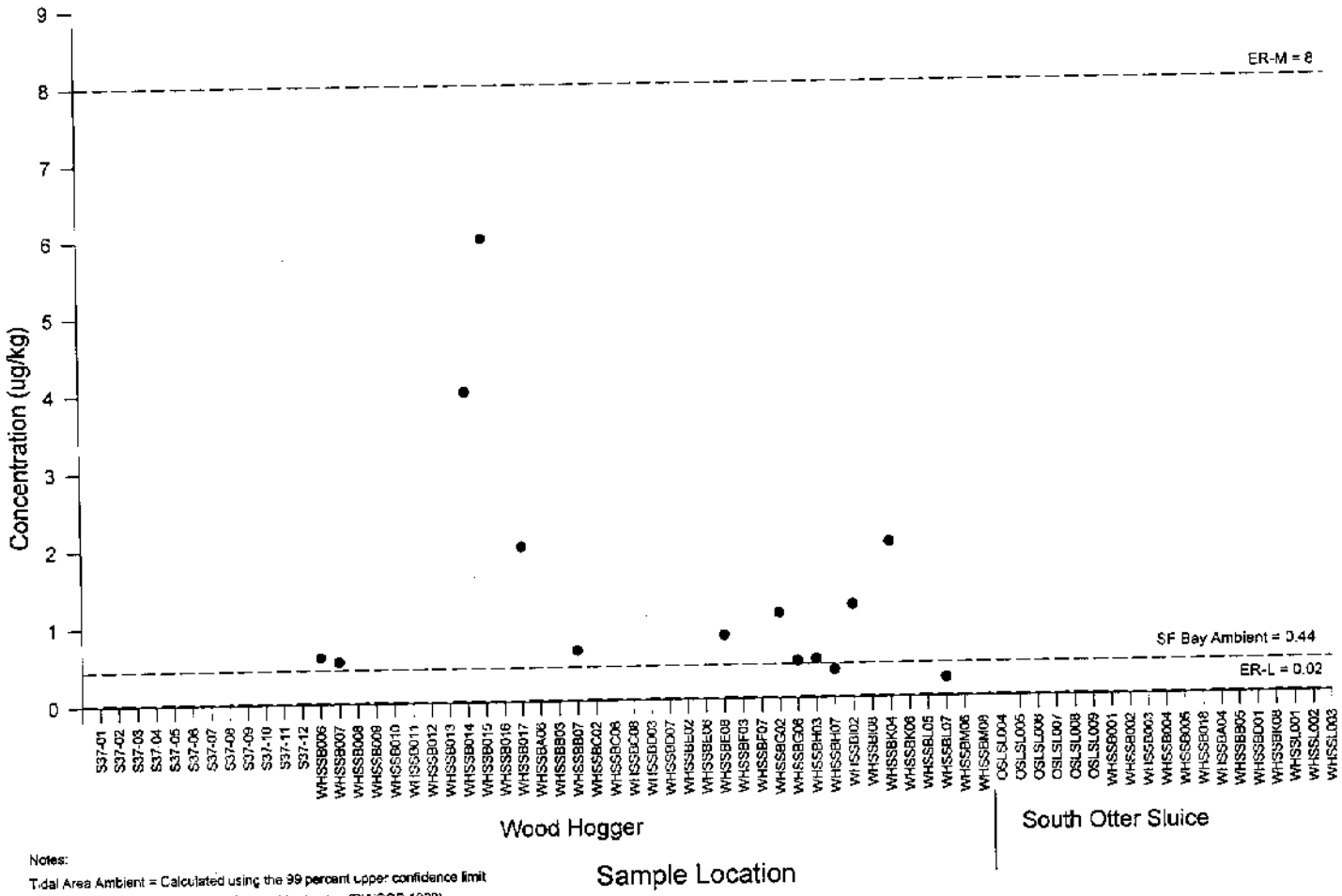
Tidal Area Ambient = Calculated using the 99 percent upper confidence limit

ER-M = Effects range median (Long and others 1995)

ER-L = Effects range low (Long and others 1995)

SF Bay Ambient = San Francisco Bay ambient value (RWQCB 1998)

FIGURE 6-39C
DETECTED CONCENTRATIONS OF DIELDRIN IN WOOD HOGGER TERRESRIAL AND SOUTH OTTER SLUICE AQUATIC UNITS, SOIL AND SEDIMENT TIDAL AREA QEA, NWS SBD CONCORD



Notes:

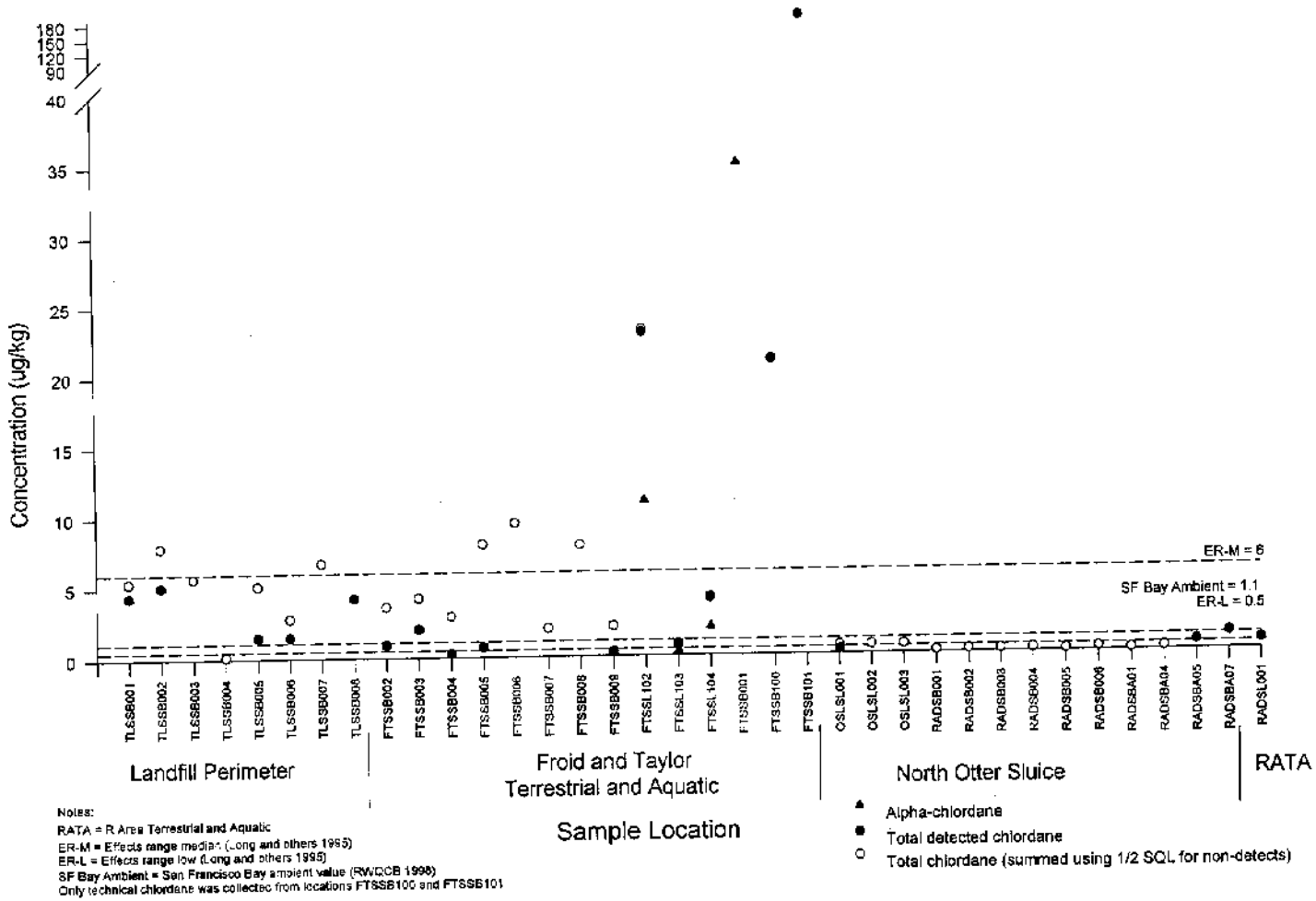
Tidal Area Ambient = Calculated using the 99 percent upper confidence limit

SF Bay Ambient = San Francisco Bay ambient value (RWQCB 1998)

ER-L = Effects range low (Long and others 1995)

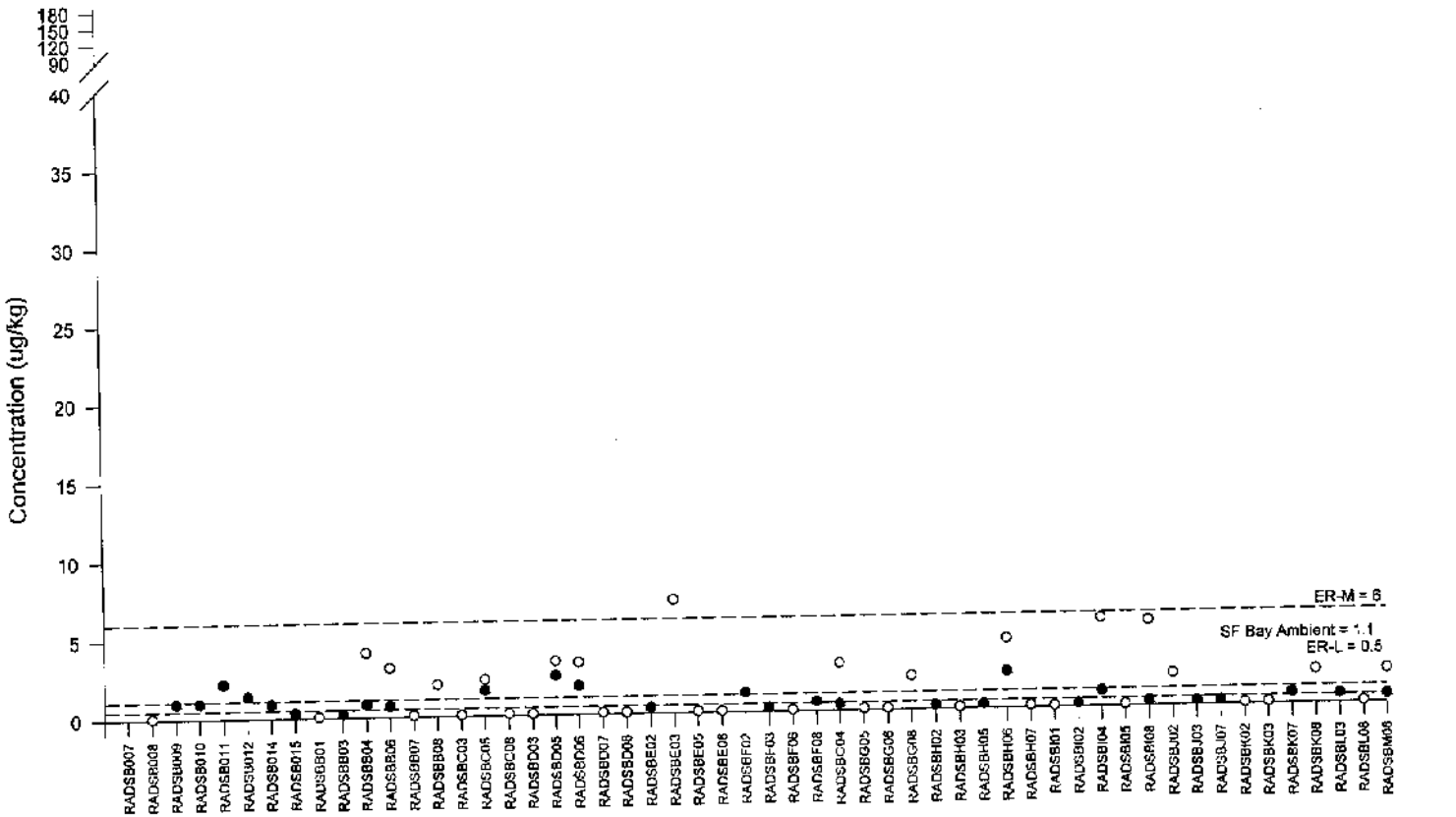
ER-M = Effects range median (Long and others 1995)

FIGURE 6-40A
DETECTED CONCENTRATIONS OF CHLORDANE IN THE LANDFILL PERIMETER TERRESTRIAL, FROID AND TAYLOR TERRESTRIAL, FROID AND TAYLOR AQUATIC, NORTH OTTER SLUICE AQUATIC, AND R AREA TERRESTRIAL AND AQUATIC UNITS, SOIL AND SEDIMENT
TIDAL AREA QEA, NWS SBD CONCORD



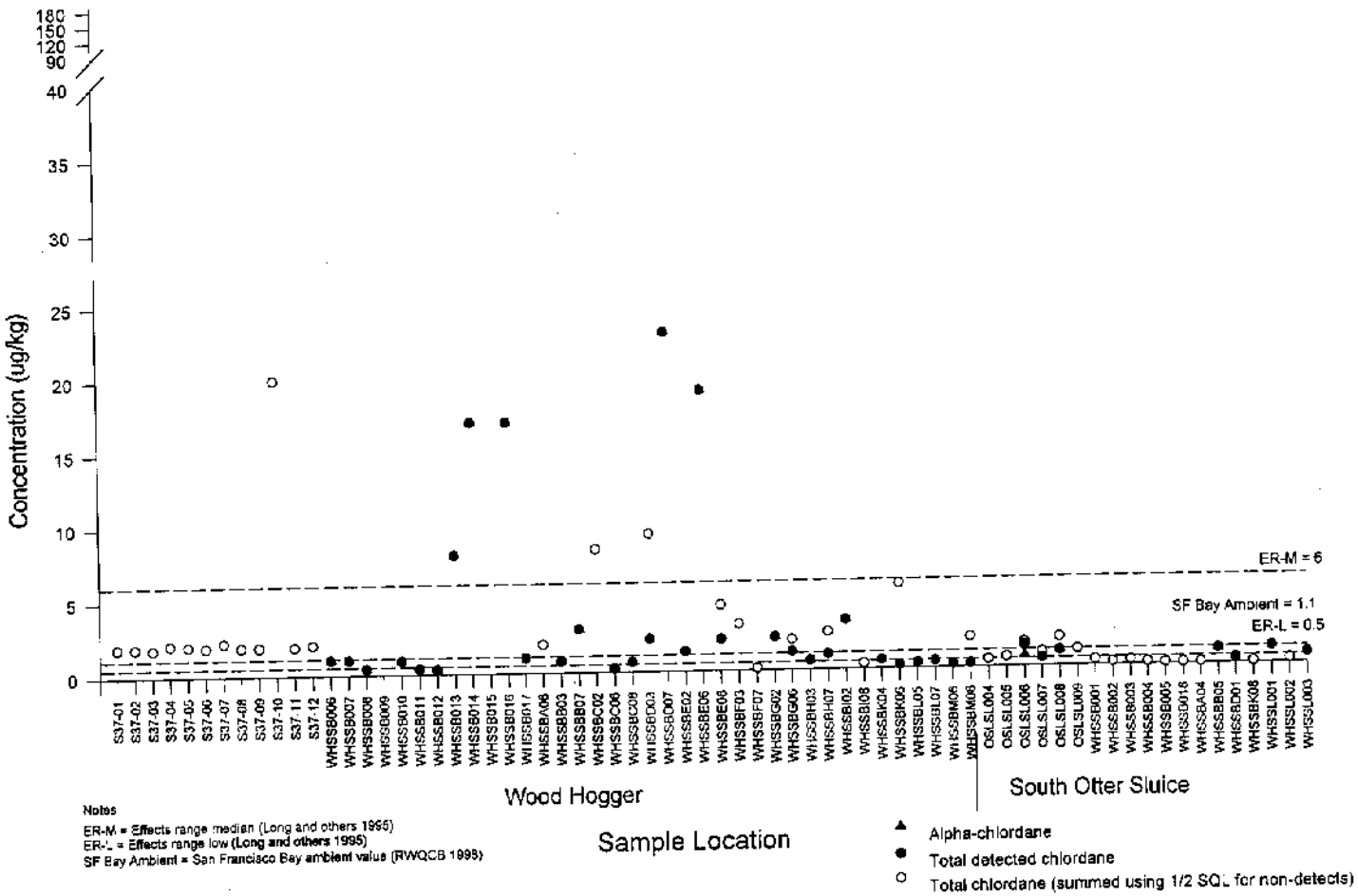
Notes:
RATA = R Area Terrestrial and Aquatic
ER-M = Effects range median (Long and others 1995)
ER-L = Effects range low (Long and others 1995)
SF Bay Ambient = San Francisco Bay ambient value (RWQCB 1998)
Only technical chlordane was collected from locations FTSSB100 and FTSSB101

FIGURE 6-40B
DETECTED CONCENTRATIONS OF CHLORDANE IN R AREA TERRESTRIAL UNIT, SOIL AND SEDIMENT TIDAL AREA QEA, NWS SBD CONCORD



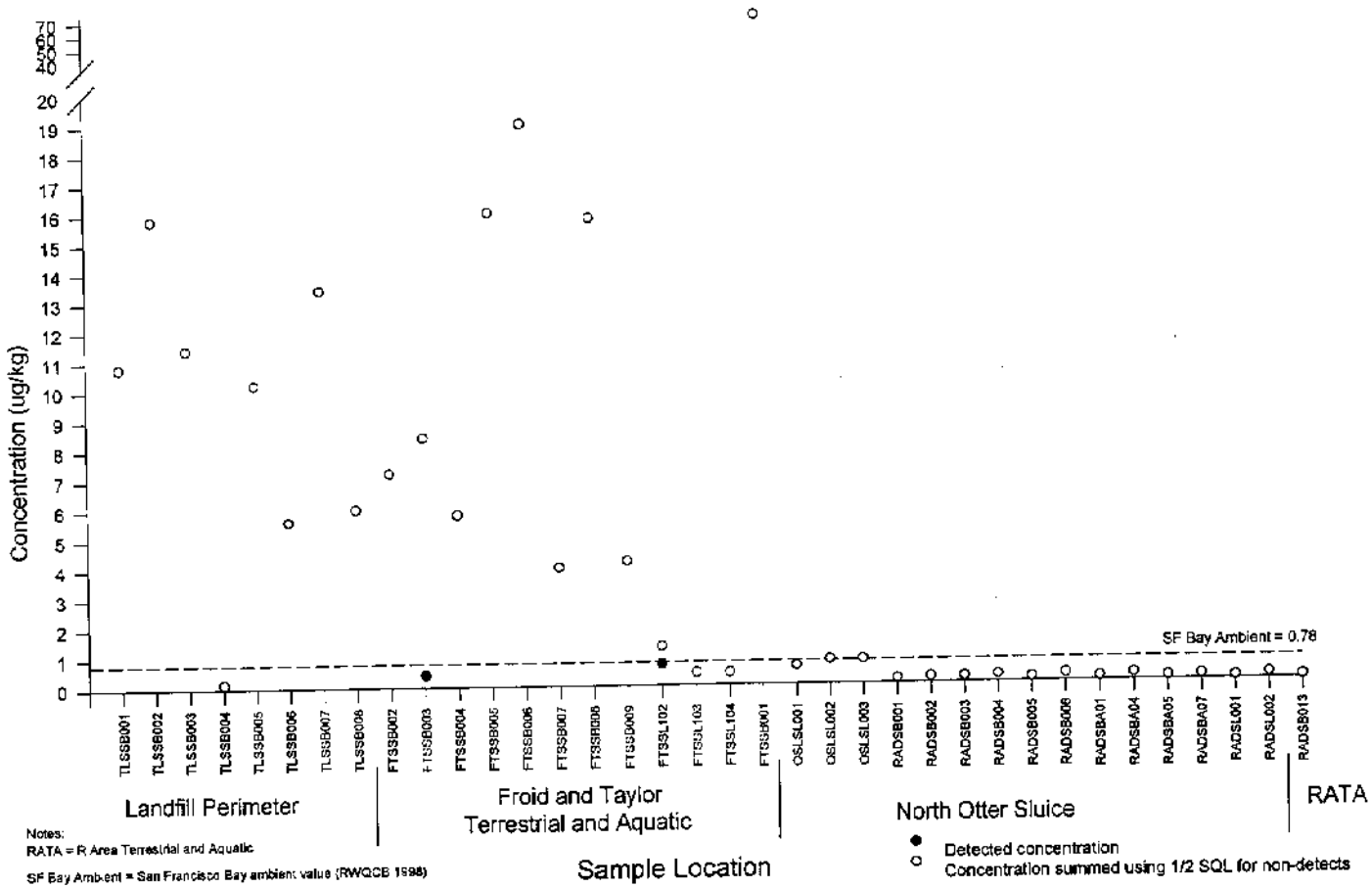
Notes:
RATA = R Area Terrestrial and Aquatic
ER-M = Effects range median (Long and others 1995)
ER-L = Effects range low (Long and others 1995)
SF Bay Ambient = San Francisco Bay ambient value (RWQCB 1998)

FIGURE 6-40C
DETECTED CONCENTRATIONS OF CHLORDANE IN WOOD HOGGER TERRESRIAL AND SOUTH OTTER SLUICE AQUATIC UNITS, SOIL AND SEDIMENT TIDAL AREA QEA, NWS SBD CONCORD



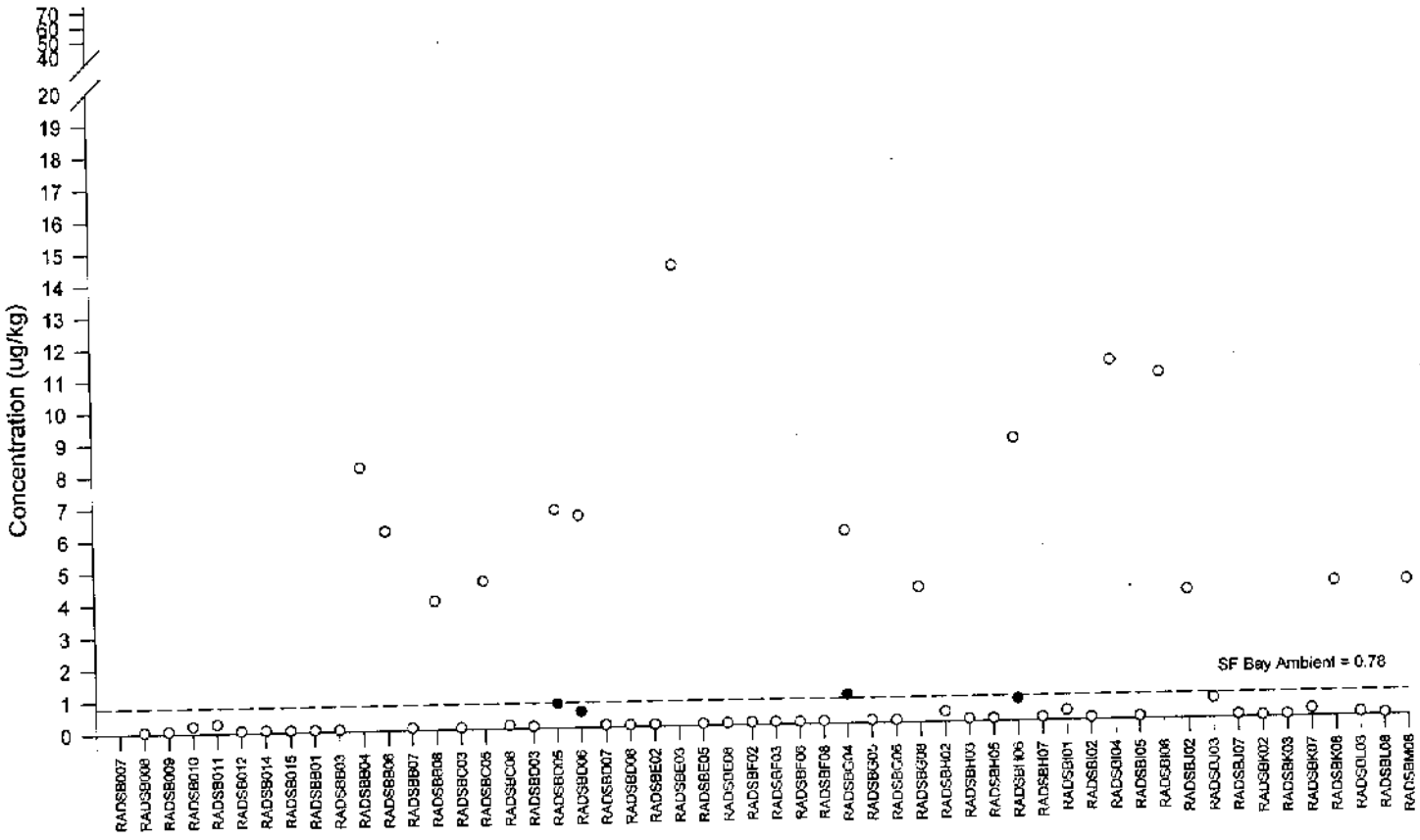
Notes
ER-M = Effects range median (Long and others 1995)
ER-L = Effects range low (Long and others 1995)
SF Bay Ambient = San Francisco Bay ambient value (RWQCB 1995)

FIGURE 6-41A
DETECTED CONCENTRATIONS OF TOTAL BHCs IN THE LANDFILL PERIMETER TERRESTRIAL, FROID AND TAYLOR TERRESTRIAL, FROID AND TAYLOR AQUATIC, NORTH OTTER SLUICE AQUATIC, AND R AREA TERRESTRIAL AND AQUATIC UNITS, SOIL AND SEDIMENT
TIDAL AREA QEA, NWS SBD CONCORD



Notes:
RATA = R Area Terrestrial and Aquatic
SF Bay Ambient = San Francisco Bay ambient value (RWQCB 1998)

FIGURE 6-41B
DETECTED CONCENTRATIONS OF TOTAL BHCs IN R AREA TERRESTRIAL UNIT, SOIL AND SEDIMENT TIDAL AREA QEA, NWS SBD CONCORD



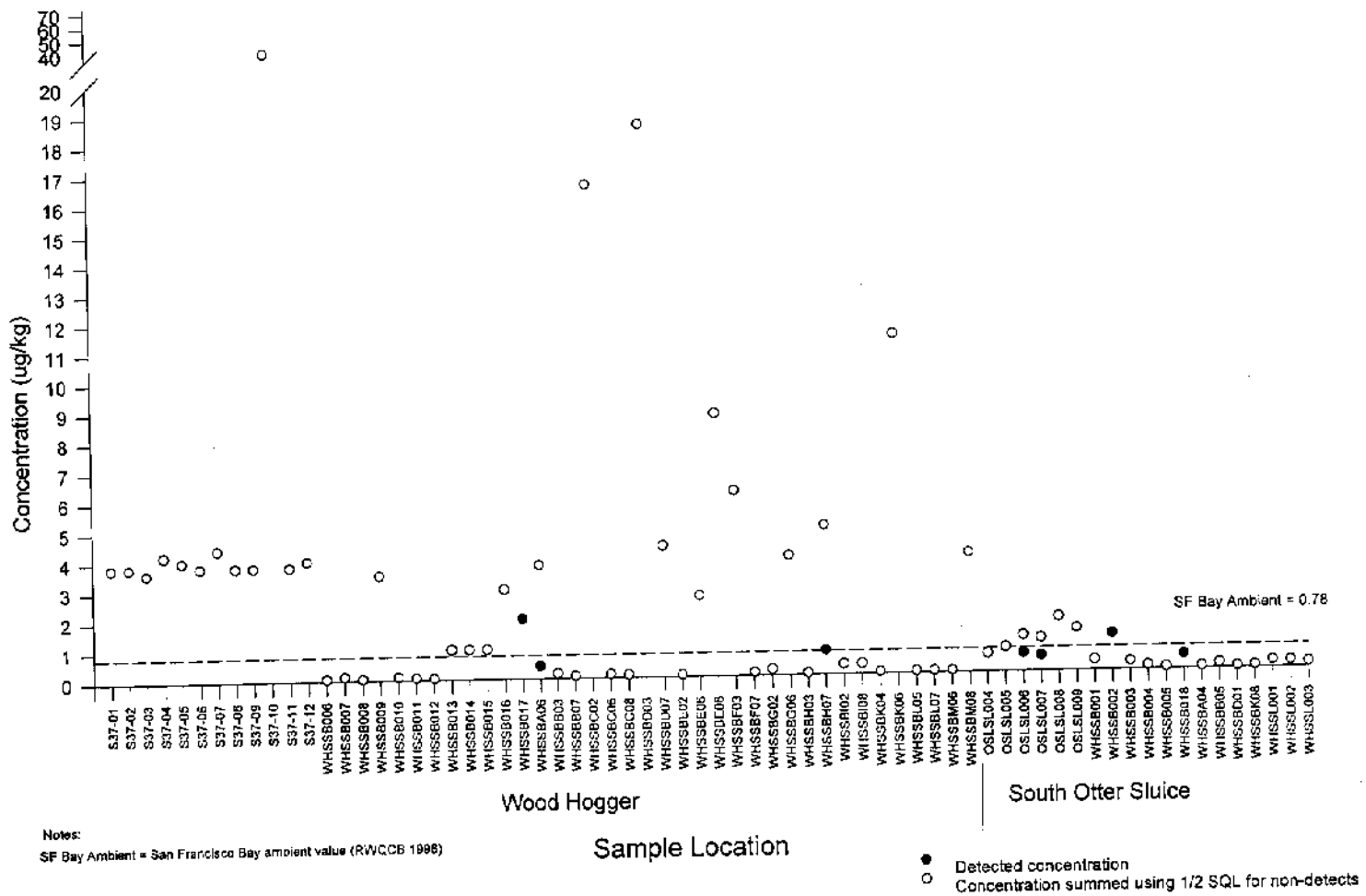
Notes:

SF Bay Ambient = San Francisco Bay ambient value (RWQCB 1998)

● Detected concentration

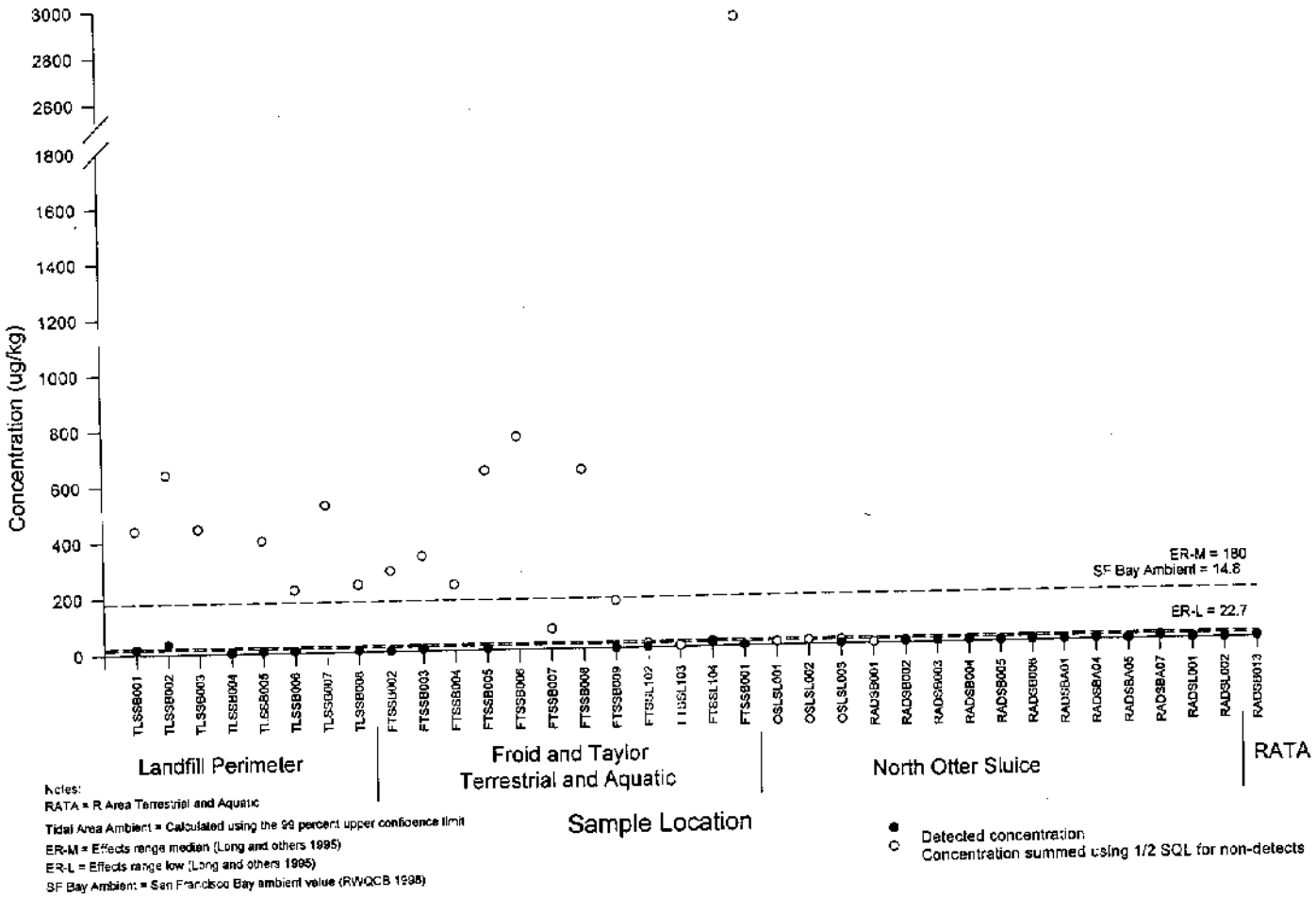
○ Concentration summed using 1/2 SQL for non-detects

FIGURE 6-41C
DETECTED CONCENTRATIONS OF TOTAL BHCs IN WOOD HOGGER TERRESRIAL AND SOUTH OTTER SLUICE AQUATIC UNITS, SOIL AND SEDIMENT TIDAL AREA QEA, NWS SBD CONCORD



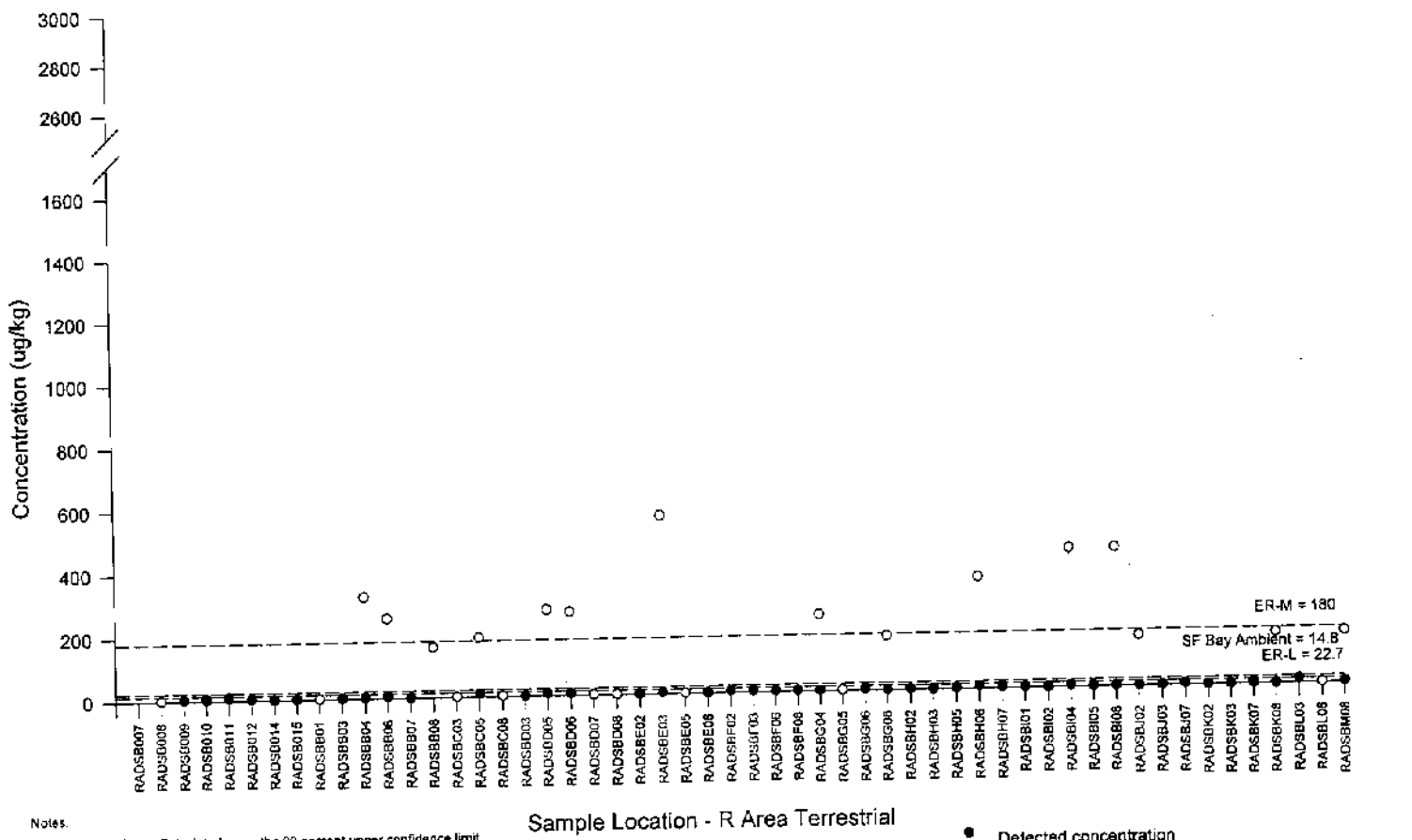
Notes:
SF Bay Ambient = San Francisco Bay ambient value (RWQCB 1998)

FIGURE 6-42A
DETECTED CONCENTRATIONS OF TOTAL PCBs IN THE LANDFILL PERIMETER TERRESTRIAL, FROID AND TAYLOR TERRESTRIAL, FROID AND TAYLOR AQUATIC, NORTH OTTER SLUICE AQUATIC, AND R AREA TERRESTRIAL AND AQUATIC UNITS, SOIL AND SEDIMENT TIDAL AREA QEA, NWS SBD CONCORD



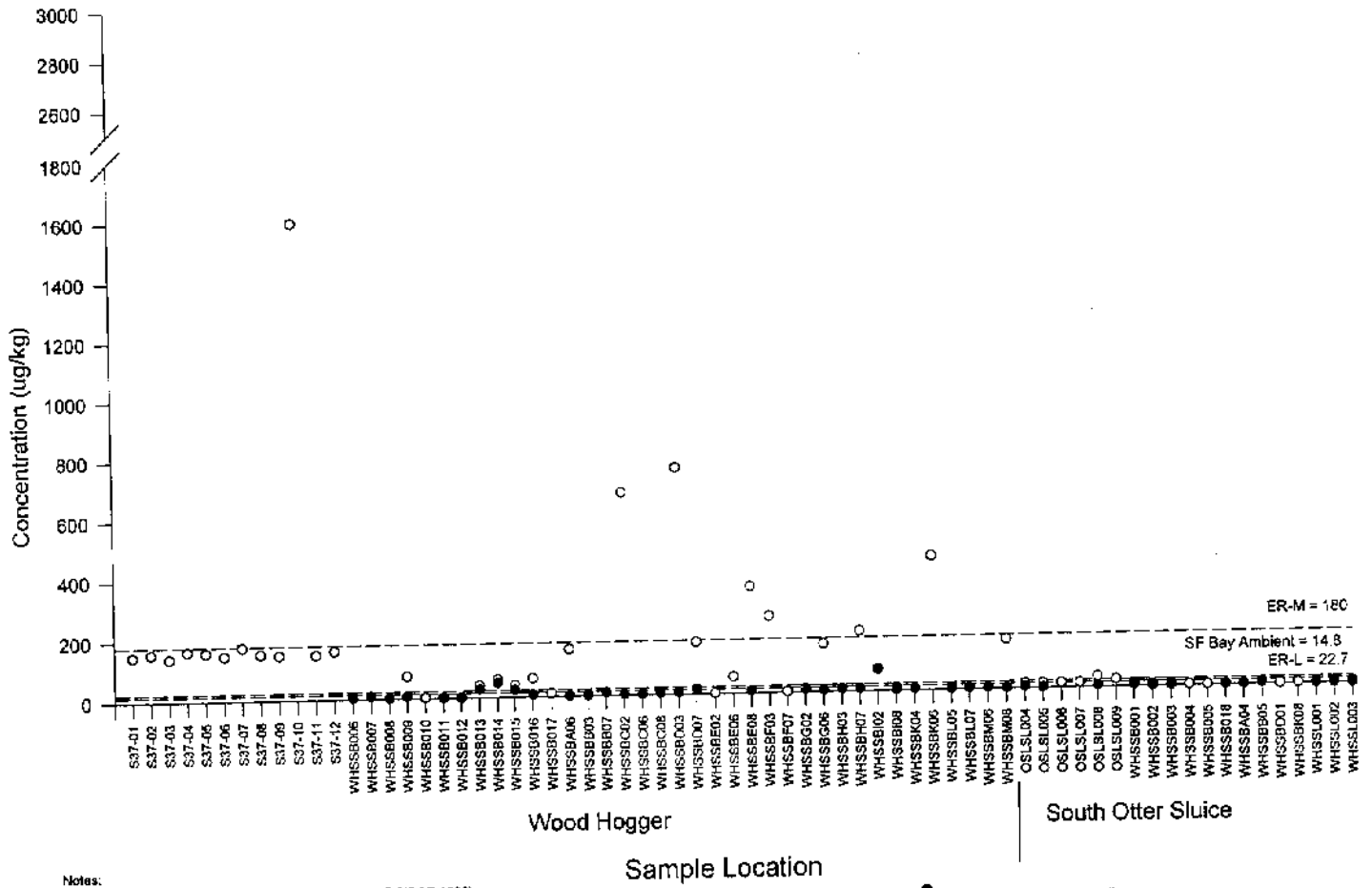
Notes:
RATA = R Area Terrestrial and Aquatic
Tidal Area Ambient = Calculated using the 99 percent upper confidence limit
ER-M = Effects range median (Long and others 1995)
ER-L = Effects range low (Long and others 1995)
SF Bay Ambient = San Francisco Bay ambient value (RWQCB 1998)

FIGURE 6-42B
DETECTED CONCENTRATIONS OF TOTAL PCBs IN R AREA TERRESTRIAL UNIT, SOIL AND SEDIMENT TIDAL AREA QEA, NWS SBD CONCORD



Notes:
Tidal Area Ambient = Calculated using the 99 percent upper confidence limit
ER-M = Effects range median (Long and others 1995)
ER-L = Effects range low (Long and others 1995)
SF Bay Ambient = San Francisco Bay ambient value (RWQCB 1998)

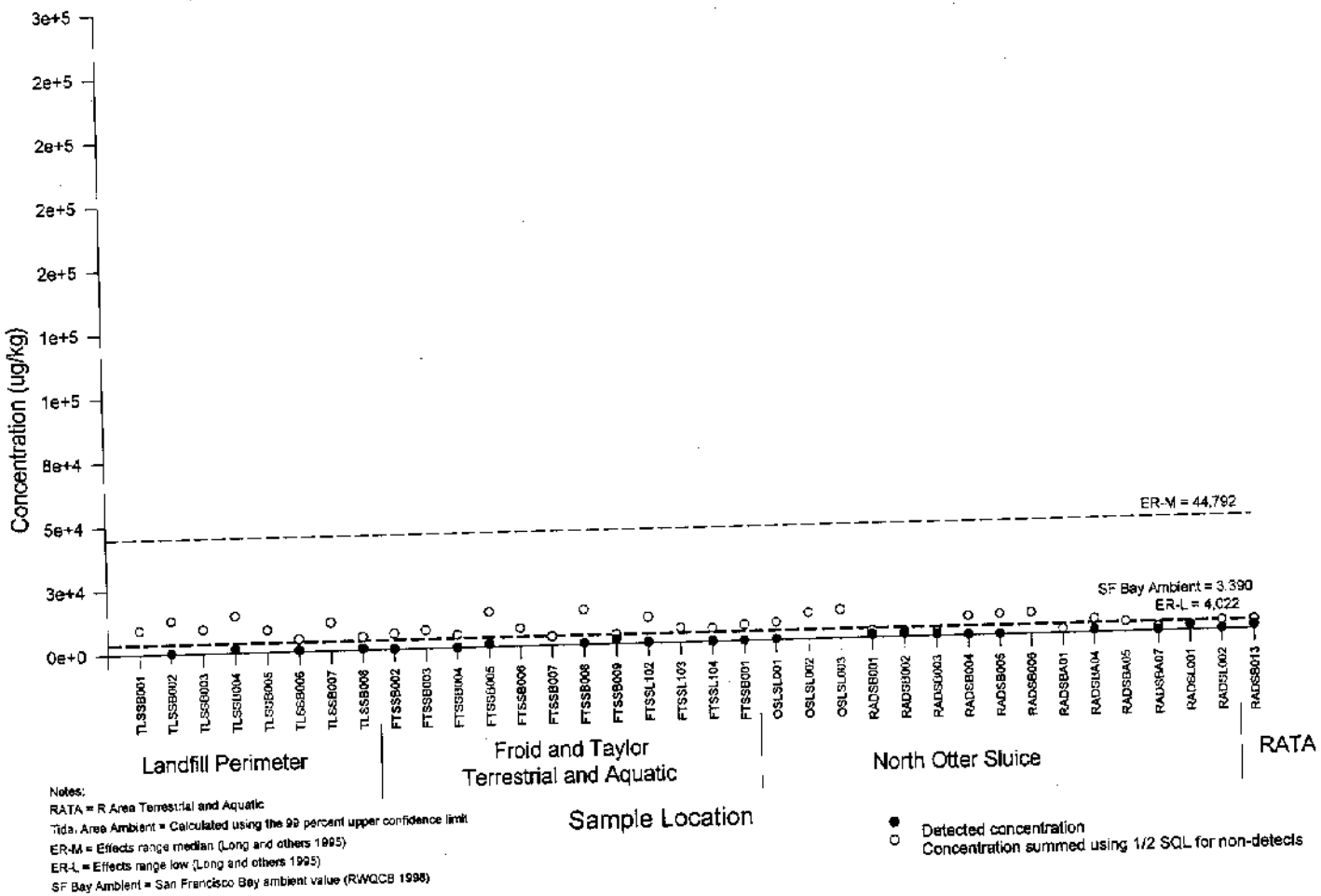
FIGURE 6-42C
DETECTED CONCENTRATIONS OF TOTAL PCBs IN WOOD HOGGER TERRESTRIAL AND SOUTH OTTER SLUICE AQUATIC UNITS, TIDAL AREA QEA, NWS SBD CONCORD



Notes:
SF Bay Ambient = San Francisco Bay ambient value (RWQCB 1998)
ER-L = Effects range low (Long and others 1995)
ER-M = Effects range median (Long and others 1995)

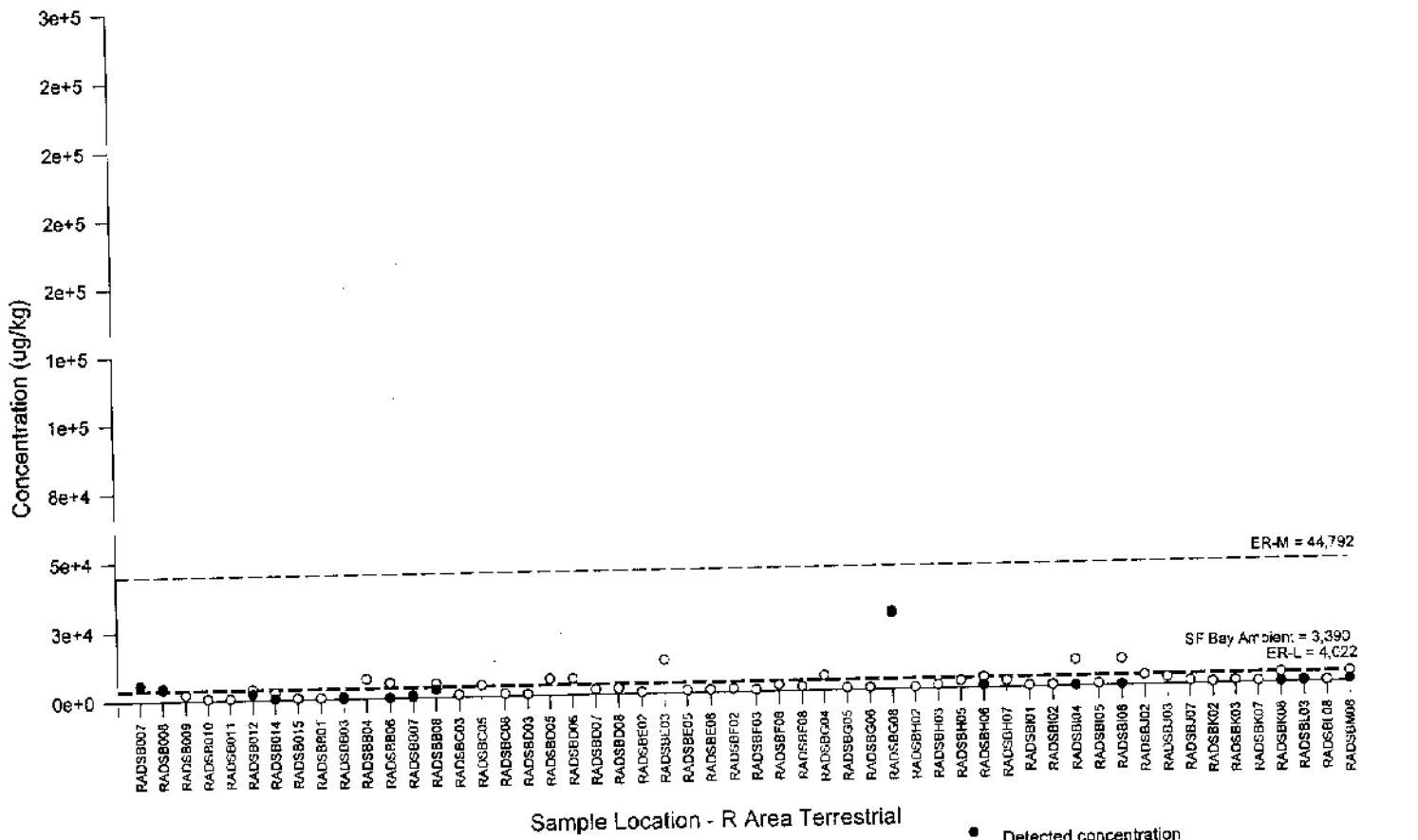
● Detected concentration
○ Concentration summed using 1/2 SQL for non-detects

FIGURE 6-43A
DETECTED CONCENTRATIONS OF TOTAL PAHs IN THE LANDFILL PERIMETER TERRESTRIAL, FROID AND TAYLOR TERRESTRIAL, FROID AND TAYLOR AQUATIC, NORTH OTTER SLUICE AQUATIC, AND R AREA TERRESTRIAL AND AQUATIC UNITS, SOIL AND SEDIMENT
TIDAL AREA QEA, NWS SBD CONCORD



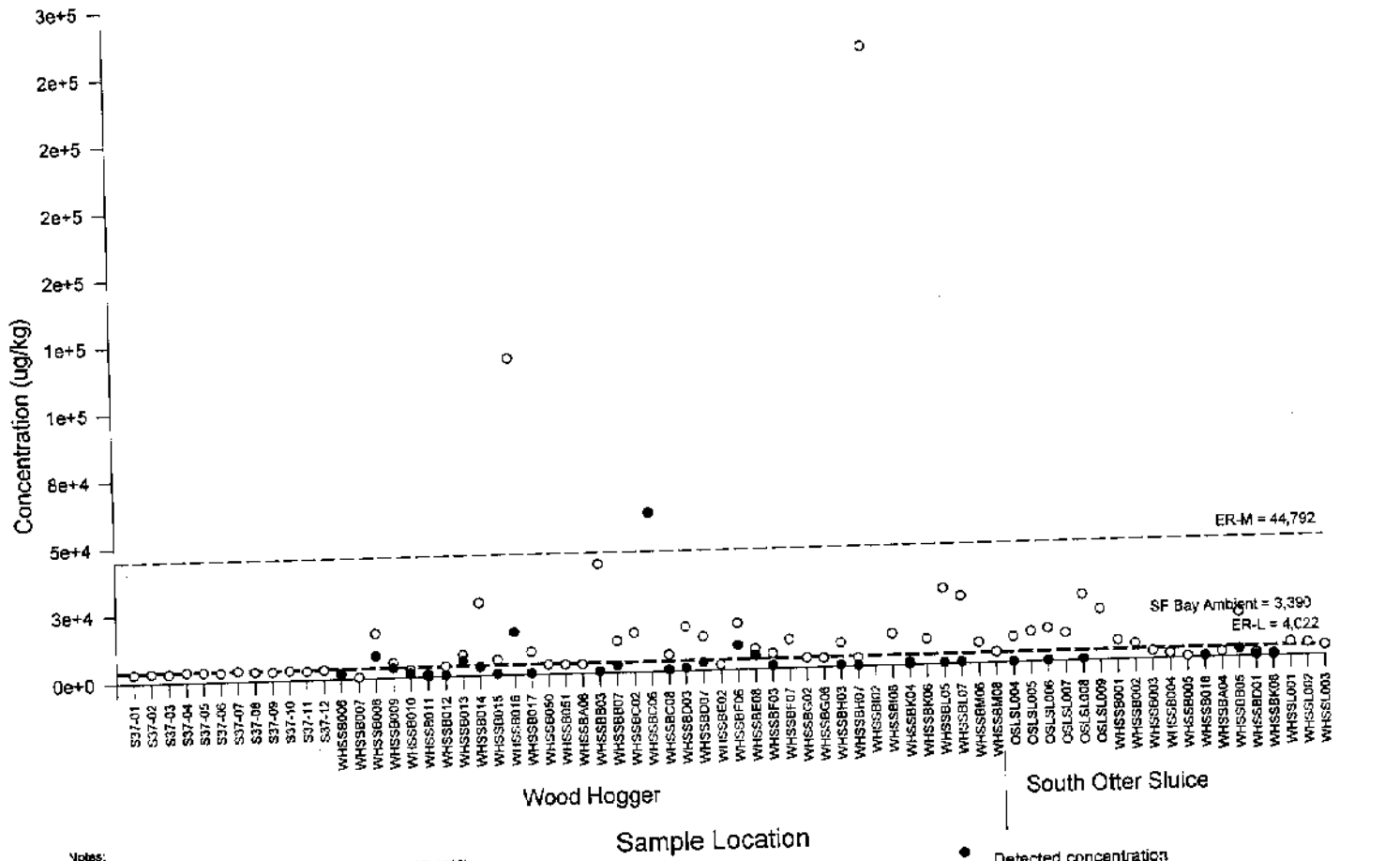
Notes:
RATA = R Area Terrestrial and Aquatic
Tidal Area Ambient = Calculated using the 99 percent upper confidence limit
ER-M = Effects range median (Long and others 1995)
ER-L = Effects range low (Long and others 1995)
SF Bay Ambient = San Francisco Bay ambient value (RWQCB 1998)

FIGURE 6-43B
DETECTED CONCENTRATIONS OF TOTAL PAHs IN R AREA TERRESTRIAL UNIT, SOIL AND SEDIMENT
TIDAL AREA QEA, NWS SBD CONCORD

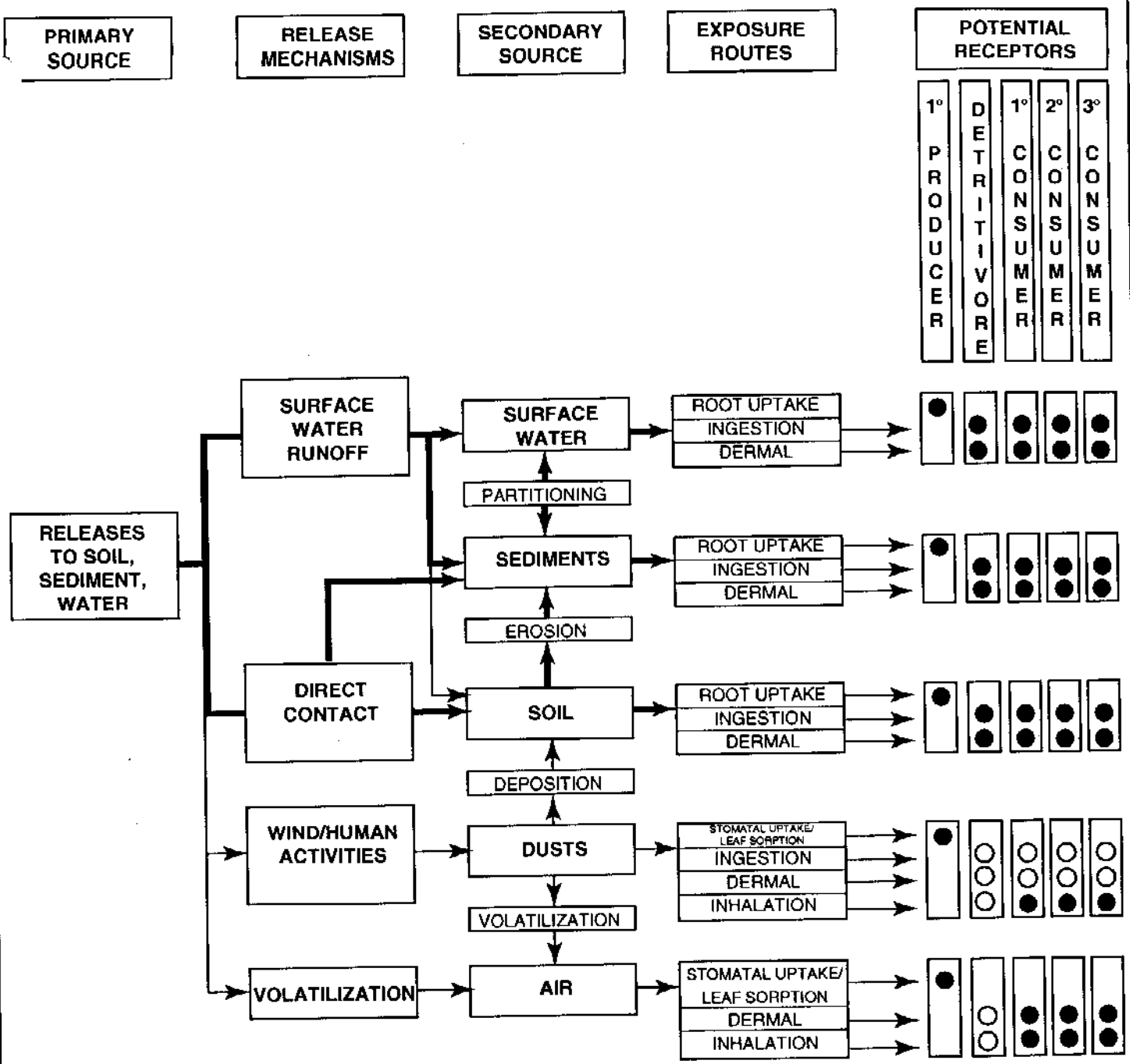


Notes:
ER-M = Effects range median (Long and others 1995)
ER-L = Effects range low (Long and others 1995)
SF Bay Ambient = San Francisco Bay ambient value (RWQCB 1998)

FIGURE 6-43C
DETECTED CONCENTRATIONS OF TOTAL PAHs IN WOOD HOGGER TERRESTRIAL AND SOUTH OTTER SLUICE AQUATIC UNITS, TIDAL AREA QEA, NWS SBD CONCORD



Notes:
SF Bay Ambient = San Francisco Bay ambient value (RWQCB 1998)
ER-L = Effects range low (Long and others 1995)
ER-M = Effects range median (Long and others 1995)



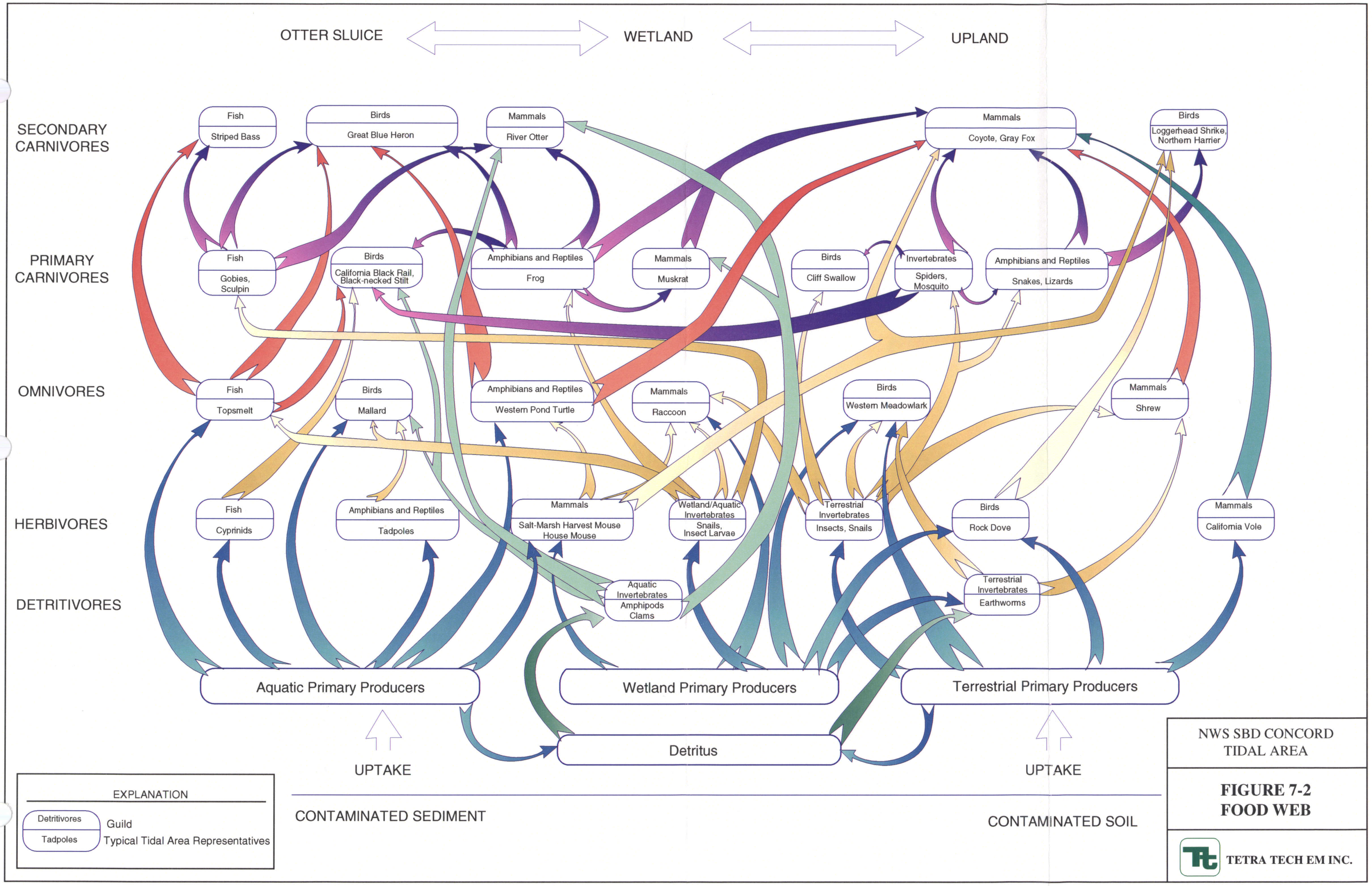
EXPLANATION

● Potential exposure pathway
○ Possible exposure pathway (insufficient data)

NWS SBD CONCORD
TIDAL AREA

FIGURE 7-1
COMPLETE EXPOSURE PATHWAYS

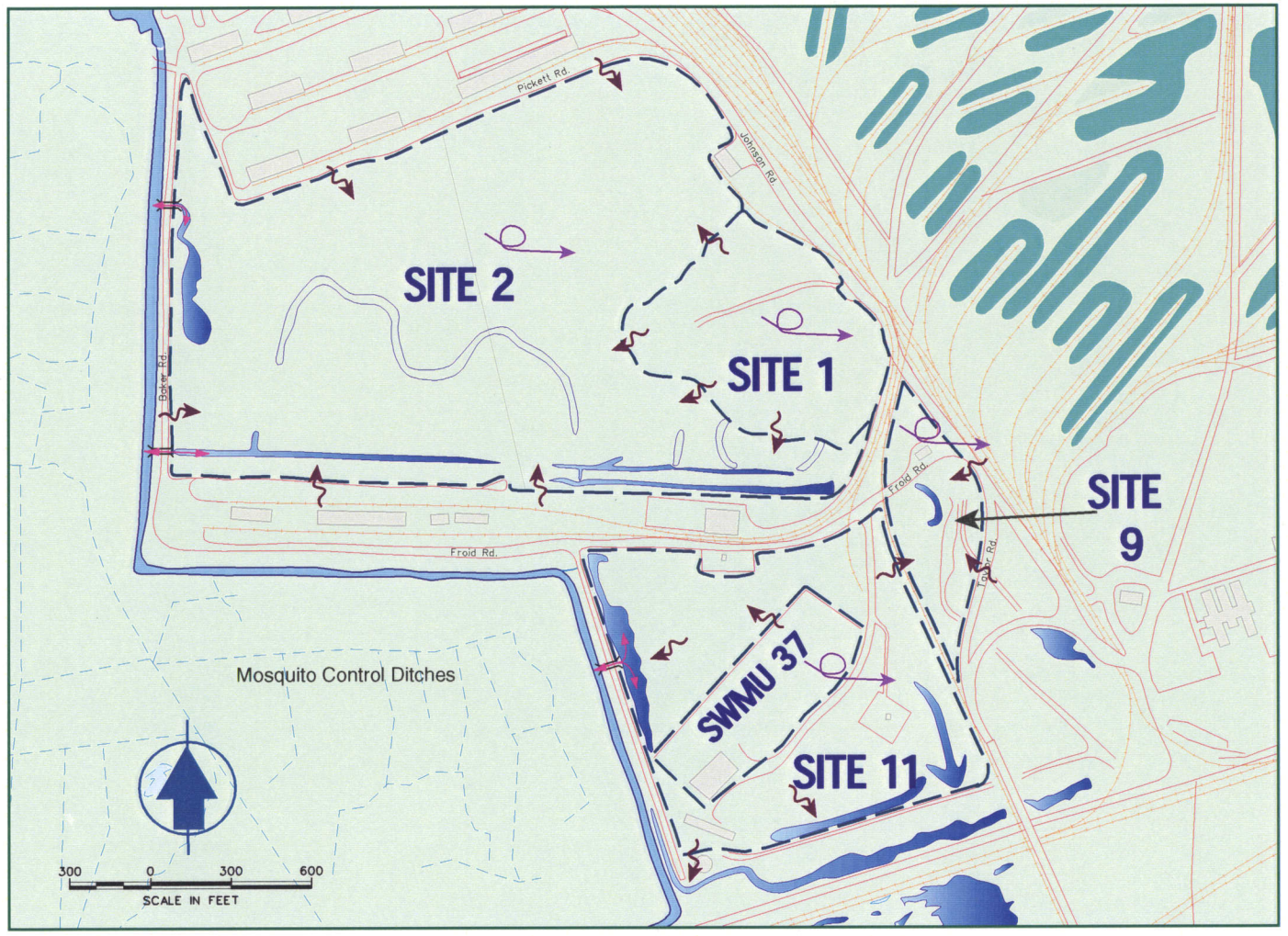
TETRA TECH EM INC.



NWS SBD CONCORD
TIDAL AREA

FIGURE 7-2
FOOD WEB

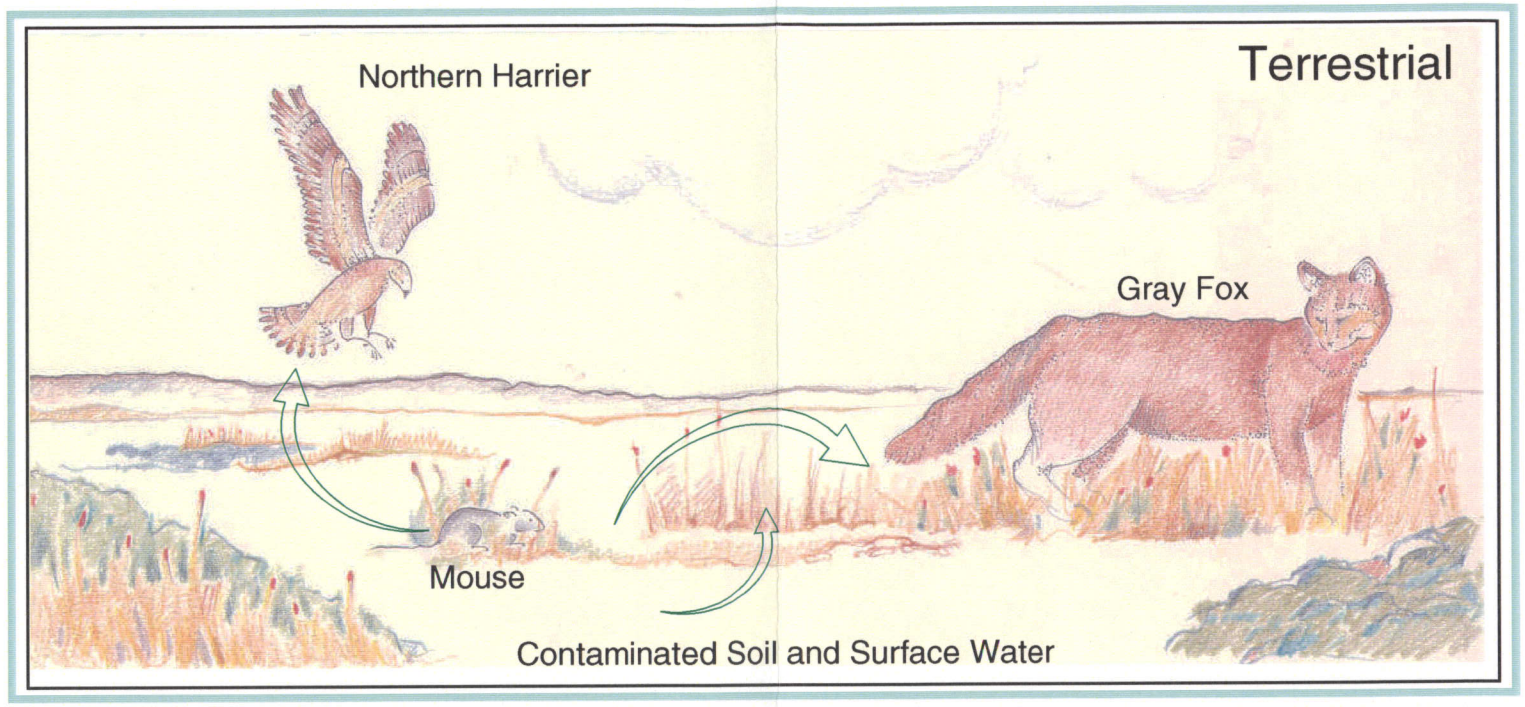
TETRA TECH EM INC.

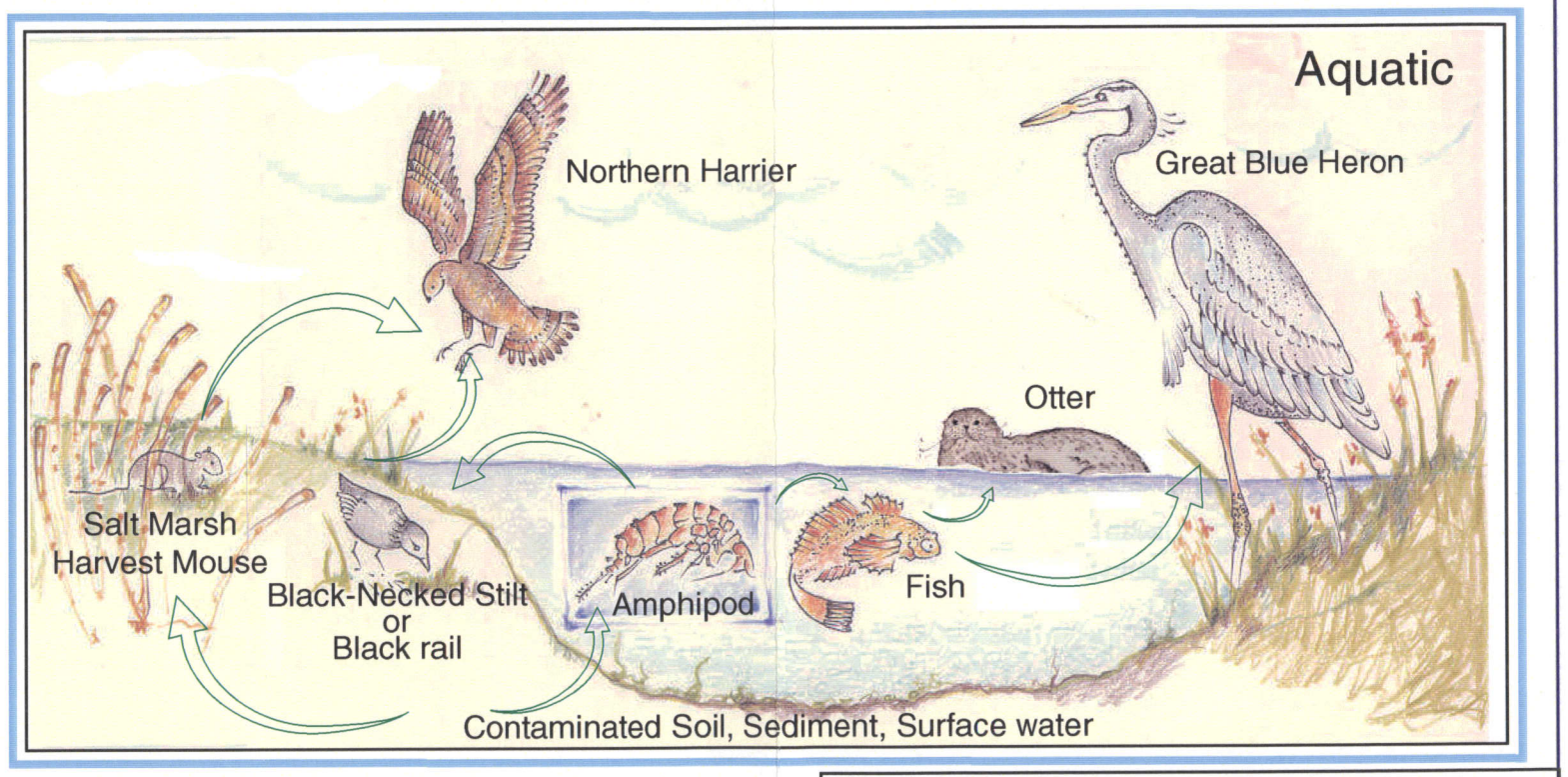


LEGEND

- Sloughs
- Railroad tracks
- Explosive berm
- Site Boundary
- Tidal exhange of surface water and particulates
- Former slough
- Biotic uptake and transfer
- Wind transport of particulates
- Run-off of surface water and particulates
- Aquatic Habitat
- Terrestrial Habitat
- Building

Biotic Uptake and Transfer





NWS SBD CONCORD
TIDAL AREA

FIGURE 7-3
CONCEPTUAL SITE MODEL
FATE AND TRANSPORT PROCESSES

TETRA TECH EM INC.