

Natural Resources Management Plan

for Raw Water Distribution System
Operations and Maintenance Activities

Final Draft

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prepared by



TABLE OF CONTENTS

CHAPTER 1.0 INTRODUCTION	1-1
1.1 Study Area Location and Description.....	1-1
1.2 Purpose.....	1-1
1.3 Report Organization.....	1-1
CHAPTER 2.0 PCWA RAW WATER DISTRIBUTION SYSTEM	2-1
2.1 Water Sources.....	2-1
2.1.1 PG&E Drum-Spaulding Project.....	2-1
2.1.2 Middle Fork Project and American River Pump Station.....	2-2
2.2 PCWA Canal System.....	2-2
2.2.1 Zone 3.....	2-5
2.2.2 Zone 1.....	2-5
2.2.3 Zone 5.....	2-15
2.3 PCWA Raw Water Distribution System Operations.....	2-15
2.3.1 Deliveries.....	2-15
2.3.2 Operations.....	2-19
2.4 PCWA Raw Water Distribution Maintenance Activities.....	2-20
2.4.1 Weed and Brush Control.....	2-21
2.4.2 Cleaning and Flushing.....	2-33
2.4.3 Canal Lining/Guniting.....	2-34
2.5 As-Needed Repair or Replacement.....	2-36
2.6 Other Maintenance Projects.....	2-36
CHAPTER 3.0 NATURAL RESOURCES SETTING	3-1
3.1 Methodology.....	3-1
3.1.1 Physical Resources.....	3-1
3.1.2 Biological Resources.....	3-15
3.2 Physical Resources Setting.....	3-24
3.2.1 Hydrology.....	3-24
3.2.2 Water Quality.....	3-30
3.2.3 Soil and Sediment Quality.....	3-85
3.3 Biological Resources Setting.....	3-99
3.3.1 Terrestrial Habitat and Species.....	3-99
3.3.2 Aquatic Habitat and Species.....	3-109
3.3.3 Special Status Species.....	3-120
CHAPTER 4.0 REGULATORY REQUIREMENTS FOR PCWA CANAL SYSTEM OPERATIONS AND MAINTENANCE ACTIVITIES	4-1
4.1 Federal Regulations.....	4-1
4.1.1 Clean Water Act.....	4-1
4.1.2 Endangered Species Act.....	4-7

- 4.1.3 Magnuson-Stevens Fishery Conservation and Management Act and the 1996 Sustainable Fisheries Act..... 4-9
- 4.1.4 The Migratory Bird Treaty Act..... 4-10
- 4.2 State Regulations 4-10
 - 4.2.1 California Environmental Quality Act..... 4-10
 - 4.2.2 Porter-Cologne Water Quality Control Act (Title 23, California Water Code) 4-11
 - 4.2.3 California Endangered Species Act 4-12
 - 4.2.4 California Fish and Game Code – Fully Protected Species 4-13
 - 4.2.5 California Fish and Game Code Section 1602 – Lake and Streambed Alteration Program..... 4-14
 - 4.2.6 California Native Plant Protection Act 4-14
- 4.3 Local Requirements and Considerations 4-14
 - 4.3.1 Placer County Conservation Plan 4-14
 - 4.3.2 Placer County Stormwater Management Plan 4-16
 - 4.3.3 Placer County Code, Tree Preservation Ordinance 4-17
 - 4.3.4 Placer County Oak Woodland Management Plan 4-17

CHAPTER 5.0 POTENTIAL EFFECTS, REGULATORY FRAMEWORK, AND BEST MANAGEMENT PRACTICES FOR SYSTEMWIDE OPERATIONS..... 5-1

- 5.1 Potential Effects of Systemwide Operations on Natural Resources 5-1
 - 5.1.1 Yearly Outages..... 5-1
 - 5.1.2 Seasonal Customer Delivery Schedule Changes 5-20
 - 5.1.3 Seasonal Flood Management Practices..... 5-22
 - 5.1.4 Routine Operations 5-24
- 5.2 Regulatory Framework for Potential Effects of Systemwide Operations..... 5-27
 - 5.2.1 Federal Regulations 5-27
 - 5.2.2 State Regulations 5-32
 - 5.2.3 Local Requirements and Considerations 5-33
- 5.3 Best Management Practice Options to Address Potential Effects of Systemwide Operations Activities 5-34
 - 5.3.1 Pre-Implementation Best Management Practices 5-34
 - 5.3.2 Implementation Best Management Practices..... 5-36
 - 5.3.3 Ongoing or Post-Implementation Best Management Practices 5-37
- 5.4 Suggestions for Further Studies 5-38

CHAPTER 6.0 POTENTIAL EFFECTS, REGULATORY FRAMEWORK, AND BEST MANAGEMENT PRACTICES FOR MAINTENANCE ACTIVITIES 6-1

- 6.1 Potential Effects of Maintenance Activities on Natural Resources 6-1
 - 6.1.1 Scheduled Maintenance Activities..... 6-1
 - 6.1.2 As-Needed Site-Specific Maintenance Activities..... 6-32
- 6.2 Regulatory Framework for Potential Effects of Maintenance Activities..... 6-56
 - 6.2.1 Federal Regulations 6-56
 - 6.2.2 State Regulations 6-66
 - 6.2.3 Local Requirements and Considerations 6-70
- 6.3 Best Management practice Options to Address Potential Effects of Maintenance Activities..... 6-72

6.3.1	Pre-Implementation Best Management Practices	6-72
6.3.2	Implementation Best Management Practices.....	6-74
6.3.3	Ongoing or Post-Implementation Best Management Practices	6-76
6.4	Suggestions for Further Studies	6-78
CHAPTER 7.0 POTENTIAL EFFECTS, REGULATORY FRAMEWORK, AND BEST MANAGEMENT PRACTICES FOR INTERRELATED PCWA OPERATIONS AND MAINTENANCE ACTIVITIES		7-1
7.1	Potential Effects of Interrelated PCWA Operations and Maintenance Activities on Natural Resources	7-1
7.1.1	Yearly Outages.....	7-1
7.1.2	Seasonal Delivery Schedule Changes.....	7-2
7.1.3	Seasonal Flood Management Practices.....	7-2
7.1.4	Routine Operations	7-4
7.1.5	Canal Cleaning and Flushing.....	7-4
7.1.6	Weed and Brush Control – Physical Removal of Vegetation.....	7-5
7.1.7	Weed and Brush Control – Algaecide Application.....	7-5
7.1.8	Weed and Brush Control – Herbicide Application.....	7-6
7.1.9	Canal Lining.....	7-7
7.2	Regulatory Framework for Potential Effects of Interrelated PCWA Operations and Maintenance Activities	7-7
7.2.1	Federal Regulations	7-8
7.2.2	State Regulations	7-8
7.2.3	Local Requirements and Considerations	7-8
7.3	Best Management Practice Options to Address Potential Effects of Interrelated PCWA Operations and Maintenance Activities	7-9
7.3.1	Pre-Implementation Best Management Practices	7-9
7.3.2	Implementation Best Management Practices.....	7-10
7.3.3	Ongoing or Post-Implementation Best Management Practices	7-10
CHAPTER 8.0 REFERENCES		8-1
Appendix A – Benthic Macroinvertebrate Data Report		
Appendix B – Water Quality Conditions for Systemwide Operations		
Appendix C – Water Quality Conditions During Maintenance Activities		

LIST OF FIGURES

Figure 1-1 Study Area.....	1-2
Figure 2-1 PCWA Retail Service Area Zones	2-3
Figure 2-2 PCWA Zone 3 Service Area and Distribution Conveyances.....	2-7
Figure 2-3 PCWA Upper Zone 1 Service Area and Distribution Conveyances.....	2-9
Figure 2-4 PCWA Lower Zone 1 Service Area and Distribution Conveyances	2-11
Figure 2-5 PCWA Lower Zone 1 Auburn Ravine Area Distribution Conveyances.....	2-13
Figure 2-6 PCWA Zone 5 Service Area and Distribution Conveyances.....	2-17
Figure 2-7 Delivery of 1 Miner’s Inch to PCWA Canal System Customers.....	2-19
Figure 2-8 Zone 3 Aquatic Herbicide and Algaecide Application Sites	2-23
Figure 2-9 Upper Zone 1 Aquatic Herbicide and Algaecide Application Sites	2-25
Figure 2-10 Lower Zone 1 Aquatic Herbicide and Algaecide Application Sites	2-27
Figure 2-11 Lower Zone 1 Auburn Ravine Area Aquatic Herbicide and Algaecide Application Sites	2-29
Figure 3-1 Zone 3 Baseline Water Quality Monitoring Sites	3-3
Figure 3-2 Upper Zone 1 Baseline Water Quality Monitoring Sites	3-5
Figure 3-3 Lower Zone 1 Baseline Water Quality Monitoring Sites.....	3-7
Figure 3-4 Lower Zone 1 Auburn Ravine Area Baseline Water Quality Monitoring Sites	3-9
Figure 3-5 Average Daily Flows in Secret Ravine at Rocklin Road	3-28
Figure 3-6 Average Daily Flows in Miners Ravine near North Sunrise Avenue	3-29
Figure 3-7 Water Temperature and Dissolved Oxygen Results from Seasonal Monitoring Events at Boardman Canal Below Lake Alta.....	3-35
Figure 3-8 pH, Hardness, and Alkalinity Results from Seasonal Monitoring Events at Boardman Canal Below Lake Alta	3-36
Figure 3-9 Total Suspended Solids and Turbidity Results from Seasonal Monitoring Events at Boardman Canal Below Lake Alta.....	3-37
Figure 3-10 Specific Conductivity Results from Seasonal Monitoring Events at Boardman Canal Below Lake Alta	3-37
Figure 3-11 Calcium Results from Seasonal Monitoring Events at Boardman Canal Below Lake Alta	3-38
Figure 3-12 Iron Results from Seasonal Monitoring Events at Boardman Canal Below Lake Alta.....	3-38
Figure 3-13 Magnesium Results from Seasonal Monitoring Events at Boardman Canal Below Lake Alta	3-39
Figure 3-14 Sodium Results from Seasonal Monitoring Events at Boardman Canal Below Lake Alta.....	3-39
Figure 3-15 Chloride Results from Seasonal Monitoring Events at Boardman Canal Below Lake Alta.....	3-40

Figure 3-16 Aluminum Results from Seasonal Monitoring Events at Boardman Canal
 Below Lake Alta 3-40

Figure 3-17 Barium Results from Seasonal Monitoring Events at Boardman Canal Below
 Lake Alta..... 3-41

Figure 3-18 Zinc Results from Seasonal Monitoring Events at Boardman Canal Below
 Lake Alta..... 3-41

Figure 3-19 Water Temperature and Dissolved Oxygen Results from Seasonal Monitoring
 Events at Auburn Ravine Below Auburn Ravine Tunnel Outlet 3-42

Figure 3-20 pH, Alkalinity, and Hardness Results from Seasonal Monitoring Events at
 Auburn Ravine Below Auburn Ravine Tunnel Outlet..... 3-43

Figure 3-21 Turbidity Results from Seasonal Monitoring Events at Auburn Ravine Below
 Auburn Ravine Tunnel Outlet..... 3-44

Figure 3-22 Specific Conductivity Results from Seasonal Monitoring Events at Auburn
 Ravine Below Auburn Ravine Tunnel Outlet 3-44

Figure 3-23 Calcium Results from Seasonal Monitoring Events at Auburn Ravine Below
 Auburn Ravine Tunnel Outlet..... 3-45

Figure 3-24 Magnesium Results from Seasonal Monitoring Events at Auburn Ravine Below
 Auburn Ravine Tunnel Outlet..... 3-45

Figure 3-25 Iron Results from Seasonal Monitoring Events at Auburn Ravine Below
 Auburn Ravine Tunnel Outlet..... 3-46

Figure 3-26 Potassium Results from Seasonal Monitoring Events at Auburn Ravine Below
 Auburn Ravine Tunnel Outlet..... 3-46

Figure 3-27 Sodium Results from Seasonal Monitoring Events at Auburn Ravine Below
 Auburn Ravine Tunnel Outlet..... 3-46

Figure 3-28 Chloride Results from Seasonal Monitoring Events at Auburn Ravine Below
 Auburn Ravine Tunnel Outlet..... 3-47

Figure 3-29 Sulfate Results from Seasonal Monitoring Events at Auburn Ravine Below
 Auburn Ravine Tunnel Outlet..... 3-47

Figure 3-30 Nitrate Results from Seasonal Monitoring Events At Auburn Ravine Below
 Auburn Ravine Tunnel Outlet..... 3-48

Figure 3-31 Aluminum Results from Seasonal Monitoring Events at Auburn Ravine Below
 Auburn Ravine Tunnel Outlet..... 3-48

Figure 3-32 Barium Results from Seasonal Monitoring Events at Auburn Ravine Below
 Auburn Ravine Tunnel Outlet..... 3-49

Figure 3-33 Copper Results from Seasonal Monitoring Events at Auburn Ravine Below
 Auburn Ravine Tunnel Outlet..... 3-49

Figure 3-34 Zinc Results from Seasonal Monitoring Events at Auburn Ravine Below
 Auburn Ravine Tunnel Outlet..... 3-49

Figure 3-35 Water Temperature and Dissolved Oxygen Results from Seasonal Monitoring
 Events in the Clover Valley Creek Watershed..... 3-50

Figure 3-36 pH, Alkalinity, and Hardness Results from Seasonal Monitoring Events in the
 Clover Valley Creek Watershed..... 3-51

Figure 3-37 Turbidity Results from Seasonal Monitoring Events in the Clover Valley Creek Watershed..... 3-52

Figure 3-38 Specific Conductivity Results from Seasonal Monitoring Events in the Clover Valley Creek Watershed 3-52

Figure 3-39 Calcium Results from Seasonal Monitoring Events in the Clover Valley Creek Watershed..... 3-53

Figure 3-40 Iron Results from Seasonal Monitoring Events in the Clover Valley Creek Watershed..... 3-53

Figure 3-41 Magnesium Results from Seasonal Monitoring Events in the Clover Valley Creek Watershed 3-53

Figure 3-42 Sodium Results from Seasonal Monitoring Events in the Clover Valley Creek Watershed..... 3-54

Figure 3-43 Chloride Results from Seasonal Monitoring Events in the Clover Valley Creek Watershed..... 3-54

Figure 3-44 Sulfate Results from Seasonal Monitoring Events in the Clover Valley Creek Watershed..... 3-55

Figure 3-45 Aluminum Results from Seasonal Monitoring Events in the Clover Valley Creek Watershed..... 3-55

Figure 3-46 Barium Results from Seasonal Monitoring Events in the Clover Valley Creek Watershed..... 3-56

Figure 3-47 Copper Results from Seasonal Monitoring Events in the Clover Valley Creek Watershed..... 3-56

Figure 3-48 Zinc Results from Seasonal Monitoring Events in the Clover Valley Creek Watershed..... 3-57

Figure 3-49 Temperature and Dissolved Oxygen Results from Seasonal Monitoring Events in the Antelope Creek Watershed..... 3-57

Figure 3-50 pH, Alkalinity, and Hardness Results from Seasonal Monitoring Events in the Antelope Creek Watershed 3-59

Figure 3-51 Turbidity Results from Seasonal Monitoring Events in the Antelope Creek Watershed..... 3-60

Figure 3-52 Specific Conductivity Results from Seasonal Monitoring Events in the Antelope Creek Watershed 3-60

Figure 3-53 Calcium Results from Seasonal Monitoring Events in the Antelope Creek Watershed..... 3-61

Figure 3-54 Iron Results from Seasonal Monitoring Events in the Antelope Creek Watershed..... 3-61

Figure 3-55 Magnesium Results from Seasonal Monitoring Events in the Antelope Creek Watershed..... 3-61

Figure 3-56 Potassium Results from Seasonal Monitoring Events in the Antelope Creek Watershed..... 3-62

Figure 3-57 Sodium Results from Seasonal Monitoring Events in the Antelope Creek Watershed 3-62

Figure 3-58 Chloride Results from Seasonal Monitoring Events in the Antelope Creek Watershed..... 3-63

Figure 3-59 Nitrate Results from Seasonal Monitoring Events in the Antelope Creek Watershed..... 3-63

Figure 3-60 Sulfate Results from Seasonal Monitoring Events in the Antelope Creek Watershed..... 3-64

Figure 3-61 Aluminum Results from Seasonal Monitoring Events in the Antelope Creek Watershed..... 3-64

Figure 3-62 Barium Results from Seasonal Monitoring Events in the Antelope Creek Watershed..... 3-65

Figure 3-63 Copper Results from Seasonal Monitoring Events in the Antelope Creek Watershed..... 3-65

Figure 3-64 Zinc Results from Seasonal Monitoring Events in the Antelope Creek Watershed..... 3-65

Figure 3-65 Temperature and Dissolved Oxygen Results from Seasonal Monitoring Events in Secret Ravine Watershed 3-67

Figure 3-66 pH, Hardness, and Alkalinity Results from Seasonal Monitoring Events in the Secret Ravine Watershed 3-68

Figure 3-67 Turbidity Results from Seasonal Monitoring Events in The Secret Ravine Watershed..... 3-69

Figure 3-68 Specific Conductivity Results from Seasonal Monitoring Events in the Secret Ravine Watershed 3-69

Figure 3-69 Calcium Results from Seasonal Monitoring Events in the Secret Ravine Watershed..... 3-69

Figure 3-70 Iron Results from Seasonal Monitoring Events in the Secret Ravine Watershed..... 3-70

Figure 3-71 Magnesium Results from Seasonal Monitoring Events in the Secret Ravine Watershed..... 3-70

Figure 3-72 Sodium Results from Seasonal Monitoring Events in the Secret Ravine Watershed..... 3-71

Figure 3-73 Chloride Results from Seasonal Monitoring Events in the Secret Ravine Watershed..... 3-71

Figure 3-74 Sulfate Results from Seasonal Monitoring Events in the Secret Ravine Watershed..... 3-71

Figure 3-75 Aluminum Results from Seasonal Monitoring Events in the Secret Ravine Watershed..... 3-72

Figure 3-76 Barium Results from Seasonal Monitoring Events in the Secret Ravine Watershed..... 3-72

Figure 3-77 Copper Results from Seasonal Monitoring Events in the Secret Ravine Watershed..... 3-73

Figure 3-78 Zinc Results from Seasonal Monitoring Events in the Secret Ravine Watershed..... 3-73

Figure 3-79 Temperature and Dissolved Oxygen Results from Seasonal Monitoring Events in Miners Ravine Watershed 3-75

Figure 3-80 pH, Alkalinity, and Hardness Results from Seasonal Monitoring Events in the Miners Ravine Watershed 3-76

Figure 3-81 Turbidity Results from Seasonal Monitoring Events in The Miners Ravine Watershed..... 3-77

Figure 3-82 Specific Conductivity Results from Seasonal Monitoring Events in the Miners Ravine Watershed 3-78

Figure 3-83 Calcium Results from Seasonal Monitoring Events in the Miners Ravine Watershed..... 3-78

Figure 3-84 Iron Results from Seasonal Monitoring Events in the Miners Ravine Watershed..... 3-79

Figure 3-85 Magnesium Results from Seasonal Monitoring Events in the Miners Ravine Watershed..... 3-79

Figure 3-86 Potassium Results from Seasonal Monitoring Events in the Miners Ravine Watershed..... 3-79

Figure 3-87 Sodium Results from Seasonal Monitoring Events in the Miners Ravine Watershed..... 3-80

Figure 3-88 Chloride Results from Seasonal Monitoring Events in the Miners Ravine Watershed..... 3-80

Figure 3-89 Nitrate Results from Seasonal Monitoring Events in the Miners Ravine Watershed..... 3-81

Figure 3-90 Sulfate Results from Seasonal Monitoring Events in the Miners Ravine Watershed..... 3-81

Figure 3-91 Aluminum Results from Seasonal Monitoring Events in the Miners Ravine Watershed..... 3-82

Figure 3-92 Barium Results from Seasonal Monitoring Events in the Miners Ravine Watershed..... 3-82

Figure 3-93 Copper Results from Seasonal Monitoring Events in the Miners Ravine Watershed..... 3-83

Figure 3-94 Zinc Results from Seasonal Monitoring Events in the Miners Ravine Watershed..... 3-83

Figure 3-95 Zone 3 Soils Map 3-87

Figure 3-96 Upper Zone 1 Soils Map 3-91

Figure 3-97 Lower Zone 1 Soils Map..... 3-93

Figure 3-98 Zone 5 Soils Map 3-97

Figure 3-99 Zone 3 Land Cover Types..... 3-101

Figure 3-100 Upper Zone 1 Land Cover Types..... 3-103

Figure 3-101 Lower Zone 1 Land Cover Types 3-105

Figure 3-102 Zone 5 Land Cover Types..... 3-107

Figure 3-103 Comparison of Benthic Index of Biotic Integrity Scores at Stream Sites in the PCWA Service Area.....	3-112
Figure 3-104 Zone 3 Designated Critical Habitat, California Natural Diversity Database Special Status Species Occurrences, and Habitat Complexes	3-121
Figure 3-105 Upper Zone 1 Designated Critical Habitat, California Natural Diversity Database Special Status Species Occurrences, and Habitat Complexes.....	3-123
Figure 3-106 Lower Zone 1 Designated Critical Habitat, California Natural Diversity Database Special Status Species Occurrences, and Habitat Complexes.....	3-125
Figure 3-107 Zone 5 Designated Critical Habitat, California Natural Diversity Database Special Status Species Occurrences, and Habitat Complexes	3-127
Figure 3-108 Major Life Stages of Fall-Run Chinook and Central Valley Steelhead in Auburn Ravine and Dry Creek Watershed During a Water Year	3-135
Figure 5-1 Canal Outlet and Secret Ravine Responses to Yearly Outages	5-3
Figure 5-2 Canal Outlet and Miners Ravine Responses to Yearly Outages	5-4
Figure 5-3 Operations and Maintenance Activity Water Quality Sampling Locations Within the Upper Zone 1 Service Area.....	5-7
Figure 5-4 Operations and Maintenance Activity Water Quality Sampling Locations Within the Lower Zone 1 Service Area	5-9
Figure 5-5 Measured Turbidity Values at Secret Ravine Watershed Sites During October 2007 Yearly Outage Sampling Event.....	5-15
Figure 5-6 Measured Copper Concentrations at Secret Ravine Watershed Sites During the October 2007 Yearly Outage Sampling Event.....	5-16
Figure 6-1 Canal Outlet and Secret Ravine Responses to Canal Cleaning and Flushing Activities	6-3
Figure 6-2 Canal Outlet and Miners Ravine Responses to Canal Cleaning and Flushing Activities	6-3
Figure 6-3 Precipitation at China Garden Road Gage During March 2006	6-4
Figure 6-4 Measured pH Levels at Miners Ravine Watershed Sites During March 27, 2007, Canal Cleaning Event.....	6-9
Figure 6-5 Measured Aluminum Levels at Miners Ravine Watershed Sites During March 15, 2007, Canal Cleaning Event	6-10
Figure 6-6 Measured Aluminum Levels at Miners Ravine Watershed Sites During March 26, 2007, Canal Cleaning Event	6-11
Figure 6-7 Measured Aluminum Levels at Miners Ravine Watershed Sites During March 27, 2007, Canal Cleaning Event	6-11
Figure 6-8 Measured Barium Levels at Miners Ravine Watershed Sites During March 26, 2007, Canal Cleaning Event	6-12
Figure 6-9 Measured Barium Levels at Miners Ravine Watershed Sites During March 27, 2007, Canal Cleaning Event	6-13
Figure 6-10 Measured Copper Levels at Miners Ravine Watershed Sites During March 15, 2007, Canal Cleaning Event	6-13

Figure 6-11 Measured Zinc Levels at Miners Ravine Watershed Sites During March 15, 2007, Canal Cleaning Event..... 6-14

Figure 6-12 Daily Air Temperatures and Precipitation Before Soil Sampling for Canal Cleaning Events 6-16

Figure 6-13 Measured pH Levels at Secret Ravine Watershed Sites During May 16, 2007, and August 15, 2007, Algaecide Application Events 6-25

Figure 6-14 Measured Copper Levels at Secret Ravine Watershed Sites During May 16, 2007, Algaecide Application Event 6-26

Figure 6-15 Measured Copper Levels at Secret Ravine Watershed Sites During August 15, 2007, Algaecide Application Event 6-27

Figure 6-16 Canal Outlet and Secret Ravine Flow Responses to Canal Lining/Guniting Activities 6-34

Figure 6-17 Measured pH Levels at Clover Valley Creek Watershed Sites During February 16, 2007, Canal Lining Event 6-36

Figure 6-18 Measured Alkalinity Levels at Clover Valley Creek Watershed Sites During February 16, 2007, Canal Lining Event 6-37

Figure 6-19 Measured Hardness Levels at Clover Valley Creek Watershed Sites During February 16, 2007, Canal Lining Event 6-37

Figure 6-20 Measured Total Suspended Solids Levels at Clover Valley Creek Watershed Sites During February 16, 2007, Canal Lining Event..... 6-38

Figure 6-21 Measured Turbidity Levels at Clover Valley Creek Watershed Sites During February 16, 2007, Canal Lining Event 6-39

Figure 6-22 Measured Aluminum Levels at Clover Valley Creek Watershed Sites During February 16, 2007, Canal Lining Event 6-40

Figure 6-23 Measured Barium Levels at Clover Valley Creek Watershed Sites During February 16, 2007, Canal Lining Event 6-40

Figure 6-24 Measured Copper Levels at Clover Valley Creek Watershed Sites During February 16, 2007, Canal Lining Event 6-41

Figure 6-25 Measured Zinc Levels at Clover Valley Creek Watershed Sites During February 16, 2007, Canal Lining Event 6-41

Figure 6-26 Measured pH Levels at Secret Ravine Watershed Sites During March 20, 2007, Canal Lining Event 6-43

Figure 6-27 Measured pH Levels at Miners Ravine Watershed Sites During March 15, 2007, Canal Lining Event 6-45

Figure 6-28 Measured Aluminum Levels at Miners Ravine Watershed Sites During March 15, 2007, Canal Lining Event 6-46

Figure 6-29 Measured Barium Levels at Miners Ravine Watershed Sites During March 15, 2007, Canal Lining Event 6-47

Figure 6-30 Measured Copper Levels at Miners Ravine Watershed Sites During March 15, 2007, Canal Lining Event 6-47

Figure 6-31 Measured Zinc Levels at Miners Ravine Watershed Sites During March 15, 2007, Canal Lining Event 6-48

LIST OF TABLES

Table 2-1 PCWA Aquatic Herbicide and Algaecide Application Sites	2-31
Table 3-1 Baseline Water Quality Monitoring Locations in Major Streams and Drainages in the PCWA Raw Water Service Area	3-2
Table 3-2 Weather Conditions During and Before Water Quality Baseline Monitoring in the PCWA Raw Water Distribution Area	3-11
Table 3-3 Water Quality Parameters Measured During Baseline Water Quality Monitoring in the PCWA Raw Water Service Area	3-12
Table 3-4 Estimated Mean Monthly Flow for Auburn Ravine Near Highway 65 Bridge	3-26
Table 3-5 National Recommended Ambient Water Quality Criteria for Freshwater Aquatic Life	3-31
Table 3-6 Criteria for Priority Toxic Pollutants in the State of California for Select Parameters	3-31
Table 3-7 Basin Plan Water Quality Objectives For Basic Parameters Associated with Beneficial Uses.....	3-33
Table 3-8 Basin Plan Water Quality Objectives For Trace Elements Associated with Beneficial Uses.....	3-34
Table 3-9 Zone 3 Soils by Generalized Texture and Classification	3-86
Table 3-10 Zone 1 Soils by Generalized Texture and Classification	3-89
Table 3-11 Zone 5 Soils by Generalized Texture and Classification	3-95
Table 3-12 Fish Species Present in Auburn Ravine.....	3-110
Table 3-13 Benthic Index of Biotic Integrity for Sites at Auburn Ravine, Secret Ravine, and Miners Ravine	3-111
Table 3-14 Physical Habitat Scores for Benthic Macroinvertebrate Analyses at Auburn Ravine, Secret Ravine, and Miners Ravine.....	3-111
Table 3-15 Water Temperature Criteria for Chinook Salmon and Steelhead.....	3-114
Table 3-16 Fish Species Present in Antelope Creek.....	3-115
Table 3-17 Fish Species Present in Secret Ravine and Miners Ravine	3-117
Table 3-18 Known Special Status Species Occurrences in Zones 1, 3, and 5.....	3-129
Table 3-19 Special Status Species Potentially Occurring in Zones 1, 3, and 5.....	3-133
Table 5-1 Continuous Flow Monitoring Stations in Zone 1 for Operations.....	5-2
Table 5-2 Water Quality Monitoring Locations in the PCWA Service Area for Yearly Outage Events	5-6
Table 5-3 Summary of Regulatory Framework and Potential Best Management Practices that may Apply to PCWA Operations Activities	5-29
Table 6-1 Continuous-Flow Monitoring Stations in Zone 1 for Maintenance	6-2
Table 6-2 Canals Outages for Cleaning and Flushing During 2006.....	6-2
Table 6-3 Water Quality Monitoring Locations in the PCWA Service Area for Canal Cleaning Activities.....	6-5

Table 6-4 Quality of Sediments Removed from Canals During Cleaning and Flushing
Activities 6-15

Table 6-5 Geometric Mean Concentrations of Cadmium, Copper, and Zinc in Soils..... 6-17

Table 6-6 Examples of Adverse Effects with Copper to Salmonids 6-21

Table 6-7 Water Quality Monitoring Locations for Algaecide Applications at Boardman
Canal Below Mammoth Reservoir..... 6-24

Table 6-8 Water Quality Monitoring Locations in the PCWA Service Area for Herbicide
Application..... 6-30

Table 6-9 Canal Outages for Canal Lining/Gunite During 2006..... 6-33

Table 6-10 Water Quality Monitoring Locations in the PCWA Service Area for Canal
Lining/Guniting Activities 6-35

Table 6-11 Summary of Regulatory Framework and Potential Best Management Practices
Applicable To PCWA Maintenance Activities 6-57

ABBREVIATIONS AND ACRONYMS

°C	degrees Celsius
°F	degrees Fahrenheit
µg/L	micrograms per liter
315BDD	Boardman Canal near Laird Pump, downstream
315BDU	Boardman Canal near Laird Pump, upstream
ACL	Administrative Civil Liability
ANTC3B	Antelope Creek watershed at Antelope Creek at Midas Avenue
ANTCA	Antelope Canal
ANTCR	Antelope Canal Outlet Release
ANTSTUBCR	Antelope Stub Canal near Antelope Canal
ARPS	American River Pump Station
AUBRAV3	Auburn Ravine below Auburn Ravine Tunnel outlet
Basin Plan	Water Quality Control Plan for the Sacramento and San Joaquin Rivers
BAUGHMANCR	Baughman Canal Outlet Release
Bay-Delta	San Francisco Bay/Sacramento-San Joaquin Delta
BCTRIB1	Tributary to Miners Ravine from Baughman Canal
B-IBI	benthic index of biotic integrity
BMI	benthic macroinvertebrate
BMP	best management practice
BO	Biological Opinion
BOARDMANCR	Boardman Canal Outlet Release
Ca ²⁺	calcium ion
CaCO ₃	calcium carbonate
CARP	County Aquatic Resources Program
CCC	Criteria Continuous Concentration
CEQA	California Environmental Quality Act
CFR	Code of Federal Regulations
cfs	cubic feet per second

Cl ⁻	chloride ion
CLVRC3	Clover Valley Creek at Midas Avenue
CLVRC3B	Clover Valley Creek near Argonaut Avenue
CLVRC6	Clover Valley Creek at Rawhide Road
CLVRESR	Clover Valley Reservoir Release to Clover Valley Creek and Antelope Canal
CMC	Criteria Maximum Concentration
CNDDB	California Natural Diversity Database
CNPS	California Native Plant Society
CO ₂	carbon dioxide
CTR	California Toxics Rule
CVCWA	Central Valley Clean Water Association
CWA	Clean Water Act
DCC	Dry Creek Conservancy
DFG	California Department of Fish and Game
DO	dissolved oxygen
DPR	Department of Pesticide Regulation
DWR	California Department of Water Resources
EFH	Essential Fish Habitat
EIR	environmental impact report
EPA	U.S. Environmental Protection Agency
ESA	Endangered Species Act
Fe ²⁺	iron
FIFRA	Federal Insecticide, Fungicide, and Rodenticide Act
FR	Federal Register
FRAP	California Department of Forestry and Fire Protection Fire and Resource Assessment Program
FRGCR	Ferguson Canal Outlet Release
FRGTRIB1	Tributary to Miners Ravine from Ferguson Canal
GIS	Geographic Information System
grams/year	grams per year

HANSENR	Hansen Outlet Release
HCO ₃ ⁻	bicarbonate ion
HCP	Habitat Conservation Plan
IBI	index of biotic integrity
K ⁺	potassium ion
MFP	Middle Fork Project
mg/L	milligrams per liter
Mg ²⁺	magnesium ion
MgCl ₂	magnesium chloride
mgd	million gallons per day
MINERSRV3	Miners Ravine at North Sunrise Avenue
MINERSRV4	Miners Ravine at Auburn-Folsom Road
MINERSRV5	Miners Ravine at Moss Lane
MINERSRV6	Miners Ravine at Dick Cook Road
MINERSRV7	Miners Ravine at Lomida Lane
MND	Mitigated Negative Declaration
mS/cm	milliSiemens per centimeter
MS4	Municipal Separate Storm Sewer System Permits
msl	mean sea level
Na ⁺	sodium ion
NaCl	sodium chloride
NCCP	Natural Community Conservation Plan
ND	Negative Declaration
ND	No Date
NEPA	National Environmental Policy Act
NID	Nevada Irrigation District
NMFS	National Marine Fisheries Service
NOP	notice of preparation
NPDES	National Pollutant Discharge Elimination System
NPPA	California Native Plant Protection Act

NRMP	Natural Resources Management Plan
NTR	National Toxics Rule
NTU	nephelometric turbidity unit
O&M	operations and maintenance
OEHHA	Office of Environmental Health Hazard Assessment
PCCP	Placer County Conservation Plan
PCFCWCD	Placer County Flood Control and Water Conservation District
PCWA	Placer County Water Agency
PG&E	Pacific Gas and Electric
PO ₄	orthophosphate
RWQCB	Regional Water Quality Control Board
SC	specific conductivity
SCWA	Sacramento County Water Agency
SECRETRV2	Secret Ravine at Roseville Parkway
SECRETRV3	Secret Ravine at Rocklin Road
SMD	Sewer Maintenance District
SO ₄ ²⁻	sulfate ion
SWMP	Stormwater Management Plan
SWPPP	Stormwater Pollution Prevention Plan
SWRCB	State Water Resources Control Board
TBEE	butoxyethyl ester
TDS	total dissolved solids
TSS	total suspended solids
USACE	U.S. Army Corps of Engineers
USC	United States Code
USDA-NRCS	U.S. Department of Agriculture Natural Resource Conservation Service
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
UV	ultraviolet
WDY	water delivery year

WHR	California Wildlife Habitat Relationship
WTP	water treatment plant
WWTP	wastewater treatment plant
YANKEE CR	Yankee Hill Canal Outlet Release
YB	Yuba-Bear
YB145	Baughman Canal at the Head of Ferguson Canal
YB154	Boardman Canal at the Head of Turner Canal
YB69A	Boardman Canal at Lubeck Road
YB78	Boardman Canal at Powerhouse Road
YB81	Boardman Canal below Mammoth Reservoir
YB96	Boardman Canal below Lake Alta
YB145	Baughman Canal at the Head of Ferguson Canal
YB154	Boardman Canal at the Head of Turner Canal
YHTRIB2	Tributary to Secret Ravine from Yankee Hill Canal

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CHAPTER 1.0 INTRODUCTION

Development of a Natural Resources Management Plan (NRMP) was initiated by Placer County Water Agency (PCWA) and the U.S. Army Corps of Engineers (USACE) for operations and maintenance (O&M) activities within PCWA's raw water distribution system. This NRMP describes natural resources conditions along the PCWA distribution system and in the region, regulatory requirements for system O&M, potential effects of O&M activities on natural resources conditions, and identifies best management practices (BMP) for PCWA O&M activities.

1.1 STUDY AREA LOCATION AND DESCRIPTION

The study area for the NRMP includes the PCWA raw water distribution system, shown in **Figure 1-1**, and natural resources in the region that may be affected by PCWA O&M activities conducted within the raw water distribution system. This includes areas adjacent to canals and reservoirs, as well as drainages and streams used for conveyance of water to PCWA customers, and streams that may receive flow contributions from the canal system through regulated or unregulated releases from canal outlets. Streams in the study area include Canyon Creek, Auburn Ravine, Clover Valley Creek, Antelope Creek, Secret Ravine, and Miners Ravine.

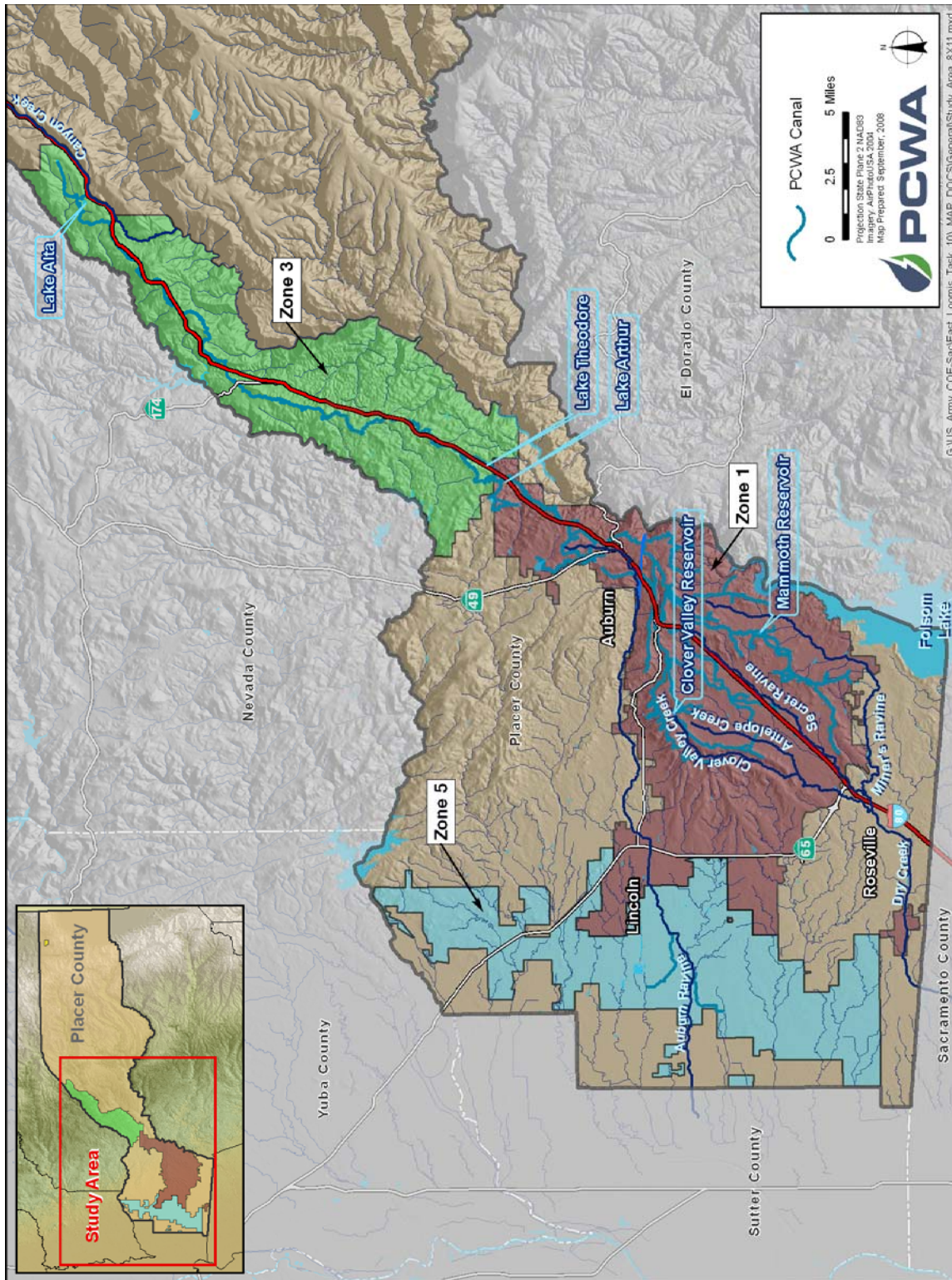
1.2 PURPOSE

The purpose of the NRMP is to provide a clear understanding of the regulatory setting for the canal system and receiving waters, and to identify how PCWA canal system O&M activities may affect natural resources conditions within and near the PCWA service area. This plan is intended to help PCWA staff identify BMPs that may assist in minimizing the effects of O&M activities on natural resources conditions.

1.3 REPORT ORGANIZATION

This plan includes the following topics:

- Background, study area location, descriptions, authorization, purpose, scope, and report organization (**Chapter 1**)
- Description of the PCWA raw water distribution system, and systemwide O&M activities (**Chapter 2**)
- Description of the physical and biological resources in the study area (**Chapter 3**)
- Description of the regulatory requirements potentially related to O&M activities (**Chapter 4**)



**FIGURE 1-1
STUDY AREA**

- Description of the potential effects of systemwide operations on natural resources conditions, regulatory framework for operations activities, and potential BMPs to minimize effects of operations activities on natural resources in the study area (**Chapter 5**)
- Description of the potential effects of maintenance activities on natural resources conditions, regulatory framework for maintenance activities, and potential BMPs to minimize effects of maintenance activities on natural resources in the study area (**Chapter 6**)
- Description of the potential effects of interrelated PCWA O&M activities on natural resources conditions, regulatory framework for interrelated PCWA O&M activities, and potential BMPs to minimize effects of interrelated activities on natural resources in the study area (**Chapter 7**)
- A list of the sources used in preparing this report (**Chapter 8**)

This plan is augmented by the following appendices:

- Appendix A – Benthic Macroinvertebrate Data Report
- Appendix B – Water Quality Conditions for Systemwide Operations
- Appendix C – Water Quality Conditions During Maintenance Activities

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CHAPTER 2.0

PCWA RAW WATER DISTRIBUTION SYSTEM

The PCWA water system was established in 1968. Water is marketed through various water contracts and five zones. Currently, PCWA supplies wholesale and retail water to a resident population and employment base of more than 1 million people. A significant amount of raw water irrigates pastures, orchards, rice fields, farms, ranches, golf courses, and is used for other uses. PCWA retails treated water to customers residing in Alta, Colfax, Auburn, Loomis, Rocklin, small portions of Roseville, Penryn, Newcastle, and in the vast unincorporated areas of western Placer County. PCWA also wholesales treated water to the City of Lincoln and several smaller special districts that then retail it to their customers. Raw water is sold to the City of Roseville, San Juan Water District (for the Granite Bay area), and special districts such as the Sacramento Suburban Water District (Sacramento Suburban, formerly Northridge Water District) that provide their own treatment and then retail water to their customers.

The following sections describe sources of PCWA's water supply, PCWA's raw water distribution system, operations of the system, and maintenance activities.

2.1 WATER SOURCES

PCWA's raw water distribution system is physically tied to Pacific Gas and Electric's (PG&E) Drum-Spaulding Project, through multiple power generation facilities, reservoirs, and water purchase points (buy points). PCWA holds water rights up to about 40 cubic feet per second (cfs) on Canyon Creek. Additional raw water supplies are pumped from the American River and delivered to customers in the lower Zone 1 and/or Zone 5 service areas. The following sections describe PCWA's water supply sources.

2.1.1 PG&E Drum-Spaulding Project

PG&E's Drum-Spaulding Project supply originates from the upper Yuba River Basin, augmented by Bowman Lake and Lake Spaulding on the South Yuba River and Rollins Reservoir on the Bear River. The water supply is conveyed primarily via the Drum, Bear River, and Upper Boardman canals. PG&E operates the Drum-Spaulding Project mainly for hydropower purposes. The majority of raw water deliveries to PCWA depend wholly on PG&E operations.

The 1968 PCWA-PG&E Water Supply Contract, as amended in 1996, provides for a maximum annual supply of 100,400 acre-feet of Zone 1 water at specified prices to be delivered through designated points at a total combined delivery rate not in excess of 244.8 cfs. PCWA also has a separate water supply contract with PG&E for an additional 25,000 acre-feet of water for PCWA's Zone 3 service area. PCWA is responsible for supplying reasonably adequate storage to meet the minimum essential requirements of its customers during any interruptions of service from PG&E, and PG&E is not liable for the insufficiency or interruption of water during droughts or as a result of certain natural or human causes.

The PG&E supply is purchased and delivered through the PG&E Towle, Bear River, Wise, and South canals at authorized buy points (points of delivery).

2.1.2 Middle Fork Project and American River Pump Station

The Middle Fork Project (MFP) is a multipurpose project designed to conserve and control waters of the Middle Fork American River, the Rubicon River, and certain tributaries for irrigation, domestic, commercial, and recreational purposes, and for the generation of electricity.

Principal MFP features include two storage reservoirs (French Meadows and Hell Hole), five diversion dams, five hydroelectric power plants, diversion and water transmission facilities, five tunnels, and related facilities. Through its MFP storage rights, PCWA has physical control of more water than it has the right to consumptively divert.

The authorized diversion points for the PCWA MFP supply are at the Auburn Dam site on the North Fork American River and Folsom Lake. When the MFP was constructed in the 1960s, the Auburn Ravine Tunnel and a 50-cfs pumping plant on the North Fork American River were installed to enable PCWA to pump water from the American River. Modifications to the Auburn Ravine Tunnel and removal of the pumping plant occurred later in anticipation of the construction of the Auburn Dam. The current facility at Auburn Dam site is a permanent pumping station installed by the U.S. Department of Interior, Bureau of Reclamation.

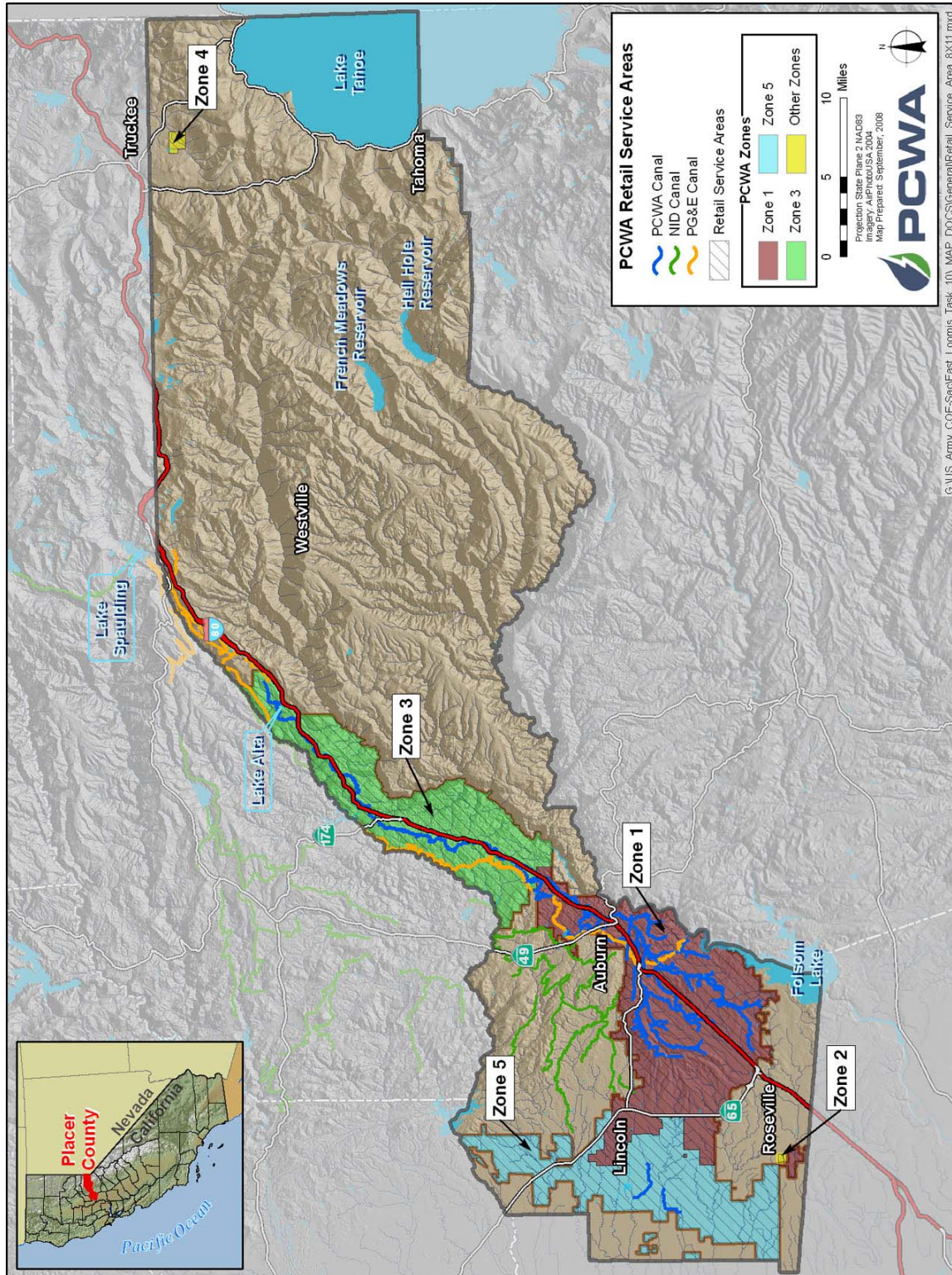
The permanent American River Pump Station (ARPS) is used to pump water from the North Fork of the American River into the Auburn Ravine Tunnel. The Auburn Ravine Tunnel discharges into the Auburn Ravine, a natural water course, to deliver raw water to the agricultural customers in the Zone 5 service area. The ARPS has a design capacity of 100 cfs, equivalent to an annual supply of 35,000 acre-feet. Water can be pumped out of the Auburn Ravine Tunnel into the PG&E South Canal through the Auburn Ravine Tunnel Pump Station (up to 100 cfs). This pumped water is mainly used to supply the Foothill Water Treatment Plant (WTP) with raw water during the annual PG&E Bear River canal maintenance, usually beginning in mid-October. Pumped water in excess of the Foothill WTP needs can be diverted for use at the PG&E buy points below Wise Powerhouse. Additional pump facilities are planned for the Auburn Ravine Tunnel Pump Station that will pump water from the Auburn Ravine Tunnel to supply the future Ophir WTP.

2.2 PCWA CANAL SYSTEM

The PCWA canal system contains approximately 165 miles of canals and ditches that carry about 65,000 acre-feet annually to meet the irrigation water demands of about 4,000 customers. The canals also convey raw water to water treatment plants within PCWA service areas.

Approximately 51 miles of the entire canal system are lined with gunite, concrete, and/or are contained in pipelines. The remaining canal sections are unlined.

PCWA has established five retail zones for water delivery within Placer County (**Figure 2-1**):



**FIGURE 2-1
PCWA RETAIL SERVICE AREA ZONES**

- Zone 3 is a water system acquired from PG&E in 1982 that serves the areas along the Interstate 80 corridor extending from Alta to Bowman.
- Zone 1 was created in 1968 to finance the purchase of PG&E's Lower Drum Division Water System. This system provided water service to the communities of Auburn, Bowman, Ophir, Newcastle, Penryn, Loomis, Rocklin, and Lincoln and included five WTPs and associated storage and distribution systems. Zone 1 encompasses approximately 125 square miles. Today, Zone 1 includes territory under the land-use authorities of the Cities of Auburn, Rocklin, Lincoln, a portion of the City of Roseville, the Town of Loomis, and Placer County. Zone 1 is further broken up into Upper Zone 1 and Lower Zone 1 to delineate the higher elevation service areas of Auburn and Bowman from the remaining lower elevation areas.
- Zone 5 was created in 1999 and assumed the boundaries of Placer County Zone 29. It was created to reduce reliance on groundwater supplies by providing surface water for commercial agriculture in the westernmost section of Placer County. Zone 5 is served entirely by raw surface water supplies.
- Zone 2 was created in 1979 and provides retail water service to a small residential development of 47 units located southwest of the City of Roseville. Before 2003, Zone 2 was supplied groundwater by two wells. Zone 2 was connected to the City of Roseville's water supply pipeline in 2003, and now receives water supplies conveyed from Zone 1. Zone 2 is under the land-use authority of Placer County.
- Zone 4 was created in 1996 and is located in the unincorporated Martis Valley portion of eastern Placer County. Zone 4 is served entirely by groundwater.

Since Zone 2 is served by pipeline from Zone 1, and Zone 4 is served entirely by groundwater; these zones are not described or discussed further in this management plan. The remaining zones, described below, receive raw surface water supplies through open canals and pipes, which are mainly gravity fed, and which run from Alta to western Placer County.

2.2.1 Zone 3

PCWA's Zone 3, shown in **Figure 2-2**, is located at the northeastern end of the canal system. The Zone 3 water system consists of a series of ditches, canals, and pipelines that extend approximately 35 miles above PCWA's Lake Theodore to PG&E's Alta Powerhouse. PCWA acquired these facilities from PG&E in 1982. The Boardman Canal is the main conveyance facility in the Zone 3 system.

2.2.2 Zone 1

Figures 2-3 and **2-4** show PCWA's Zone 1 service area. In addition to the PCWA supplies entering Zone 1 from Zone 3, PCWA obtains water supplies to meet customer demands in Zone 1 through purchases from PG&E just above Halsey forebay, and from Rock Creek Reservoir, Wise Canal, and South Canal. A portion of the raw water supply conveyed through Zone 1 is delivered to the Auburn, Bowman, Foothill, and Sunset WTPs for treatment and delivery to retail treated water customers, and the City of Lincoln, a wholesale treated water customer. Water for Zone 5 can be purchased at the designated PG&E buy point Yuba-Bear (YB) 136, below Wise Powerhouse, and diverted into Auburn Ravine for use by customers.

Raw water customers throughout the Zone 1 area are predominantly serviced through the Boardman, Caperton, Antelope, and Dutch Ravine canals, and numerous other canals fed from the Boardman Canal, including the Fiddler-Green, Greeley, Banvard, Sugarloaf, Red Ravine, Barton, Perry, and several other canals. The Dutch Ravine Canal, which receives flows from PG&E's South Canal, may either convey raw water to customers below in Zone 1, or during rare instances, supplement flows in Auburn Ravine for deliveries to raw water customers in the Zone 5 service area. The Auburn Ravine area within lower Zone 1 is shown in greater detail in **Figure 2-5**.

PCWA operates two regulating reservoirs within Zone 1 to manage deliveries to raw water customers. The Clover Valley Reservoir, which receives water flows from the Antelope Canal, releases water to the lower Antelope Canal, as well as the Antelope Stub Canal. Mammoth Reservoir receives water flows from the Boardman Canal, and releases to the Boardman Canal downstream. Several canals receive water flows from the Boardman Canal downstream from Mammoth Reservoir and make deliveries to raw water customers, including the Turner, Yankee Hill, Ferguson, Stallman, and Baughman canals.

The terminus of PCWA's raw water canal system in Zone 1 is the end of the Boardman Canal, located in northeastern Roseville.

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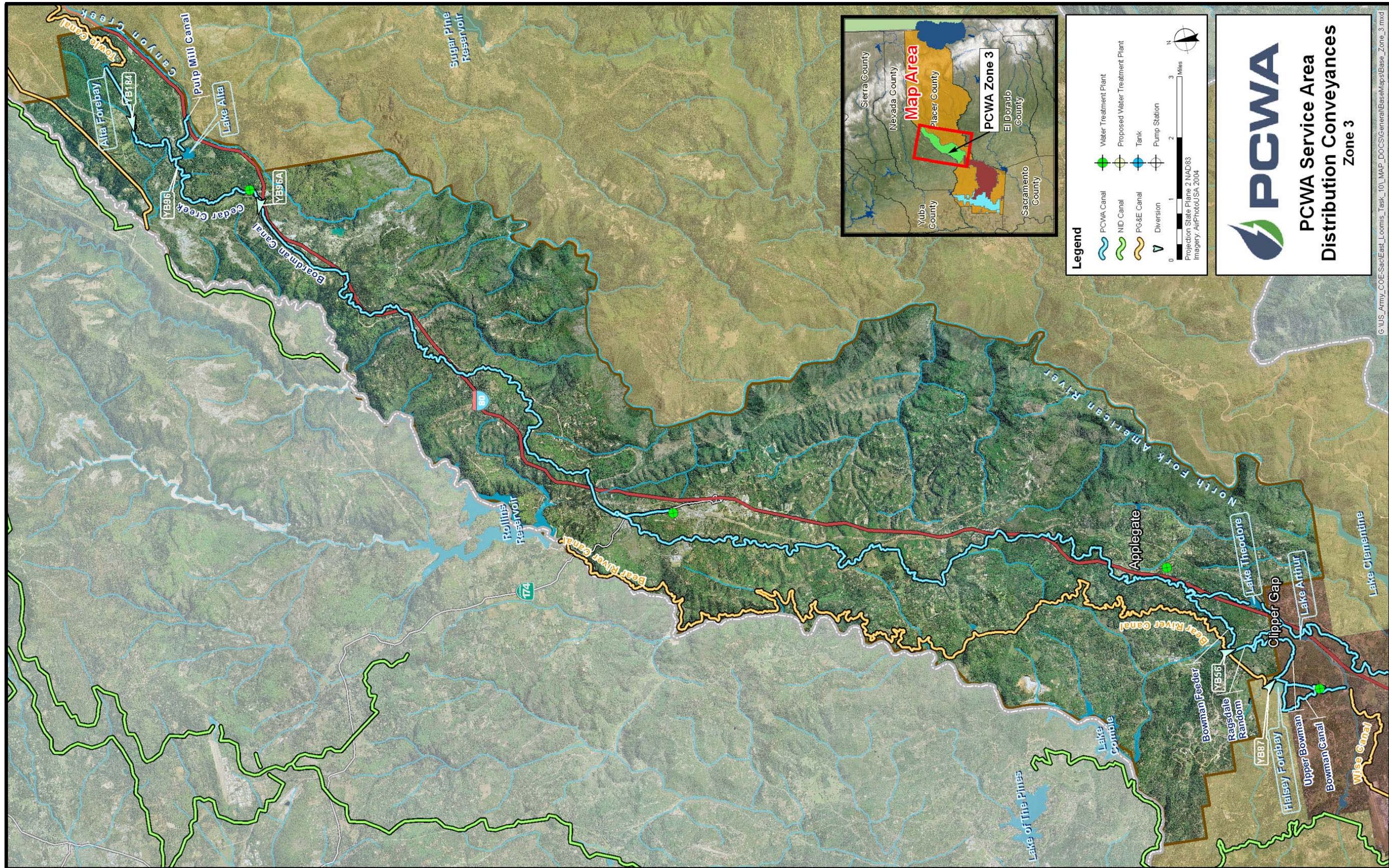


FIGURE 2-2
 PCWA ZONE 3 SERVICE AREA AND DISTRIBUTION CONVEYANCES

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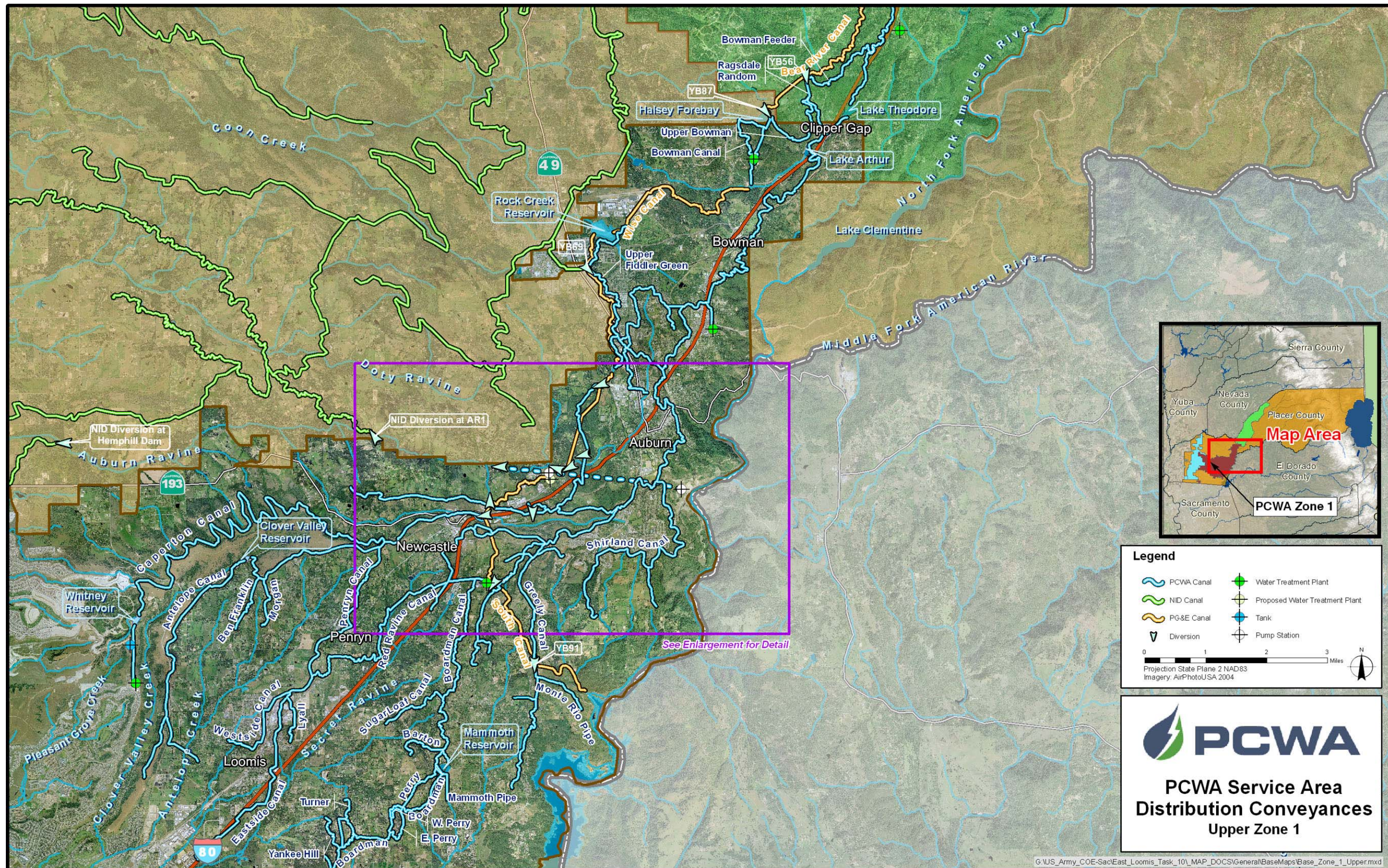


FIGURE 2-3
PCWA UPPER ZONE 1 SERVICE AREA AND DISTRIBUTION CONVEYANCES

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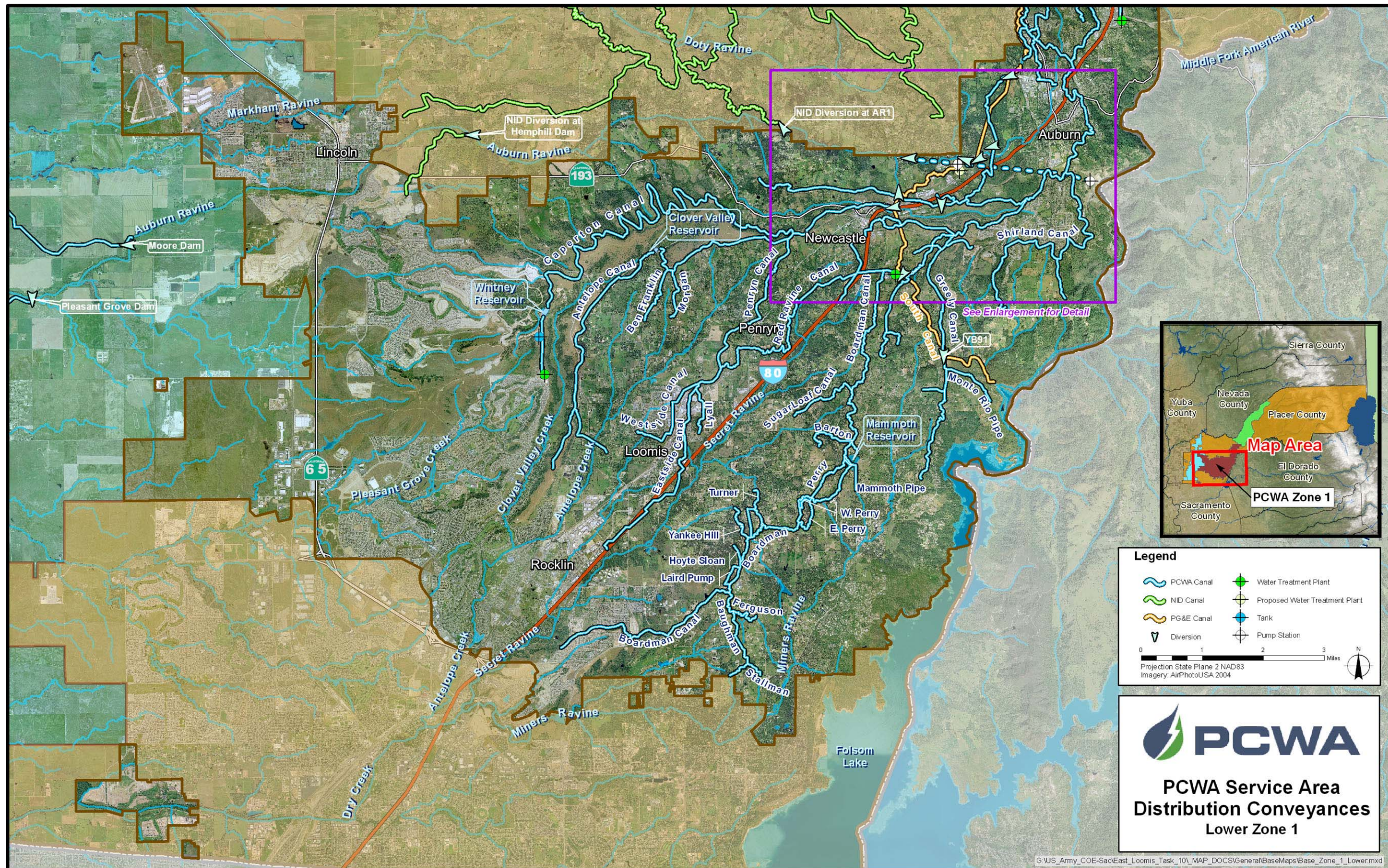


FIGURE 2-4
PCWA LOWER ZONE 1 SERVICE AREA AND DISTRIBUTION CONVEYANCES

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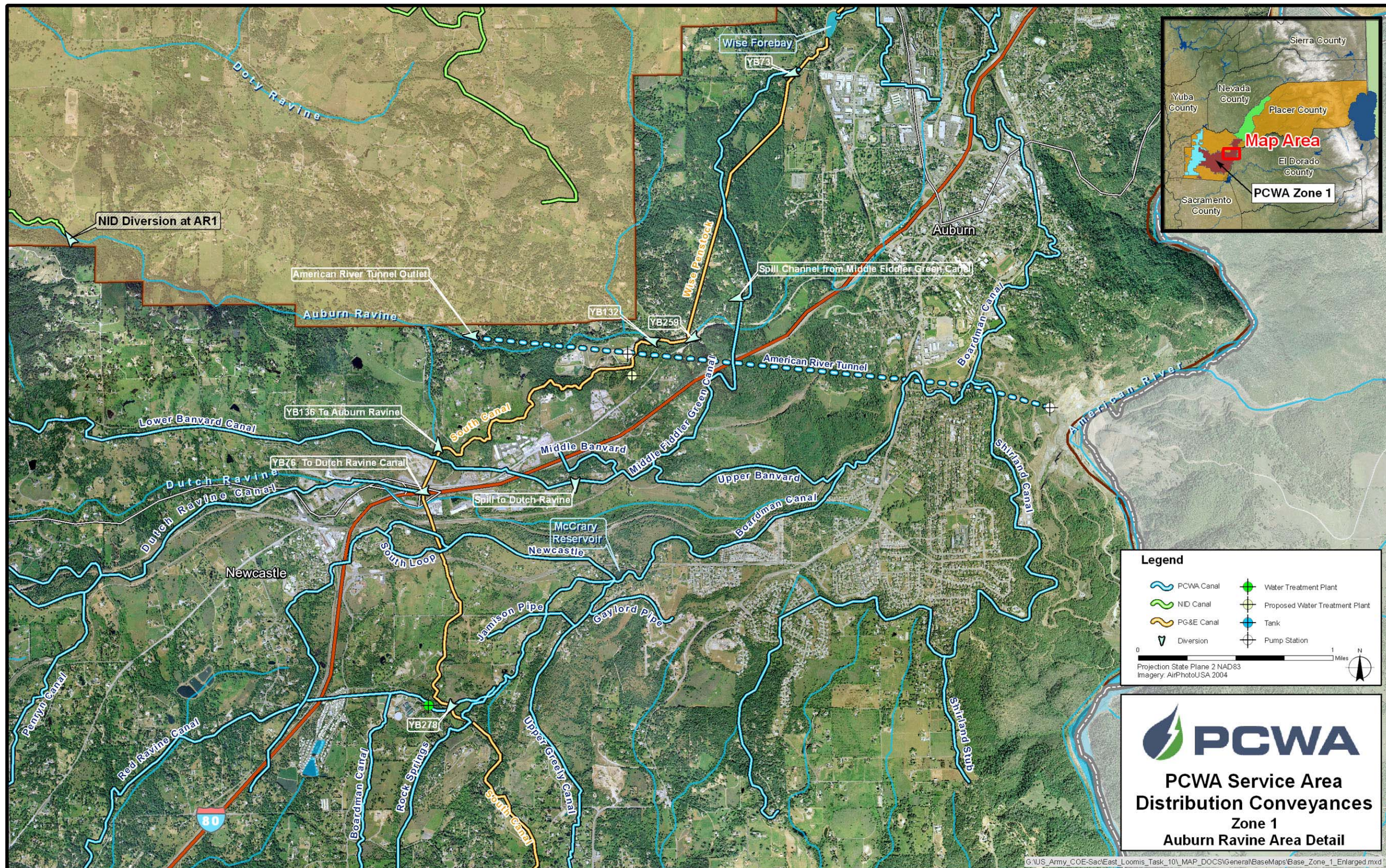


FIGURE 2-5
PCWA LOWER ZONE 1 AUBURN RAVINE AREA DISTRIBUTION CONVEYANCES

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2.2.3 Zone 5

The Zone 5 service area, shown in **Figure 2-6**, receives water deliveries from PG&E conveyed through Auburn Ravine, and delivered to customers along Auburn Ravine and canals used by the PCWA downstream. PCWA water supplies originating from either the South Fork Yuba and/or Bear River watersheds are purchased from PG&E and diverted to Auburn Ravine at a few locations downstream from PG&E Wise Penstock to meet raw water delivery demands in Zone 5. These diversions include the Dutch Ravine Canal, which receives flows from PG&E's South Canal and YB 136. PCWA may also deliver water to Zone 5 customers pumped from the North Fork of the American River through the ARPS and conveyed through the Auburn Ravine. The Nevada Irrigation District (NID) purchases water from PG&E below the Wise Powerhouse for release into Auburn Ravine. NID also releases water to Auburn Ravine from their North Canal, especially during the yearly PG&E outage.

Auburn Ravine is seasonally dammed at Moore Dam, where flows are diverted to Moore Canal for deliveries to PCWA Zone 5 customers. Further downstream, flows are diverted from Auburn Ravine for deliveries to PCWA Zone 5 customers at the Pleasant Grove Dam to the Pleasant Grove Canal. Several NID canals divert flows from Auburn Ravine with temporary and permanent control structures for deliveries to NID customers.

2.3 PCWA RAW WATER DISTRIBUTION SYSTEM OPERATIONS

The majority of the PCWA raw water distribution area is serviced by gravity flow through the canal system, as described above. Reservoirs provide flexibility in operations, allowing capture and storage of flow from portions of the upper system for release, as needed, to portions of the lower system. PCWA monitors regulating gates and staff gages throughout the system, and uses information collected to make decisions on purchase quantities from PG&E at either of the buy points described above, and adjusts deliveries in accordance with water demands and meteorological conditions.

2.3.1 Deliveries

PCWA's delivery schedules are for an entire year, or an irrigation season. The irrigation season is identified as April 15 to October 15. Water is sold to raw water customers by the miner's inch. One miner's inch equates to the flow of water through a 1-inch-square orifice with 6 inches of head, as shown in **Figure 2-7**. The purchase of 1 miner's inch of water for the irrigation season entitles the purchaser to 0.025 cfs, 24 hours a day, from April 15 to October 15. Most PCWA raw water customers receive their water from a service pipe that goes through the canal berm to their service box. Water deliveries to these customers equals the customer's real time raw water demand, with the number of miner's inches purchased being the maximum rate of delivery. Consequently, the actual delivery quantities through the service boxes are typically less than the quantity purchased.

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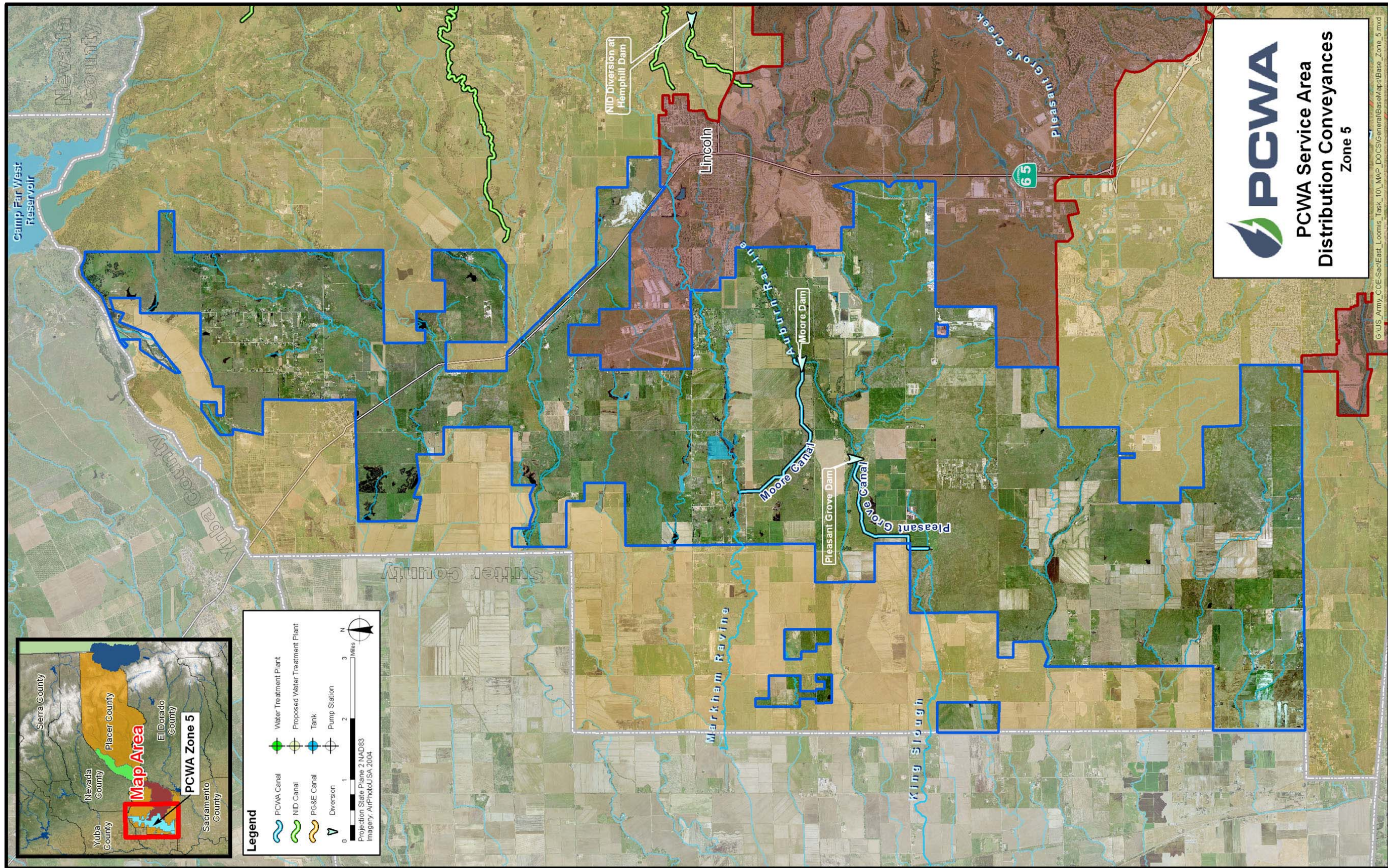


FIGURE 2-6
PCWA ZONE 5 SERVICE AREA AND DISTRIBUTION CONVEYANCES

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Orifices at delivery points may be intentionally or inadvertently removed or replaced, and/or enlarged at locations. Adjusting the size of the delivery orifice alters the rate of flow delivery at the location. Debris accumulation at a delivery orifice also affects the rate of flow, and may lead to decreases in raw water delivery quantities.

Raw water delivery purchases are associated with parcels. New customers in the PCWA service area are permitted to purchase a maximum of 0.5 miner's inch, or 0.0055 cfs, of raw water during the irrigation season, only. If a parcel is sold and service to that parcel is terminated, the new parcel owner is only permitted to purchase 0.5 miner's inch, or 0.0055 cfs, of raw water during the irrigation season.

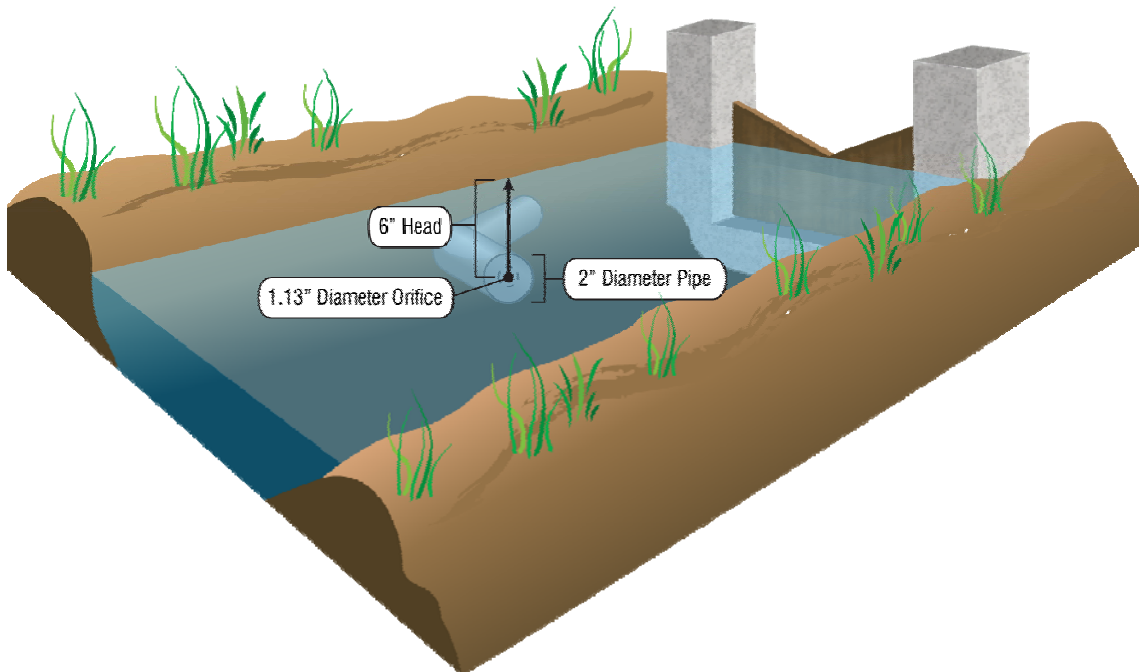


FIGURE 2-7
DELIVERY OF 1 MINER'S INCH TO PCWA CANAL SYSTEM CUSTOMERS

2.3.2 Operations

PCWA's raw water distribution is governed by customer demand and the availability of supplies. Regular operations activities occur on a yearly, seasonal, or more routine basis.

2.3.2.1 Yearly

PG&E implements an annual water delivery outage to PCWA while PG&E conducts maintenance on its system. The outage typically takes place from mid-October to mid-November, reducing water available to PCWA's Zone 1 customers from PG&E's Wise, Bear, and South canals. The amount of water available for raw water delivery depends on customer demands for treated water from PCWA's WTPs. Generally, treated water needs are met before raw water needs. During the PG&E outage, PCWA relies on stored water in surface reservoirs,

water bypassed through Zone 3, and water delivered through the ARPS to supplement flow to the WTPs and to canal customers. Water pumped from the North Fork American River through the ARPS is pumped again at PCWA's Auburn Ravine Tunnel Pump into PG&E's South Canal, and then diverted by PCWA at the Foothill WTP. Flow is greatly reduced in some areas within PCWA's raw water distribution system requiring alternative delivery schedules, such as rotating outages among canals.

2.3.2.2 Seasonal

As described previously, PCWA's delivery schedules are either for an entire year, or for an irrigation season. Depending on the purchased quantity of raw water, the orifice at each delivery point in the system may be changed before each delivery season (winter and summer). PCWA replaces the orifices at delivery points with delivery schedule changes for the irrigation season during the week of April 15, and after the irrigation season during the week of October 15. Schedule changes after the irrigation season take place during PG&E's annual water delivery outages. This activity takes about 1 week to complete, with minimal interruptions to service.

PCWA also performs flood management practices. Portions of the PCWA canal system are likely to receive and convey stormwater runoff during precipitation events, typically during the winter months. During high precipitation events that generate runoff and excess flows within the canal system, blockages along the canal cause overtopping and high water leaks develop. Resulting high canal flows may also cause bank erosion along unlined canals and at canal outlets, and can damage property. During these high precipitation events, PCWA personnel use selected outlet locations along the canals to release excess water for flood management.

2.3.2.3 Routine

Based on meteorological conditions and anticipated customer water demands, PCWA staff make operational decisions on purchase quantities from PG&E, as well as conveyance and storage decisions based on treated and raw water demands. Daily operations include reading water levels and flows at heads and ends of canals, and adjusting flows throughout the canal system, particularly at the reservoirs. Flows within the canals may be adjusted by canal operators through installing check boards, or temporary weirs, to alter head conditions and reduce or decrease diversions. PCWA's reservoirs allow for PCWA staff to make adjustments to outflows with a valve control. A limited number of pumps within the system are regularly visited by PCWA to check their operation and usage. Canal operators also frequently respond to customer requests related to canal deliveries through removing debris near delivery points, and installing or removing check boards to change head conditions at delivery locations.

2.4 PCWA RAW WATER DISTRIBUTION MAINTENANCE ACTIVITIES

PCWA performs scheduled canal maintenance in the canal system as needed and cleans the canal on an annual basis. Maintenance activities include cleaning debris from the canals, lining leaky canal sections, repairing damaged pipes and/or flumes, and controlling vegetative growth in the canals and on the canal berms through algaecide and herbicide applications. Cleaning is

performed during the winter months and is scheduled a month or more in advance. Canal lining is conducted throughout the year. Algaecide and herbicide applications are scheduled in advance and performed on a monthly or as-needed basis during the irrigation season.

2.4.1 Weed and Brush Control

PCWA has an extensive weed and brush control program for their canal distribution system that includes algaecide application to waters within the canals, physical removal of vegetation and/or herbicide applications along canal berms, and herbicide applications on aquatic vegetation in PCWA reservoirs. All algaecides and herbicides are applied by PCWA staff according to Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) label instructions and PCWA application plans. Before application, PCWA evaluates the potential impacts to environmental resources, and prepares an environmental compliance document to satisfy California Environmental Quality Act (CEQA) requirements. PCWA's weed and brush control programs are described below. All algaecide and herbicide applications are performed under the supervision of a California Department of Pesticide Regulations (DPR)-certified applicator at PCWA.

2.4.1.1 Physical Removal of Vegetation

PCWA staff periodically mow, disk, trim, and/or remove vegetation along canals. Physical removal of vegetation occurs on an as-needed basis.

2.4.1.2 Algaecide Application

The growth of algae and other submerged aquatic weeds in the canal system can reduce capacity and flow velocity, as well as clog screens, pipes, siphons, and delivery outlets. To control algae and other submerged aquatic weeds, an aqueous copper-based algaecide (Cutrine-Plus[®]) is applied throughout the system on a monthly basis beginning in April and continuing through the summer delivery season. Copper sulfate, a stronger algaecide, is applied as needed to areas with acute algae growth.

During 2007, PCWA initiated the application of Algimycin-PWF[®], also a copper-based algaecide, at select locations within the canal system upstream of WTPs. Water treated with Algimycin-PWF[®] does not cause increased chlorine demand, which is often a concern with the use of organic chelated copper algaecides in water treatment facilities (Applied Biogeochemists, 2007).

The aquatic weed control program is conducted under strict guidelines and supervised by a DPR-certified applicator and applied by DPR Qualified Applicators. PCWA maintains an application log for each of the sites shown in **Figures 2-8 to 2-11** and listed in **Table 2-1**. There are 21



Algae growth within Boardman Canal downstream of Mammoth Reservoir

established points of algaecide application within the system, with “spot” treatments at other locations as conditions warrant. The uppermost point of application is in the Boardman Canal as it leaves Lake Alta. The rate of application is based on the rate of flow at the point of application for the canal receiving the application and the amount of targeted vegetation growth.

The PCWA logs the following information during each aquatic pesticide application:

- Flow rate
- Application start time
- Application end time
- Pesticide(s) used
- Concentration
- Application rate
- Total amount applied
- Special-status species visually observed
- Environmental observations, including
 - Air temperature
 - Water temperature
 - Wind speed
 - Wind (calm, breezy, or windy)
 - Cloud cover (no clouds, partly cloudy, or overcast)
 - Precipitation (none, foggy, drizzle, rain, or snow)
 - Water clarity (clear water, cloudy water, or murky water)
 - Sample color (none, amber, yellow, green, brown, gray, other)
 - Sample odor (none, fresh algae smell, chlorine, sulfide, or sewage)
 - Other (algae, oily sheen, foam or suds, leaves, or trash)
- Any additional comments

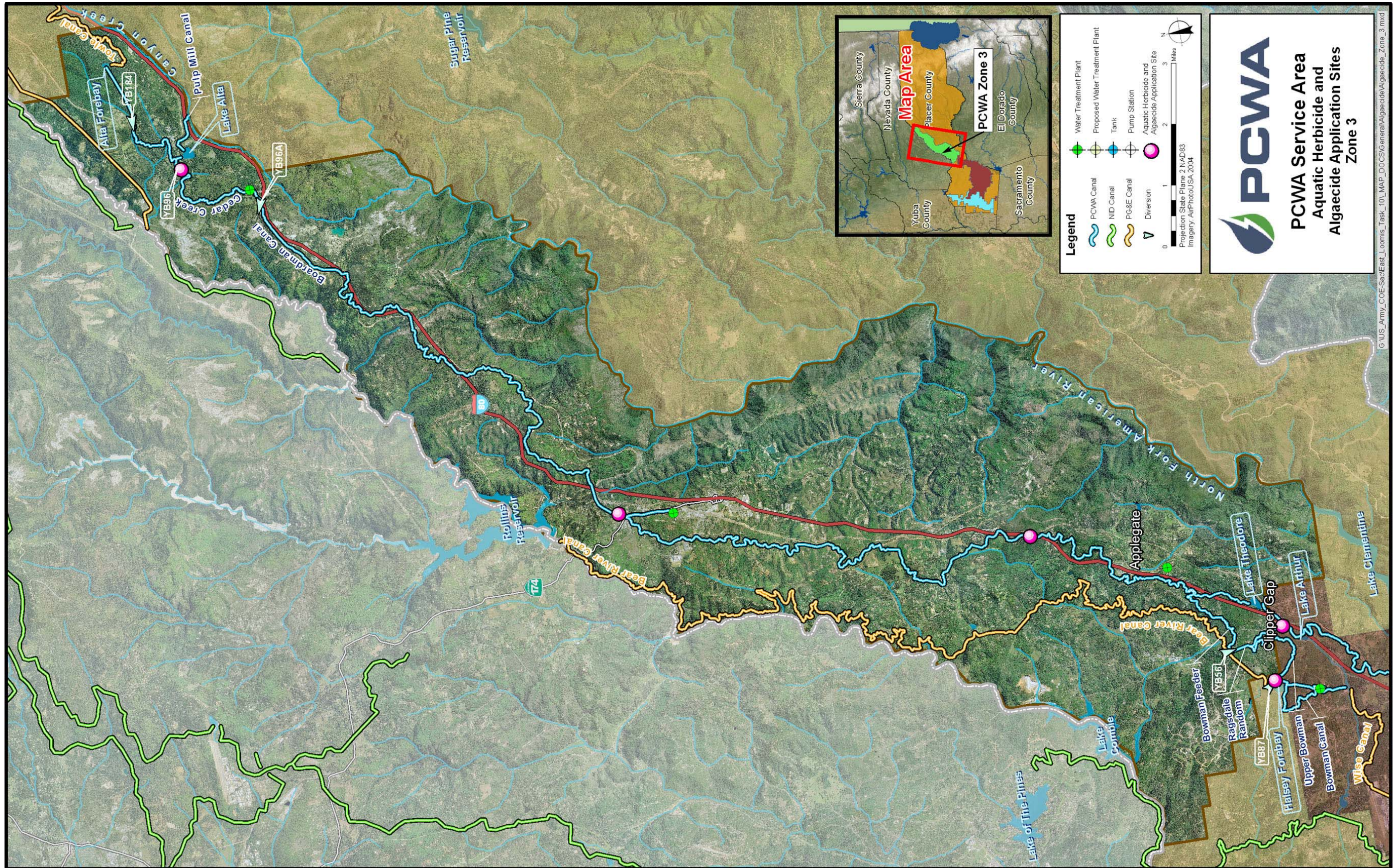
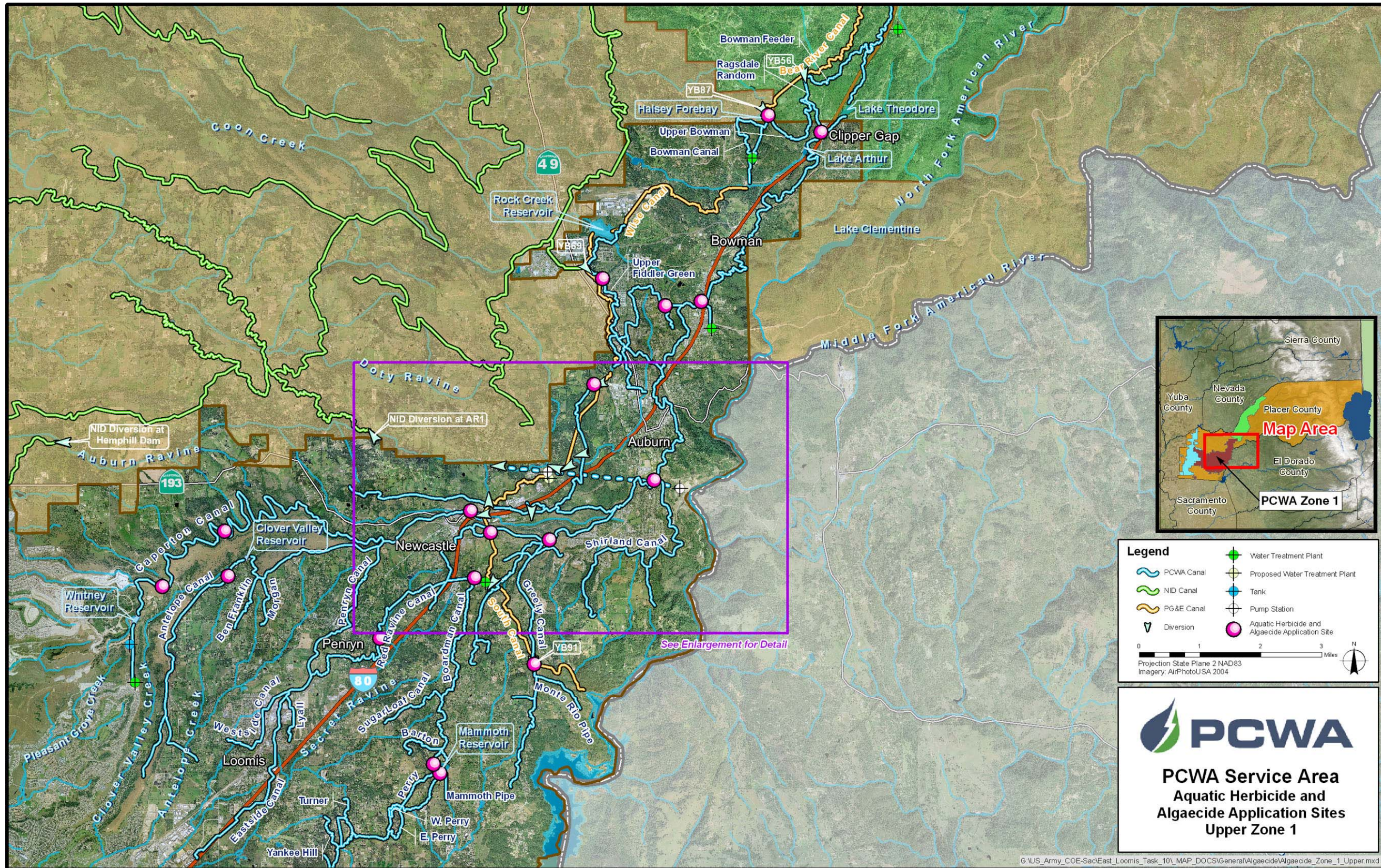
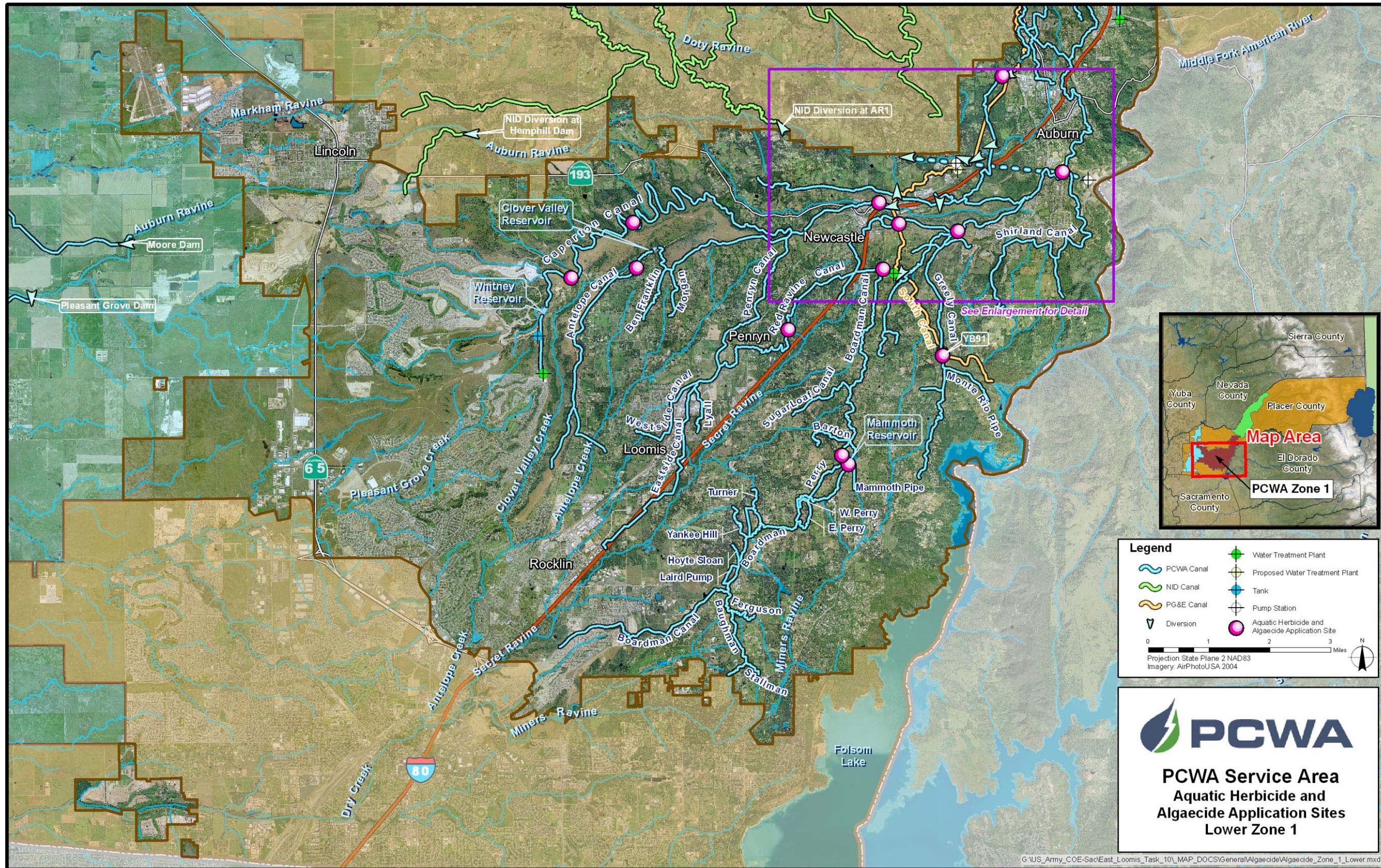


FIGURE 2-8
ZONE 3 AQUATIC HERBICIDE AND ALGAEICIDE APPLICATION SITES

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**FIGURE 2-10
LOWER ZONE 1 AQUATIC HERBICIDE AND ALGAEICIDE APPLICATION SITES**

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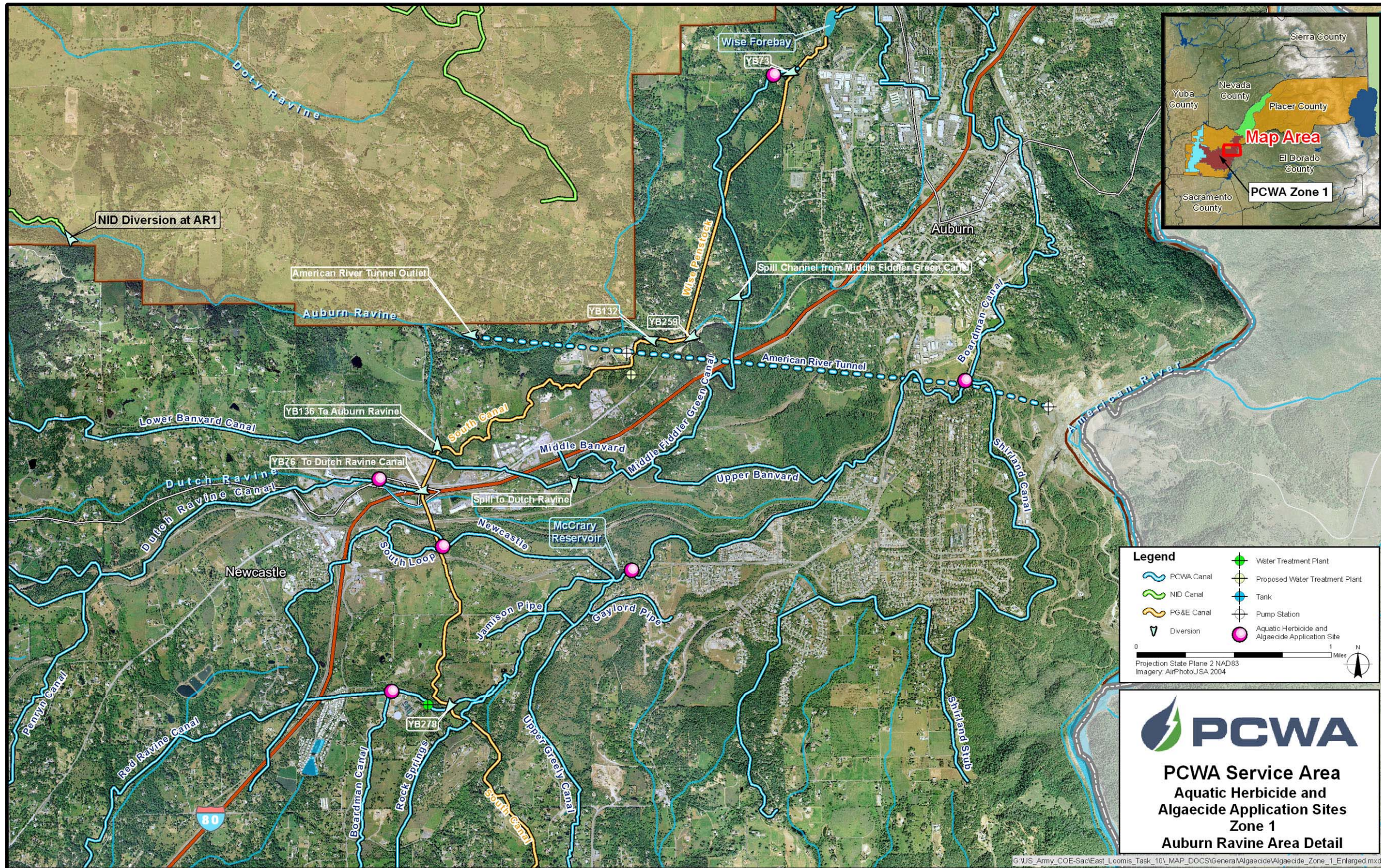


FIGURE 2-11
LOWER ZONE 1 AUBURN RAVINE AREA AQUATIC HERBICIDE AND ALGAECIDE APPLICATION SITES

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**TABLE 2-1
PCWA AQUATIC HERBICIDE AND ALGAEICIDE APPLICATION SITES**

Zone 3 Application Sites	Zone 1 Application Sites
Cedar Creek (YB 96)	Boardman Canal at Luther and Channel Hill Rd (356+05)
Boardman Canal at Colfax Header Box (YB 49)	Bowman Canal (YB 87)
Boardman Canal at Heather Glenn and 49er spill (1289+42)	Freeman and Shockley canals at Luther Rd (22+79)
Boardman Canal at Clipper Gap (YB 179) (Zone 1 application point)	Upper Fiddler Green at RR Spill (85+83)
	Boardman Canal at Foothill Water Treatment Plant (YB 78)
	Middle Fiddler Green Canal at Raccoon Hollow (16+40)
	Shirland Canal at Pacific (YB 147)
	Dutch Ravine Canal at Ridge and Taylor Rd (11+60)
	Boardman Canal at McCrary Reservoir (YB 92)
	Caperton Canal at Clark Tunnel Rd (316+80)
	Caperton Canal below Caperton Reservoir
	Newcastle Canal at Head of South Loop (50+92)
	Lower Greely Canal (YB 91)
	Red Ravine Canal at Gilardi Rd (126+45)
	Lower Antelope Canal and Antelope Stub Canal (194+05)
	Boardman Canal below Mammoth Reservoir (343+22)
	Perry Canal at Mammoth Drive and Hooter Spill (23+51)

Key:

YB = Pacific Gas and Electric Yuba-Bear Buy Point

Copper sulfate, Cutrine-Plus[®], and Algimycin-PWF[®] are toxic to fish. The toxicity to fish varies with the species and their developmental stage, and with the physical and chemical characteristics of the water. Copper toxicity to fish generally increases as water hardness and pH decreases (Pimental 1971). Fish eggs are more resistant than young fish fry to the toxic effects of copper sulfate (Gangstad 1986). Copper will bind to soil particles and organic matter in water and settle out of solution, but it will not degrade chemically or biologically. Cutrine-Plus[®], a chelated copper compound contains less copper than copper sulfate and because the copper is gradually released from its chelate, it is less toxic to fish than copper sulfate (Ross and Lembi 1985).

2.4.1.3 Herbicide Application

The growth of plants on canal berms can damage the berm through destabilizing the canal banks, as well as decrease canal flow velocities algal mat buildup can decrease canal flow capacities, and increase the accumulation of debris in the channel. Plant growth is controlled as needed with the application of herbicide. This is typically performed in the late spring at the beginning of the summer delivery season, when plants have emerged. Glyphosate and triclopyr herbicides are used in the PCWA system. Specific herbicides typically include Garlon4[™] (triclopyr), Rodeo[®] (glyphosate), Roundup[®] (glyphosate), or AquaMaster[™] (glyphosate). Applications usually involve a tank mix of herbicides to control the growth of different types of vegetation. PCWA also performs a pre-emergent application on the walking side of berms for the lower portion of the canal system after the first soaking rain of the wet season; sometime between

October and January. The tank mix for pre-emergent applications includes Drexel-Diuron (Diuron-80) or Milestone[®] (aminopyralid), Roundup[®] (glyphosate), and Dimension[®] (dithiopyr). Surfactants are also added to the tank mix to enable herbicide penetration of plant cuticles. R-11[®], a non-ionic alkylphenol ethoxylate surfactant, is added to the tank mix whenever glyphosate is used in aquatic systems. Alkylphenol ethoxylates may break down into a variety of metabolites, including nonylphenol (Ferguson et al. 2001). Primary contributors of nonylphenol to the environment are wastewater sources. Under aerobic conditions, nonylphenol tends to break down to inert products (Maguire 1999, Staples et al. 1998). Red Top Mor-Act[®], a nonphytotoxic paraffin-based petroleum oil, is also used by PCWA. Both R-11[®] and Red Top Mor-Act[®] are manufactured by Wilbur-Ellis Company[®] (Wilbur-Ellis 1999).



Herbicide application to aquatic vegetation in Mammoth Reservoir

Rodeo[®] and AquaMaster[™] are glyphosate herbicides rated for use near water. AquaMaster[™] is applied when the targeted growth occurs on the inside edge of the canal berm and when the potential for some herbicide to reach the water is present, because it dissipates in water by binding to soil particles and organic material or through microbial degradation. AquaMaster[™], or Reward[®] (diquat dibromide), is also applied to aquatic vegetation in Lake Alta, Lake Theodore, Clover Valley Reservoir, and Mammoth Reservoir once per year. These herbicides are also applied to control vegetative growth on the downstream faces of dams at these reservoirs, as needed.

The half-life of glyphosate is highly variable, depending on the environmental conditions. In standing water, the half-life is from 12 days to 10 weeks; in soil, it is from 1 to 174 days. Glyphosate has low toxicity to birds and virtually no toxicity to fish (EXTOXNET 1994). Diquat dibromide is persistent (half-life approximately 1,000 days), toxic to fish and wildlife, tightly adsorbed to soil particles, and is unavailable to soil microbes and for plant uptake (Syngenta 2002).

Garlon4[™] is a pyridine-based triclopyr herbicide used for the control of woody plants and annual and perennial broadleaf weeds, and is applied to plants on the outside of the canal berm when the potential exposure to canal water is minimal. Garlon4[™] contains triclopyr in the form of butoxyethyl ester (TBEE). TBEE is rapidly converted to triclopyr acid through hydrolysis in both natural water and soil in less than a day (Ganapathy 1997, Somasundaram and Coats 1991, Bidlack 1978). In natural waters, triclopyr is degraded by sunlight with a half-life of about 1.3 days. Oxamic acid is the main photodegradation product in water, with low molecular-weight organic acids as minor products (Ganapathy 1997, Woodburn et al. 1993). TBEE has a tendency to adsorb to organic matter and is relatively immobile. TBEE rapidly hydrolyzes to triclopyr acid with a half-life of 3 hours (Ganapathy 1997, Bidlack 1978), and triclopyr is broken down

through microbial degradation. Aerobic degradation in soil produces the intermediate metabolites (3,5,6-trichloro-2-pyridinol and 3,5,6-trichloro-2-methoxypyridine), that eventually convert to carbon dioxide (CO₂) (Ganapathy 1997, Cryer et al. 1993). Triclopyr is listed as “fairly degradable” in soil at reported half-lives ranging from 12 to 27 days (Ganapathy 1997, Linders et al. 1994). TBEE is classified as very toxic to aquatic organisms, but is rapidly degraded to triclopyr, which has a low toxicity to fish, Daphnia, and algae. Garlon4™ is not classified as harmful to game, wild birds, and animals (Dow AgroSciences 2006).

2.4.2 Cleaning and Flushing

As an open channel system, debris that accumulates in the canals can decrease canal flow capacity by raising water levels within the canal, and clog piped sections and delivery points, causing blockages and subsequent canal overtopping. Accumulated debris in the canals may lead to overflowing canals and/or interruptions to customer deliveries. This debris is cleaned and/or flushed from the canal system on an as-needed basis. PCWA conducts comprehensive canal cleaning activities within their system during winter and spring each year, and requires several months to complete.



Debris removal from Baughman Canal

Annual cleaning is performed throughout the raw water distribution system, beginning in early January in the upper (northeastern) portion of Zone 1 and moving downward through the system to the end of Zone 1, then to the upper portion of Zone 3 and moving downward to the end of Zone 3. Canals in PCWA’s Zone 5 service area are maintained by South Sutter Water District. During cleaning activities, canal system operations are typically maintained upstream of the canal segment to be cleaned, and water is diverted from the canal segment through an intermediate regulated canal outlet just upstream of the segments being cleaned to dewater the canal. Water deliveries to canal system customers receiving their purchased water downstream from canal segments being cleaned are temporarily interrupted due to the upstream diversions.



Boardman Canal at Hanson Spill dewatered and prepared for cleaning

Large debris is removed from the channel by machinery (small excavator compact loader), where accessible. Hand crews follow machinery with hand tools to complete debris and accumulated

sediment removal. Where canals are inaccessible to machinery, hand crews alone perform the cleaning. Debris and sediment removed from the canals are typically deposited along canal banks.

After cleaning is completed and before restoring flow to downstream segments, intermediate outlet releases upstream from canal cleaning are closed, and intermediate outlet releases downstream from canal cleaning are opened to flush remaining debris and sediment from the canal. The cleaned canal segments are typically flushed for about 1 hour, but the duration of flushing depends on the length of canal cleaned, amount of debris and sediment remaining in the canal segment, and the flow rate of the water in the canal. After a period of flushing, the outlet release is closed, and canal flows are restored to the system downstream from the cleaned canal segment.

Canal cleaning takes place during normal business hours, and canal flows are restored during the evening, thereby minimizing service interruptions to customers. PCWA Customer Service informs their customers of the expected interruption to service with informational letters distributed through the postal mail in the area affected by canal cleaning activities.

Outlets and siphons may also accumulate debris, and are cleaned year round, as required by debris accumulation and flow restrictions. During the cleaning process, customer delivery points and flow-control structures in canal outlets, and siphons may be removed, and canal flows are conveyed through the outlets and siphons to flush out debris and sediment. Outlet and siphon flushing is typically accomplished in under an hour, but may take longer, depending on the extent of debris and sediment accumulation.

2.4.3 Canal Lining/Guniting

Canal lining is typically performed during winter months, when water demands are lower, to reduce erosion and sloughing of canal banks, improve the efficiency of water delivery in canal segments, and to repair and prevent leaks in canal sections that may cause damage to infrastructure and/or property. Canal sections are also lined outside of winter months in areas that are inaccessible during winter, to address leaks that arise during the year, and to continue canal lining activities that were not completed during winter. Canals are lined with gunite, a dry-mix concrete material blown through a nozzle where water is injected immediately before application. Gunite is applied to canals to reduce seepage from the canal channel to adjacent soils. Small cracks in the gunited canals are repaired with Burke Plug, a hydraulic cement manufactured by Edoco[®].



Ponding on landowner property due to seepage visible in background, and recent lining on Baughman Canal



Baughman Canal lining

Water is diverted from the segment to be lined, and the canal segment is dewatered by pumping any remaining water in the canal segment out of the canal and releasing the water to storm drains, ditches, drainage swales, or the ground surface adjacent to the canal. The segment is then cleaned as described above, and reinforced with wire mesh laid into the bottom of the canal before spraying with gunite. Several hundred feet of canal are lined with gunite at a time, and allowed to cure for several hours. Canal flows are restored to the newly lined segments during the evening after the segment has cured. The newly lined canal segment is flushed to remove any accumulated debris and sediment in the canal using the nearest intermediate canal outlet downstream from the lining activities, as described for canal cleaning.

Canal lining requires relatively dry weather and is not performed during or just after heavy rain, as runoff can wash out fresh gunite from the channel. Therefore, the canal-lining schedule, developed a month or more in advance of the activities, is subject to changes and delays according to weather. PCWA Customer Service informs customers of the expected interruption to service with informational letters distributed through the postal mail in the area affected by canal-lining activities.

Before canal-lining activities, PCWA evaluates the potential impacts to environmental resources, and prepares an environmental compliance document to satisfy CEQA requirements.

2.5 AS-NEEDED REPAIR OR REPLACEMENT



Barton Canal pipe replacement

PCWA repairs and/or replaces pipes, flumes, culverts, siphons, outlet structures, flow-control structures, and customer delivery points throughout the PCWA canal system on a scheduled and as-needed basis. These activities may involve minor repairs with minimal disturbance

to customer deliveries and minor effects on environmental resources, while others requiring onsite construction may become more involved.

In all instances of as-needed repair or replacement, PCWA staff members evaluate the potential impacts to environmental resources, and prepare an environmental compliance document to satisfy CEQA requirements.



Pipe repair performed on PCWA canal

2.6 OTHER MAINTENANCE PROJECTS

Other maintenance projects performed infrequently by PCWA and not addressed in this report include:

- Sediment removal from reservoirs
- Sediment removal from Canyon Creek
- Dam, reservoir berm, and canal berm maintenance to address problems due to muskrats, beavers, and otters

For these other maintenance projects, PCWA staff members evaluate the potential impacts to environmental resources, and prepare an environmental compliance document to satisfy CEQA requirements.

CHAPTER 3.0 NATURAL RESOURCES SETTING

This chapter presents methodology for defining natural resources settings and describes physical and biological resources conditions in the NRMP study area.

3.1 METHODOLOGY

This section provides the methodology used to describe the natural resources setting of the NRMP study area during routine operations of the PCWA raw water distribution activities system. Operations activities include routine flow adjustments, seasonal adjustments to delivery points, and annual outages due to PG&E operations.

3.1.1 Physical Resources

The following sections describe the methodology for characterizing physical resource conditions in the NRMP study area. Physical resources evaluated for the NRMP include hydrology, water quality, and soil and sediment quality.

3.1.1.1 Hydrology

This section describes the methodology used to describe the hydrology setting of the PCWA raw water distribution area during routine operations activities within the PCWA raw water distribution area.

Information on the hydrology setting was gathered through discussions with PCWA staff, existing literature, and from U.S. Geological Survey (USGS) stream gaging stations. In addition to information obtained through other sources, extensive flow monitoring performed by PCWA in lower Zone 1 provided data that were valuable to developing a better understanding of the roles of the canals in the hydrology of the interrelated stream systems. This understanding is used here to better describe the hydrology of the rest of Zone 1 as well as Zones 3 and 5.

3.1.1.2 Water Quality

This section describes the methodology for characterizing baseline water quality conditions in the PCWA raw water distribution area. Water quality information was obtained from several reports and studies conducted by various organizations. Water quality data was collected in the study area by PCWA, Central Valley Regional Water Quality Control Board (RWQCB), Dry Creek Conservancy (DCC), and the Central Valley Clean Water Association (CVCWA).

PCWA conducted water quality monitoring at sites within the PCWA raw water distribution system, and receiving water tributaries, streams, and ravines on dates during different seasons intended to provide representative samples of baseline conditions within the study area: December 7, 2006, January 29, 2007, May 30, 2007, and August 30, 2007, representing the fall, winter, spring, and summer seasons, respectively. Data collected during these dates are presumed to be representative of routine canal operations, considered to be baseline activities

within the study area. The Central Valley RWQCB collected water quality information for Secret Ravine and Miners Ravine monthly from December 2000 through February 2002. DCC tested Secret Ravine at multiple locations for a suite of water quality constituents between 2001 and 2005. The constituents tested included heavy metals, nutrients, bacteria, pesticide components, and typical water quality parameters such as pH, alkalinity, and hardness. The CVCWA monitored methylmercury from August 2004 through April 2005 in Miners Ravine below the discharge of the Placer County Sewer Maintenance District (SMD) No. 3 tertiary wastewater treatment plant (WWTP).

Sampling locations, times, and water quality parameters, as well as the baseline concept and its seasonal framework, are described in the following sections.

Monitoring Locations

In situ water quality conditions were measured using a handheld multi-meter, and grab samples were obtained at eight locations within the PCWA raw water service area during the 2007 water delivery year (WDY) (October 16, 2006, through October 15, 2007). These locations, listed in **Table 3-1** and shown in **Figures 3-1 through 3-4**, were selected to represent the variety of conditions and physical locations within the watersheds downstream from potential flow contributions from the PCWA canal system, while allowing reliable site access through public rights-of-way or easements.

**TABLE 3-1
BASELINE WATER QUALITY MONITORING LOCATIONS IN MAJOR STREAMS
AND DRAINAGES IN THE PCWA RAW WATER SERVICE AREA**

BASELINE MONITORING LOCATIONS		
Site Description	Site Identification	Site Type
Zone 3		
Boardman Canal below Lake Alta	YB96	Canal
Zone 1		
Boardman Canal at Powerhouse Road	YB78	Canal
Clover Valley Reservoir Release to Clover Valley Creek and Antelope Canal	CLVRESR	Canal
Boardman Canal below Mammoth Reservoir	YB81	Canal
Yankee Hill Canal Outlet Release	YANKEECR	Canal
Baughman Canal Outlet Release	BAUGHMANCR	Canal
Tributary to Secret Ravine from Yankee Hill Canal	YHTRIB2	Drainage
Secret Ravine at Rocklin Road	SECRETRV3	Stream
Tributary to Miners Ravine from Baughman Canal	BCTTRIB1	Drainage
Miners Ravine at Dick Cook Road	MINERSRV6	Stream
Miners Ravine near N. Sunrise Avenue	MINERSRV3	Stream
Auburn Ravine below American River Tunnel outlet	AUBRAV3	Stream
Clover Valley Creek near Argonaut Avenue (at Golf Course)	CLVRC3B	Stream
Antelope Creek at Midas Avenue	ANTC3B	Stream

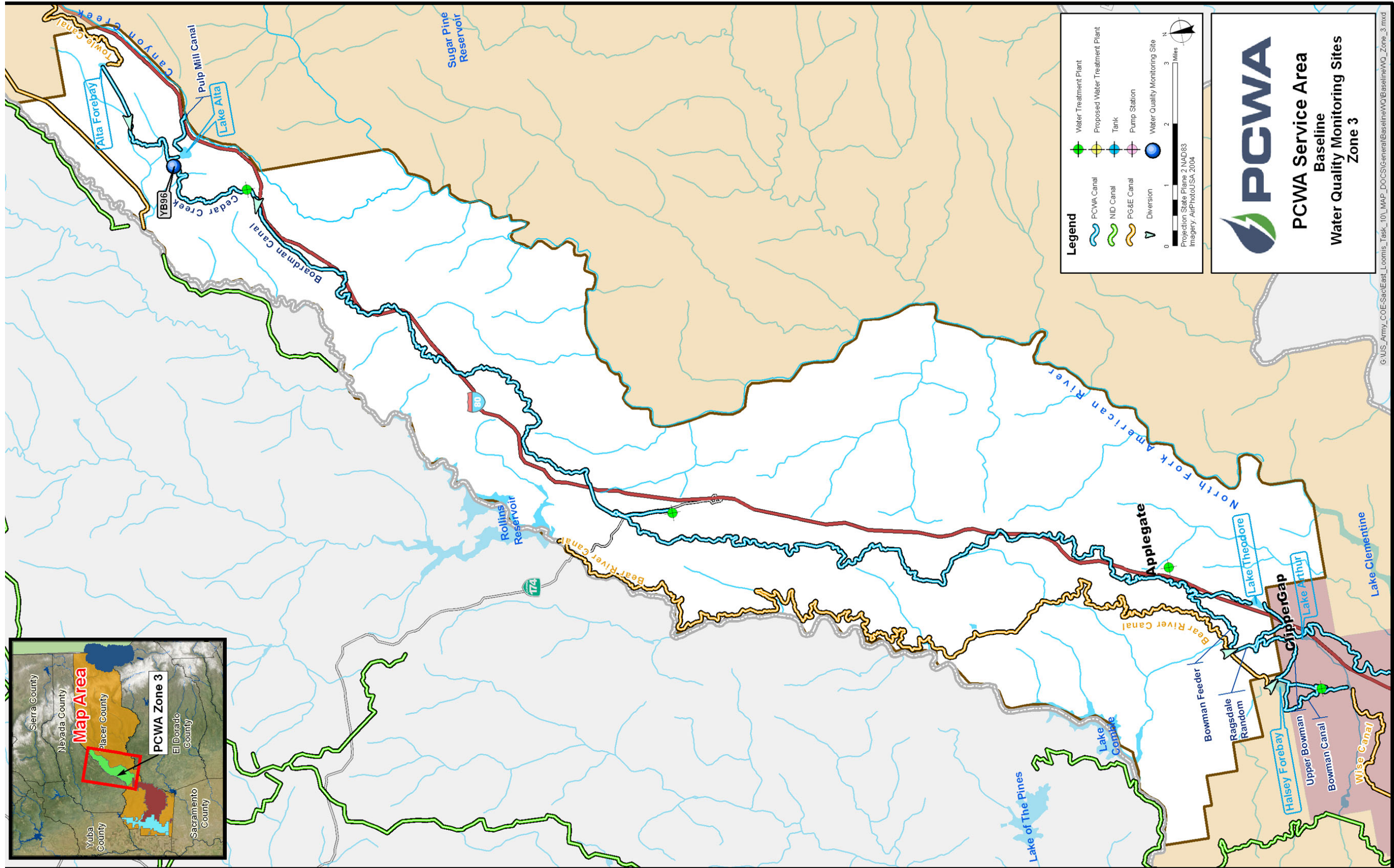
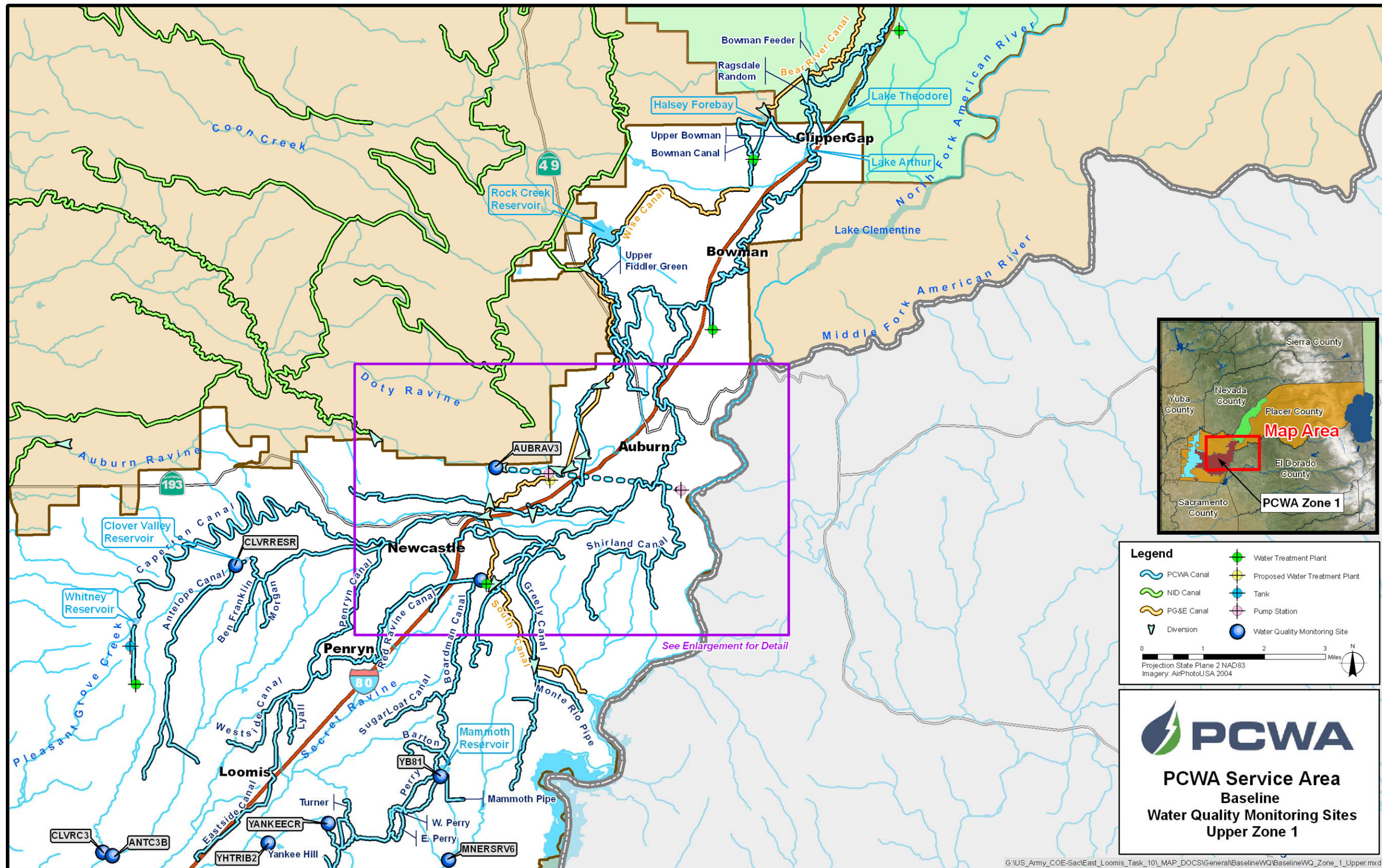


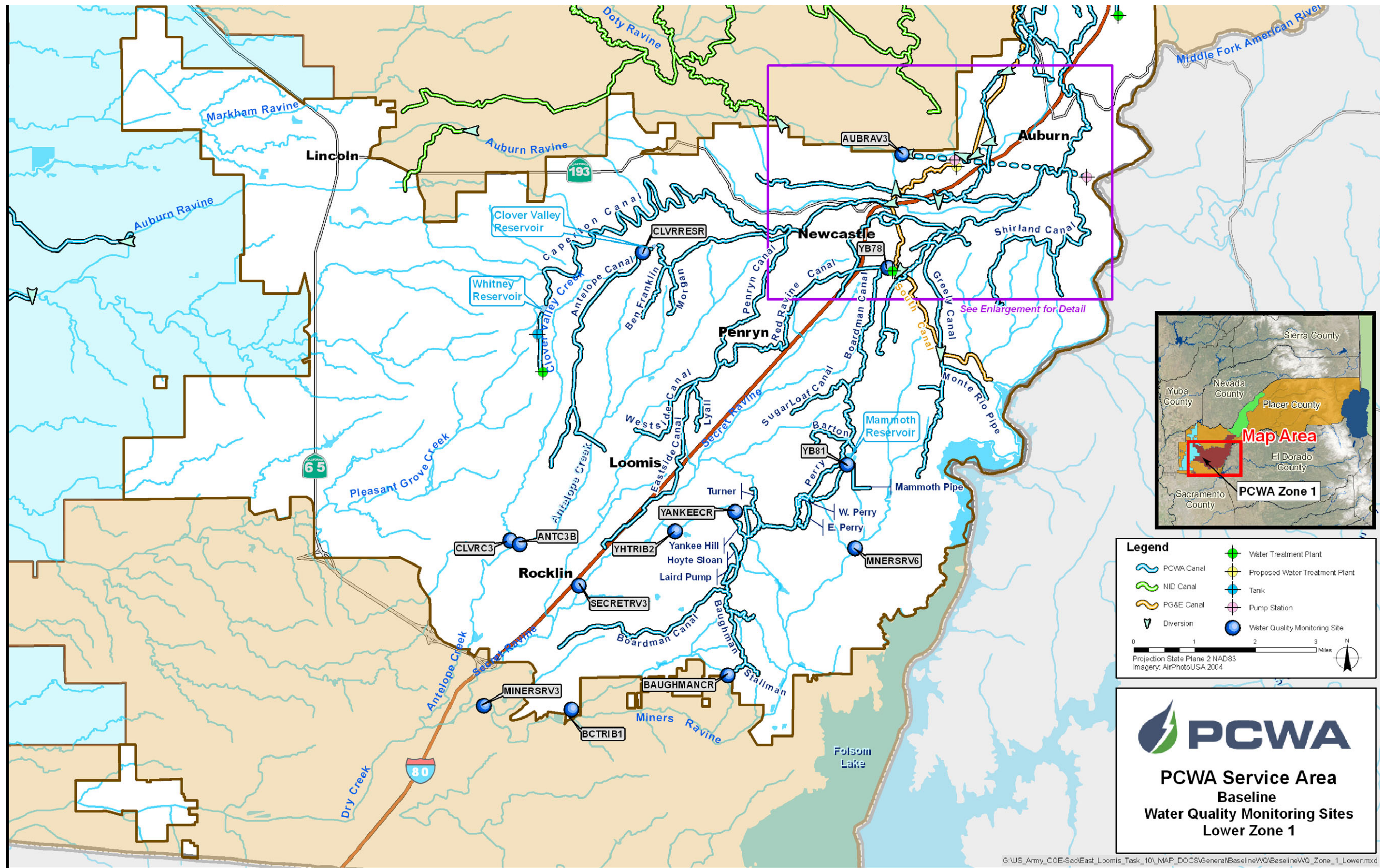
FIGURE 3-1
 ZONE 3 BASELINE WATER QUALITY MONITORING SITES

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**FIGURE 3-2
UPPER ZONE 1 BASELINE WATER QUALITY MONITORING SITES**

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**FIGURE 3-3
LOWER ZONE 1 BASELINE WATER QUALITY MONITORING SITES**

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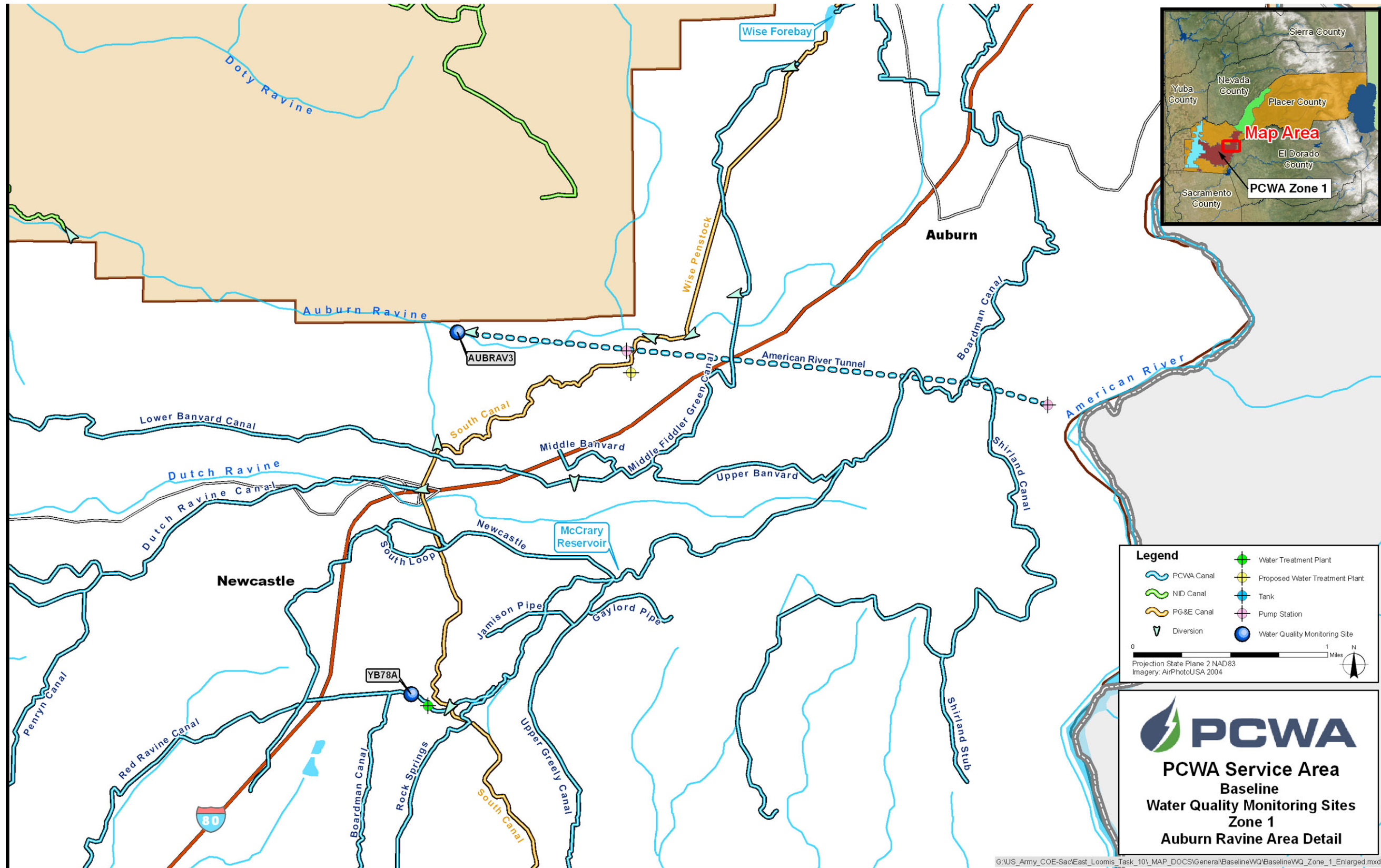


FIGURE 3-4
LOWER ZONE 1 AUBURN RAVINE AREA BASELINE WATER QUALITY MONITORING SITES

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Sample Timing

Samples were collected at each location on a day intended to represent the general background water quality and flow conditions in the system during the fall, winter, spring, and summer seasons.¹ Baseline water quality sampling events avoided days with rainfall on the day of, or during the days preceding, sample collection. Timing of water quality sampling during the day may affect concentrations of certain parameters, including water temperature, dissolved oxygen (DO), and pH due to diurnal temperature changes and biogeochemical processes. As a result, to reduce the potential for differences in water quality at a particular site, measurement and sample collection were conducted at approximately the same time for each of the eight sites during the baseline sampling events.

Fall, winter, spring, and summer baseline water quality was measured on December 7, 2006, January 29, 2007, May 30, 2007, and August 30, 2007, respectively. Each event was scheduled after at least 1 week of dry weather so as to adequately represent baseline canal water quality contributions. Weather on the sampling dates was dry, and no precipitation fell in the sampling areas during the weeks preceding the sampling events except a slight rain event during the week preceding the spring baseline sampling. Weather conditions during and before the baseline sampling events are summarized in **Table 3-2**.

**TABLE 3-2
WEATHER CONDITIONS DURING AND BEFORE WATER QUALITY BASELINE
MONITORING IN THE PCWA RAW WATER DISTRIBUTION AREA**

Season	Date	Weather on Sampling Date		Weather During Preceding Week		
		Maximum Air Temperature (°F)	Total Precipitation (inches)	Maximum Air Temperatures (°F)	Minimum Air Temperatures (°F)	Average Daily Precipitation (inches)
Fall	December 7, 2006	67	0.00	56-68	37-45	0.00
Winter	January 29, 2007	55	0.00	51-65	29-42	0.00
Spring	May 30, 2007	80	0.00	79- 80	52- 54	0.16
Summer	August 30, 2007	98	0.00	89-99	59-75	0.00

Key:

°F = degrees Fahrenheit

Water Quality Parameters

Sampled water quality parameters are shown in **Table 3-3**. A maximum of 22 water quality parameters was measured at each baseline location. Most of the basic physical and chemical water quality parameters, including DO, pH, specific conductivity (SC), water temperature, and turbidity, were measured *in situ* with a Hydrolab Quanta handheld water quality instrument at each sampling location. Water samples were collected and analyzed by MWH Laboratories for the following water quality parameters: alkalinity, total suspended solids (TSS), aluminum,

¹ Periodic water quality measurement and grab samples only provide general qualitative information on water quality of the streams. Continual long-term monitoring is required for a more detailed water quality analysis.

calcium, iron, magnesium, sodium, chloride, sulfate, nitrate, potassium, barium, cadmium, copper, mercury, and zinc. Mercury was measured during the spring only; the remaining 21 parameters were measured during all four seasons. Constituent concentrations measured below the detectable limits for laboratory analyses are provided at the minimum reporting level.

**TABLE 3-3
WATER QUALITY PARAMETERS MEASURED DURING BASELINE WATER
QUALITY MONITORING IN THE PCWA RAW WATER SERVICE AREA**

Water Quality Parameters		
Basic Physical and Chemical Parameters	Major Ions	Trace Elements
Water Temperature	Calcium	Aluminum
pH	Iron	Barium
Alkalinity	Magnesium	Cadmium
Dissolved Oxygen	Potassium	Copper
Specific Conductivity	Sodium	Mercury
Turbidity	Chloride	Zinc
Total Suspended Solids	Nitrate	
	Sulfate	

Water Temperature and Dissolved Oxygen

Water temperature is an important water quality parameter because it affects water chemistry. Higher temperatures can increase the rate of chemical reactions, which can increase chemical toxicity. Water temperatures reflect seasonal variations in air temperatures, with higher temperatures in spring and summer than in fall and winter. Flow velocity also influences water temperatures because a particle of water in a fast-moving stream is exposed to sunlight for a shorter time than that in a slow-moving stream. Water temperature changes in these streams within the PCWA raw water distribution area are assumed to be affected by changes in canal flows. Water temperatures change as water flows downstream from reservoirs. Inputs from runoff and tributaries can also change downstream water temperatures.

DO is a measure of gaseous oxygen dissolved in a liquid. Waters with higher, relatively stable levels of DO are usually considered healthy ecosystems, supporting many different kinds of aquatic organisms. Extreme DO fluctuations may cause organism stress. DO levels would be expected to be greater in areas with higher flows and colder water temperatures. DO is inversely related to temperature because as water temperature increases, the water has less capacity to hold gases, and DO levels decrease. Therefore, warmer water holds less oxygen than colder water. DO levels typically increase with higher flows due to increased turbulence, which may bring more water into contact with the atmosphere, aerating the moving water. DO levels also naturally fluctuate daily depending on rates of respiration, decomposition, or chemical reactions (decrease), and photosynthesis, or diffusion with surrounding air (increase). Daily maximum DO levels typically occur in the afternoon and daily minimum levels occur in the early morning.

pH, Alkalinity, and Hardness

The parameters pH, hardness, and alkalinity are interrelated. The parameter pH is a measure of dissolved hydrogen ions, or acidity. The pH scale ranges from 0 and 14, with 7.0 defined as neutral; solutions with pH lower than 7.0 are considered acidic, while solutions with pH greater

than 7.0 are considered basic. The lower the pH value, the higher the acidity. Seasonal pH trends within canals can be influenced by biological processes. Respiration occurs primarily in reservoirs within the system, and rates are highest during spring and summer, when aquatic organisms are more active. Rates of photosynthesis are also highest during spring or summer, when the most sunlight is available. Seasonal pH trends within canals can also be influenced by flow volumes and rainfall.

Whereas acidity is the capacity to neutralize bases, alkalinity is a measure of the capacity of water to neutralize strong acid (Snoeyink and Jenkins, 1980). Alkalinity is a bicarbonate concentration. In general, alkalinity concentrations in natural waters are primarily composed of carbonate, bicarbonate (HCO₃⁻), and hydroxyl ions (Tchobanoglous and Schroeder, 1985). High alkalinity values will reduce the variation in pH.

Water hardness is the measurement of the total dissolved minerals, primarily calcium and magnesium ions, in water. Water hardness is the total quantity of bases present to absorb acid in water. Calcium and magnesium are the most common sources of water hardness; therefore, water hardness is typically represented as the sum of calcium and magnesium concentrations. A low hardness value can indicate that calcium carbonate (CaCO₃) concentrations are low, but high hardness does not necessarily reflect a high calcium concentration. There are two types of hardness: carbonate and noncarbonate. Carbonate hardness is associated with HCO₃⁻ and carbonates, and noncarbonate hardness is associated with other anions, particularly chloride, and sulfate. Since water hardness was not measured in this study, it is calculated as total hardness using the following equation:

$$\left[\frac{(\text{Ca}^{2+}) \text{ mg/L}}{\left(\frac{(\text{Molecular Weight Ca}^{2+}) \text{ mg/mmol}}{\text{Number of moles}} \right)} \right] \times \left[\frac{\text{Eq. Wt. of CaCO}_3 \text{ (mg/meq)}}{\text{mg/meq}} \right] + \left[\frac{(\text{Mg}^{2+}) \text{ mg/L}}{\left(\frac{(\text{Molecular Weight Mg}^{2+}) \text{ mg/mmol}}{\text{Number of moles}} \right)} \right] \times \left[\frac{\text{Eq. Wt. of CaCO}_3 \text{ (mg/meq)}}{\text{mg/meq}} \right]$$

Water alkalinity and hardness are often reported as an equivalent of the CaCO₃ concentration in milligrams per liter (mg/L).

Total Suspended Solids and Turbidity

TSS is a water quality parameter that provides a measurement of particulates in a water sample. Turbidity is an optical measurement of water's ability to scatter light, resulting from the interaction of incident light with particulate material in a water sample, commonly referred to as the cloudiness or haziness of water. Increased turbidity is caused, in part, by TSS in water, but the correlation is spatially and temporally variable.

Specific Conductivity and Ions

SC is a measure of the capacity to transmit electricity through a water sample at 25 degrees Celsius (°C), and typically displays a linear relationship to total dissolved solids (TDS) and salinity of the water. SC is a function of the quantity of dissolved (ionic) constituents, primarily calcium (Ca²⁺), magnesium (Mg²⁺), sodium (Na⁺), potassium (K⁺), HCO₃⁻, sulfate (SO₄²⁻), and chloride (Cl⁻). Freshwater has a low SC compared to that of seawater. Rainwater can increase

SC because it often contains dissolved airborne gases and dust from the air. Agricultural and urban runoff can also increase SC through loading of salts or other dissolved constituents.

Trends in ion concentrations typically follow trends in SC. Major ions include elements that naturally occur in high concentrations and/or nutrients. This study included analyses for several major cations including calcium, iron (Fe^{2+}), magnesium, potassium, and sodium. Calcium is an essential mineral, is common in waters, and contributes to water hardness as CaCO_3 . Iron is a common element in the regional geology and soils that can leach into water; however, most iron compounds are relatively insoluble in the pH ranges observed in streams. Magnesium occurs widely in rocks and soils, and is a major contributor to water hardness in many water bodies in the form of magnesium carbonates. Potassium is also an essential nutrient and occurs in nature as an ionic salt. Compounds consisting of potassium generally have excellent water solubility. Sodium is a very active ion. Excess sodium in runoff water may affect soils by decreasing rates of infiltration, and result in a build-up of salts on the soil surface.

Major anions evaluated for this study include chloride, nitrate, and sulfate. Chlorides include negatively charged chloride ions and salts containing chloride ions, such as sodium chloride (NaCl) and magnesium chloride (MgCl_2). Nitrate is an essential nutrient which, in excessive concentrations, leads to eutrophication of waterways and drinking water toxicity. Eutrophication promotes excessive aquatic plant growth and decay, which decreases DO and the overall water quality of a water body. Major sources of nitrate include fertilizers and sewage. SO_4^{2-} is a major anion in hard water reservoirs, and can be naturally occurring or the result of municipal or industrial discharges. When naturally occurring, SO_4^{2-} is often associated with organic matter decay, rocks or soil containing gypsum and other common minerals, or atmospheric deposition. Point sources include sewage treatment plants and industrial discharges. Fertilizers in runoff also contribute sulfates to water bodies. SO_4^{2-} can interact and precipitate with several parameters, including barium, copper, calcium, and magnesium; these interactions are interdependent with the pH, water temperature, and alkalinity contents in each water sample.

Trace Elements

Elements that typically occur in very low concentrations are referred to as trace elements. At higher concentrations, most trace elements become toxic to plants, animals, or humans. Sources may be natural or urban, agricultural, or municipal. The solubility of most trace elements – whether they adsorb to bottom sediments or remain in the water column – is dependent on oxidation and reduction potential and pH. Water quality monitoring included analyses for the following trace elements: aluminum, barium, cadmium, copper, mercury, and zinc.

Aluminum is one of the most abundant elements in the earth's crust and occurs in many rocks and soils. Many aluminum salts are readily soluble; those that are insoluble will precipitate and settle out of water. Barium is an alkaline earth metal that is primarily insoluble. Barium concentrations in water are often associated with mining activities. Cadmium is a metal commonly associated with wastewater, pesticides, and fertilizers. It is toxic to humans and aquatic species, although toxicity levels vary widely by species.

Copper persists and cycles through ecosystems. It can be dissolved in water, or bound to organic and inorganic materials either in suspension or in sediment. Dissolved copper is known to affect a variety of biological endpoints in fish (e.g., survival, growth, behavior, osmoregulation, sensory function, and others (NMFS 2007, Eisler 1998). Water hardness, alkalinity, pH, and dissolved organic matter tend to alter the bioavailability of dissolved copper to aquatic organisms. Exposure routes other than the water column, such as consumption of contaminated prey items (dietary) or direct contact with contaminated sediments are also important (NMFS 2007). Potential sources of copper in the environment include vehicle emissions and brake pad dust (Drapper et al. 2000), pesticides (EPA 2005a), herbicides, fungicides, algacides, industrial processes, municipal discharges, mining, and rooftops (Good 1993; Thomas and Greene 1993) (NMFS 2007). Recent studies indicate typical dissolved copper concentrations originating from road runoff from a California study were 3.4 to 64.5 micrograms per liter ($\mu\text{g/L}$), with a mean of 15.8 $\mu\text{g/L}$ (NMFS 2007).

Mercury is a legacy contaminant present in the source waters of PCWA (Yuba and Bear rivers), associated with hydraulic gold mining activities in the Sierra Nevada and foothill region during the nineteenth century. Methyl mercury, the species of mercury formed during a process known as methylation, is known as the predominant form bioaccumulated in fish, and is toxic to animals and humans. The California Environmental Protection Agency issued a health advisory and report during 2003 on the health effects of eating fish from water bodies in Nevada, Placer, and Yuba counties after high concentrations of mercury were found in samples collected within the Yuba River and Bear River watersheds. NID is currently proposing a pilot project to remove mercury from Lake Combie, a small reservoir on the Bear River.

Zinc is a relatively insoluble metal, and will precipitate from the water column. Zinc is supplied in animal feeds and fertilizers in the form of zinc sulfate, and occurs naturally in the environment. It is also associated with a wide variety of industrial activities, and may be associated with WWTP discharges.

3.1.1.3 Soils and Sediment Quality

Soil and sediment characteristics in the study area were evaluated by reviewing existing reports and studies conducted within the region, and soil survey data for Placer County from the U.S. Department of Agriculture Natural Resource Conservation Service (USDA-NRCS). These survey data comprise soil classifications and soil textures that cover most of Placer County, including the majority of PCWA Zones 1, 3, and 5.

3.1.2 Biological Resources

The following sections describe methodology for characterizing biological resource conditions in the NRMP study area. Biological resources evaluated for the NRMP include terrestrial habitat and species, aquatic habitat and species, as well as special-status species.

3.1.2.1 Terrestrial Habitat and Species

The study area for terrestrial habitat and species includes areas adjacent to canals and reservoirs that may be directly affected by O&M activities. Reservoirs in the analysis are: Clover Valley Reservoir, Mammoth Reservoir, Lake Alta, McCray, Whitney, Caperton, Lake Arthur, and Lake Theodore. In addition, habitats and species along water bodies that serve as conveyances, specifically Auburn Ravine and Canyon Creek, could be affected indirectly by changes in flow, water quality, and sedimentation.

This analysis focuses on habitat types and their associated species. The linear extents of habitat types paralleling all PCWA canals in Zones 1, 3, and 5 and reservoirs that may be affected by O&M activities were evaluated to describe the setting. Habitat types and their associated species are discussed in the following sections.

Existing habitat data used in quantitative analysis were obtained from:

- Placer Legacy Phase 1 prepared by Jones and Stokes Associates for Placer County on May 13, 2003 and last updated April 9, 2007
- California Department of Forestry and Fire Protection Fire and Resource Assessment Program (FRAP) Multi-source Land Cover Data (v02_2) published in 2002

Habitat classifications for both of these sources were assigned based on the California Wildlife Habitat Relationship (WHR) system, with some modifications as appropriate for the study area.

Field reconnaissance-level visits were conducted on December 1 and 2, 2005; September 28 and 29, 2006; and September 13 and 14, 2007, to calibrate and verify habitat mapping for portions of the study area.

Terrestrial habitat types in the study area can be grouped into general categories: forested, shrub-dominated, herbaceous-dominated, agricultural, urban, and barren. The general structure, composition, and wildlife value of habitats within the study area are described below.

Forested

A variety of forested habitat types occurs in the study area. These are summarized in the following categories: valley foothill riparian, Sierra Nevada montane forest, and foothill hardwood woodland.

Valley Foothill Riparian Forest

Valley foothill riparian forests are found in floodplains and lower foothills in seasonally or permanently wet areas. The structure of this habitat is multi-layer, consisting of a mix of trees, shrubs, and vines including valley oak (*Quercus lobata*), cottonwood (*Populus fremontii*), sycamore (*Platanus racemosa*), willow (*Salix* spp.), white alder (*Alnus rhombifolia*), Oregon ash (*Fraxinus latifolia*), elderberry (*Sambucus* spp.), California grape (*Vitis californica*), and the nonnative Himalayan blackberry (*Rubus discolor*). Grasses, sedges (*Carex* spp.), rushes (*Juncus* spp.), and forbs, such as mugwort (*Artemisia douglasiana*) and hoary nettle (*Urtica dioica* ssp. *holosericea*), may occur in the understory. This habitat provides cover, forage, and breeding

areas for a number of wildlife species, including numerous species of resident and migratory birds, at least 50 amphibian and reptile species, and large and small mammals (Mayer and Laudenslayer 1988).

Sierra Nevada Montane Forests

Sierra Nevada montane forest types in the study area include conifer-dominated habitats (ponderosa pine [*Pinus ponderosa*], Sierran mixed conifer, Douglas-fir [*Pseudotsuga menziesii*], and closed-cone pine-cypress), and hardwood-dominated habitats (montane hardwood and montane hardwood conifer). Conifer-dominated habitats are multi-layer and contain a variety of species, with conifers typically forming a closed canopy. Sierra Nevada montane forest habitat types generally occur at higher elevations than hardwood habitats (Brussard 1999). These habitat types intergrade, with ponderosa pine occurring at lower elevations and Sierran mixed conifer occurring at higher elevations (Placer County Planning Department 2005a). Sierran mixed conifer habitats support coniferous and hardwood species including ponderosa pine, knobcone pine (*Pinus attenuate*), sugar pine (*Pinus lambertiana*), Douglas-fir, white fir (*Abies concolor*), California black oak (*Quercus kelloggii*), incense cedar (*Calocedrus decurrens*), white alder, and bigleaf maple (*Acer macrophyllum*). Common shrub species include deerbrush (*Ceanothus integerrimus*), manzanita (*Arctostaphylos* spp.), chinquapin (*Chrysolepis chrysophylla*), mountain whitethorn (*Ceanothus cordulatus*), sagebrush (*Artemisia* spp.), and gooseberry (*Ribes* spp.). Closed-cone pine-cypress habitat is dominated by knobcone pine and generally occurs in areas with rockier, thinner soil.

Montane hardwood and montane hardwood conifer habitats are dominated by black oak and canyon live oak (*Quercus chrysolepis*). Other common tree species include interior live oak (*Quercus wislizeni*), ponderosa pine, bigleaf maple, Douglas-fir, Pacific madrone (*Arbutus menziesii*), Jeffrey pine (*Pinus jeffreyi*), sugar pine, incense cedar, white fir, and quacking aspen (*Populus tremuloides*). Shrub species include poison oak (*Toxicodendron diversilobum*), ceanothus (*Ceanothus* spp.), manzanita, and mountain mahogany (*Cercocarpus betuloides*) (Placer County Planning Department 2005a).

A variety of wildlife and plant species occur in Sierra Nevada montane forest habitats including cavity-nesting birds, raptors, large mammals, rodents, bats, reptiles, and amphibians.

Foothill Hardwood Woodlands

Hardwood habitat types in the study area include several habitat types: blue oak (*Quercus douglasii*) woodland, oak woodland savanna, interior live oak woodland, and oak foothill pine. These habitats contain a variety of species but are dominated by oaks. Blue oak woodlands are found on drier sites with shallower soils than valley foothill riparian forests. This habitat is generally more open than valley foothill riparian habitats in the study area and grades to oak woodland savanna in some places. Dominant species are blue oak and live oak, with a more open, grassy understory. Shrubs and small trees, including California buckeye (*Aesculus californica*), ceanothus, manzanita, and elderberry may occur, but are generally less dense than in valley foothill riparian forests. Numerous wildlife species use blue oak woodland for nesting and foraging, including acorn woodpecker (*Melanerpes formicivorus*), oak titmouse (*Parus inornatus*), yellow-billed magpie (*Pica nuttalli*), western gray squirrel (*Sciurus griseus*), and

coyote (*Canis latrans*) (Mayer and Laudenslayer 1988). Oak foothill pine habitats contain many similar species to those found in blue oak woodlands, but foothill pine is more common and the shrub layer is generally denser.

Shrub

Shrub-dominated habitats in the study area are primarily foothill chaparral ecosystems. These are areas that generally do not support forested habitats due to rocky/thin soils or steep slopes. Common shrub species in this habitat include chamise (*Adenostoma fasciculatum*), whiteleaf manzanita (*Arctostaphylos manzanita*), and buckbrush (*Ceanothus cuneatus*). Small interior live oaks also frequently occur. This habitat type occurs on a variety of substrates, including serpentine soils, which may support some special status plant species. A number of wildlife species use chaparral for foraging and nesting including rodents, snakes, mountain lion (*Puma concolor*), black bear (*Ursus americanus*), coyote, ringtail (*Bassariscus astutus*), and a variety of bird species such as western scrub-jay (*Aphelocoma californica*), spotted towhee (*Pipilo maculates*), California towhee (*Pipilo crissalis*), American robin (*Turdus migratorius*), Townsend's solitaire (*Myadestes townsendi*), and wrentit (*Chamaea fasciata*).

Herbaceous

Herbaceous habitats in the study area are generally disturbed areas dominated by nonnative species. These areas provide limited wildlife habitat value. Small mammals and some bird species, including western meadowlark (*Sturnella neglecta*) and horned lark (*Eremophila alpestris*), may breed in less disturbed grassland and pasture areas. These habitats also provide foraging areas for snakes, coyotes, and raptors, such as Northern harrier (*Circus cyaneus*), Red-tailed Hawk (*Buteo jamaicensis*), and White-tailed Kite (*Elanus leucurus*).

Annual Grassland

Annual grasslands in California primarily support nonnative species such as wild oat (*Avena fatua*), bromes (*Bromus* spp.), wild barley (*Hordeum marinum*), and fescue (*Festuca* spp.). Annual grasslands often support vernal pools; however, these were not observed in the study area. Vernal pools are found within the southwestern portion of the watershed near the confluence of Secret and Miners ravines, but these are outside of the study area and do not appear to be influenced by the drainages addressed in this analysis.

Vernal Pool Complexes

Vernal pools are small to large depressions, generally in grassland habitat, that are seasonally wet and support an assemblage of species adapted to these conditions. A number of special status plant and animal species occur in vernal pools including vernal pool fairy shrimp (*Branchinecta lynchi*), vernal pool tadpole shrimp (*Lepidurus packardi*), California linderiella (*Linderiella occidentalis*), legenere (*Legenere limosa*), Red Bluff dwarf rush (*Juncus leiospermus* var. *leiospermus*), dwarf downingia (*Downingia pusilla*), Bogg's Lake hedge-hyssop (*Gratiola heterosepala*), and Ahart's dwarf rush (*Juncus leiospermus* var. *ahartii*). Vernal pool complexes are mapped grassland areas that contain individual vernal pools in high, medium, or low densities.

Wetland

Wetlands types in the study area include fresh emergent wetlands and seasonal wetlands. Fresh emergent wetlands support permanently or frequently flooded herbaceous vegetation including cattails (*Typha* spp.), sedges, rushes, and nutsedges (*Cyperus* spp.), and spike-rush (*Eleocharis* spp.). In the study area this habitat may be associated with the margins of artificial ponds, roadside swales, and depressional wetlands. These areas are often isolated, and dominated by nonnative species, such as Johnsongrass (*Sorghum halepense*), dallisgrass (*Paspalum dilatatum*), rabbit's foot grass (*Polypogon monspeliensis*), knotweed (*Polygonum* spp.), and dock (*Rumex* spp.). Seasonal wetlands contain some similar species to those found in fresh emergent wetlands, including grasses and sedges. During summer months, seasonal wetlands may support more upland species such as tarweed (*Hemizonia fitchii*), vinegar weed (*Trichostema lanceolatum*), and yellow star-thistle (*Centaurea solstitialis*). Wetlands are used by a number of wildlife species, particularly birds, amphibians, and reptiles. Special status plant species that may occur in wetlands in the study area include hispid bird's-beak (*Cordylanthus mollis* ssp. *hispidus*), dwarf downingia, legenera, Bogg's Lake hedge-hyssop, Ahart's dwarf rush, red-anthered rush (*Juncus marginatus* var. *marginatus*), and Red Bluff dwarf rush.

Agricultural

Agricultural habitat types in the study area include pasture, row crops, rice fields, and unidentified crops. Pasture vegetation is composed primarily of nonnative perennial grasses and legumes such as ryegrass (*Lolium* spp.), fescue, and clover (*Trifolium* spp.). Habitat value may be similar to annual grassland, but is dependent on management. Row crops include wheat, corn, rye, barley, strawberries, and other grains and vegetable crops. Rice fields are seasonally flooded areas that may provide important habitat elements for birds, including shorebirds, water fowl, and raptors. Other species, such as the giant garter snake (*Thamnophis gigas*), may also use rice fields.

Urban

Urban habitats can support trees, shrubs, herbaceous species, or more commonly, a mosaic of these vegetation types interspersed with barren areas (see below). In the study area, urban habitat consists of urban parks, rural residential forested, rural residential, urban/suburban, and urban woodland. Vegetation includes native and nonnative species, including some native forested habitat remnant patches. Urban areas can provide wildlife habitat, the value of which may be determined by vegetative structure and management activities such as pesticide/herbicide applications and mowing and clearing activities. Species using urban habitat types may include western scrub-jay, northern mockingbird (*Mimus polyglottos*), house finch (*Carpodacus mexicanus*), bushtit (*Psaltriparus minimus*), oak titmouse, chestnut-backed chickadee (*Parus rufescens*), California quail (*Callipepla californica*), black-tailed deer (*Odocoileus hemionus*), black-tailed jackrabbit (*Lepus californicus*), raccoon (*Procyon lotor*), opossum (*Didelphis virginiana*), California slender salamander (*Batrachoseps attenuatus*), gopher snake (*Pituophis catenifer*), and fence lizard (*Sceloporus undulatus*). Special status species, including White-tailed Kite, tricolored blackbird (*Agelaius tricolor*), Swainson's hawk (*Buteo swainsoni*), western pond turtle (*Actinemys marmorata*), and purple martin (*Progne subis*), may also use urban habitats.

Barren

Barren areas include unvegetated disturbed lands (roads, parking lots, gravel pads, and other open areas) and rock outcrop and cliffs. Disturbed lands are dispersed in small areas throughout the study area and provide limited wildlife habitat value. Rock outcrops and cliffs may provide nesting and roosting habitat for some bats, raptors, and other bird species. Some special status plant species, such as Red Hills soaproot (*Chlorogalum grandiflorum*), may occur in rocky outcrops.

3.1.2.2 Aquatic Habitat and Species

This section describes the methodology used to characterize the existing conditions of aquatic resources in streams that may be affected by PCWA O&M activities conducted within the raw water distribution system. These include drainages and streams used for conveyance of water to PCWA customers, and streams that may receive flow contributions from the canal system through regulated or unregulated releases from canal outlets. Streams in the study area include Canyon Creek, Auburn Ravine, Clover Valley Creek, Antelope Creek, Secret Ravine, and Miners Ravine.

Descriptions of aquatic biological resources are based on a literature review of studies conducted within the study area and reconnaissance-level site visits along the streams. Documents consulted in the literature review include the following:

- Dry Creek Watershed Coordinated Resource Management Plan (Dry Creek Watershed Council 2003).
- Streams of Western Placer County: Aquatic Habitat and Biological Resources Literature Review (Sierra Business Council 2003).
- Miners Ravine Habitat Assessment (California Department of Water Resources 2002).
- Secret Ravine Adaptive Management Plan (Dry Creek Conservancy 2001).
- Perennial Rearing Habitat for Juvenile Steelhead in the Dry Creek Drainage (Placer County) (California Department of Fish and Game 2001).
- Survey Habitat in Secret Ravine, Tributary to Dry Creek: Anadromous Fish Restoration Program. Document Control No. 11332-8-J113 (U.S. Fish and Wildlife Service 1998).
- Dry Creek, Secret Ravine and Miners Ravine, Placer County. Memorandum to Nick Villa, California Department of Fish and Game, Region 2, Rancho Cordova, California (John Nelson 1997).
- Auburn Ravine/Coon Creek Ecosystem Restoration Plan (Placer County/CALFED 2002).

- Draft Roseville Creek and Riparian Management and Restoration Plan (City of Roseville 2005).
- Clover Valley Large and Small Lot Tentative Subdivision Maps, Draft Environmental Impact Report (City of Rocklin 2006).
- Aquatic Habitat Survey and Fisheries Assessment for Clover Valley (Placer County 2006).
- A Benthic Macroinvertebrate Survey of Secret Ravine: The Effects of Urbanization on Species Diversity and Abundance (De Barruel and West 2003).
- Assessment of Habitat Conditions for Chinook Salmon and Steelhead in Western Placer County, California (Placer County Planning Department 2005b).

Aquatic habitat conditions and species descriptions are focused on fish communities in the study area. Central Valley steelhead and fall-run Chinook salmon are emphasized due to their statuses under the State and Federal Endangered Species Acts (ESA), and the presence of designated Critical Habitat for Central Valley steelhead in the study area. Central Valley steelhead are listed as threatened under the Federal ESA but have no special status under the State ESA. Fall/Late-fall-run Chinook salmon are a Federal Species of Concern and California Species of Special Concern.

California Department of Fish and Game (DFG) is currently working on a program to inventory and perform a landscape-level assessment of fish communities within and across stream systems throughout California, including Auburn Ravine, Secret Ravine, and Miners Ravine, based on an index of biotic integrity (IBI). An IBI assigns scores to predetermined fish community characteristics that are summed and normalized to create an index of the gross ecological health of the stream (Titus et al. 2005). Reference fish assemblages applied to the IBI include Central Valley pikeminnow, hardhead, sucker, deep-bodied fish assemblages (California roach, speckled dace, rainbow trout, riffle sculpin, tule perch) (State Water Resources Control Board [SWRCB] 2005, Moyle 2002), and anadromous species (lamprey, Chinook salmon, steelhead) (SWRCB 2005). Aquatic habitat conditions and species are presented by the presence of fish communities in the study area and 2004-2005 IBI rating results for Auburn, Secret, and Miners ravines.

Benthic macroinvertebrate (BMI) samples were collected during fall 2007 by DCC using the targeted riffle method described in Standard Operating Procedures for Collecting Benthic Macroinvertebrate Samples and Associated Physical and Chemical Data for Ambient Bioassessments in California (DFG 2007) at three sites: Auburn Ravine below Auburn Ravine Tunnel outlet, Secret Ravine at Loomis Basin Park, and Miners Ravine below Sierra College Boulevard. BMI analyses are used as indicators of stream health. These organisms live in, on, or near streambed material where hydrophobic chemicals tend to concentrate, and have limited mobility. Therefore, the organisms show cumulative impacts of pollution and habitat degradation over a relatively small spatial area not detected by traditional water quality analyses. A benthic

index of biotic integrity (B-IBI), recently developed by the DFG's Aquatic Bioassessment Laboratory, was applied to BMI analysis results obtained from Auburn, Secret, and Miners ravines. The index is based on BMI samples collected from 275 sites in central and Southern California by the U.S. Forest Service, U.S. EPA, and RWQCBs. The B-IBI provides a method for measuring ecological conditions in streams characterized by seven metrics for comparison with reference streams with an index of BMI assemblages when human disturbance is absent or minimal, and allows categorization of site conditions as "Good," "Fair," or "Poor" (Ode et al. 2005). The seven metrics for the B-IBI assessment include:

- Coleoptera Richness – the total number of Coleoptera taxa present in the subsamples.
- EPT Richness – the total number of taxa from the *Ephemeroptera*, *Plecoptera*, and *Trichoptera* insect orders.
- Predator Richness – total number of taxa categorized as predators.
- Collectors (%) – the percent of individuals present in the subsample categorized as collectors.
- Intolerant Organisms (%) (0-3) – the percent of individuals present in the subsample categorized as having a tolerance value of 0 to 3.
- Non-insect Taxa (%) – The percent of the subsample taxa that are non-insect.
- Tolerant Taxa (%) – The percent of taxa from the subsample that are considered tolerant of stream degradation.

In addition to the BMI analyses conducted for the sites described above, BMI data collected by DCC from sites across the PCWA service area were reviewed for comparison. Data collected by DCC before 2005 using protocols described in the California Stream Bioassessment Procedure were standardized with data collected during fall 2007 for consistency.

3.1.2.3 Special Status Species

This document was prepared with information obtained from species database searches and literature review. Databases and documents consulted include:

- California Natural Diversity Database (CNDDDB) Geographic Information System (GIS) layer (CDFG 2008)
- U.S. Fish and Wildlife Service (USFWS) on-line service for information regarding Threatened and Endangered Species final Critical Habitat designation across the U.S. Accessed for Placer County on October 6, 2008. (USFWS 2008)
- On-line Inventory of Rare and Endangered Plants. Accessed for USGS project quadrangles on August 21, 2008. (California Native Plant Society (CNPS) 2008)

- Federal Endangered and Threatened Species that Occur In or May Be Affected by Projects in the Counties and/or USGS 7 1/2 Minute Quadrangles. On-line data accessed for project quadrangles on August 21, 2008 (USFWS 2008)

Project USGS quadrangles are those that contain features (canals and reservoirs) that would be directly affected by operations and maintenance activities, specifically:

- Auburn (Zones 1 and 3)
- Chicago Park (Zone 3)
- Colfax (Zone 3)
- Dutch Flat (Zone 3)
- Gold Hill (Zone 1)
- Greenwood (Zone 3)
- Pilot Hill (Zone 1)
- Pleasant Grove (Zone 5)
- Rocklin (Zone 1)
- Roseville (Zone 5)
- Sheridan (Zone 5)

For purposes of this evaluation, special status species are those that are federally listed (threatened or endangered), species of concern (for aquatic species only), or candidate species; California listed (endangered or threatened) species or species of special concern; and/or species listed on the CNPS inventory of rare and endangered plants. To identify known special status species occurrences in the study area, a GIS layer of PCWA Zones 1, 3, and 5 was overlain on the most recently distributed DFG CNDDDB data (this conservatively includes all of Zones 1, 3, and 5, even though most of this area would not be affected). To identify other species that could potentially occur in the study area, databases were queried for known or potential occurrences of special status species in the project USGS quadrangles. Other special status species may have the potential to occur in the study area. Resource agencies should be consulted for information on a site-specific basis.

3.2 PHYSICAL RESOURCES SETTING

The sections below describe physical resources within Zones 3, 1, and 5 of the PCWA raw water distribution area during routine canal operations. Categories of physical resources described are hydrology, water quality, and soil and sediment quality, each of which is organized by watersheds within each PCWA zone.

3.2.1 Hydrology

Hydrology in PCWA's raw water distribution system is affected by release directly from canal outlets and discharge locations, and by return flows from customers. The interrelationship between canals owned by PG&E and PCWA delivers water originating from the Yuba and Bear river systems in varying proportions throughout the raw water distribution system, depending on the season and buy point(s) used. The following sections describe the characteristics that determine the sources and destinations of raw water within Zones 3, 1, and 5 of the PCWA raw water distribution system. These zones are described in the general direction of flow, with Zone 3 representing the upstream zone, and Zone 5 the furthest downstream extent of the system.

3.2.1.1 Zone 3

Hydrology in Zone 3 canals is largely regulated by releases from Lake Alta, a small reservoir near the town of Alta, with a surface area of approximately 20 acres and storage capacity of about 270 acre-feet. Water is conveyed to Lake Alta from PG&E's Alta Powerhouse through the Alta Tailrace, or from PCWA's Pulp Mill Canal, which conveys water from Canyon Creek.

PCWA holds water rights of 40 cfs on Canyon Creek, a tributary to the North Fork American River. PG&E uses Canyon Creek to convey water from PG&E's Drum Forebay to PG&E's Towle Canal, which flows to Alta Forebay. PG&E is required to maintain an instream flow of 1 cfs that is released to Canyon Creek below Pulp Mill Diversion Dam. Canyon Creek flows parallel to Interstate 80 for much of its 10.5-mile length, before turning south to its confluence with the North Fork American River near the town of Dutch Flat (Durham 1998).

The Canyon Creek watershed is small and confined in a steep canyon. Streamflows in Canyon Creek are monitored by USGS at two gaging stations upstream from Pulp Mill Diversion Dam, located upstream and downstream from PG&E's Towle Canal Diversion. USGS Station No. 11426195 (Canyon Creek near Blue Canyon, California) is located upstream of PG&E's Towle Canal Diversion, and reflects streamflow generated within a 0.5-square-mile watershed. USGS Station No. 11426196 (Canyon Creek below Towle Diversion Dam, near Blue Canyon, California) is downstream from PG&E's Towle Diversion, and reflects streamflow for a 1.3-square-mile watershed. Streamflows at these stations are not recorded above 1.2 cfs. Flows at these stations often exceed 1.2 cfs during the winter, but frequently drop below 1 cfs during the summer (USGS, 2007a, 2007b). The hydrology of Canyon Creek is likely representative of other streams in the area, with high flow during winter and spring, and low flow during summer and fall, due, in part, to the small watershed and lack of baseflow contributions from

groundwater. Much of the land in Zone 3 is rural with some agriculture and pasture lands. Urbanization increases at the southern portion of Zone 3 near Zone 1.

PCWA releases water from Lake Alta to Cedar Creek Canal, which conveys water to the Monte Vista WTP and Boardman Canal. Boardman Canal is the main conveyance feature in Zone 3. The canal parallels Interstate 80 through much of the zone, generally following the topographical divide of the North Fork American River watershed to the east and the Bear River watershed to the west.

3.2.1.2 Zone 1

Zone 1 hydrology is primarily affected by the topographical transition from the steep slopes and narrow canyons of Zone 3 to the broad, relatively flat topography of Zone 5. Zone 1 is characterized by gradually decreasing gradients from the upper to lower portions, and by numerous branches of gravity-fed canals that deliver water to customers over a large area. Several Zone 1 streams receive flow contributions from the canal system through regulated or unregulated releases from canal outlets, or are used as conveyance features within the PCWA raw water distribution system. These include Auburn Ravine, Clover Valley Creek, Antelope Creek, Miners Ravine, and Secret Ravine.

Auburn Ravine originates on the north side of the City of Auburn, and has a watershed area of approximately 79 square miles. Upstream from the City of Auburn, the stream is confined within a natural channel, is unimpaired, and receives mostly local watershed contributions to streamflow, with some PCWA contributions that are diverted further downstream. Immediately west of the City of Auburn, the character of the stream changes and Auburn Ravine is used as a conveyance feature for PG&E, NID, and the PCWA canal system.

Auburn Ravine's natural streamflow is supplemented through four primary sources: (1) PG&E Drum-Spaulding Project source water; (2) PCWA deliveries from the North Fork American River through the Auburn Ravine Tunnel; (3) City of Auburn effluent discharges from its WWTP; and (4) Auburn Ravine watershed stormwater runoff. In addition to hydrologic influences of PG&E, NID, and PCWA flow contributions and diversions on Auburn Ravine, NID and PCWA customers indirectly affect Auburn Ravine hydrology through customer return flows (remaining portions of customer water deliveries that return to drainages). Middle Fiddler Green Canal, Lower Banvard Canal, Dutch Ravine Canal, and Caperton Canal are the main PCWA canals that supply customers raw water in the Auburn Ravine watershed.

Instantaneous peak flows in Auburn Ravine are highest in the winter months, ranging from less than 3 cfs to an estimated 100-year flow event exceeding 14,000 cfs near the City of Lincoln. Estimated monthly average streamflow for Auburn Ravine under existing management conditions and historic natural streamflow are provided in **Table 3-4** (Reclamation and PCWA 2002). Flows in Auburn Ravine are lowest during the fall, when NID and PCWA customer demands are low. Auburn Ravine flows can vary substantially on a daily and monthly basis. The supplemental flows described above significantly augment the estimated natural late summer and early fall streamflows. Without the influence of existing water management conditions in the

watershed, Auburn Ravine would remain an intermittent stream carrying only flow originating at its headwaters and runoff from the watershed (Reclamation and PCWA 2002).

**TABLE 3-4
ESTIMATED MEAN MONTHLY FLOW FOR AUBURN RAVINE
NEAR HIGHWAY 65 BRIDGE**

	October	November	December	January	February	March	April	May	June	July	August	September
	Mean Monthly Flow (cubic feet per second)											
Estimated Under Existing Management Conditions¹	30	39	84	117	120	132	66	88	82	114	99	43
Estimated Natural Streamflow²	4.1	11.7	38.2	70.6	50.9	32.3	20.1	2.4	0.2	0.1	0.0	0.0

¹ Source: Eco:Logic Engineering Water Balances; Nevada Irrigation District (NID) Gauge in Auburn Ravine below Highway 65 in City of Lincoln 1999.

² Source: City of Auburn 1997 in City of Lincoln 1999.

Clover Valley Creek, a tributary to Antelope Creek (described below), is 7.1 miles in length, and has a watershed area of about 10.2 square miles (Placer and Sacramento Counties 2003). Clover Valley Creek watershed is a tributary of Dry Creek, and comprises approximately 3.6 percent of the Dry Creek watershed (Placer and Sacramento Counties 2003). Clover Valley Creek receives direct flow contributions from the PCWA raw water distribution system in the form of regulated releases at Clover Valley Reservoir and unregulated releases from the end of the Antelope Canal outlet, as well as indirect flow contributions through customer return flows. Additionally, flows to Clover Valley Creek may be augmented by PCWA during storms through overflow releases from Whitney Reservoir. Clover Valley Creek serves as a natural drainage system for the primarily undeveloped Clover Valley area. The level of development within the Clover Valley Creek watershed increases from upstream to downstream, with significant portions of the land adjacent to the upper reaches undeveloped. Estimated peak flows for 10- and 100-year flood events at the Clover Valley Creek confluence with Antelope Creek are approximately 1,650 cfs and 3,050 cfs, respectively (City of Rocklin 2006).

Antelope Creek Watershed

Antelope Creek flows roughly parallel to Interstate 80 for approximately 9.5 miles in the southern portion of Zone 1. Antelope Creek is a tributary to Dry Creek, which in turn is a tributary to the Sacramento River via Steelhead Creek (formerly the Natomas East Main Drain Canal), and has a watershed area of approximately 21.4 square miles. Antelope Creek comprises approximately 11 percent of the Dry Creek watershed (Placer and Sacramento Counties 2003). Its watershed is urbanized with some light agriculture in the uppermost portions (Placer and Sacramento Counties 2003). Antelope Creek receives direct flow contributions from the PCWA raw water distribution system in the form of unregulated releases from the end of the Antelope Stub Canal outlet, indirect flow contributions through customer return flows, and treated effluent

from a sewage disposal pond located a few miles upstream from its confluence with Dry Creek. Antelope Creek also receives treated effluent from a sewage disposal pond located a few miles upstream from its confluence with Dry Creek, north of Highway 65 (Placer County Planning Department 2005b). Flows in Antelope Creek during summer and early fall months are often less than 1 cfs, while potential peak flows for 10- and 100-year flood events at Rocklin Road were calculated by the Placer County Flood Control and Water Conservation District (PCFCWCD) are of approximately 1,430 cfs and 3,490 cfs, respectively (PCFCWCD and Sacramento County Water Agency (SCWA) 1992).

Secret Ravine Watershed

Secret Ravine is a tributary to Miners Ravine, described below. It is 7.8 miles long, flows in a narrow valley underlain by Recent alluvial deposits, and has a watershed area of about 22.3 square miles (Placer and Sacramento Counties 2003). The Secret Ravine watershed comprises approximately 22 percent of the Dry Creek watershed (Placer and Sacramento Counties 2003). Shallow, impermeable soils, granitic bedrock, and a narrow riparian zone characterize the upper watershed of Secret Ravine. The bedrock of the lower watershed is volcanic cap rock. These conditions, coupled with rapid urban and residential development in the watershed, which increases the impervious fraction of land cover, result in rapid surface and subsurface runoff generation, and an increase in peak flows in Secret Ravine.

Secret Ravine flows vary greatly during the year. Flows in Secret Ravine are as low as 0.5 cfs during summer and early fall months, while potential peak flows for 10- and 100-year flood events at Rocklin Road calculated by the PCFCWCD were approximately 1,750 cfs and 3,820 cfs, respectively (Placer County and SCWA 1992). Current summer streamflows are greater than the historic unimpaired flow on Secret Ravine (Placer and Sacramento Counties 2003). Summer flows are most likely attributed to direct flow contributions from the PCWA raw water distribution system in the form of unregulated releases from several PCWA canal outlets, indirect flow contributions through customer return flows, and treated effluent from two sewage disposal ponds located near Interstate 80 and Gilardi Road. Summer flows are two or three times the historic unimpaired flow (Placer County Planning Department 2005b).

Numerous PCWA canals augment flows in tributaries to Secret Ravine through unregulated releases from the ends of canal outlets, including Westside, Lyall, and Eastside canals to the west, and Sugarloaf, Barton, Turner, Yankee Hill, and Boardman canals to the east. Customer return flows also augment streamflow in Secret Ravine. PCWA canal system contributions dominate dry season flows in Secret Ravine (USACE and PCWA 2008). Flows in Secret Ravine at Rocklin Road in Roseville between December 2004 and December 2006 are logarithmically displayed in **Figure 3-5**.

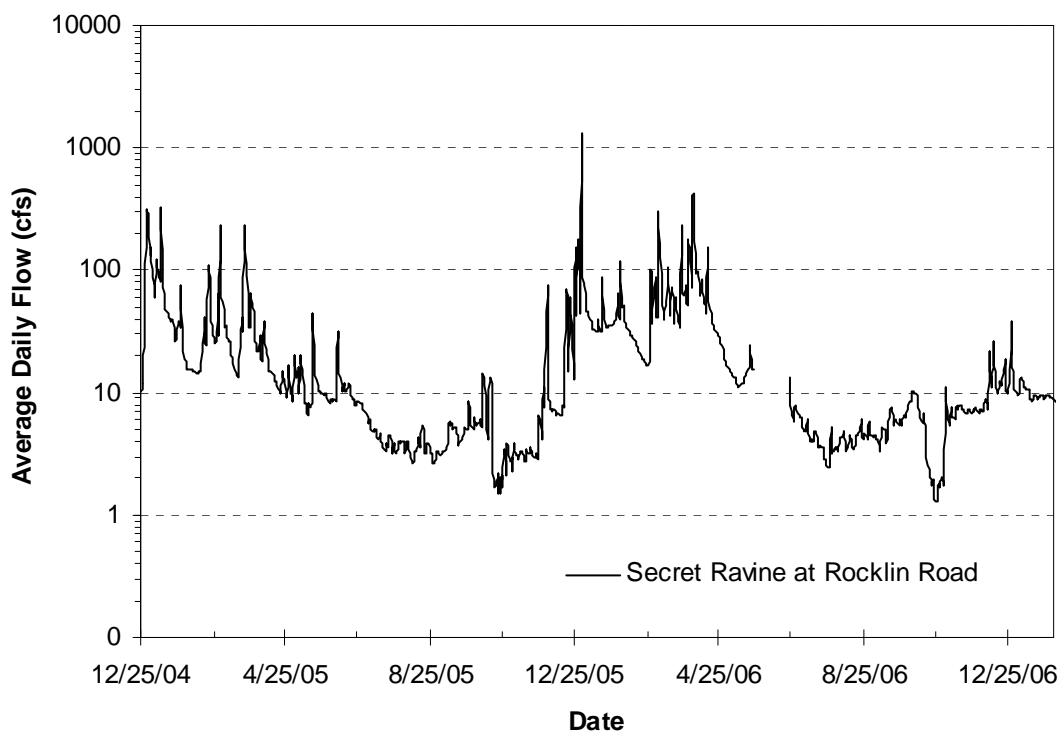


FIGURE 3-5
AVERAGE DAILY FLOWS IN SECRET RAVINE AT ROCKLIN ROAD

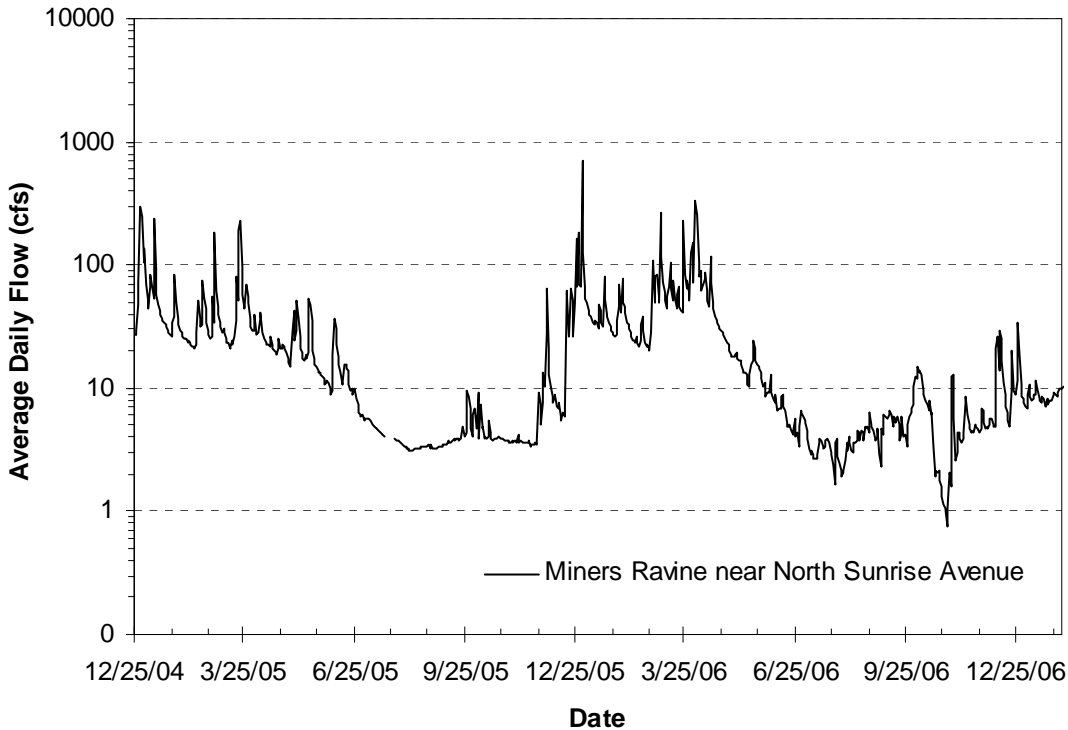
Miners Ravine Watershed

Miners Ravine is a tributary to Dry Creek, and is approximately 15.2 miles long, with a watershed area of 20.1 square miles. Miners Ravine watershed represents approximately 20 percent of the Dry Creek watershed. The headwaters for Miners Ravine are in the western foothills of the Sierra Nevada where livestock grazing is common, whereas the downstream portion flows through more developed areas. Similar to Secret Ravine, impermeable soils and shallow depth to bedrock in the Miners Ravine watershed contribute to rapid surface and subsurface runoff generation. Apart from the main channel, the watershed drainage consists of small, intermittent tributaries that only carry low flows and can be expected to flood, on average, every 5 years (Placer and Sacramento Counties 2003).

Summer flows in Miners Ravine are often less than 1 cfs, while peak flows for 10- and 100-year events at Sunrise Avenue were calculated by the Placer County Flood Control and Water Conservation District to be approximately 2,497 cfs and 6,642 cfs, respectively (Placer County and SCWA 1992). Localized flooding often occurs in the Miners Ravine watershed. Fences and other structures within or immediately adjacent to the watercourse and inadequately sized culverts at bridge crossings create flow obstructions, and contribute to issues of flooding in the watershed.

Similar to Secret Ravine, canal system contributions comprise most of the dry weather flows in Miners Ravine (USACE and PCWA 2008). These contributions include customer return flows and unregulated releases from the Lower Greely, Ferguson, and Baughman canals. Additional

inputs include the Placer County SMD No. 3 (National Pollutant Discharge Elimination System ((NPDES)) CA0079367) WWTP. The design flow rate of Placer County SMD No. 3 is 0.75 million gallons per day (mgd) (1.16 cfs), but the facility is currently operating at less than 20 percent design capacity. Under current operations, effluent contributes 2 to 3 percent of total flow during high-flow conditions and less than 10 percent of total flow during low-flow conditions (Placer and Sacramento Counties 2003). Flows in Miners Ravine near North Sunrise Avenue in Roseville between December 2004 and December 2006 are logarithmically displayed in **Figure 3-6**.



**FIGURE 3-6
AVERAGE DAILY FLOWS IN MINERS RAVINE NEAR NORTH SUNRISE AVENUE**

3.2.1.3 Zone 5

The Zone 5 service area receives water deliveries diverted from Auburn Ravine. As described above, streamflow in Auburn Ravine is supplemented through diversions from the American, Bear, and Yuba rivers, as well as treated effluent from the City of Lincoln’s WWTP. Due to these supplemental sources to flow in Auburn Ravine, monthly average streamflow for Auburn Ravine under existing management conditions vary considerably from estimated natural flow conditions (**Table 3-4**). Up to 50 cfs of water pumped from the North Fork American River are conveyed to Auburn Ravine in Zone 1 by PCWA for diversion in Zone 5. PCWA may also divert water purchased from PG&E at YB 136 for deliveries to Zone 5 customers. Auburn Ravine is seasonally dammed at Moore Dam, where flows are diverted to Moore Canal. Further downstream, flows are diverted from Auburn Ravine at the Pleasant Grove Dam to the Pleasant

Grove Canal. PCWA Zone 5 customers receive deliveries conveyed either directly from Auburn Ravine or diverted to Moore or Pleasant Grove canals. In addition to these diversions to PCWA's Zone 5 service area, several dams and diversions on Auburn Ravine provide for water deliveries to NID customers.

3.2.2 Water Quality

This section presents the results of seasonal water quality monitoring efforts during routine operations, describes general trends observed, and presents some stronger trends and potential relationships among different water quality parameters. As previously mentioned, more extensive sampling would be required to accurately derive quantitative results. Therefore, the information in this section is descriptive and should be used for qualitative discussion purposes only. The data are described below by watershed within each zone, and discussed with respect to basic physical and chemical parameters, major ions, and trace elements.

Water quality is expected to vary over space and time in the PCWA canal and associated stream systems. Spatially, in the upstream areas of the canal system, the canal water is expected to more closely resemble the quality of source water from the Yuba and Bear rivers. As water flows farther downstream through the canal system, it encounters many factors that affect its quality, including debris in the canal channels, irrigation return flows and additional watershed contributions from property along the canals, and water storage in mid-system reservoirs. Water pumped from the American River through the ARPS contributes to flow in the PCWA canal system during certain times of the year, and additional Yuba and Bear supplies can be added to the PCWA system at various points. As water reaches tributaries and streams and flows further from the canal outlets, it encounters many factors characteristic of the stream's watershed that affect its quality, including irrigation return flows, runoff, ponds, tributaries, and in-channel vegetation. Residual constituents from historical activities in the basin, such as hydraulic mining, quarries, a pulp mill, and large agricultural areas, could affect canal and stream water quality.

These water quality results can be compared to Federal and State water quality criteria and objectives stipulated in the National Toxics Rule (NTR), California Toxics Rule (CTR), and Porter-Cologne Water Quality Control Act, described in **Chapter 4**. The U.S. EPA National Recommended Ambient Water Quality Criteria for Freshwater Aquatic Life (NTR) and Criteria for Priority Toxic Pollutants in the State of California (CTR) are shown in **Tables 3-5** and **3-6**, respectively. Normally, two types of limits are presented in the NTR and CTR; chronic and acute. These limits are presented as Criteria Maximum Concentrations (CMC) to protect aquatic organisms from short-term or acute exposures (expressed as 1-hour average or instantaneous maximum concentrations) to pollutants. Criteria Continuous Concentrations (CCC) are intended to protect aquatic organisms from long-term or chronic exposures (expressed as 4-day or 24-hour average concentrations). Of the constituents measured in study area streams, cadmium, copper and zinc have freshwater CMC and CCC limits.

**TABLE 3-5
NATIONAL RECOMMENDED AMBIENT WATER QUALITY CRITERIA FOR
FRESHWATER AQUATIC LIFE**

Parameter	Maximum or Acute Concentration (CMC) (1-hour Average) in µg/L	Continuous or Chronic Concentration (CCC) (4-day Average) in µg/L	Pollutant Type
Aluminum ¹	750	87	Non Priority
Alkalinity ³		20,000	Non Priority
Cadmium ²	2.0	0.25	Priority
Copper ²	13	9	Priority
Iron ³		1000	Non Priority
Zinc ²	120	120	Priority
Dissolved Oxygen ³	Warmwater and Coldwater Matrix (Document N)		Non Priority
TSS and Turbidity ³	Narrative Statement (Document F)		Non Priority
Temperature ³	Species-dependent Criteria (Document M)		Non Priority
Hardness ³	Narrative Statement		Non Priority
pH ³	6.5-9.5 in pH units		Non Priority

Source:

U.S. EPA 2006.

Notes:

¹ Total recoverable aluminum for waters with pH between 6.5 and 9.0.

² Expressed in terms of dissolved metal in water column as a function of hardness (mg/L). The value given here corresponds to a hardness of 100 mg/L. Criteria values for other hardness may be calculated based on information in Appendix B- Parameters for Calculating Freshwater Dissolved Metals Criteria

That Are Hardness-Dependent.

³ U.S. EPA 1986.

Key:

CCC = Criteria Continuous Concentration (estimate of the highest concentration of a material in surface water to which an aquatic community can be exposed indefinitely without resulting in an unacceptable effect)

CMC = Criteria Maximum Concentration (an estimate of the highest concentration of a material in surface water to which an aquatic community can be exposed briefly without resulting in an unacceptable effect)

µg/L = microgram per liter

**TABLE 3-6
CRITERIA FOR PRIORITY TOXIC POLLUTANTS IN THE STATE OF CALIFORNIA
(CALIFORNIA TOXICS RULE) FOR SELECT PARAMETERS**

Parameter Name	Freshwater CMC (µg/L)	Freshwater CCC (µg/L)
Cadmium ¹		2.2
Copper ¹	13	9
Zinc ¹	120	120

Source: EPA 40 Code of Federal Regulations Part 131

Note:

1 The California Toxics Rule for the maximum concentration for Cadmium does not apply to the Sacramento River

Key:

CCC = Criteria Continuous Concentration

CMC = Criteria Maximum Concentration

µg/ = micrograms per liter l

Under the Porter Cologne Water Quality Control Act, the Water Quality Control Plan for the Sacramento and San Joaquin Rivers (Basin Plan) presents the following designated beneficial uses established for the Sacramento River; Colusa Basin Drain to the “I” Street Bridge, or Hydrologic Unit Number 520 (RWQCB 2007):

- **Municipal Domestic Supply (MUN)** - Uses of water for community, military, or individual water supply systems including, but not limited to, drinking water supply.
- **Agricultural Supply (AGR)** for Irrigation – Uses of water for farming, horticulture, or ranching including, but not limited to, irrigation (including leaching of salts), stock watering, or support of vegetation for range grazing.
- **Water Contact Recreation (REC-1)** – Uses of water for recreational activities involving body contact with water, where ingestion of water is reasonably possible. These uses include, but are not limited to, swimming, wading, waterskiing, skin and scuba diving, surfing, white water activities, fishing, or use of natural hot springs.
- **Non-contact Water Recreation (REC-2)** – Uses of water for recreational activities involving proximity to water, but where there is generally no body contact with water, nor any likelihood of ingestion of water. These uses include, but are not limited to, picnicking, sunbathing, hiking, beachcombing, camping, boating, tidepool and marine life study, hunting, sightseeing, or aesthetic enjoyment in conjunction with the above activities.
- **Warm and Cold Freshwater Habitat (WARM and COLD)** – Resident does not include anadromous fish. Any segments with both COLD and WARM beneficial use designations will be considered COLD water bodies for the application of water quality objectives.
- **Warm and Cold Migration of Aquatic Organisms (MIGR)** – More specifically referring to striped bass, sturgeon, and shad.
- **Warm and Cold Fish Spawning, Reproduction, and/or Early Development (SPWN)** – More specifically referring to salmon and steelhead.
- **Wildlife Habitat (WILD)** - Uses of water that support terrestrial or wetland ecosystems including, but not limited to, preservation and enhancement of terrestrial habitats or wetlands, vegetation, wildlife (e.g., mammals, birds, reptiles, amphibians, invertebrates), or wildlife water and food sources.
- **Navigation (NAV)** - Uses of water for shipping, travel, or other transportation by private, military, or commercial vessels.

Of the water quality constituents measured in study area streams, water quality objectives for the Sacramento River watershed, from Keswick Dam to the I Street Bridge in the City of Sacramento, have been established concerning thresholds for the basic parameters of dissolved oxygen, pH, electrical (specific) conductivity, and turbidity (**Table 3-7**), as well as the ions and trace elements of barium, copper, iron, and zinc (**Table 3-8**). This segment of the Sacramento River is also on the 303d list of impaired water bodies for mercury and diazinon, an organophosphate pesticide. Organophosphate pesticides are not used by PCWA and not discussed further in this report.

**TABLE 3-7
BASIN PLAN WATER QUALITY OBJECTIVES FOR BASIC PARAMETERS
ASSOCIATED WITH BENEFICIAL USES**

Parameter	Water Quality Criterion	Units	Applicable Water Bodies
Dissolved Oxygen	>85% saturation (Monthly median of the mean daily DO concentration in mg/L) >75% saturation (95 th percentile concentration) 7.0 (Minimum level for waters with designated COLD beneficial uses)	(mg/L)	Surface water bodies outside the legal boundaries of the Delta.
pH ¹	6.5-8.5 Changes in normal ambient pH levels shall not exceed 0.5 in fres waters with designated COLD or WARM beneficial uses		All
Turbidity ²	Will not increase by greater than 20%		

Source: Central Valley RWQCB, 2007

Notes:

¹ Changes in normal ambient pH levels shall not exceed 0.5 in freshwaters with designated COLD or WARM beneficial uses

² Where natural turbidity is between 5 and 50 NTU

Key:

DO = dissolved oxygen

mg/L = milligram per liter

**TABLE 3-8
BASIN PLAN WATER QUALITY OBJECTIVES FOR TRACE ELEMENTS
ASSOCIATED WITH BENEFICIAL USES**

Parameter	Maximum Concentration	Unit
Barium ²	100	µg/L
Copper ²	10	µg/L
Iron ²	0.3	mg/L
Zinc ²	10	µg/L

Source: Central Valley RWQCB, 2007

Notes:

¹ These concentrations are based on a hardness of 40 mg/L. Where deviations from 40 mg/L of water hardness occur, the objectives (mg/L) shall be determined by the following formula:

$$\text{Cu} = e^{(0.905)(\text{Ln hardness}) - 1.612} \times 10^{-3}$$

$$\text{Zn} = e^{(0.830)(\text{Ln hardness}) - 0.289} \times 10^{-3}$$

$$\text{Cd} = e^{(1.160)(\text{Ln hardness}) - 5.777} \times 10^{-3}$$

² Metal objectives are dissolved concentrations

Key:

These objectives are applicable to the Sacramento River from Keswick Dam to the I Street Bridge at City of Sacramento (13, 30); American River from Folsom Dam to the Sacramento River (51); Folsom Lake (50); and the Sacramento-San Joaquin Delta.

mg/L = milligrams per liter

µg/L = micrograms per liter

3.2.2.1 Zone 3

The water quality of Canyon Creek is likely representative of other streams within the western Sierra Nevada montane forest area. Because the creek is located deep within a steep canyon characterized by coarse loam soils, it may be particularly vulnerable to erosion through scouring of the banks from high flows during the wet season, which increases the potential for naturally high sediment loads in streams. Although much of the land around Canyon Creek is rural, water quality conditions may be affected by historic mining activities in the area. Eleven of the 24 major watersheds in the Sierra had portions in which mercury was found, and eight watersheds were found with traces of copper detected (Sierra Nevada Alliance 2006). In addition, 50 percent of these major watersheds were found to have elevated concentrations of nutrients, and 29 percent were found to be affected by pesticides (Sierra Nevada Alliance 2006).

Water quality was evaluated at one site in Zone 3, Boardman Canal below Lake Alta (YB96). Lake Alta is located near the top of the PCWA water delivery system, at an elevation of 3,543 feet above mean sea level (msl). Releases from Lake Alta are delivered to Boardman Canal, which is the main conveyance feature in Zone 3.

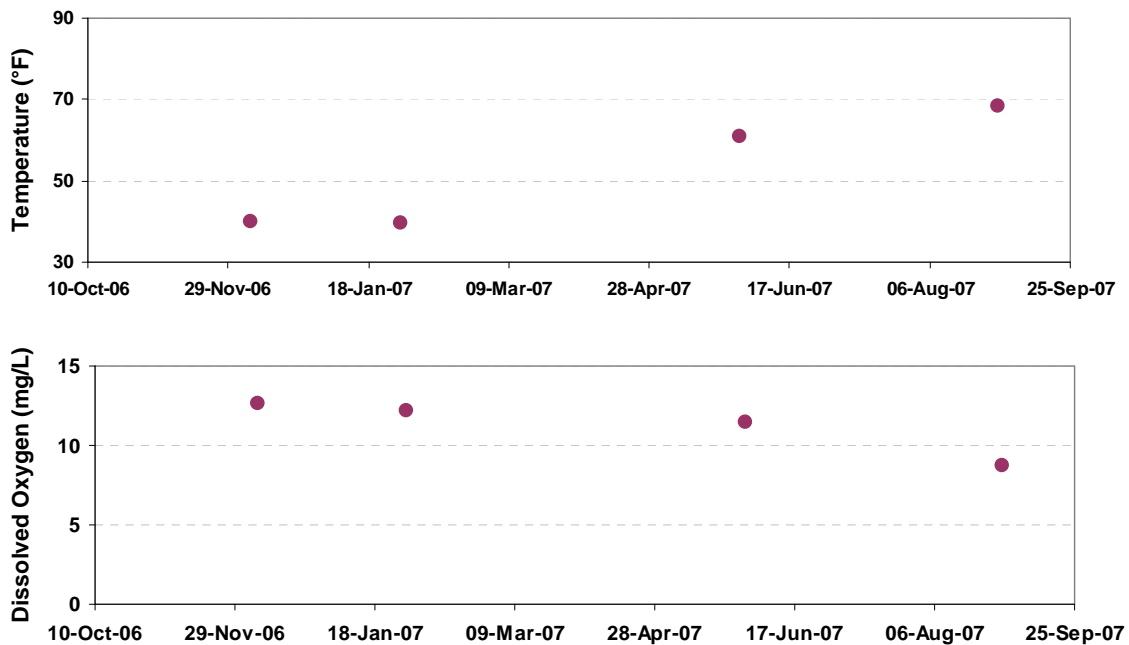
The following sections describe water quality conditions observed during PCWA routine operations within the Zone 3 service area at Boardman Canal below Lake Alta (YB96).

Water Temperature and Dissolved Oxygen

Water temperature results for YB96 from baseline water quality monitoring events are shown in **Figure 3-7**. These water temperatures are of the coldest for all canal sampling locations because

this site is the most upstream location within the canal system and is located at an elevation of 3,543 feet msl, which is significantly higher than the other sampling locations.

An inverse relationship between water temperature and DO was observed, shown in **Figure 3-7**, exhibiting higher DO levels when water temperatures were lower. In the PCWA canal system, DO levels were highest in late fall and decreased through winter and into spring. These DO results are of the highest among all canal sampling locations.



**FIGURE 3-7
WATER TEMPERATURE AND DISSOLVED OXYGEN RESULTS FROM SEASONAL MONITORING EVENTS AT BOARDMAN CANAL BELOW LAKE ALTA**

pH, Alkalinity, and Hardness

As shown in **Figure 3-8**, values for pH remained relatively close to the neutral level of 7.0, and were relatively constant in the canal system regardless of season, varying between pH 7.0 and pH 7.58. Results for pH at YB96 were closest to “neutral” among the water quality monitoring sites within the PCWA raw water distribution system.

The geology and soils of the region typically exhibit low pH and low concentrations of CaCO₃, a mineral that contributes to alkalinity and raises pH. However, many of the streams in the PCWA raw water service area are associated with xerofluvents, soils with up to pH 8.5, and some of the only soils in Placer County containing CaCO₃ (up to 5 percent) (USDA-NRCS 2007). As shown in **Figure 3-8**, alkalinity values at YB96 varied between 14 and 23 mg/L CaCO₃, which are similar to the values exhibited at the other canal sampling locations, described below. The highest alkalinity value of 23 mg/L CaCO₃ at YB96 is associated with the lowest pH value during the spring sampling event at that site. Calculated hardness values coincide with alkalinity

values, with the exception of the summer sampling event, which was calculated to be lower than the measured alkalinity value. This could indicate the hardness is completely CaCO_3 -derived.

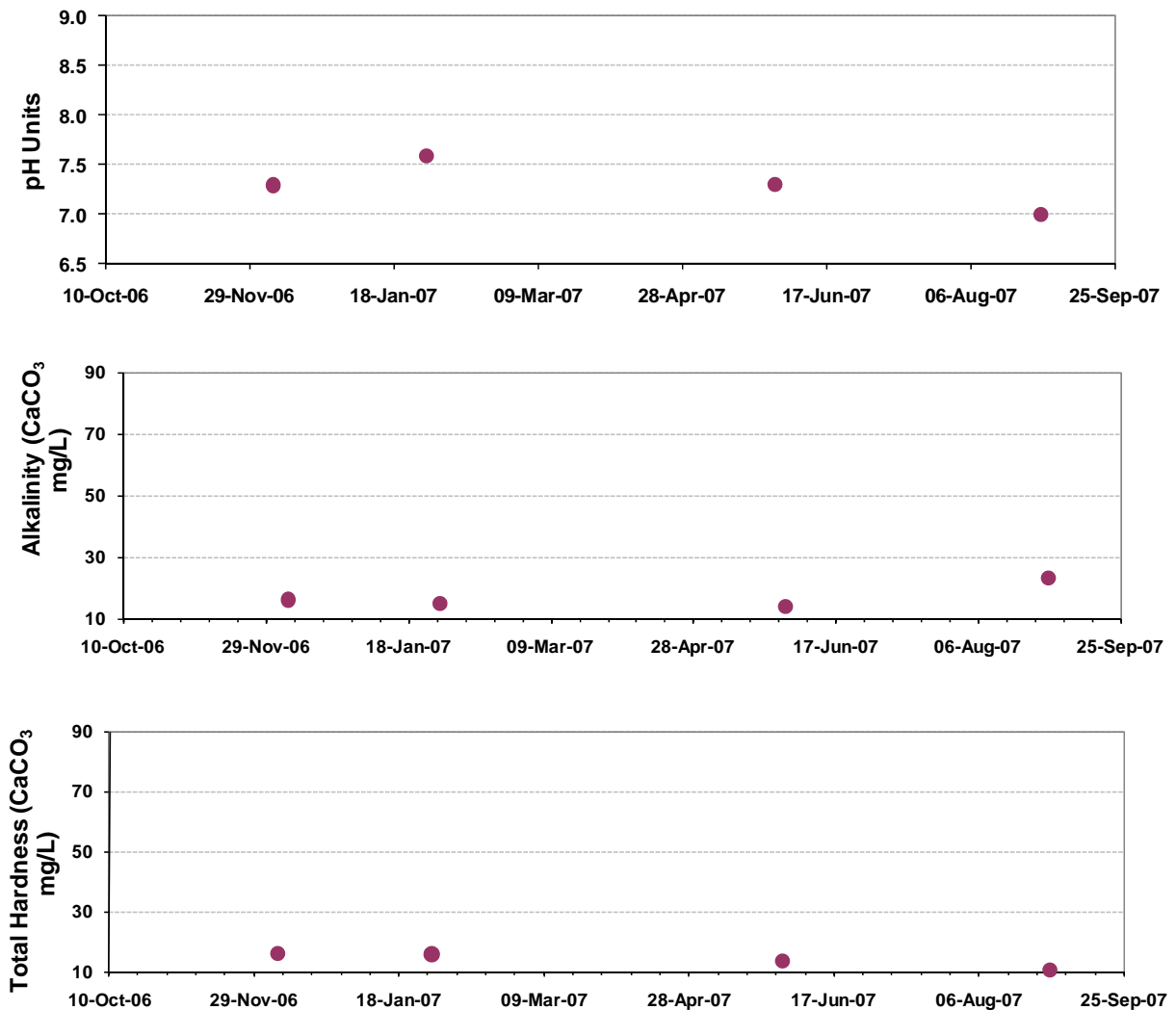


FIGURE 3-8

PH, HARDNESS, AND ALKALINITY RESULTS FROM SEASONAL MONITORING EVENTS AT BOARDMAN CANAL BELOW LAKE ALTA

Total Suspended Solids and Turbidity

All TSS values at YB96 were below detection limits (10 mg/L) during baseline sampling events. Turbidity was relatively low and constant in the PCWA canal system during routine operations activities. As shown in **Figure 3-9**, turbidity values at YB96 ranged between 8.0 and 15.7 nephelometric turbidity units (NTUs). Overall TSS and turbidity at the Boardman Canal below Lake Alta were low for seasonal baseline sampling events.

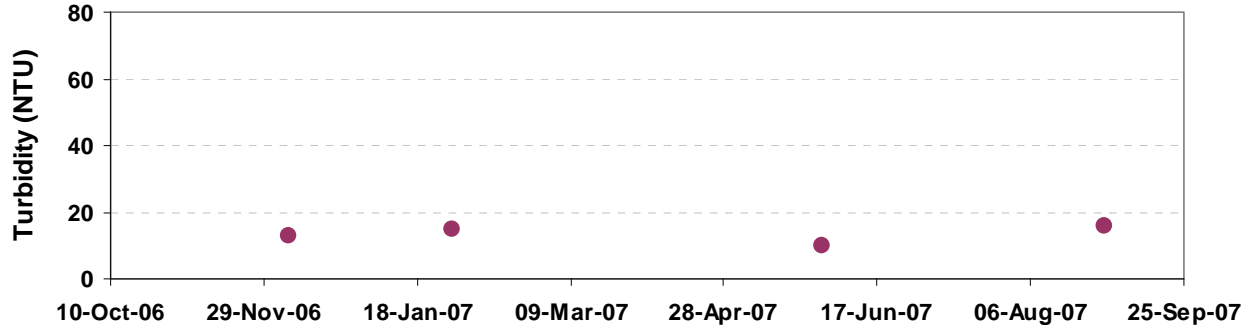


FIGURE 3-9
TOTAL SUSPENDED SOLIDS AND TURBIDITY RESULTS FROM SEASONAL MONITORING EVENTS AT BOARDMAN CANAL BELOW LAKE ALTA

Specific Conductivity and Ions

SC in water sampled in the Boardman Canal below Lake Alta was highest in fall and winter and decreased in spring and summer, as shown in **Figure 3-10**. With the exception of the summer result, these results were the highest among all other canal sampling locations.

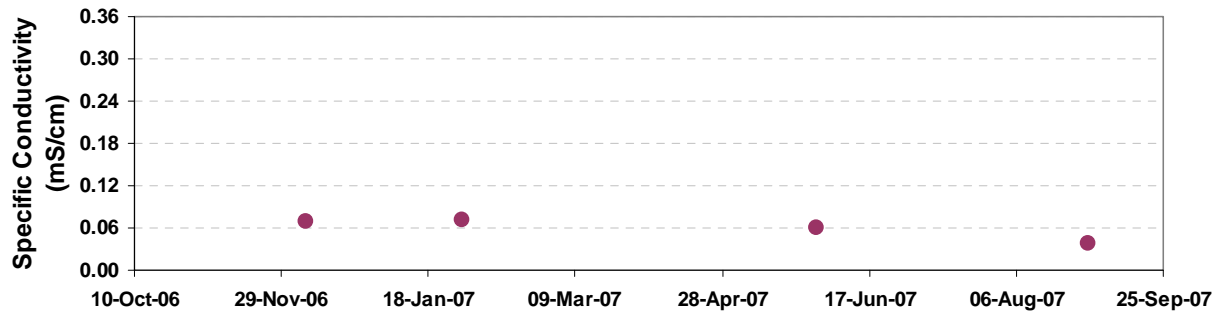


FIGURE 3-10
SPECIFIC CONDUCTIVITY RESULTS FROM SEASONAL MONITORING EVENTS AT BOARDMAN CANAL BELOW LAKE ALTA

As shown in **Figure 3-11**, calcium concentrations at YB96 display similar trends to that of SC, in which results were higher in fall and winter than in spring and summer. Seasonal calcium results at the Boardman Canal below Lake Alta were very low and ranged from 3.1 to 4.3 mg/L.

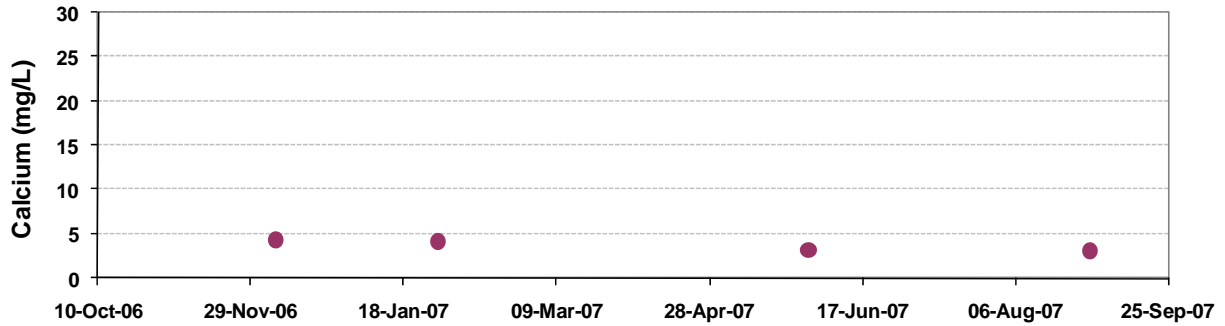


FIGURE 3-11
CALCIUM RESULTS FROM SEASONAL MONITORING EVENTS AT BOARDMAN CANAL BELOW LAKE ALTA

Iron was low at the YB96 site under routine operations, as shown in **Figure 3-12**. Concentrations ranged from 0.081 to 0.16 mg/L.

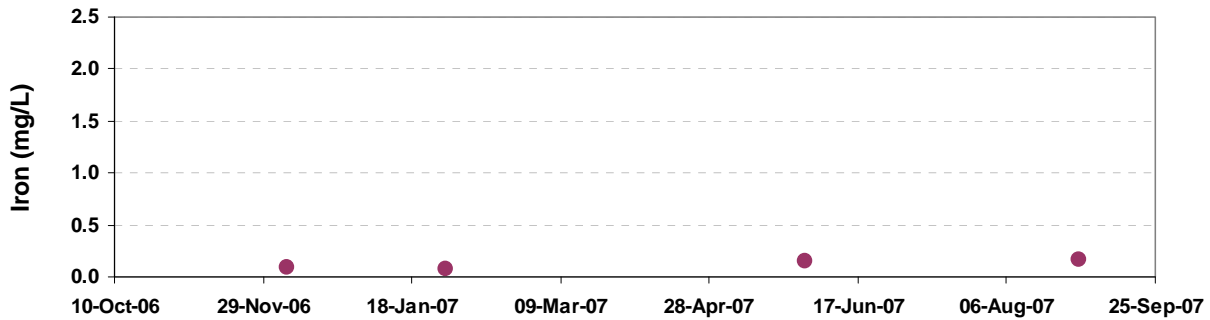
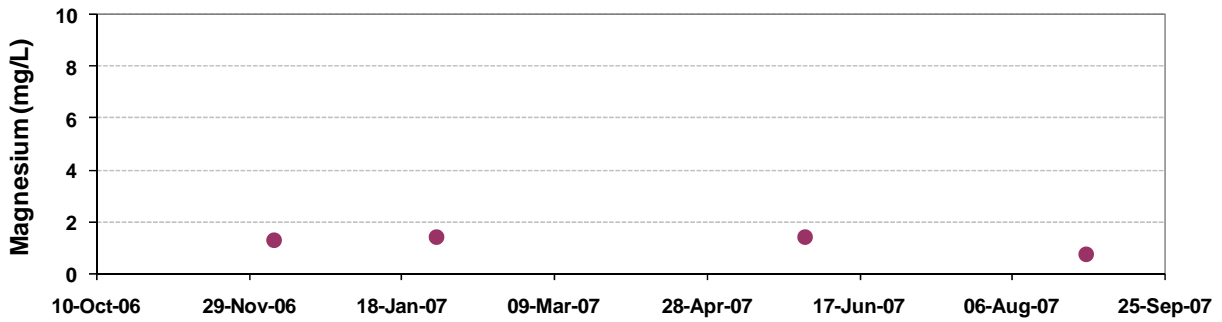


FIGURE 3-12
IRON RESULTS FROM SEASONAL MONITORING EVENTS AT BOARDMAN CANAL BELOW LAKE ALTA

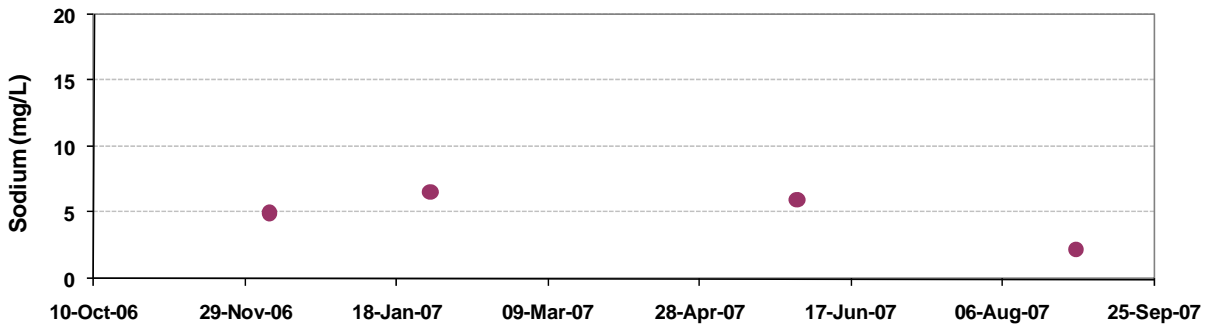
As shown in **Figure 3-13**, magnesium concentrations observed at YB96 were low, with values ranging from 0.73 to 1.4 mg/L. Results did not vary greatly over different seasons, which is similar to results for calcium.



**FIGURE 3-13
MAGNESIUM RESULTS FROM SEASONAL MONITORING EVENTS AT
BOARDMAN CANAL BELOW LAKE ALTA**

No potassium results were detected, with a detection limit of 1.0 mg/L, at Boardman Canal below Lake Alta during routine canal operations.

Figure 3-14 shows that sodium values range from 2.2 to 6.6 mg/L, with the lowest value in the summer and the highest value in the winter. Although sodium concentrations were very low at the Boardman Canal below the Lake Alta site, they were higher than all other canal sampling locations, with the exception of the summer, which exhibited the lowest value.



**FIGURE 3-14
SODIUM RESULTS FROM SEASONAL MONITORING EVENTS AT BOARDMAN
CANAL BELOW LAKE ALTA**

Chloride was present in the canal system at low levels during baseline sampling, as shown in **Figure 3-15**. Observed chloride concentrations at YB96 ranged from 1.9 to 9.5 mg/L. Similar to sodium concentrations at Boardman Canal below Lake Alta, chloride levels were elevated above concentrations in the remainder of the canal system, with the exception of summer baseline samples, when concentrations were lowest.

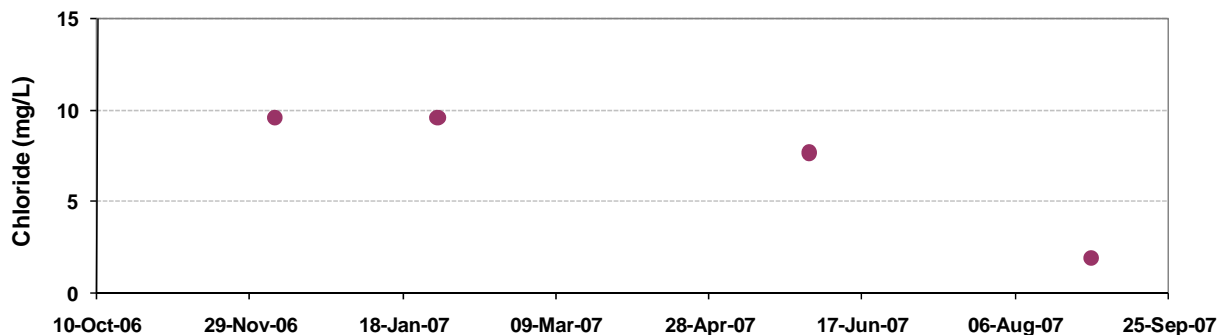


FIGURE 3-15
CHLORIDE RESULTS FROM SEASONAL MONITORING EVENTS AT BOARDMAN CANAL BELOW LAKE ALTA

Similar to potassium levels, no nitrate was detected at Boardman Canal below Lake Alta under baseline conditions. All results were below the detection limit of 0.1 mg/L.

Concentrations of sulfate are very low at the Boardman Canal below Lake Alta during routine operations. Concentrations were below the detection limit of 0.5 mg/L, with the exception of the winter sampling event, when the result was 1 mg/L.

Trace Elements

Elements that typically occur in very low concentrations are referred to as trace elements. At higher concentrations, most trace elements become toxic to plants, animals, or humans. Sources may be natural or urban, agricultural, or municipal. The solubility of most trace elements – whether they adsorb to bottom sediments or remain in the water column – is dependent on oxidation and reduction potential and pH. Water quality sampling in Zone 3 included analyses for several trace elements: barium, cadmium, copper, iron, mercury, and zinc. The toxicity and potential sources of these individual elements are described below with their observed trends.

Figure 3-16 shows aluminum results for the Boardman Canal below the Lake Alta site. These results are among the lowest of the results at the canal sampling locations.

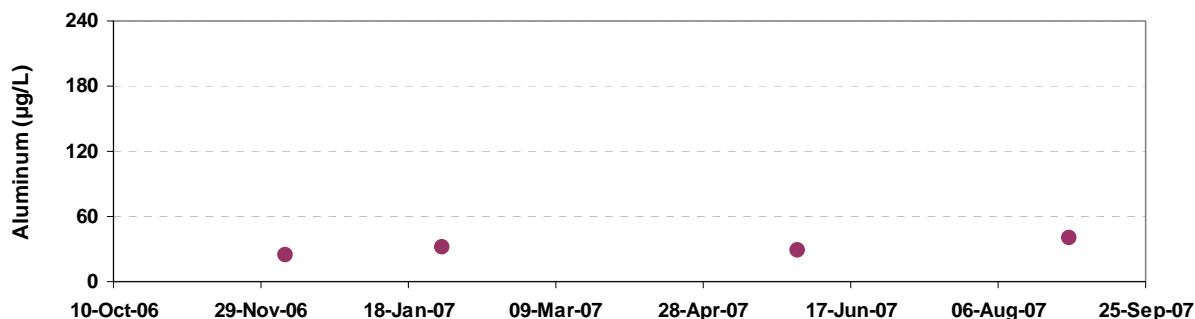


FIGURE 3-16
ALUMINUM RESULTS FROM SEASONAL MONITORING EVENTS AT BOARDMAN CANAL BELOW LAKE ALTA

Compared to other canal sites evaluated for this study, the highest seasonal barium concentrations were observed at Boardman Canal below Lake Alta; all of which were more than an order of magnitude greater than concentrations at sites evaluated elsewhere in the canal system (**Figure 3-17**).

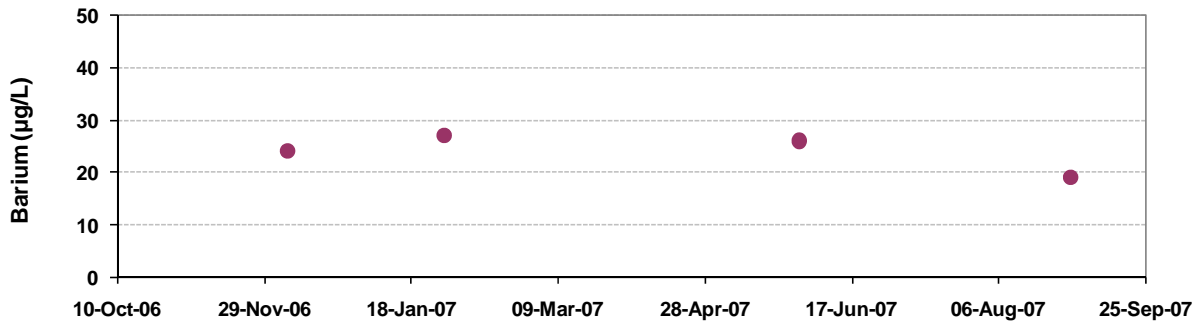


FIGURE 3-17
BARIUM RESULTS FROM SEASONAL MONITORING EVENTS AT BOARDMAN CANAL BELOW LAKE ALTA

All cadmium, copper, and mercury concentrations measured for baseline sampling events at Boardman Canal below Lake Alta were below the detection limits of 0.5, 2, and 0.2 µg/L, respectively. The only detected result for zinc at Boardman Canal below Lake Alta occurred during the winter sampling event, and exhibited the highest concentration, 22 µg/L, of all the canal sites (**Figure 3-18**). Modifications in laboratory measurement procedures for zinc led to the adjustments to the detection limit during the study period, from 5 to 10 to 20 µg/L.

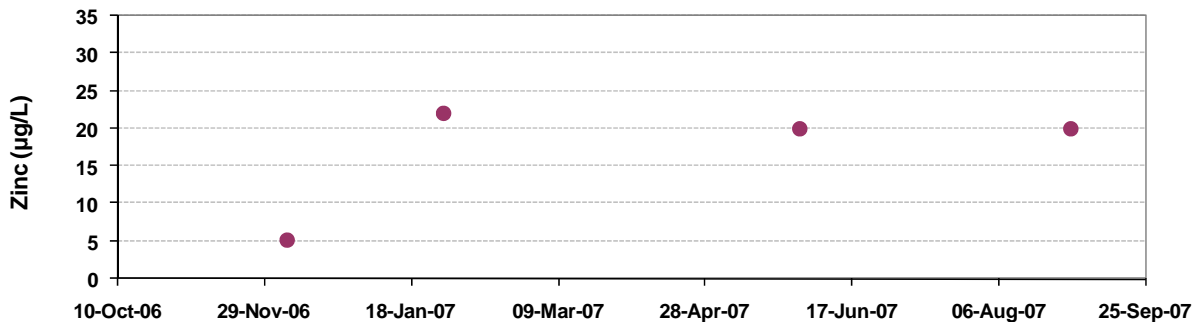


FIGURE 3-18
ZINC RESULTS FROM SEASONAL MONITORING EVENTS AT BOARDMAN CANAL BELOW LAKE ALTA

3.2.2.2 Zone 1

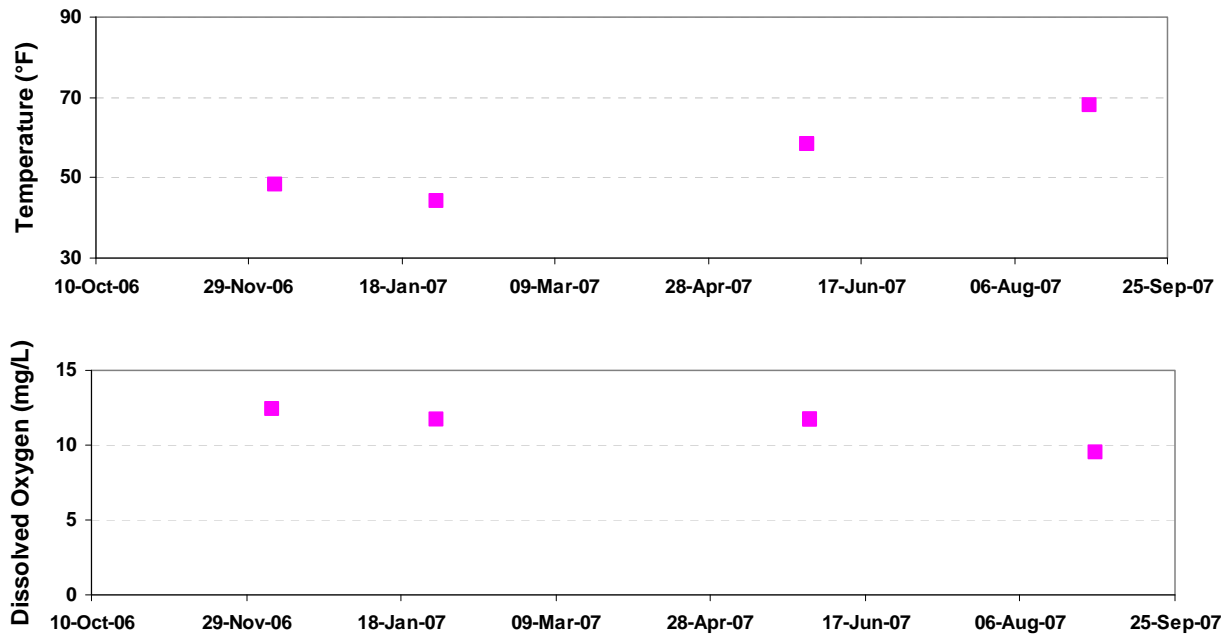
As shown in **Figures 3-2** and **3-3** and listed in **Table 3-1**, five canal sampling locations and nine stream sites were monitored in Zone 1 for baseline sampling events. Water quality results for canal and stream sites are discussed by watershed. Zone 1 watersheds evaluated include Auburn Ravine, Clover Valley Creek, Antelope Creek, Miners Ravine, and Secret Ravine.

Auburn Ravine Watershed

Water quality was evaluated at one sampling location within the Auburn Ravine watershed in Zone 1; Auburn Ravine below Auburn Ravine Tunnel outlet (AUBRAV3).

Water Temperature and Dissolved Oxygen

Water temperature and DO results are shown in **Figure 3-19**. Temperatures at AUBRAV3 display seasonal trends, with lowest temperatures during winter and highest during summer. DO levels remain relatively high throughout the year, ranging between 9.51 to 12.31 mg/L.



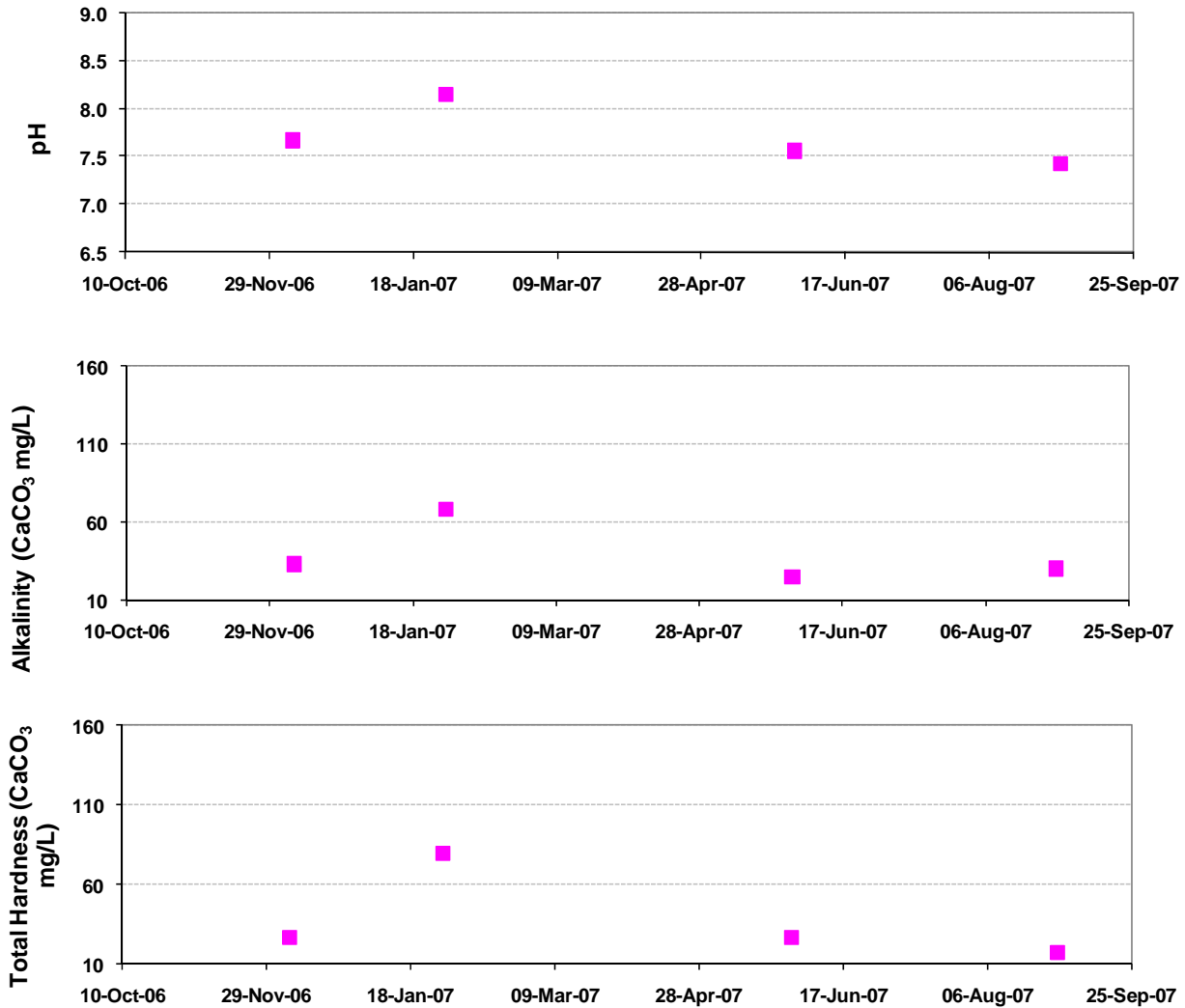
**FIGURE 3-19
WATER TEMPERATURE AND DISSOLVED OXYGEN RESULTS FROM SEASONAL
MONITORING EVENTS AT AUBURN RAVINE BELOW AUBURN RAVINE TUNNEL
OUTLET**

Water temperature data collected from other sources include hourly temperature monitoring conducted by Bailey Environmental between April 1999 and August 2003 at Fowler Road, an NID gaging station near Highway 65 in Lincoln, Moore Road, and at Aitken Ranch. Water temperature data from Bailey Environmental show summer values (May 28 to August 4, 2003) ranging from approximately 62 degrees Fahrenheit (°F) to 82 °F, fall values (September 9 to December 28, 2002) ranging from 48 °F to 69 °F, winter values (January 1 to April 27, 2003) ranging from 43 °F to 64 °F, and spring values (May 1 to July 31, 2003) ranging from 50 °F to 73 °F (Sierra Business Council 2003).

Lincoln High School Water Quality Monitoring Program funded by NID, Placer County, and the City of Lincoln, measured high DO values at three different stations along the creek during September 2001, and September and October 2002: Mackenroth Road, Highway 193 Bridge crossing, and the Joiner Parkway Bridge crossing (Sierra Business Council 2003).

pH, Alkalinity, and Hardness

Results for pH, alkalinity, and hardness from AUBRAV3 are shown in **Figure 3-20**. Values for pH at Auburn Ravine below the Auburn Ravine Tunnel outlet ranged from 7.43 to 8.14. Alkalinity values in the streams varied between 25 and 68 mg/L CaCO₃, with the highest alkalinity during summer.



**FIGURE 3-20
PH, ALKALINITY, AND HARDNESS RESULTS FROM SEASONAL MONITORING
EVENTS AT AUBURN RAVINE BELOW AUBURN RAVINE TUNNEL OUTLET**

Data on pH was collected monthly by the California Department of Water Resources (DWR) in the lower portion of the Auburn Ravine watershed reveal a wide range of pH values (5.6 to 7.7). The lower end of this range is considered extremely low for the types of streams found in the Sierra Nevada Foothills (Placer County Planning Department 2003).

Total Suspended Solids and Turbidity

TSS values measured in Auburn Ravine were below detection limit (10 mg/L) during all baseline monitoring events. As shown in **Figure 3-21**, turbidity values measured for AUBRAV3 were all low and consistent during sampling events, with values below 18 NTUs.

Turbidity and TSS in the Auburn Ravine were measured at the Lincoln and Auburn WWTPs under NPDES permit requirements. TSS loads were observed to significantly increase in winter and spring, likely from stormwater runoff. During low flows in Auburn Ravine, turbidity was measured at less than 1 NTU. Turbidity loads of greater than 2 NTUs were measured in the effluent from the Lincoln WWTP during this time (Placer County 2002). Turbidity was also measured in the Auburn Ravine by DWR between January 2001 and January 2002. Turbidity results ranged from 5 to 33 NTUs, with one higher value observed during December 2001 at 136 NTUs.

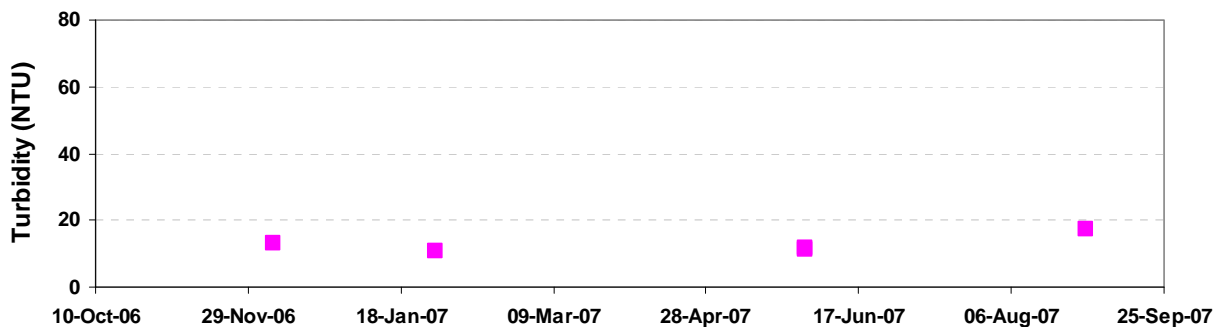


FIGURE 3-21
TURBIDITY RESULTS FROM SEASONAL MONITORING EVENTS AT AUBURN RAVINE BELOW AUBURN RAVINE TUNNEL OUTLET

Specific Conductivity and Ions

SC results for baseline monitoring events at AUBRAV3 were among the lowest of the stream monitoring sites, with the exception of the winter monitoring event, which exhibited the highest SC value across all stream monitoring sites. However, the highest value measured of 0.2 milliSiemens per centimeter (mS/cm) is still considered low (**Figure 3-22**).

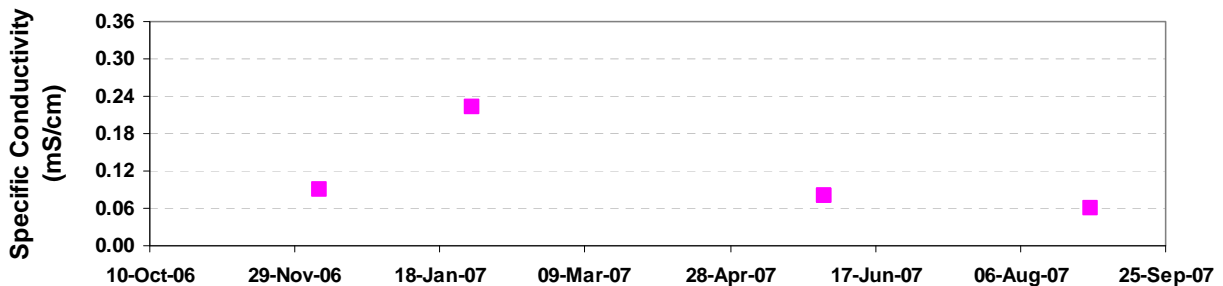


FIGURE 3-22
SPECIFIC CONDUCTIVITY RESULTS FROM SEASONAL MONITORING EVENTS AT AUBURN RAVINE BELOW AUBURN RAVINE TUNNEL OUTLET

Calcium values range from 4.7 mg/L during the summer monitoring event to 16.0 mg/L during the winter event (**Figure 3-23**), and magnesium results range from 1.4 mg/L during the summer monitoring event to 9.7 mg/L during the winter event. Magnesium results display similar trends as for calcium during baseline monitoring events at AUBRAV3, in which seasonal concentrations are highest during the winter monitoring event and lowest during the summer monitoring event (**Figure 3-24**).

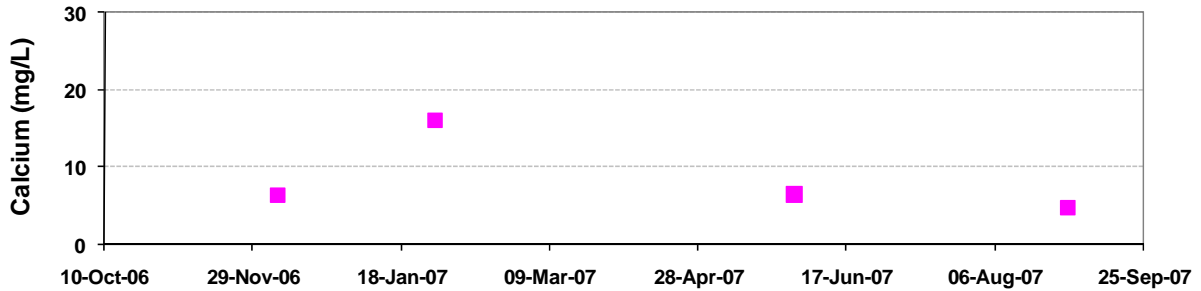


FIGURE 3-23
CALCIUM RESULTS FROM SEASONAL MONITORING EVENTS AT AUBURN RAVINE BELOW AUBURN RAVINE TUNNEL OUTLET

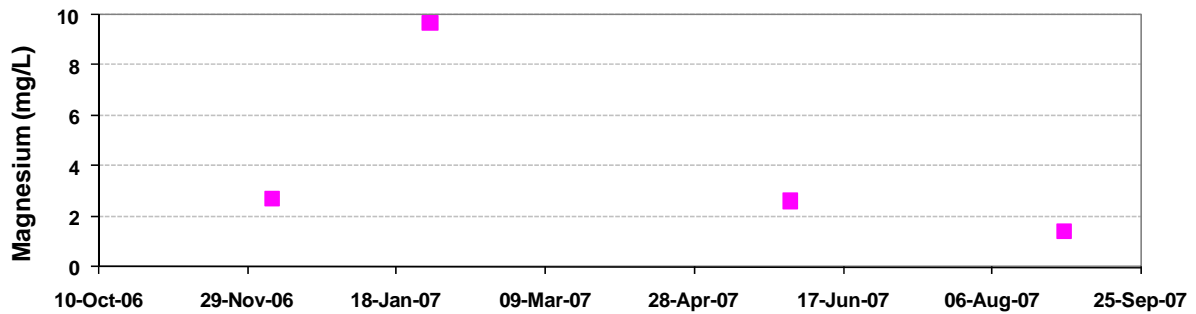


FIGURE 3-24
MAGNESIUM RESULTS FROM SEASONAL MONITORING EVENTS AT AUBURN RAVINE BELOW AUBURN RAVINE TUNNEL OUTLET

Very low iron values were observed at AUBRAV3. As shown in **Figure 3-25**, iron results ranged from 0.08 to 0.21 mg/L.

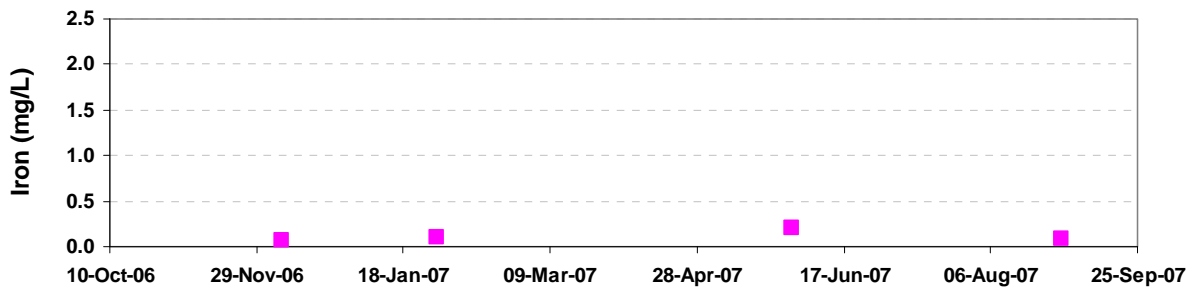


FIGURE 3-25
IRON RESULTS FROM SEASONAL MONITORING EVENTS AT AUBURN RAVINE
BELOW AUBURN RAVINE TUNNEL OUTLET

Potassium values at AUBRAV3 were also very low; with concentrations below the detection limit (1.0 mg/L for spring event, 1.4 mg/L for summer event) during the spring and summer monitoring events, to 2.2 mg/L during the winter monitoring event (**Figure 3-26**).

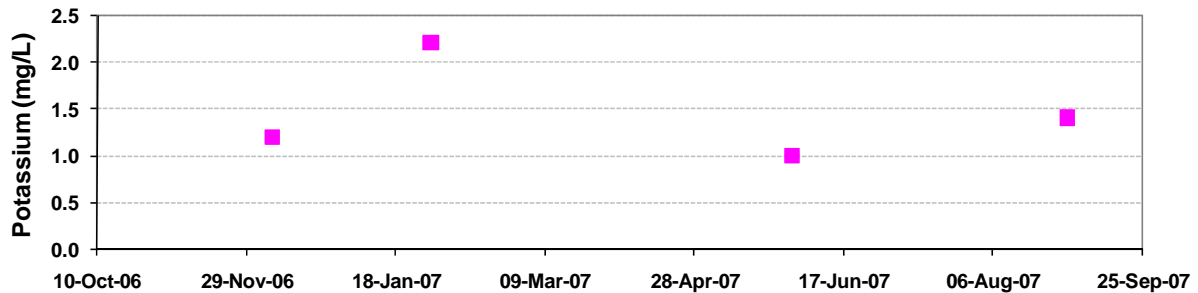


FIGURE 3-26
POTASSIUM RESULTS FROM SEASONAL MONITORING EVENTS AT AUBURN
RAVINE BELOW AUBURN RAVINE TUNNEL OUTLET

As shown in **Figure 3-27**, sodium results ranged from 4.0 to 14.0 mg/L at AUBRAV3. The highest sodium values were observed during the winter monitoring event and the lowest values during the summer monitoring event.

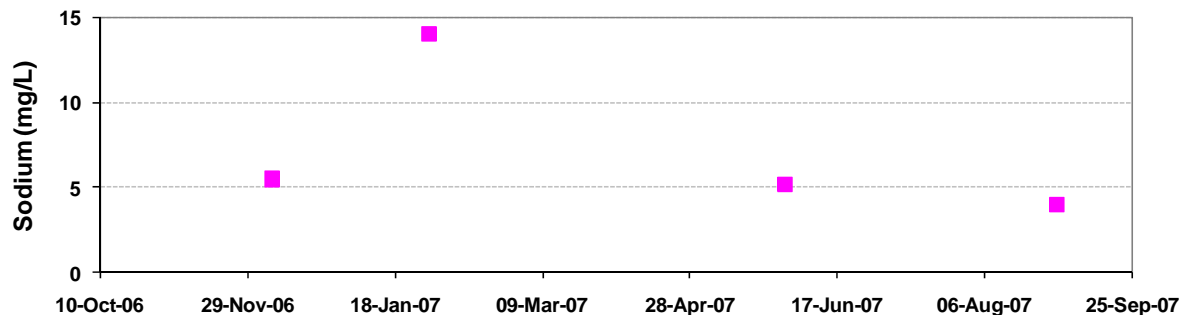


FIGURE 3-27
SODIUM RESULTS FROM SEASONAL MONITORING EVENTS AT AUBURN
RAVINE BELOW AUBURN RAVINE TUNNEL OUTLET

Chloride results are similar to those of sodium at AUBRAV3, with values ranging from 3.6 mg/L during the summer monitoring event to 13.0 mg/L during the winter monitoring event (**Figure 3-28**).

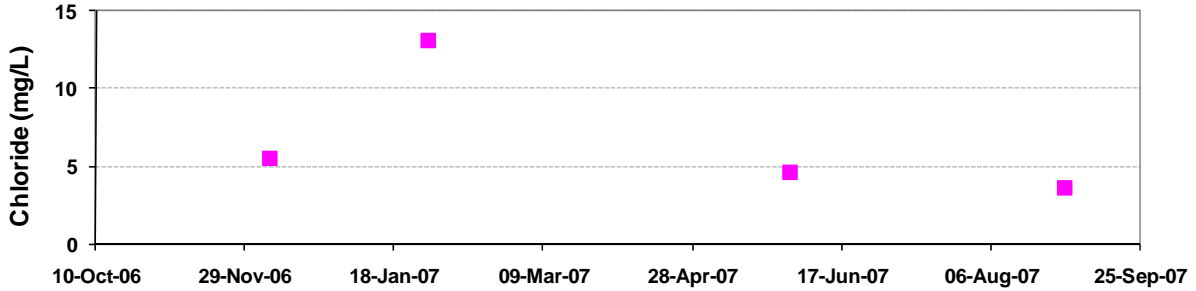


FIGURE 3-28
CHLORIDE RESULTS FROM SEASONAL MONITORING EVENTS AT AUBURN RAVINE BELOW AUBURN RAVINE TUNNEL OUTLET

Sulfate concentrations at AUBRAV3 ranged from 3.3 mg/L during the summer monitoring event to 17 mg/L during the winter monitoring event, as shown in **Figure 3-29**.

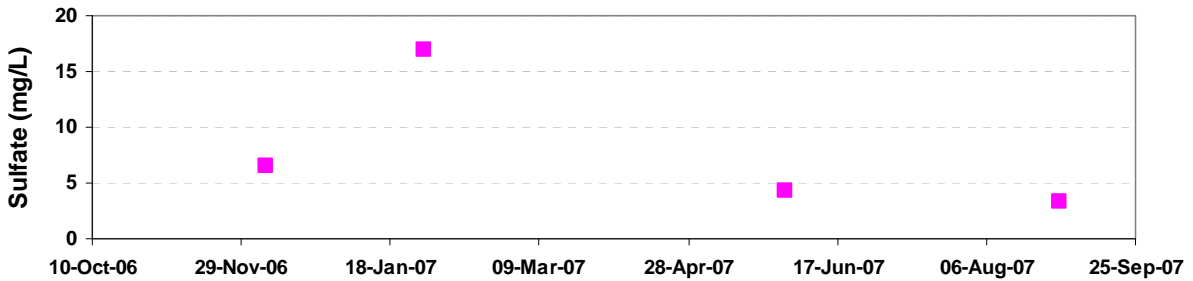


FIGURE 3-29
SULFATE RESULTS FROM SEASONAL MONITORING EVENTS AT AUBURN RAVINE BELOW AUBURN RAVINE TUNNEL OUTLET

As shown in **Figure 3-30**, nitrate results at the AUBRAV3 monitoring site were very low during baseline sampling events. Nitrate concentrations ranged from the detection limit (0.1 mg/L) during the summer monitoring event to 1.3 mg/L during the winter monitoring event.

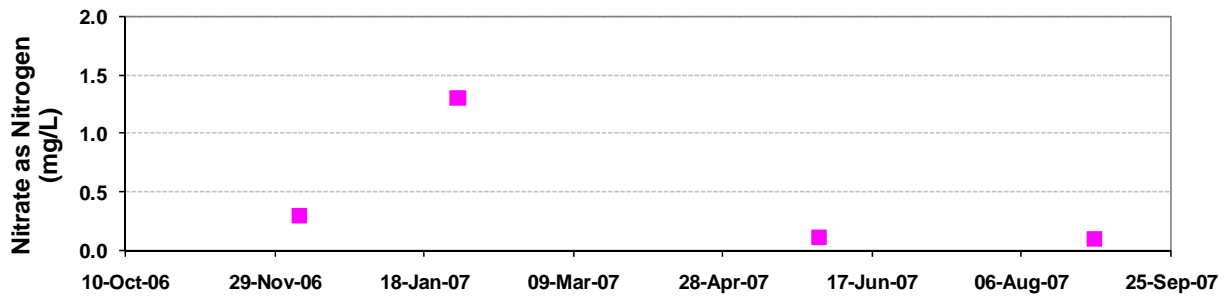


FIGURE 3-30
NITRATE RESULTS FROM SEASONAL MONITORING EVENTS AT AUBURN RAVINE BELOW AUBURN RAVINE TUNNEL OUTLET

Nitrogen and phosphorus were measured at the Auburn WWTP in 1995 (Placer County 2002). Nitrogen and phosphorus levels in Auburn WWTP effluent averaged 0.5 mg/L, and Auburn Ravine downstream from the Auburn WWTP did not show evidence of eutrophication. However, Auburn Ravine downstream from the Lincoln WWTP has been observed to be influenced by both wastewater effluent and stormwater runoff.

Trace Elements

Aluminum results at AUBRAV3 ranged from 40 $\mu\text{g/L}$ during the summer monitoring event to 120 $\mu\text{g/L}$ during the spring monitoring event (**Figure 3-31**).

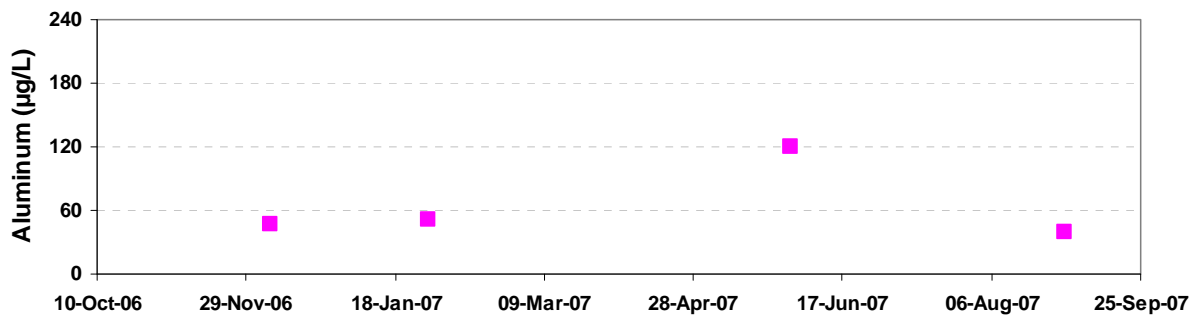


FIGURE 3-31
ALUMINUM RESULTS FROM SEASONAL MONITORING EVENTS AT AUBURN RAVINE BELOW AUBURN RAVINE TUNNEL OUTLET

There was little variation in barium results at AUBRAV3, with concentrations ranging from 9.5 $\mu\text{g/L}$ during the fall monitoring event to 12 $\mu\text{g/L}$ during the winter monitoring event (**Figure 3-32**).

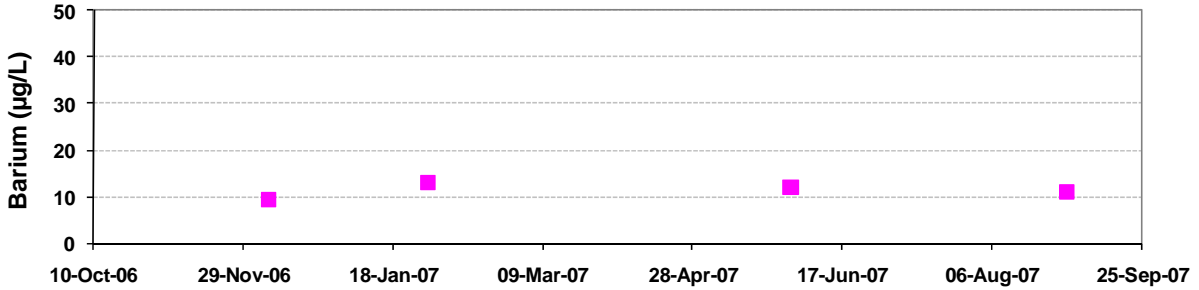


FIGURE 3-32
BARIUM RESULTS FROM SEASONAL MONITORING EVENTS AT AUBURN RAVINE BELOW AUBURN RAVINE TUNNEL OUTLET

Cadmium and mercury concentrations measured during baseline sampling events at AUBRAV3 were below detection limits. All copper concentrations at the AUBRAV3 site were below the detection limit of 2 µg/L, except for the winter monitoring event, during which copper was measured at 2.4 µg/L (Figure 3-33). As shown in Figure 3-34, zinc concentrations ranged from 9 µg/L during the fall monitoring event to 31 µg/L during the winter monitoring event.

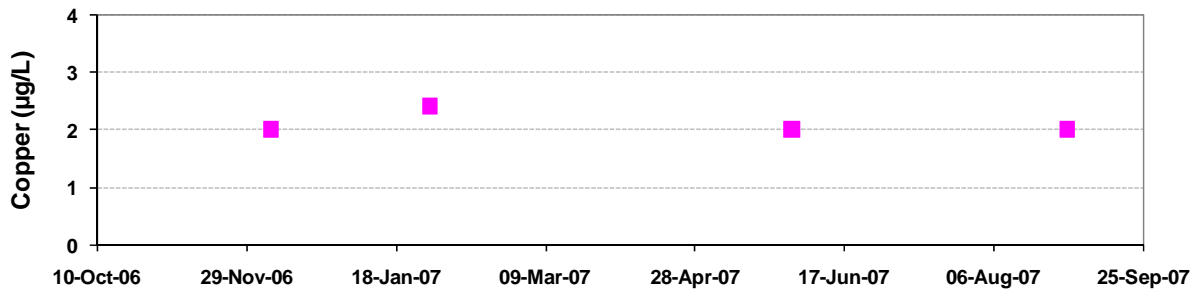


FIGURE 3-33
COPPER RESULTS FROM SEASONAL MONITORING EVENTS AT AUBURN RAVINE BELOW AUBURN RAVINE TUNNEL OUTLET

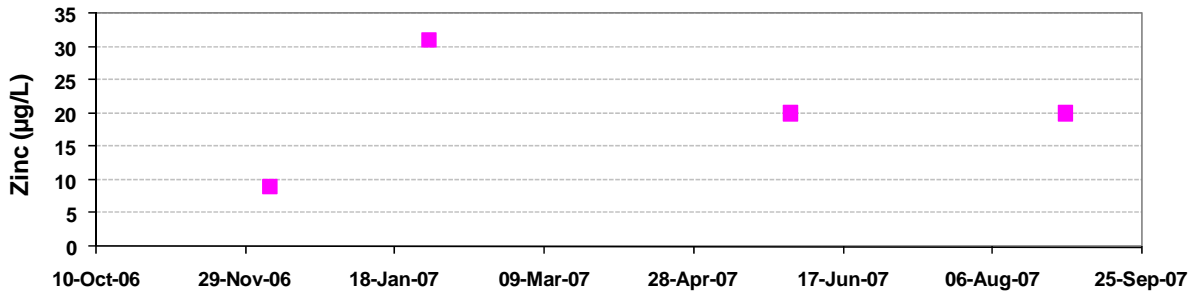


FIGURE 3-34
ZINC RESULTS FROM SEASONAL MONITORING EVENTS AT AUBURN RAVINE BELOW AUBURN RAVINE TUNNEL OUTLET

Data collected by Placer County for the Auburn Ravine/Coon Creek Ecosystem Restoration Plan in 1999 and 2000 show cadmium, copper, and zinc levels in the Auburn Ravine all exceed the CTR standards for aquatic life at various times throughout the year (Placer County 2002).

Copper exceeded CTR standards in June, July, and October 1999 and in January, February, and April 2000.

Clover Valley Creek Watershed

Water quality in the Clover Valley Creek watershed was evaluated at the Clover Valley Reservoir Release to Clover Valley Creek and Antelope Canal (CLVRESR) and at Clover Valley Creek near Argonaut Avenue (CLVRC3B). The monitoring location is upstream from the Sunset Whitney Country Club on Midas Avenue in Rocklin (**Figure 3-3**). Originally, sampling was conducted at a site located at the golf course in the Sunset Whitney Country Club, but the golf course gates lock at sundown, which rendered the site inaccessible during key monitoring periods, so the alternate upstream site was selected for further monitoring.

Water Temperature and Dissolved Oxygen

Water temperature and DO measurements taken at CLVRESR and CLVRC3B during baseline sampling events are shown in **Figure 3-35**. Water temperatures at the two sampling locations are similar and exhibit seasonal trends, ranging from 42°F during fall to about 76°F during summer. DO levels at the two locations are also similar, and range from 8.2 mg/L in the summer to 13 mg/L in the fall (**Figure 3-19**).

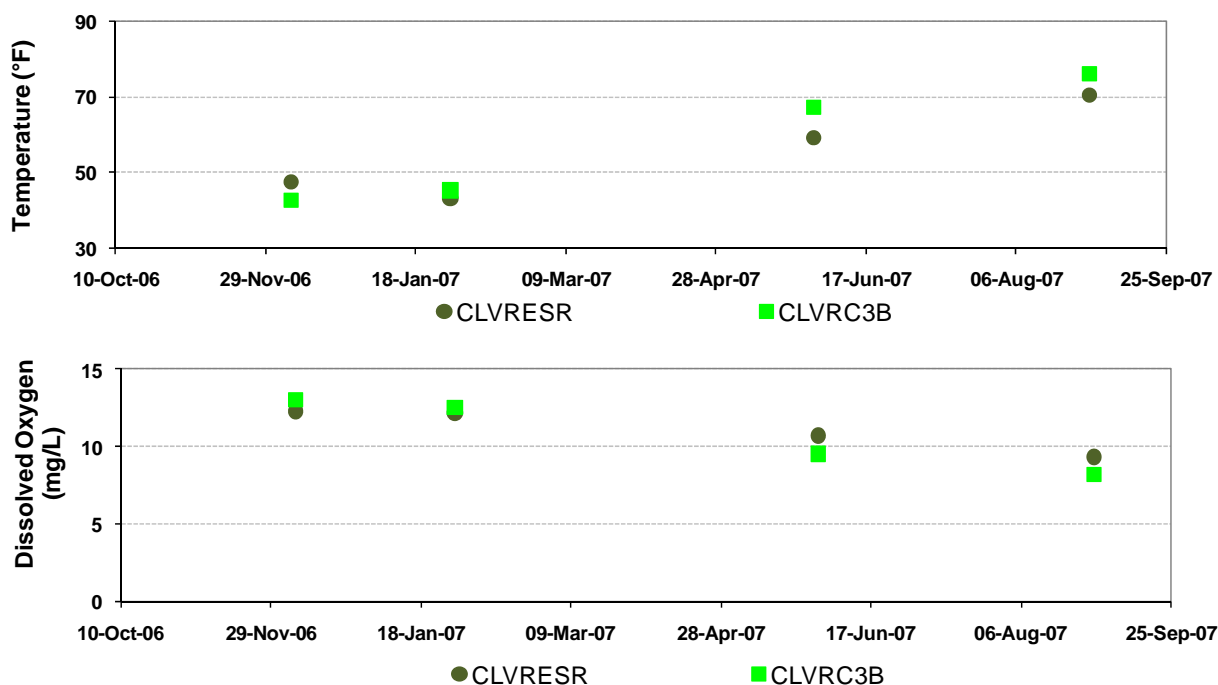


FIGURE 3-35
WATER TEMPERATURE AND DISSOLVED OXYGEN RESULTS FROM SEASONAL MONITORING EVENTS IN THE CLOVER VALLEY CREEK WATERSHED

pH, Alkalinity, and Hardness

Figure 3-36 shows pH, alkalinity, and hardness results from baseline water quality monitoring at CLVRESR and CLVRC3B. Measured pH levels at the two locations ranged from 7.1 to 7.9.

Alkalinity results ranged from 14.0 to 45.0 mg/L CaCO₃. Calculated hardness values were similar to alkalinity, ranging from 9.5 to 42.4 mg/L CaCO₃.

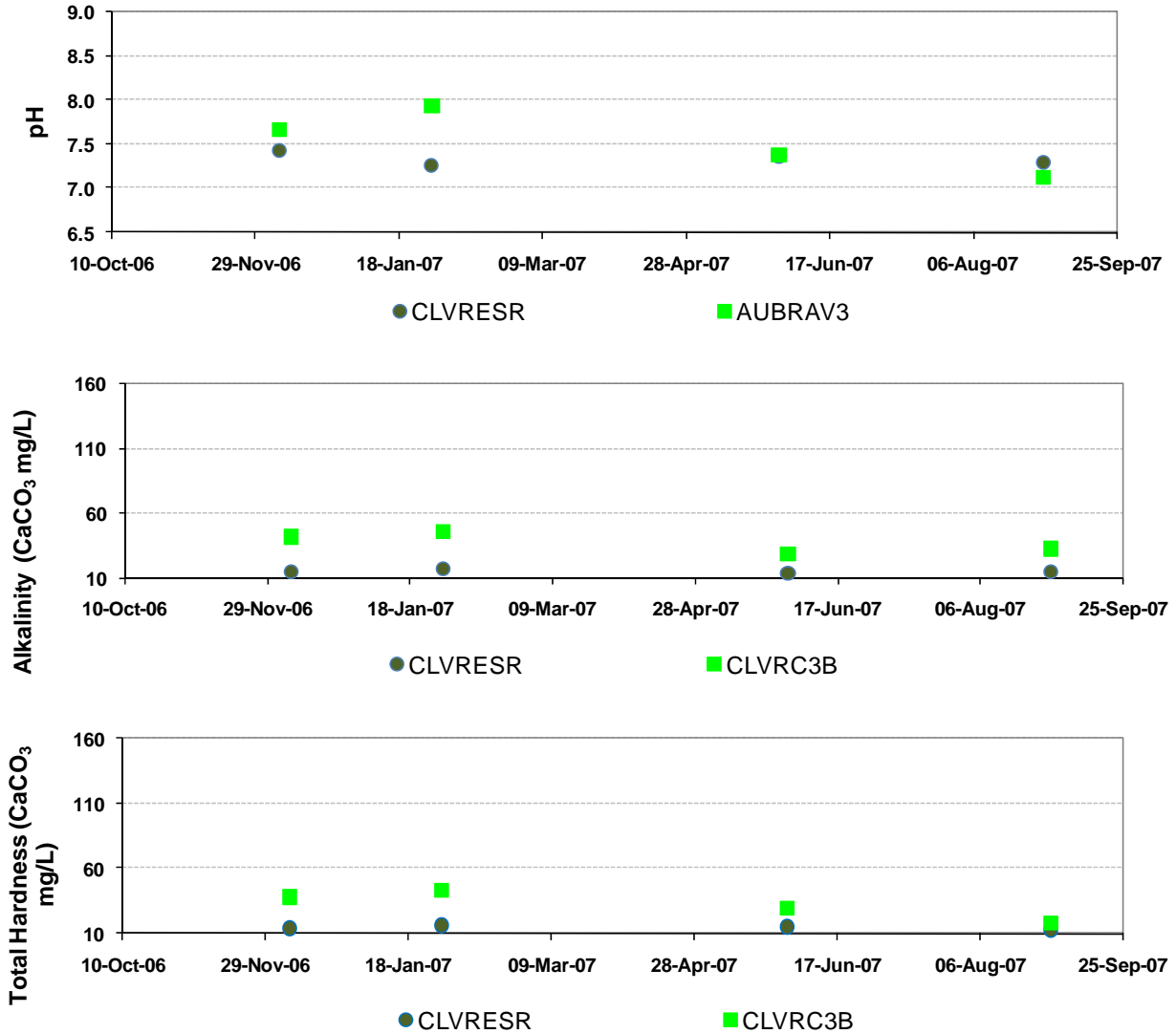


FIGURE 3-36
PH, ALKALINITY, AND HARDNESS RESULTS FROM SEASONAL MONITORING
EVENTS IN THE CLOVER VALLEY CREEK WATERSHED

Data on pH in the Clover Valley Creek watershed were collected by the DCC during a periodic “first flush” monitoring program in between 2001 and 2003. Measured pH values ranged from 7.27 in October 2002 to 7.70 in March 2002, indicating fairly stable pH levels throughout the year.

Total Suspended Solids and Turbidity

TSS values measured at the CLVRESR and CLVRC3B during baseline monitoring events were below the detection limit of 10 mg/L. As shown in **Figure 3-37**, turbidity levels at CLVRESR and CLVRC3B were also low during baseline sampling events, with all turbidity values ranging between 11.8 and 27.4 NTUs.

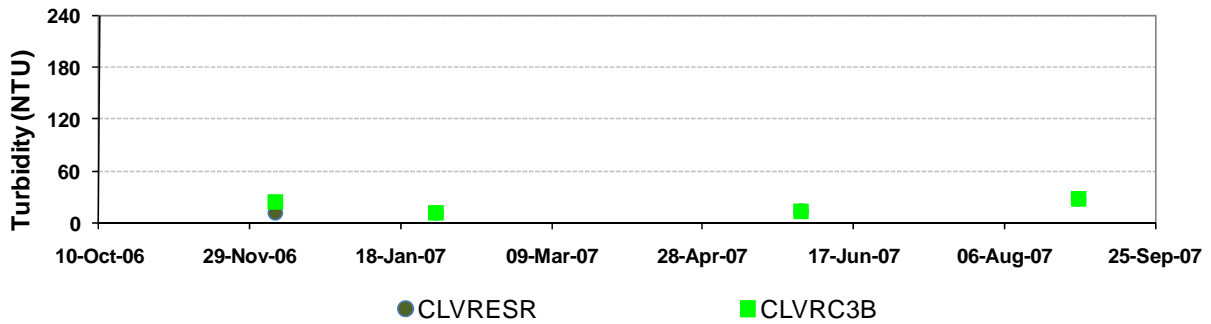


FIGURE 3-37
TURBIDITY RESULTS FROM SEASONAL MONITORING EVENTS IN THE CLOVER VALLEY CREEK WATERSHED

Specific Conductivity and Ions

SC values for CLVRESR and CLVRC3B are shown in **Figure 3-38**. Although SC values measured at CLVRESR were consistently lower than CLVRC3B values, they were low at both monitoring locations, ranging from 0.04 mS/cm during the fall monitoring event to 0.11 mS/cm during the winter monitoring event.

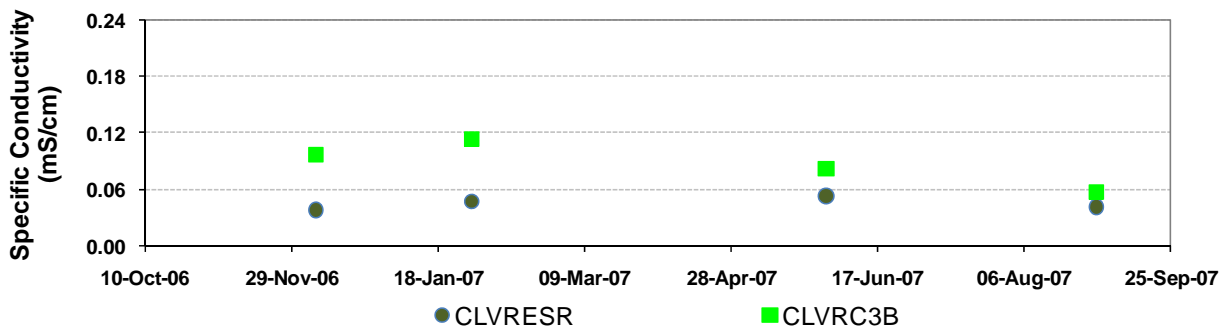


FIGURE 3-38
SPECIFIC CONDUCTIVITY RESULTS FROM SEASONAL MONITORING EVENTS IN THE CLOVER VALLEY CREEK WATERSHED

Calcium results at CLVRESR and CLVRC3B followed similar seasonal trends as seasonal specific conductivity levels. As shown in **Figure 3-39**, calcium results ranged from 3.8 mg/L at CLVRESR during the fall monitoring event to 9.9 mg/L at CLVRC3B during the winter monitoring event.

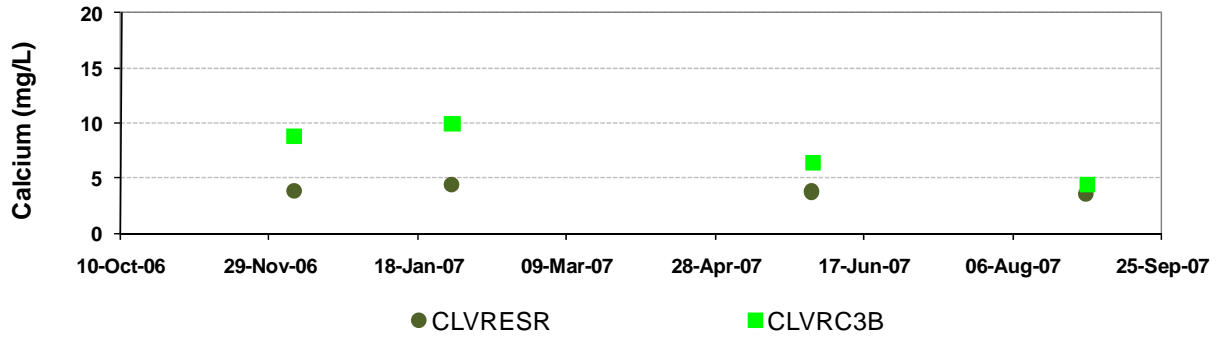


FIGURE 3-39
CALCIUM RESULTS FROM SEASONAL MONITORING EVENTS IN THE CLOVER VALLEY CREEK WATERSHED

Iron results at CLVRESR and CLVRC3B differed most during the spring monitoring event. **Figure 3-40** shows iron values ranging from 0.06 mg/L during the fall monitoring event to 0.75 mg/L during the spring event.

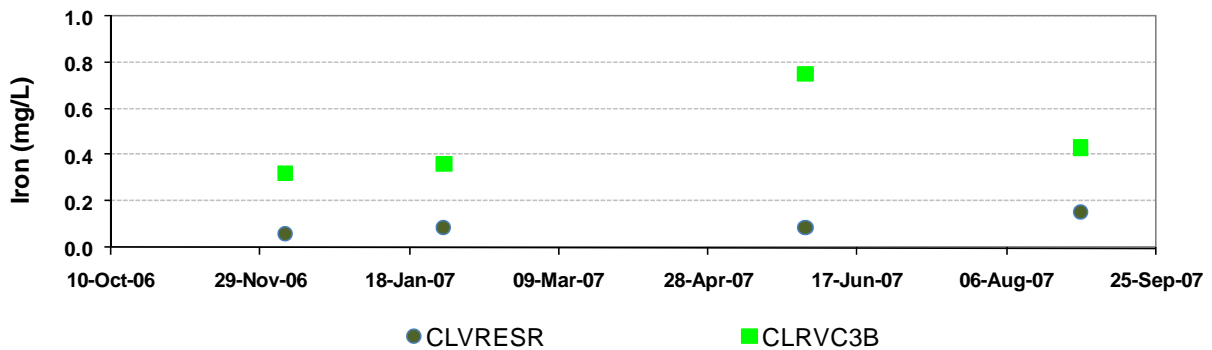


FIGURE 3-40
IRON RESULTS FROM SEASONAL MONITORING EVENTS IN THE CLOVER VALLEY CREEK WATERSHED

Magnesium results varied from 0.1 mg/L at CLVRESR during the summer monitoring event and 4.3 mg/L at CLVRC3B during the winter event (**Figure 3-41**).

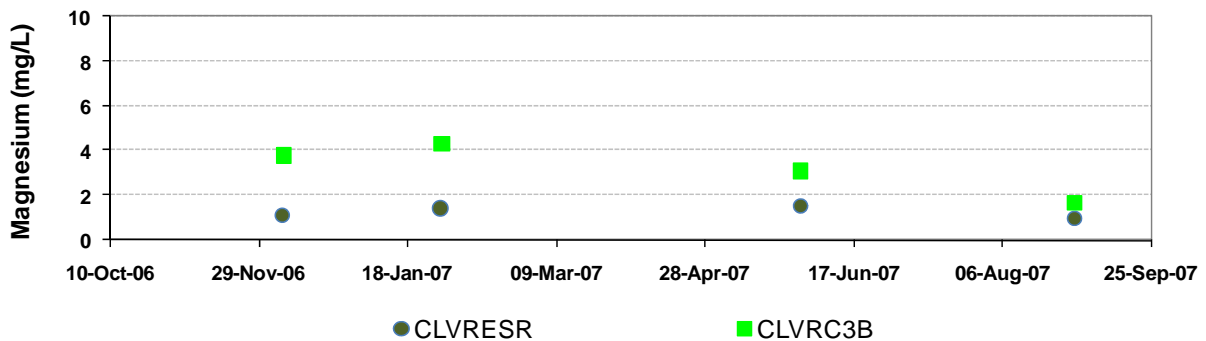


FIGURE 3-41
MAGNESIUM RESULTS FROM SEASONAL MONITORING EVENTS IN THE CLOVER VALLEY CREEK WATERSHED

All seasonal potassium results were below the detection limit of 0.1 mg/L and 1.0 mg/L, respectively, at the CLVRC3B monitoring site.

Sodium results at CLVRESR and CLVRC3B ranged from 1.1 to 5.7 mg/L, as shown in **Figure 3-42**.

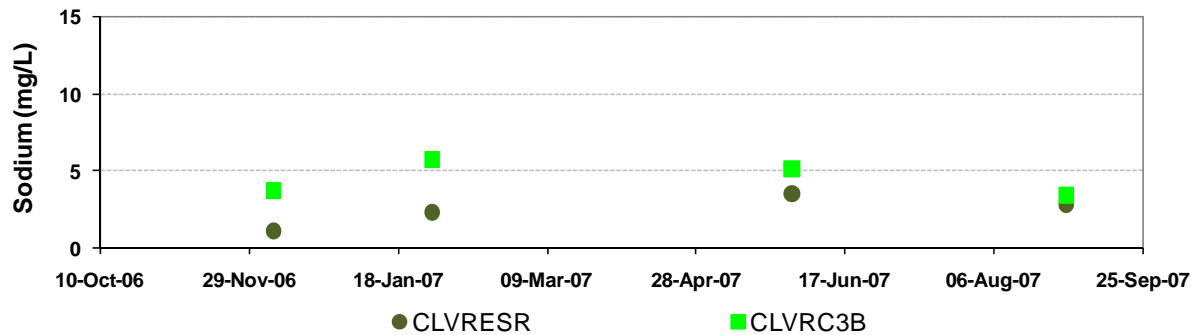


FIGURE 3-42
SODIUM RESULTS FROM SEASONAL MONITORING EVENTS IN THE CLOVER VALLEY CREEK WATERSHED

Chloride results at CLVRESR and CLVRC3B are similar to those observed for sodium, and ranged from 1.0 to 4.7 mg/L, as shown in **Figure 3-43**.

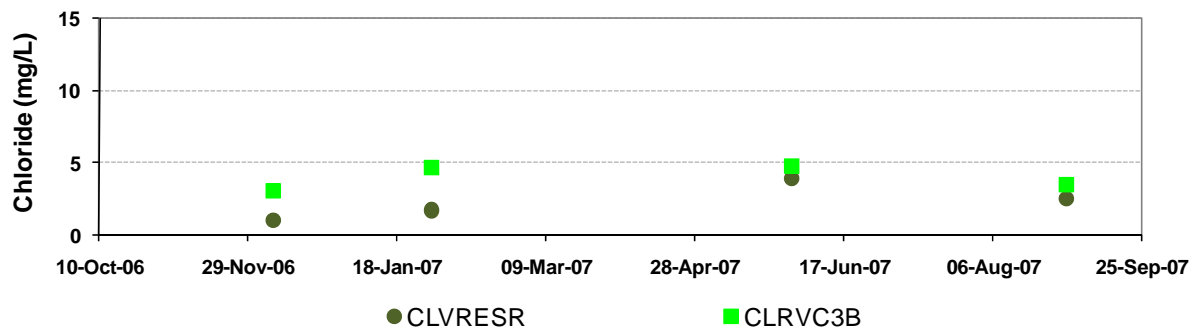


FIGURE 3-43
CHLORIDE RESULTS FROM SEASONAL MONITORING EVENTS IN THE CLOVER VALLEY CREEK WATERSHED

Similar to potassium results, all seasonal nitrate concentrations were below the detection limit of 0.1 mg/L and 1.0 mg/L, respectively, at the CLVRC3B monitoring site.

Sulfate concentrations at CLVRESR and CLVRC3B ranged from 0.5 mg/L during the fall monitoring event to 5.1 mg/L during the winter monitoring event (**Figure 3-44**).

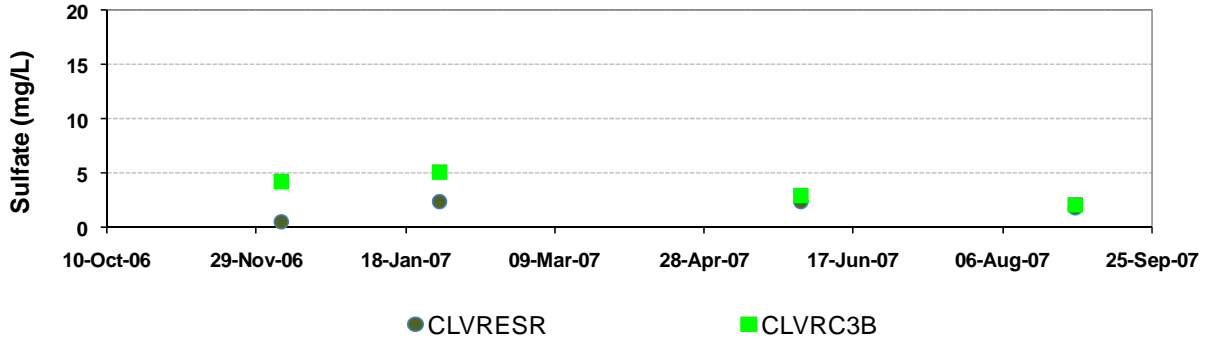


FIGURE 3-44
SULFATE RESULTS FROM SEASONAL MONITORING EVENTS IN THE CLOVER VALLEY CREEK WATERSHED

Trace Elements

Aluminum concentrations at CLVRESR and CLVRC3B varied considerably during the spring monitoring event. As shown in **Figure 3-45**, aluminum concentrations ranged from 25 µg/L during the fall monitoring event to 240 µg/L during the spring monitoring event.

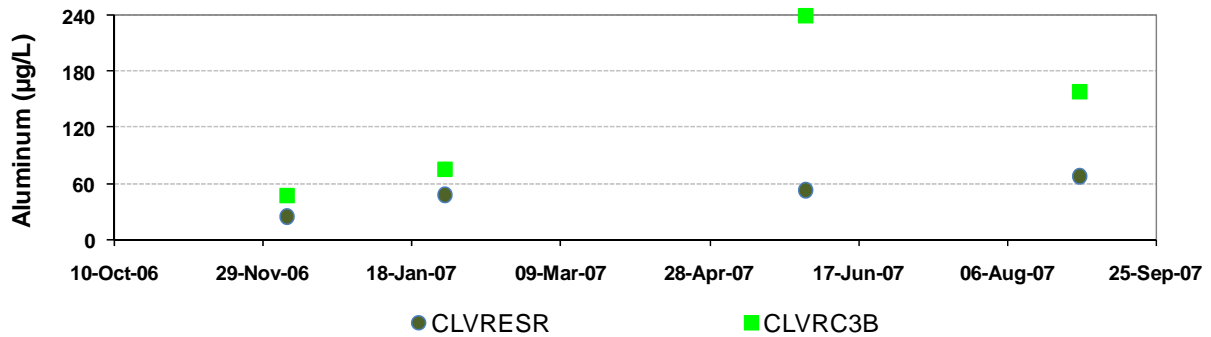


FIGURE 3-45
ALUMINUM RESULTS FROM SEASONAL MONITORING EVENTS IN THE CLOVER VALLEY CREEK WATERSHED

Barium concentrations at CLVRC3B were consistently higher than those at CLVRESR, and also among the highest compared to other stream sites monitored within Zone 1. As shown in **Figure 3-46**, barium values measured at these sites range from 11 µg/L at CLVRESR during fall to 42 µg/L at CLVRC3B during winter.

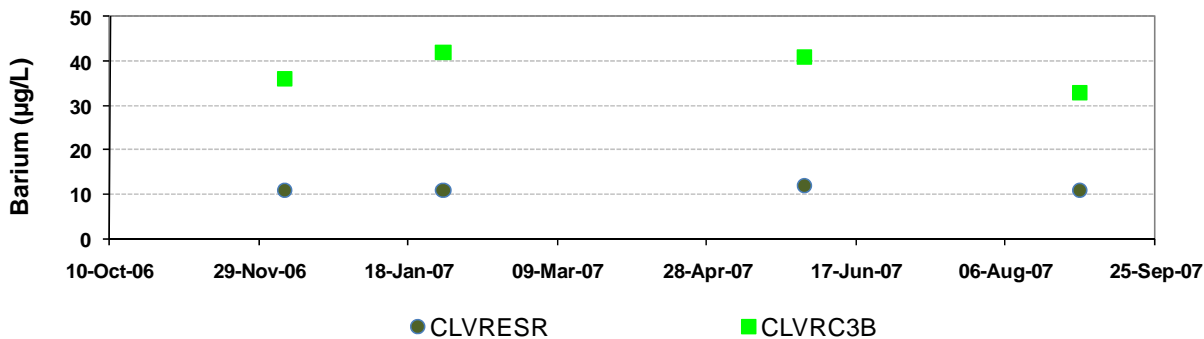


FIGURE 3-46
BARIUM RESULTS FROM SEASONAL MONITORING EVENTS IN THE CLOVER VALLEY CREEK WATERSHED

Cadmium concentrations at CLVRESR and CLVC3B were below detection limits for all baseline monitoring events.

Copper levels were below the detection limit of 2 µg/L at CLVC3B during the fall and winter sampling events, and were measured at 2.1 and 2.2 µg/L during the spring and summer monitoring events, respectively (**Figure 3-47**).

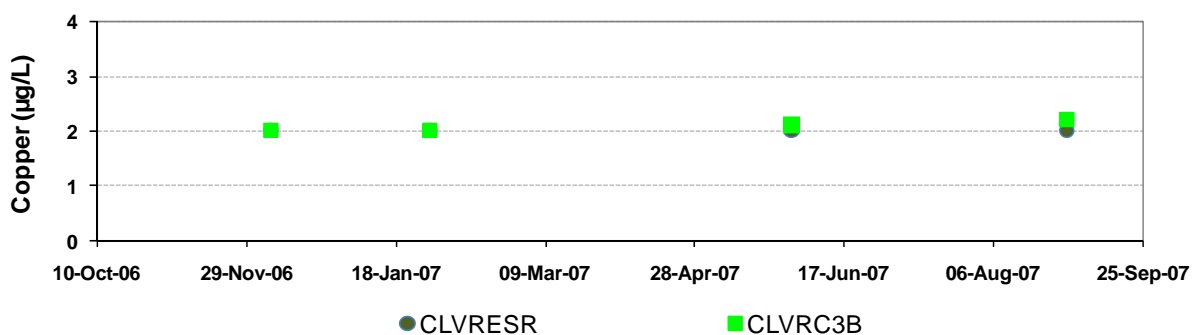


FIGURE 3-47
COPPER RESULTS FROM SEASONAL MONITORING EVENTS IN THE CLOVER VALLEY CREEK WATERSHED

Similar to cadmium results, mercury concentrations at CLVRESR and CLVC3B were below detection limits for all seasonal monitoring events.

Zinc was only detected at CLVRESR and CLVRC3B during the winter monitoring event (20 and 21 µg/L, respectively), as shown in **Figure 3-48**. According to laboratory results, the detection limits for zinc changed from 5 mg/L in the fall, 10 mg/L in the winter, and 20 mg/L in the spring and summer.

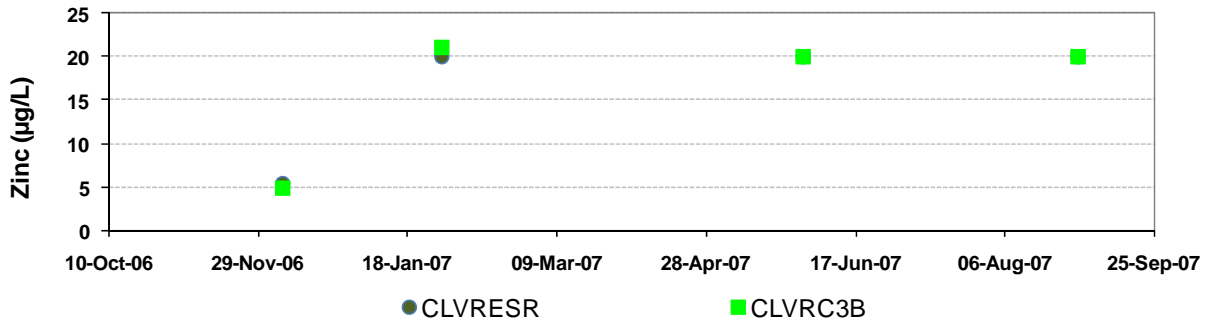


FIGURE 3-48
ZINC RESULTS FROM SEASONAL MONITORING EVENTS IN THE CLOVER VALLEY CREEK WATERSHED

Antelope Creek Watershed

Water quality was evaluated within the Antelope Creek watershed at CLVRESR and Antelope Creek at Midas Avenue (ANTC3B), which is located immediately above Antelope Creek’s confluence with Clover Valley Creek.

Water Temperature and Dissolved Oxygen

Water temperature and DO results from monitoring at CLVRESR and ANTC3B are shown in **Figure 3-49**. Seasonal water temperatures at the two monitoring locations ranged from 41.7 to 75.4 °F. DO results ranged from 8.2 mg/L in the summer to 13.9 mg/L in the fall.

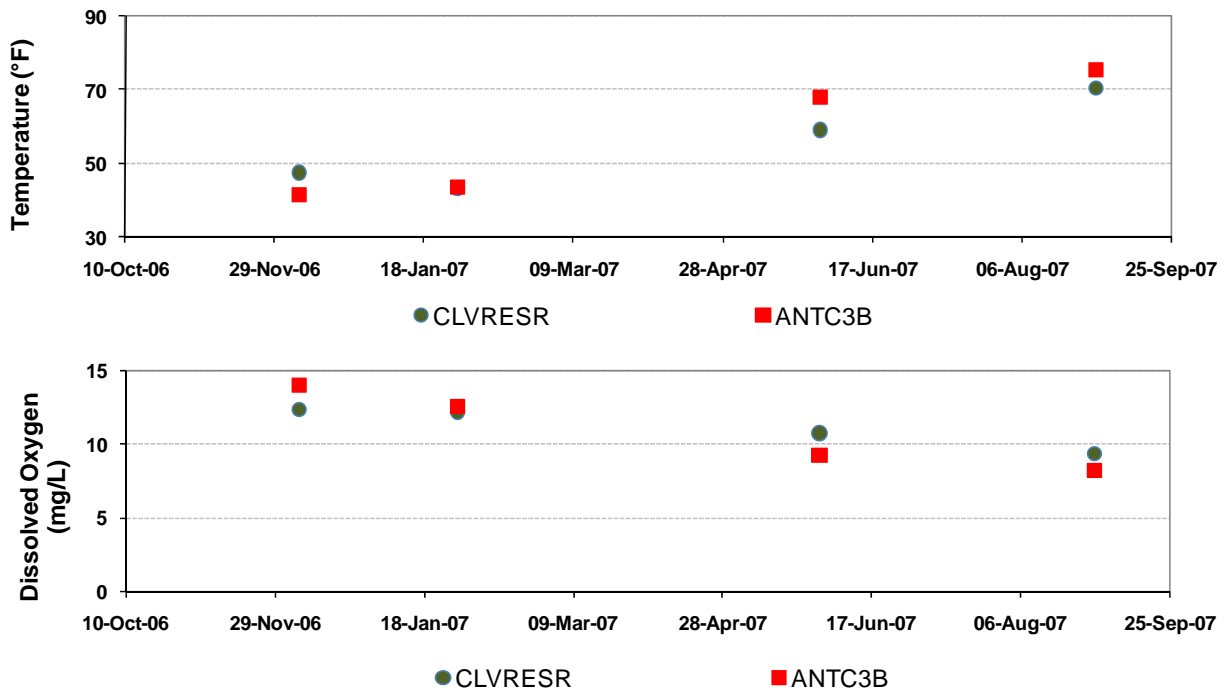
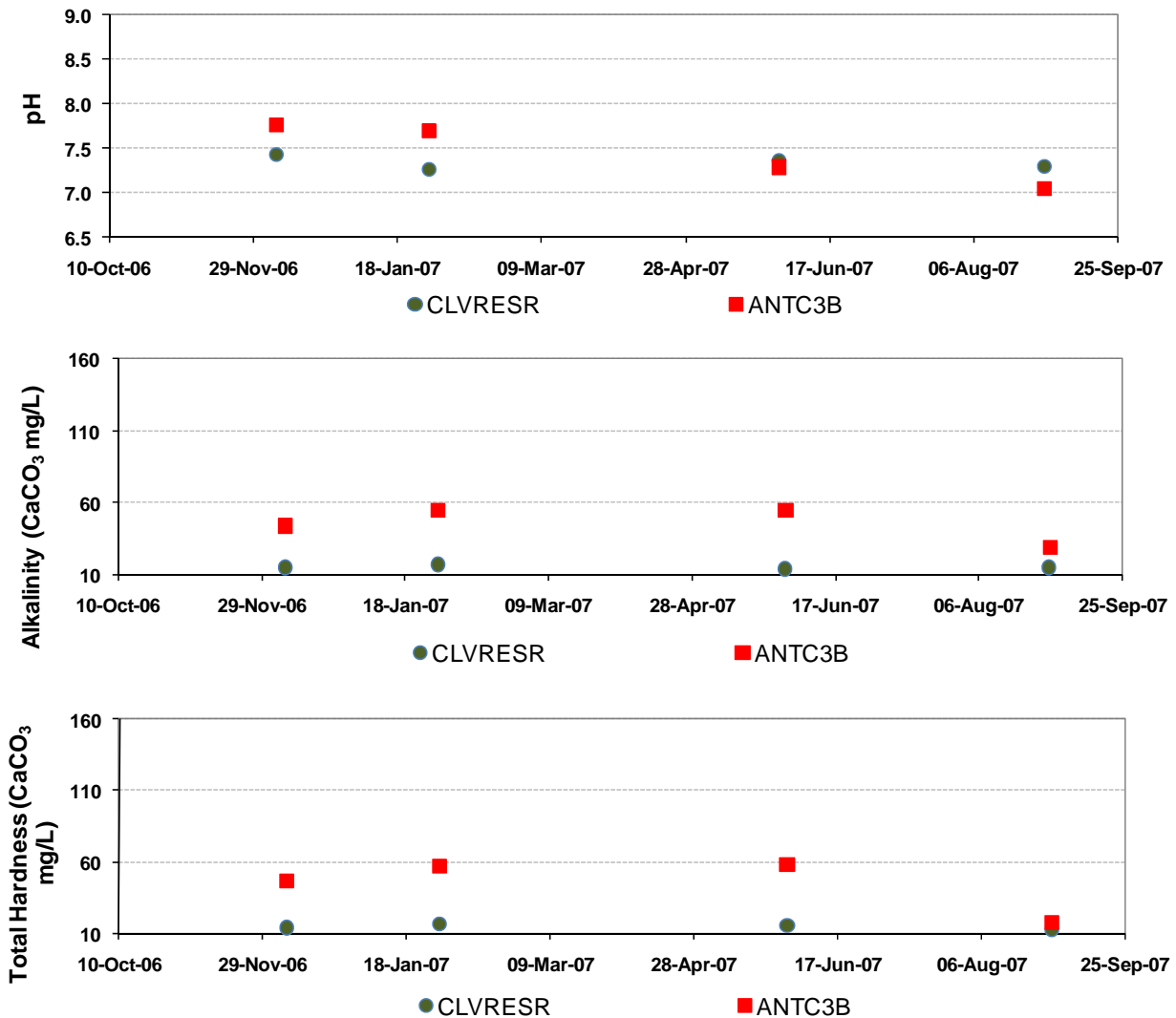


FIGURE 3-49
TEMPERATURE AND DISSOLVED OXYGEN RESULTS FROM SEASONAL MONITORING EVENTS IN THE ANTELOPE CREEK WATERSHED

Water temperature data collected along Antelope Creek by other sources includes periodic monitoring conducted by the Central Valley RWQCB and DCC. Water temperature was recorded by the Central Valley RWQCB and DCC at Sierra College Boulevard and Sunset Boulevard between December 12, 2000, and April 8, 2003. Water temperature values measured by the Central Valley RWQCB and DCC ranged from 43 °F in January 2001 to 82 °F in June 2001 at the Sunset Boulevard site, and from 43 °F in January 2001 to 75 °F in July 2001 at the Sierra College Boulevard site (Sierra Business Council 2003). Water temperature data were collected by Bailey Environmental between April 1999 and August 2003 at Antelope Creek Drive, 311 Sunset Blvd., and the Myers residence station. Water temperatures in spring (May 29, 2003 to July 30, 2003) ranged from 63 °F to 84 °F (Sierra Business Council 2003).

pH, Alkalinity, and Hardness

Seasonal pH, alkalinity, and hardness results for baseline monitoring at CLVRESR and ANTC3B are shown in **Figure 3-50**. Results for pH indicate little seasonal variation; pH values ranged from 7.0 to 7.8. Alkalinity and hardness values are consistently lower at CLVRESR than ANTC3B. Alkalinity levels range from 14 mg/L CaCO₃ at CLVRESR to 55 mg/L CaCO₃ at ANTC3B, and calculated hardness values ranged from 12.8 mg/L CaCO₃ at CLVRESR to 58.3 mg/L CaCO₃ ANTC3B.



**FIGURE 3-50
PH, ALKALINITY, AND HARDNESS RESULTS FROM SEASONAL MONITORING
EVENTS IN THE ANTELOPE CREEK WATERSHED**

The Antelope Creek watershed was monitored by DCC for pH during “first flush” events between 2000 and 2003. Monitoring was conducted at the Sierra College Boulevard, Sunset Boulevard, and Atlantic Avenue sites. Results for pH in Antelope Creek varied widely at the Sierra College Boulevard site, at which pH values ranged from 6.70 in November 2001 to 8.16 in December 2000, and at the Sunset Boulevard site, ranging from 6.5 in February 2002 to 8.65 in July 2001 (Sierra Business Council 2003). Results from the Atlantic Avenue site ranged from 7.08 in November 2002 to 7.77 in March 2003. Although it is difficult to interpret such a limited data set, the pH result is considered relatively high for the creek (Placer County Planning Department 2003).

Total Suspended Solids and Turbidity

TSS values at CLVRESR and ANTC3B were below detection limits (10 mg/L) during all seasonal monitoring events, with the exception of the summer monitoring event, during which TSS was measured at 13 mg/L. As shown in **Figure 3-51**, turbidity values were very similar at the two monitoring locations were low, ranging between 12.2 and 32.9 NTUs.

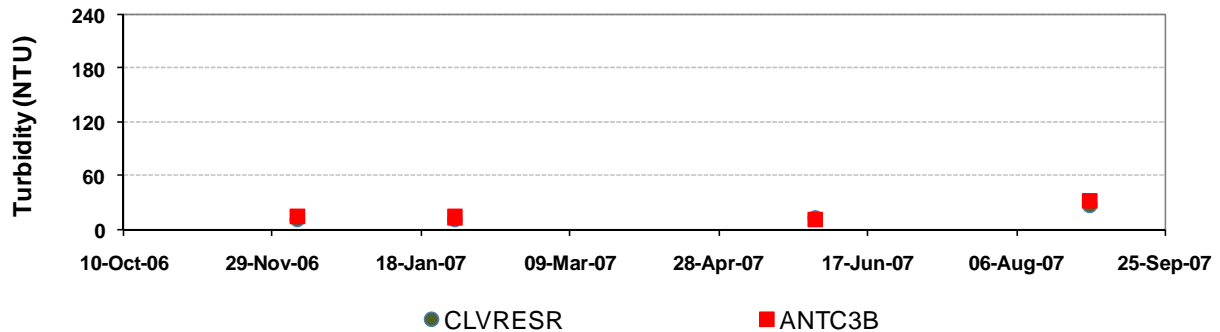


FIGURE 3-51
TURBIDITY RESULTS FROM SEASONAL MONITORING EVENTS IN THE ANTELOPE CREEK WATERSHED

Specific Conductivity and Ions

SC values were consistently lower at CLVRESR than at ANTC3B. Overall, SC values ranged from 0.04 mS/cm at CLVRESR during the fall monitoring event to 0.16 mS/cm at ANTC3B during the winter monitoring event (**Figure 3-52**).

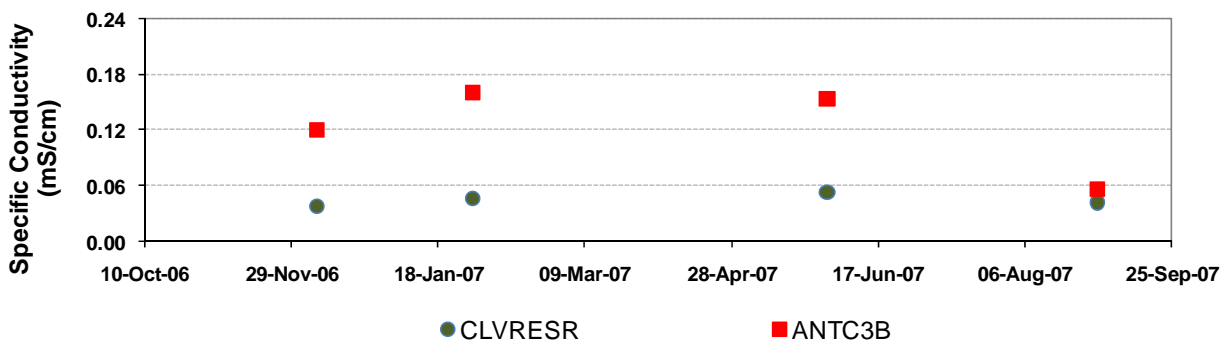


FIGURE 3-52
SPECIFIC CONDUCTIVITY RESULTS FROM SEASONAL MONITORING EVENTS IN THE ANTELOPE CREEK WATERSHED

Calcium results at CLVRESR and ANTC3B monitoring locations follow a pattern similar to that of SC. As shown in **Figure 3-53**, calcium results ranged from 3.5 mg/L at CLVRESR during the summer sampling event to 13.0 mg/L at ANTC3B during winter and spring sampling events.

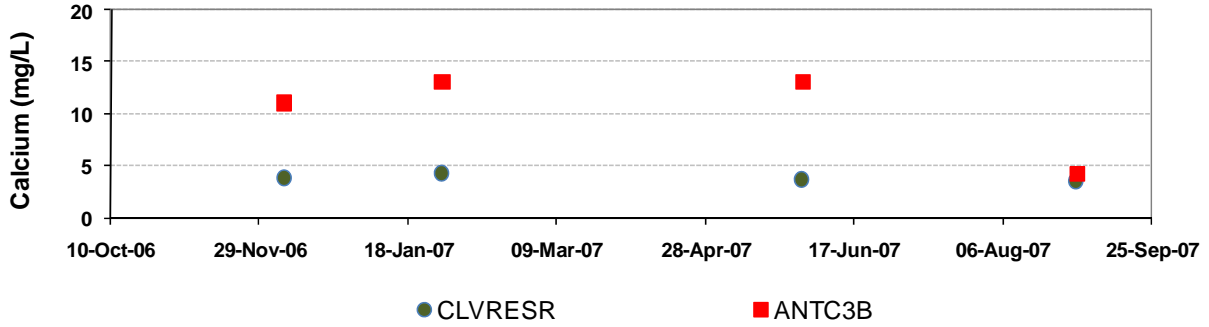


FIGURE 3-53
CALCIUM RESULTS FROM SEASONAL MONITORING EVENTS IN THE ANTELOPE CREEK WATERSHED

Iron results were consistently higher at ANTC3B than at CLVRESR. As shown in **Figure 3-54**, iron concentrations ranged from 0.06 mg/L at CLVRESR during the fall monitoring event to 0.94 mg/L at ANTC3B during the spring monitoring event.

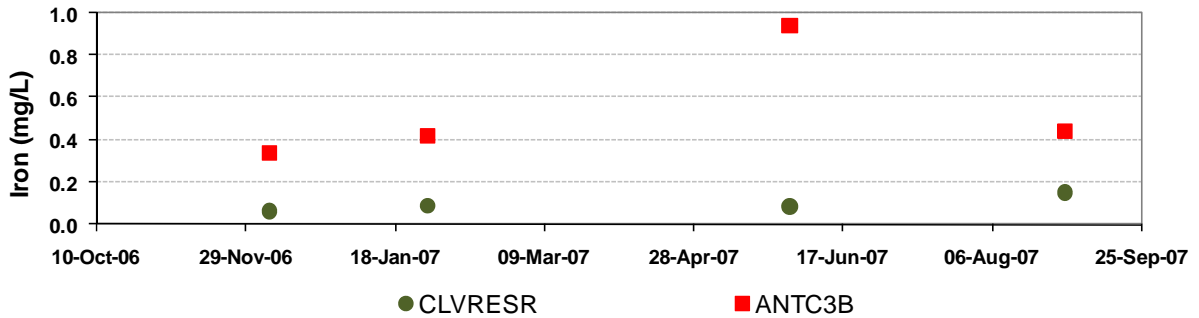


FIGURE 3-54
IRON RESULTS FROM SEASONAL MONITORING EVENTS IN THE ANTELOPE CREEK WATERSHED

Magnesium concentrations ranged from 0.1 mg/L at CLVRESR during the summer monitoring event to 6.3 mg/L at ANTC3B during the spring monitoring event (**Figure 3-55**).

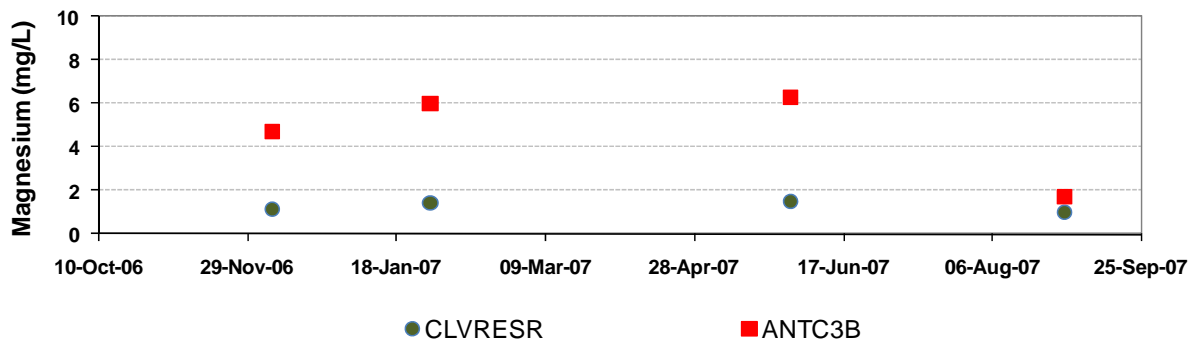


FIGURE 3-55
MAGNESIUM RESULTS FROM SEASONAL MONITORING EVENTS IN THE ANTELOPE CREEK WATERSHED

Potassium results for CLVRESR and ANTC3B during baseline sampling events were also low, as shown in **Figure 3-56**.

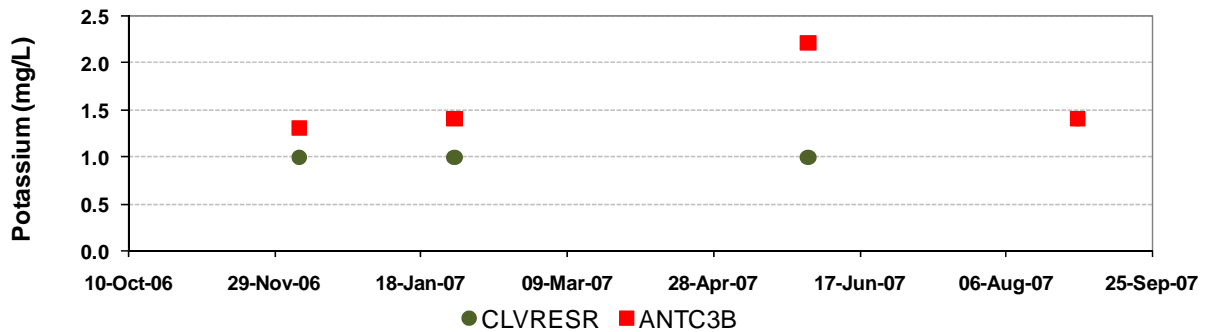


FIGURE 3-56
POTASSIUM RESULTS FROM SEASONAL MONITORING EVENTS IN THE ANTELOPE CREEK WATERSHED

Sodium results for CLVRESR and ANTC3B display similar trends as at the other stream monitoring sites; results are higher during the winter and spring monitoring events than during the fall and summer events. **Figure 3-57** shows sodium results ranging from 1.1 mg/L at CLVRESR during the fall monitoring event to 8.0 mg/L at ANTC3B during the spring monitoring event.

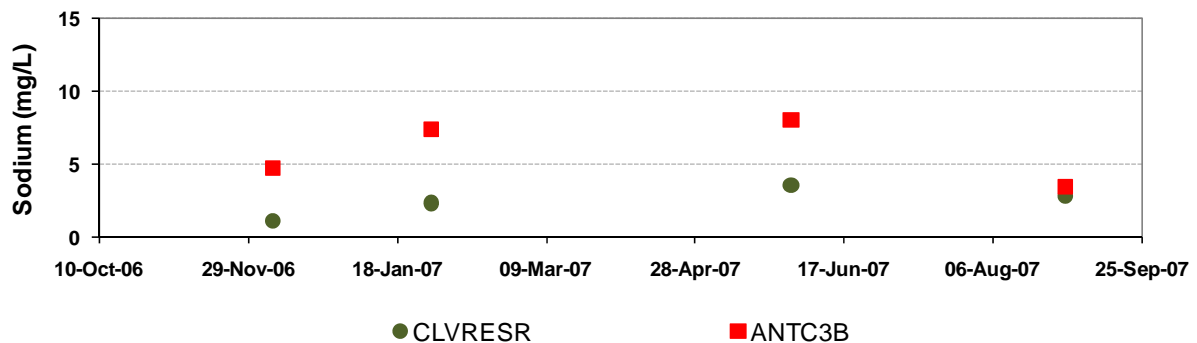


FIGURE 3-57
SODIUM RESULTS FROM SEASONAL MONITORING EVENTS IN THE ANTELOPE CREEK WATERSHED

Chloride results ranged from 1.0 mg/L at CLVRESR during the fall monitoring event to 7.1 mg/L at ANTC3B during the winter monitoring event (**Figure 3-58**).

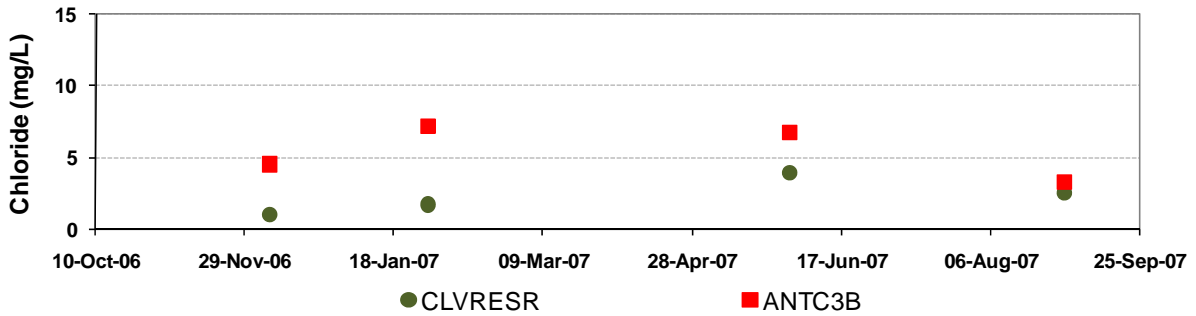


FIGURE 3-58
CHLORIDE RESULTS FROM SEASONAL MONITORING EVENTS IN THE ANTELOPE CREEK WATERSHED

No nitrate was detected at CLVRESR and nitrate levels at ANTC3B were very low during baseline monitoring events. As shown in **Figure 3-59**, nitrate results ranged from the detection limit (0.1 mg/L) during the summer monitoring event to 0.24 mg/L during the spring monitoring event.

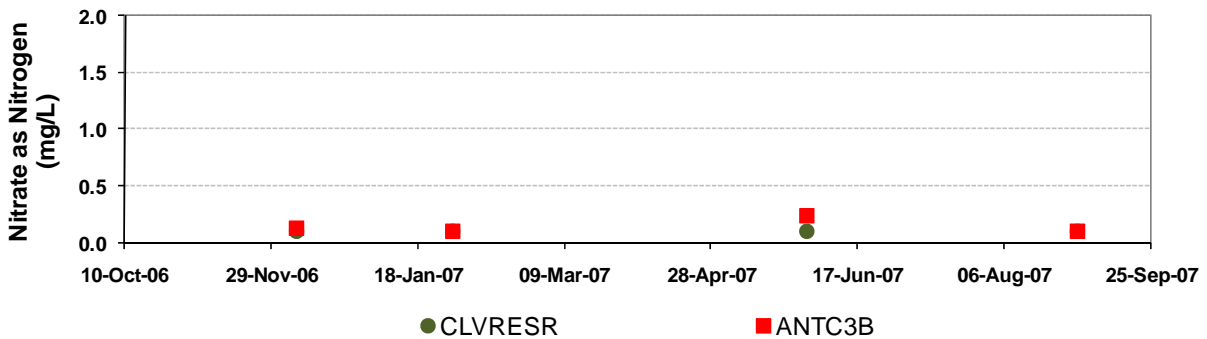


FIGURE 3-59
NITRATE RESULTS FROM SEASONAL MONITORING EVENTS IN THE ANTELOPE CREEK WATERSHED

Nitrate and orthophosphate (PO₄) were measured by the DCC and Central Valley RWQCB in the Antelope Creek watershed. Although overall nitrate and phosphate values were low, data suggest that the nitrate-to-phosphate ratio is lower than the biologically desirable ratio of 10:1 (Placer County Planning Department 2003).

As shown in **Figure 3-60**, sulfate levels ranged from 0.5 mg/L at CLVRESR during the fall monitoring event to 8.7 mg/L at ANTC3B during the spring monitoring event.

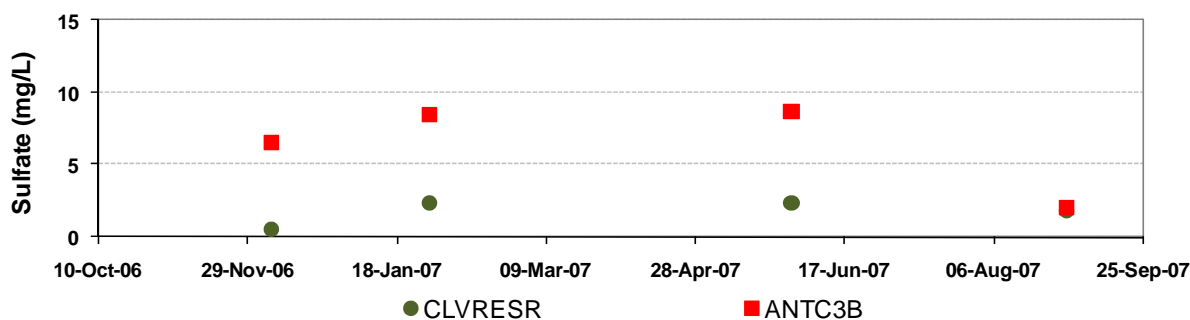


FIGURE 3-60
SULFATE RESULTS FROM SEASONAL MONITORING EVENTS IN THE ANTELOPE CREEK WATERSHED

Trace Elements

Aluminum results at ANTC3 were consistently higher compared to values measured at CLVRESR, and displayed a particularly high value during the spring monitoring event. Aluminum concentrations at both monitoring locations ranged from 25 $\mu\text{g/L}$ at CLVRESR during the fall monitoring event to 160 $\mu\text{g/L}$ during the spring monitoring event (**Figure 3-61**).

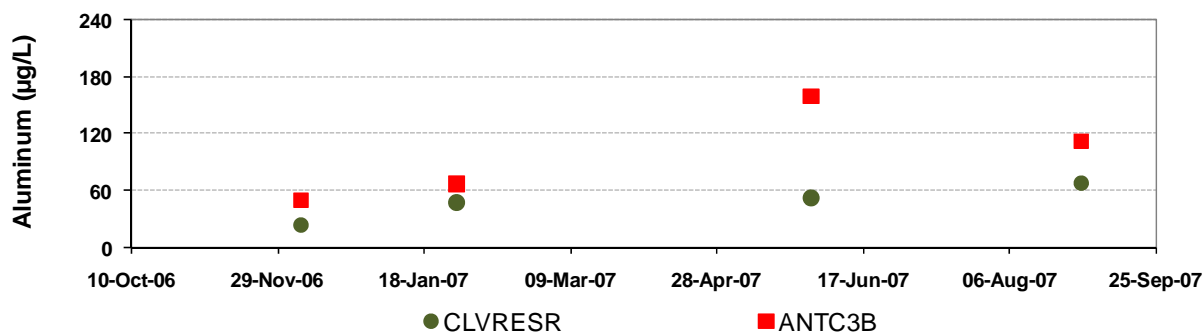


FIGURE 3-61
ALUMINUM RESULTS FROM SEASONAL MONITORING EVENTS IN THE ANTELOPE CREEK WATERSHED

Barium concentrations at ANTC3B were consistently higher than at CLVRESR during seasonal monitoring events. As shown in **Figure 3-62**, barium results ranged from 11 $\mu\text{g/L}$ at CLVRESR during the fall, winter and summer monitoring events to 40 $\mu\text{g/L}$ at ANTC3 B during the spring monitoring event.

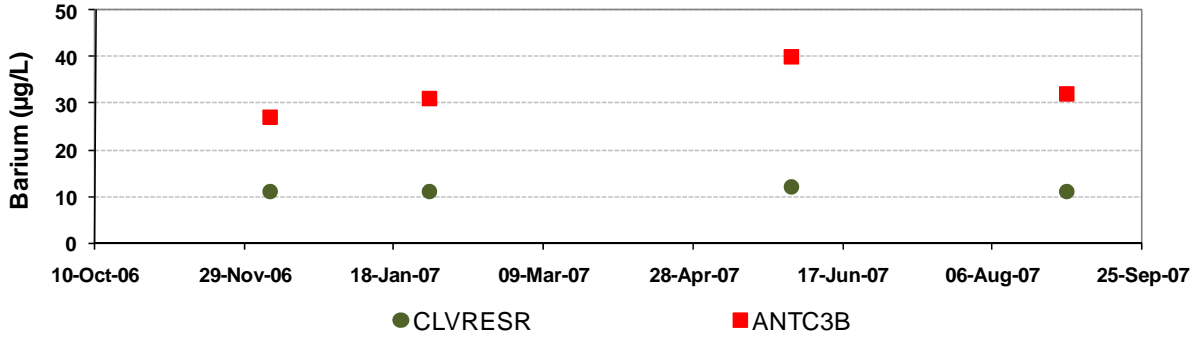


FIGURE 3-62
BARIUM RESULTS FROM SEASONAL MONITORING EVENTS IN THE ANTELOPE CREEK WATERSHED

Cadmium concentrations at ANTC3B were below detection limits for baseline sampling events. Copper was only detected at CLVRESR and ANTC3B during the spring and summer monitoring events, and ranged from 2.1 to 4.5 µg/L (Figure 3-63).

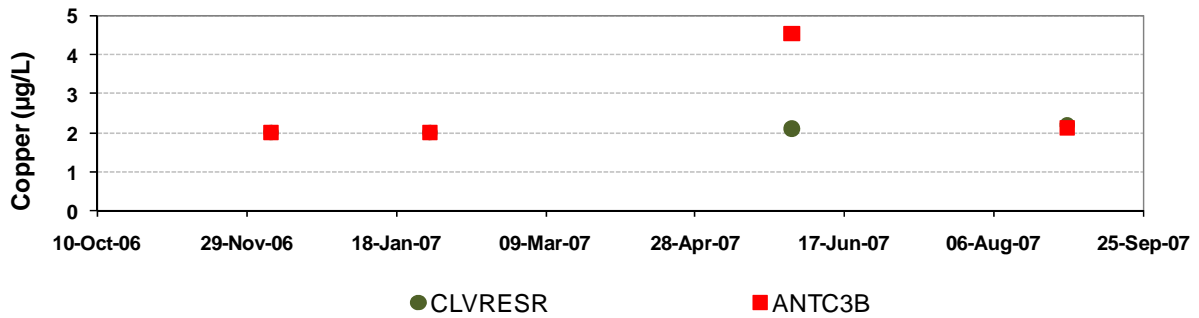


FIGURE 3-63
COPPER RESULTS FROM SEASONAL MONITORING EVENTS IN THE ANTELOPE CREEK WATERSHED

As shown in Figure 3-64, zinc was only detected at CLVRESR and ANTC3B during the winter monitoring event (at 20 µg/L 19 µg/L, respectively). Seasonal copper trends were similar to those of other stream monitoring sites. Mercury concentrations at ANTC3B were below detection limits for baseline sampling events.

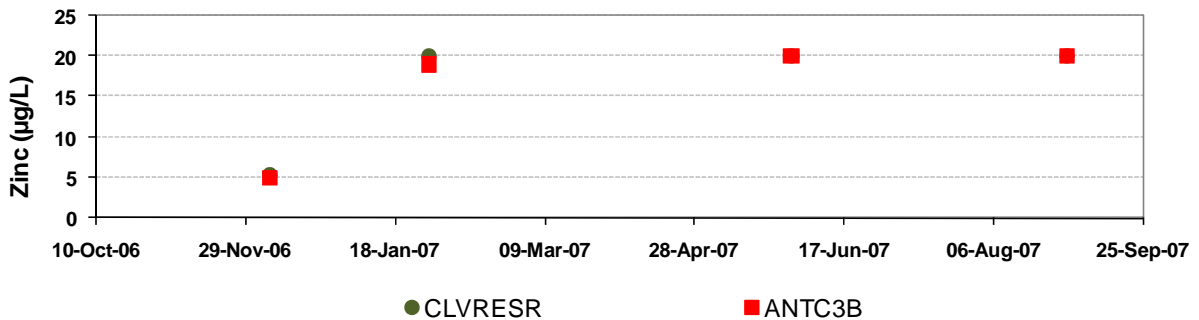


FIGURE 3-64
ZINC RESULTS FROM SEASONAL MONITORING EVENTS IN THE ANTELOPE CREEK WATERSHED

DCC and the Central Valley RWQCB measured trace elements at three different locations in the Antelope Creek watershed in 2001. Barium results ranged from 50 to 60 µg/L and zinc levels ranged from 7 to 3.9 µg/L (Sierra Business Council 2003). Copper levels were detected at 7 µg/L, which is above the CTR chronic water quality standard of 5 µg/L.

Secret Ravine

Five baseline water quality monitoring sites were evaluated within the Secret Ravine watershed:

- **Boardman Canal at Powerhouse Road (YB78):** Located near the town of Auburn at an elevation of 1,300 feet. This site is the next monitoring location downstream from Boardman Canal below Lake Alta (YB96).
- **Boardman Canal below Mammoth Reservoir (YB81):** PCWA regulates flow releases from Mammoth Reservoir to the Boardman Canal, and lower portions of the PCWA raw water distribution system (East Loomis basin).
- **Yankee Hill Canal Outlet Release (YANKEE CR):** A canal south of Mammoth Reservoir that stems from the Boardman Canal to the northwest. Unregulated releases from this canal flow into an unnamed tributary that contributes flows to Secret Ravine.
- **Tributary to Secret Ravine from Yankee Hill Canal (YHTRIB2):** Located along the unnamed tributary receiving unregulated releases from the Yankee Hill Canal outlet YHTRIB2 near Barton Road, upstream from its confluence with Secret Ravine. The site is at the downstream edge of Indian Creek Country Club.
- **Secret Ravine at Rocklin Road (SECRET RV3):** Located just east of Interstate 80. This site has been monitored by DCC for the past few years.

Water Temperature and Dissolved Oxygen

Figure 3-65 shows water temperature and DO results from water quality monitoring at the five sites during baseline sampling events. Water temperature results exhibited a broad seasonal range at the locations, ranging from 41.2 °F at YB78 in the winter to 83.1 °F at YHTRIB2 during the summer monitoring event. DO levels also ranged seasonally from 7.2 mg/L at YHTRIB2 in the summer to 14.1 mg/L at SECRET RV3 in the fall.

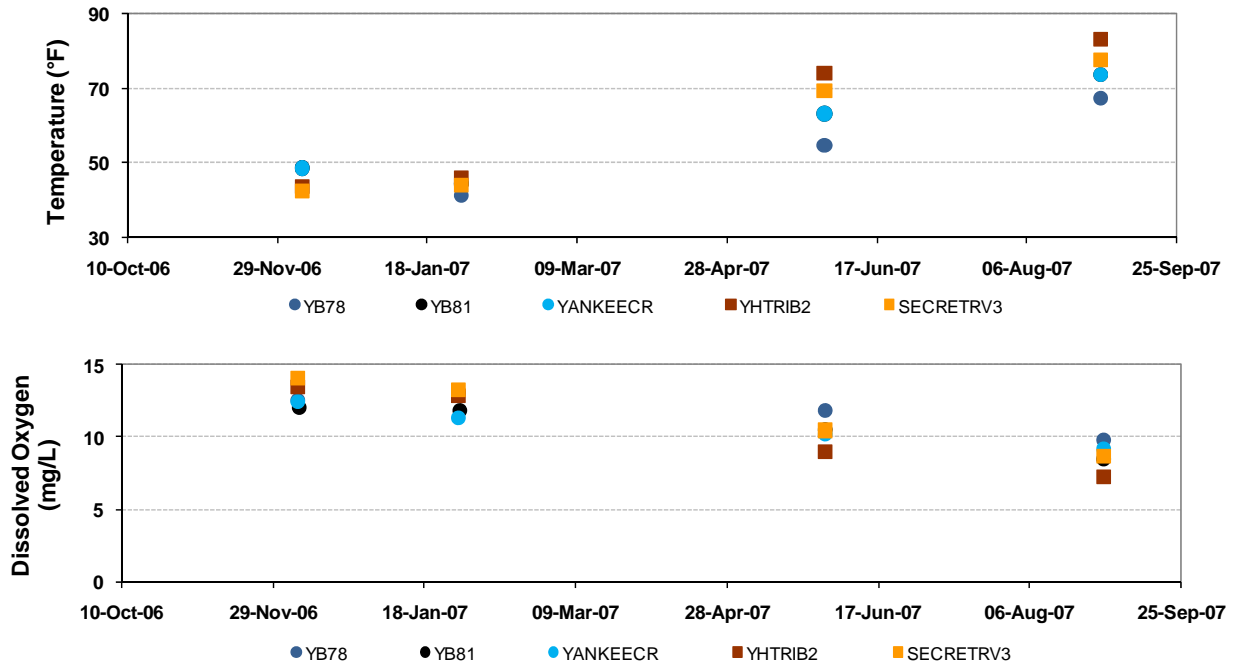


FIGURE 3-65
TEMPERATURE AND DISSOLVED OXYGEN RESULTS FROM SEASONAL MONITORING EVENTS IN SECRET RAVINE WATERSHED

DCC collected temperature data at multiple locations along Secret Ravine between 2001 and 2005 (Sierra Business Council 2003). Water temperature results from DCC studies found average summer water temperatures ranged from 57 °F to 84 °F and average winter water temperatures ranged from 45 °F to 64 °F. Water temperatures were recorded by the DFG in 1984 at two monitoring locations on Secret Ravine: Rocklin Road and Brace Road. Water temperatures ranged from 50 °F in February 1984 to 64 °F in late May 1984. The Central Valley RWQCB collected water quality information at Loomis Basin Park on a monthly basis from December 2000 through February 2002 (Sierra Business Council 2003). Water temperature results from the Central Valley RWQCB study found average summer temperatures ranged from 54 °F to 86 °F and average winter water temperatures ranged from 41 °F to 66 °F.

DO data were collected by DCC during a periodic “first flush” and/or quarterly monitoring program upstream from Rocklin Road at the Secret Ravine confluence with Miners Ravine. DO levels measured during this program in 2002 and 2003 were within a reasonable range of expected values and did not raise concerns (Sierra Business Council 2003).

pH, Alkalinity, and Hardness

Figure 3-66 shows baseline pH, alkalinity, and hardness results for sites monitored in the Secret Ravine watershed. Consistently higher pH values were observed at SECRETRV3 compared to the other monitoring locations, with the exception of YANKEE CR during the summer baseline monitoring event. Overall, pH results for all sites ranged from 7.1 to 8.4.

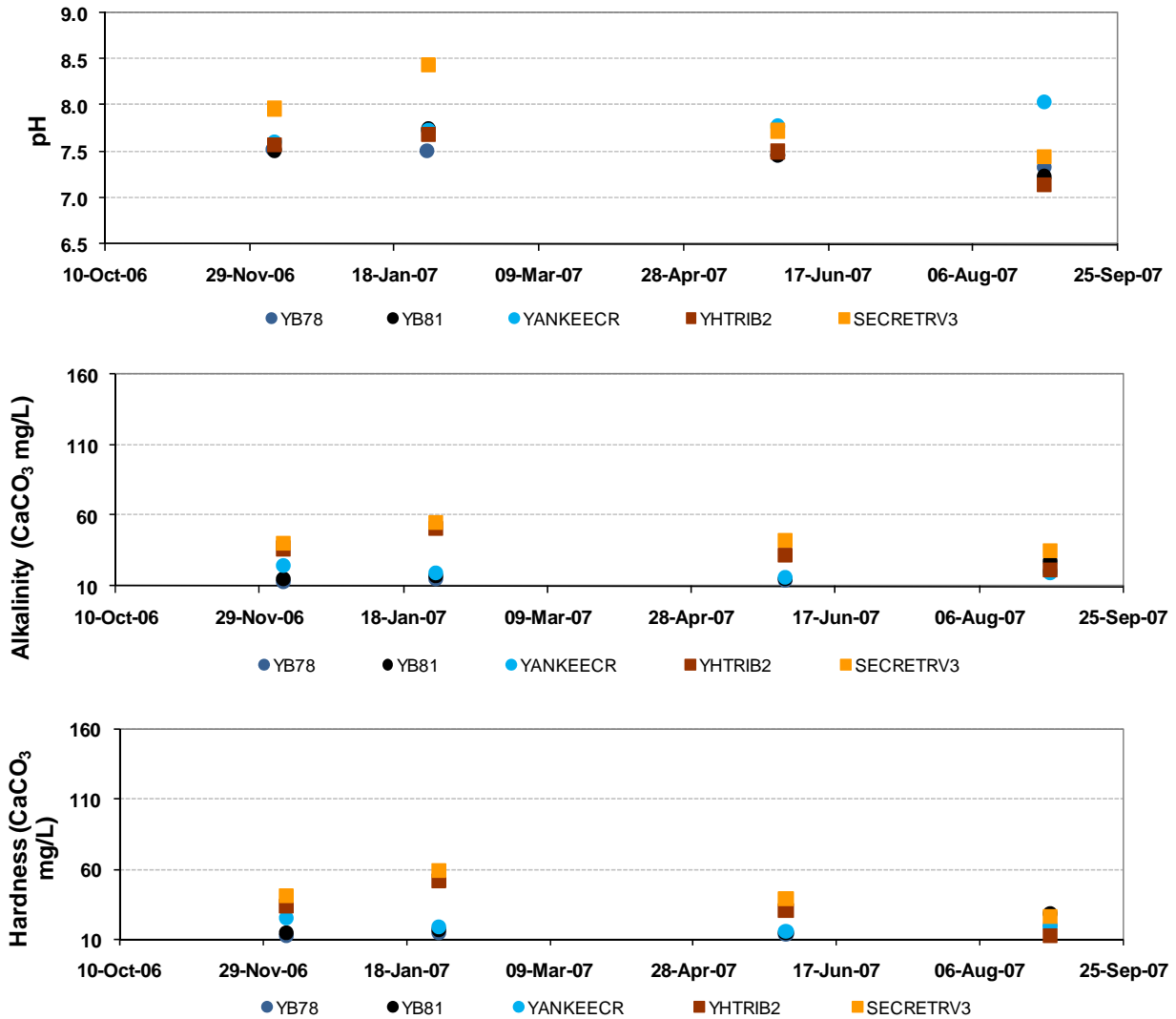


FIGURE 3-66
PH, HARDNESS, AND ALKALINITY RESULTS FROM SEASONAL MONITORING
EVENTS IN THE SECRET RAVINE WATERSHED

Wide fluctuations in pH values were found during sampling conducted by the Central Valley RWQCB. Although the total magnitude of annual change is within an acceptable range for water quality considerations, the fluctuations occur rapidly, particularly during the fall. Monthly sampling between December 2000 and February 2002 at Loomis Basin Park ranged from 8.3 in December 2000 to 6.7 in November 2001 (Sierra Business Council 2003).

Total Suspended Solids and Turbidity

TSS values were below detection limits (10 mg/L) at all locations in the Secret Ravine watershed during all baseline monitoring events. Turbidity values at the five monitoring locations, shown in **Figure 3-67**, ranged between 10.2 and 65.9 NTUs during seasonal monitoring events, with the exception of a measured value of 218 NTU at YB78, which may be an outlier due to sampling procedures or a large object in the water affecting the signal of the optical turbidity sensor.

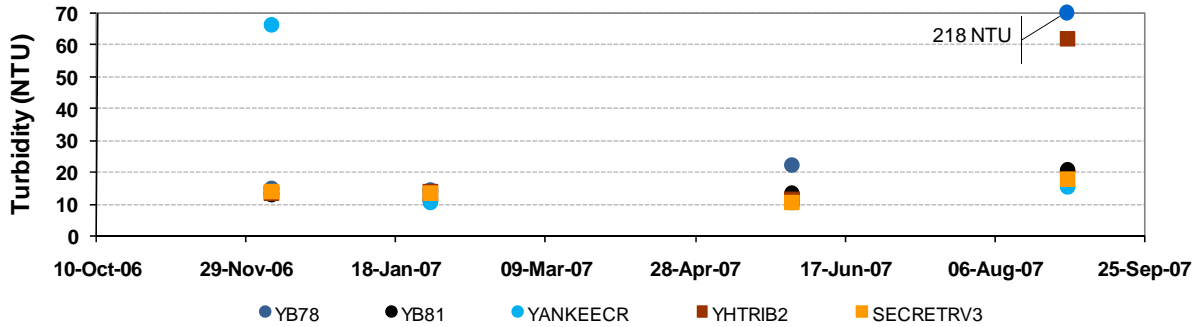


FIGURE 3-67
TURBIDITY RESULTS FROM SEASONAL MONITORING EVENTS IN THE SECRET RAVINE WATERSHED

Specific Conductivity and Ions

Values for SC at YHTRIB2 and SECRETRV3 ranged from 0.05 and 0.08 mS/cm, whereas they ranged from 0.04 and 0.05 mS/cm at canal locations monitored within the Secret Ravine watershed (Figure 3-68).

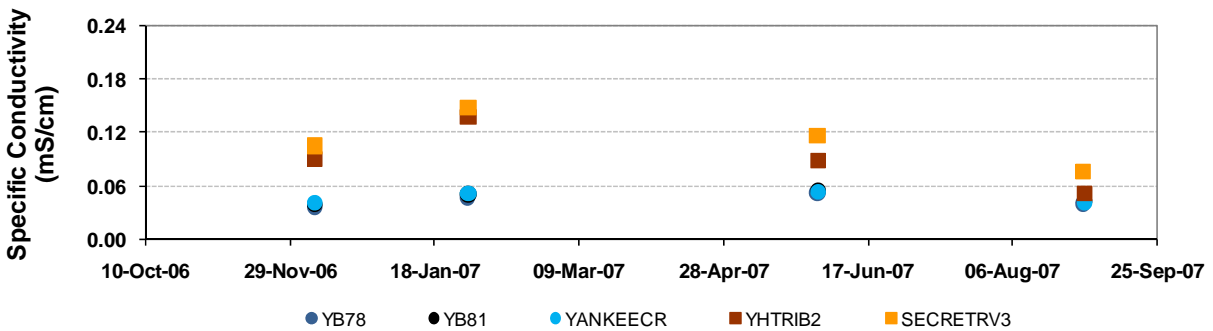


FIGURE 3-68
SPECIFIC CONDUCTIVITY RESULTS FROM SEASONAL MONITORING EVENTS IN THE SECRET RAVINE WATERSHED

Similar to trends observed for SCs, calcium concentrations at YHTRIB2 and SECRETRV3 were consistently higher than at the canal monitoring locations. Calcium values ranged from 3.6 to 12 mg/L at YHTRIB2 and SECRETRV3, and from 3.6 to 3.8 mg/L at canal sites (Figure 3-69).

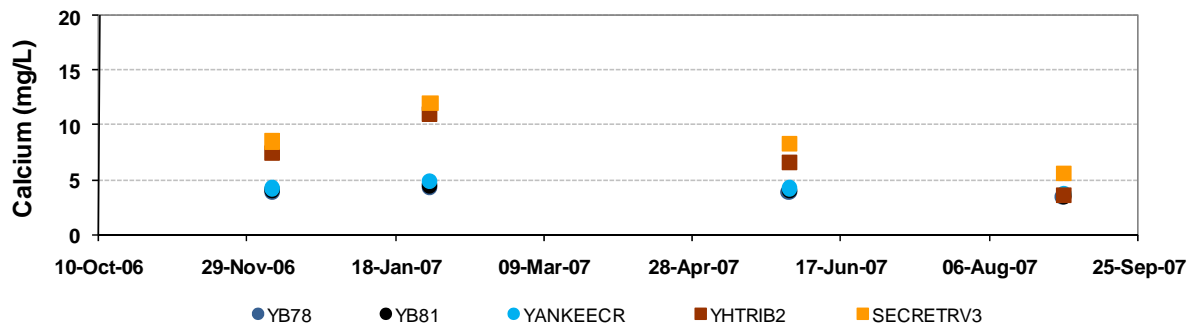


FIGURE 3-69
CALCIUM RESULTS FROM SEASONAL MONITORING EVENTS IN THE SECRET RAVINE WATERSHED

Iron concentrations at the two stream sites monitored within the Secret Ravine watershed, YHTRIB2 and SECRETRV3, display a greater range than those at canal sites. As shown in **Figure 3-70**, iron concentrations at YHTRIB2 and SECRETRV3 ranged from 0.18 mg/L to 0.88 mg/L, whereas iron levels at canal monitoring locations ranged from 0.74 to 0.81 mg/L.

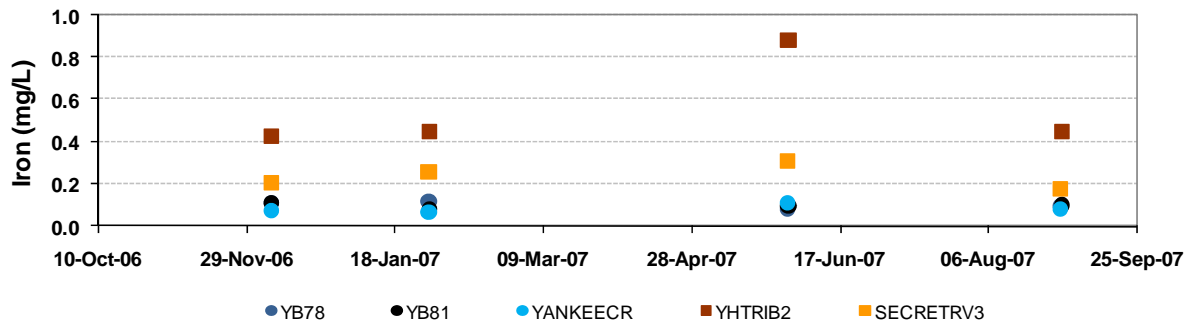


FIGURE 3-70
IRON RESULTS FROM SEASONAL MONITORING EVENTS IN THE SECRET RAVINE WATERSHED

Magnesium concentrations followed the same trend exhibited by SC and calcium results (**Figure 3-71**).

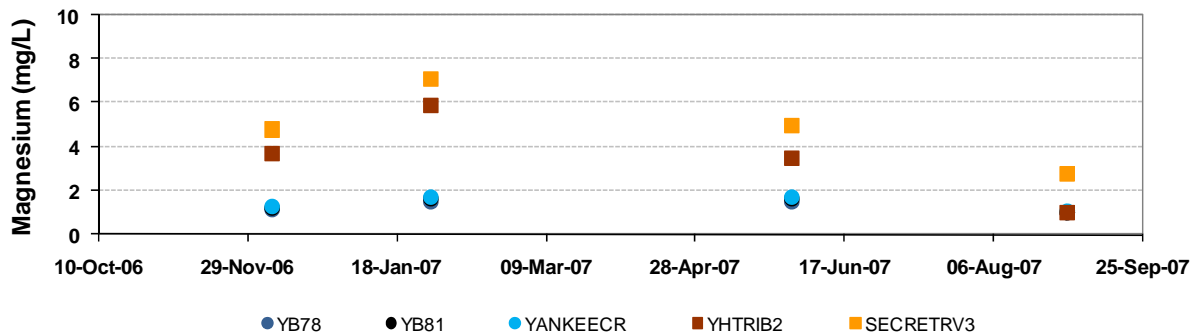


FIGURE 3-71
MAGNESIUM RESULTS FROM SEASONAL MONITORING EVENTS IN THE SECRET RAVINE WATERSHED

Potassium was not detected at canal monitoring locations during baseline sampling events. Potassium results at YHTRIB2 and SECRETRV3 during baseline sampling events were either just above (1.1 mg/L), at, or below the detection limit of 1.0 mg/L.

Sodium results also were consistently higher at YHTRIB2 and SECRETRV3 than at canal monitoring locations. Sodium values at YHTRIB2 and SECRETRV3 ranged from 3.0 mg/L to 7.7 mg/L and ranged from 1.2 to 3.8 mg/L at canal monitoring locations (**Figure 3-72**).

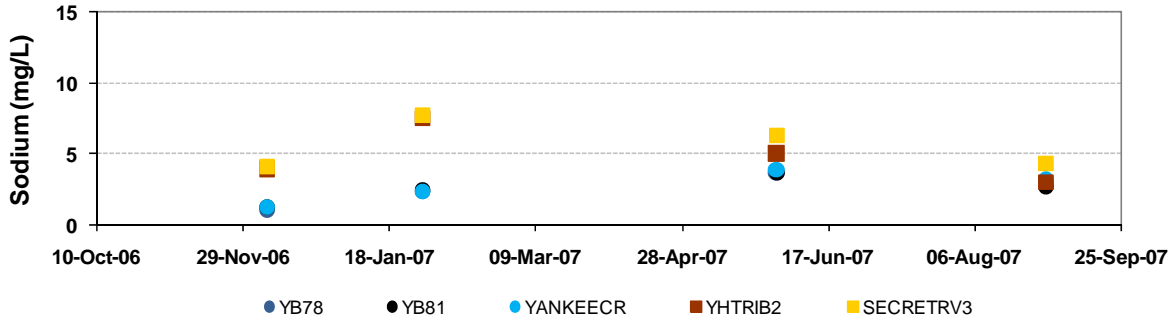


FIGURE 3-72
SODIUM RESULTS FROM SEASONAL MONITORING EVENTS IN THE SECRET RAVINE WATERSHED

Chloride concentrations at YHTRIB2 and SECRETRV3 ranged from 3.4 to 8.2 mg/L, and from 1.0 to 4.0 mg/L at canal monitoring locations (Figure 3-73).

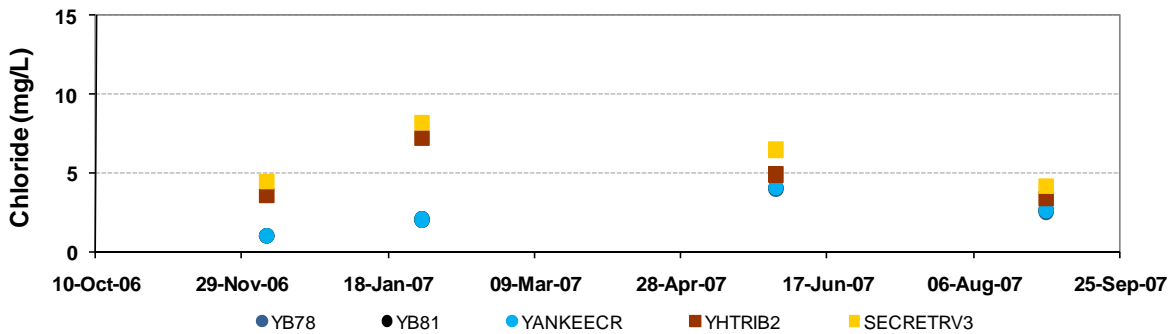


FIGURE 3-73
CHLORIDE RESULTS FROM SEASONAL MONITORING EVENTS IN THE SECRET RAVINE WATERSHED

Nitrate results were at or below the detection limit of 0.1 mg/L at Secret Ravine watershed monitoring sites during baseline sampling events.

Sulfate concentrations at the five monitoring sites exhibited trends similar to SC and several other ions. Across all the sites, sulfate results ranged from 0.5 mg/L to 7.8 mg/L (Figure 3-74).

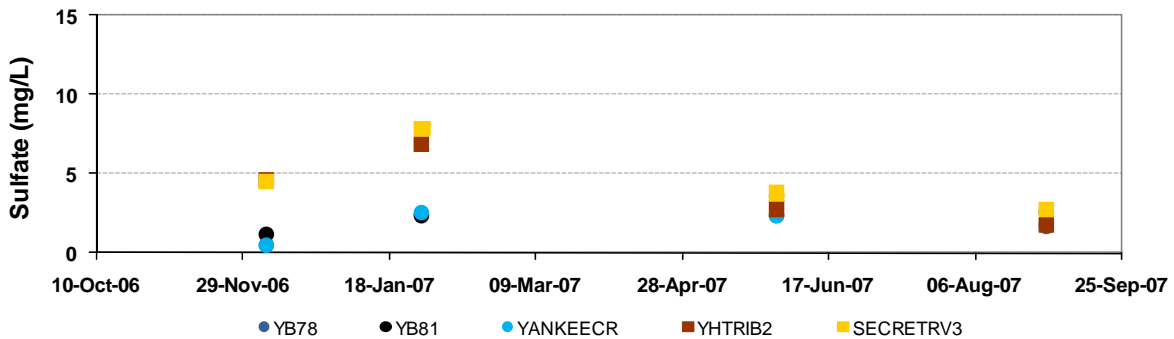


FIGURE 3-74
SULFATE RESULTS FROM SEASONAL MONITORING EVENTS IN THE SECRET RAVINE WATERSHED

The 2001 to 2005 DCC study collected nitrate data at various locations along Secret Ravine. Nitrate results from this study ranged from 0.09 to 0.20 mg/L during the summer and 0.05 to 0.08 mg/L during winter (Sierra Business Council 2003).

Trace Elements

As shown in **Figure 3-75**, no specific trend was noted with aluminum results at the five monitoring sites. Aluminum concentrations varied at the sites from below the detection limit of 40 µg/L to 137 µg/L.

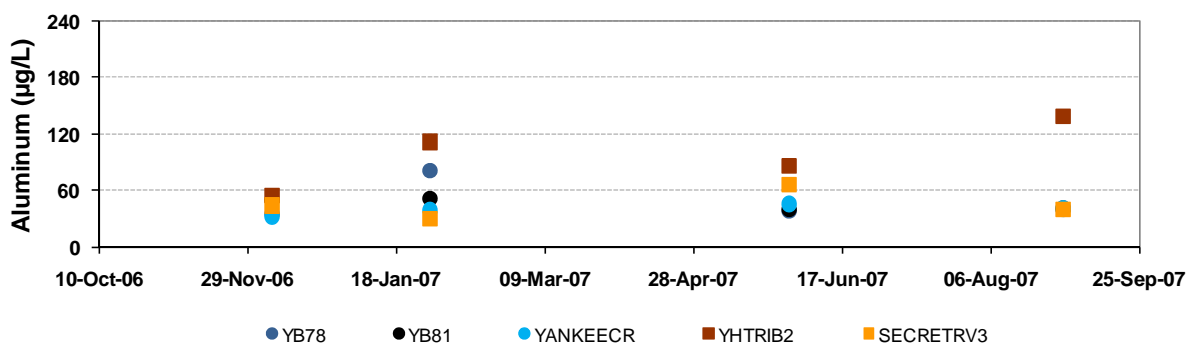


FIGURE 3-75
ALUMINUM RESULTS FROM SEASONAL MONITORING EVENTS IN THE SECRET RAVINE WATERSHED

Barium results at the YHTRIB2 and SECRETRV3 monitoring sites were consistently higher compared to those at the canal monitoring sites. As shown in **Figure 3-76**, barium levels ranged from 9.7 to 22.0 µg/L at the five monitoring locations.

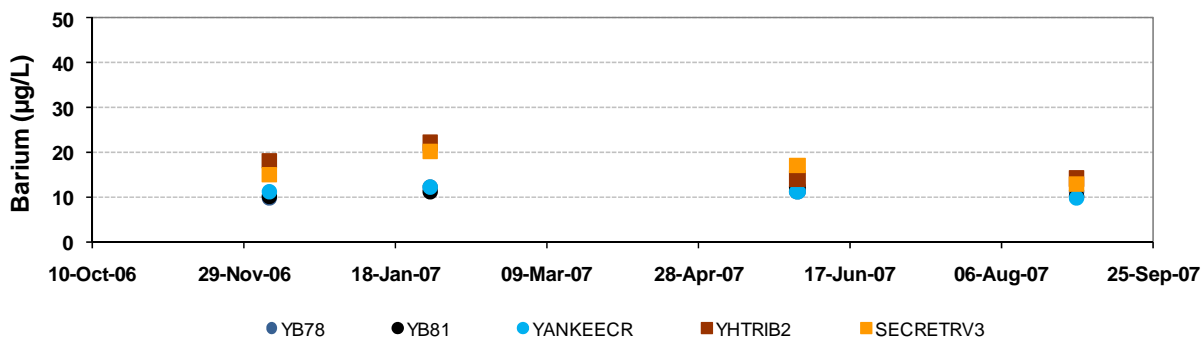


FIGURE 3-76
BARIUM RESULTS FROM SEASONAL MONITORING EVENTS IN THE SECRET RAVINE WATERSHED

Cadmium concentrations at sites monitored in the Secret Ravine watershed were below detection limits for baseline sampling events. Copper concentrations were below the detection limit during the fall monitoring event at the five monitoring locations. During the other seasons, concentrations of copper remained fairly low, with the highest copper concentration measured at 3.5 µg/L at SECRETRV3 during the spring monitoring event and at YB78 during the winter

monitoring event (**Figure 3-77**). Similar to cadmium results, mercury concentrations at sites monitored in the Secret Ravine watershed were below detection limits for baseline sampling events.

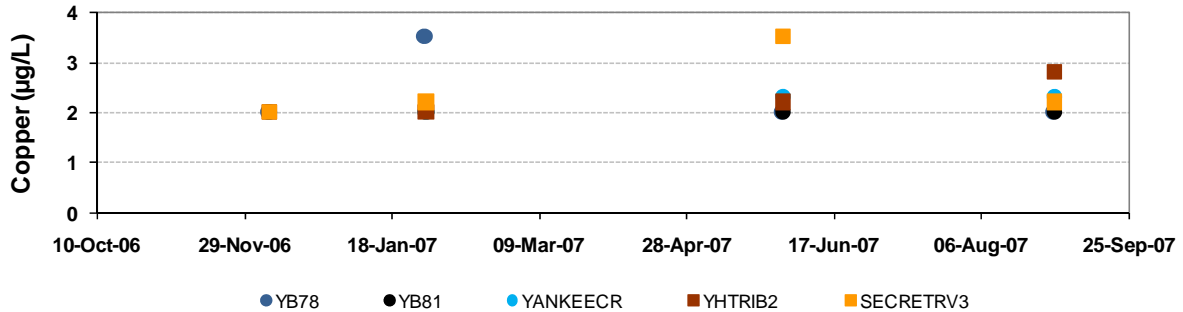


FIGURE 3-77
COPPER RESULTS FROM SEASONAL MONITORING EVENTS IN THE SECRET RAVINE WATERSHED

Measured zinc concentrations were similar at all sites, with detections only during the fall and winter monitoring events at YHTRIB2 and SECRETRV3 sites (**Figure 3-78**). Concentrations of zinc during the spring and summer monitoring events were below the detection limit (20 µg/L).

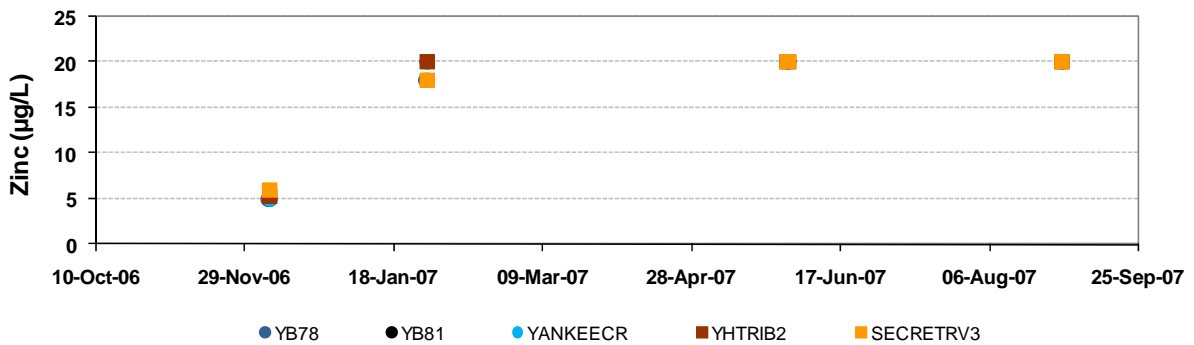


FIGURE 3-78
ZINC RESULTS FROM SEASONAL MONITORING EVENTS IN THE SECRET RAVINE WATERSHED

The Central Valley RWQCB collected data on cadmium, copper, and zinc from Secret Ravine at Loomis Basin Park on a monthly basis from December 2000 through February 2002. Copper, cadmium, and zinc levels exceeded standards of the CTR in November 2002, with reported levels of 12 µg/L, 0.010 mg/L, and 70.0 µg/L, respectively, at the confluence with Miners Ravine (Sierra Business Council 2003).

Miners Ravine

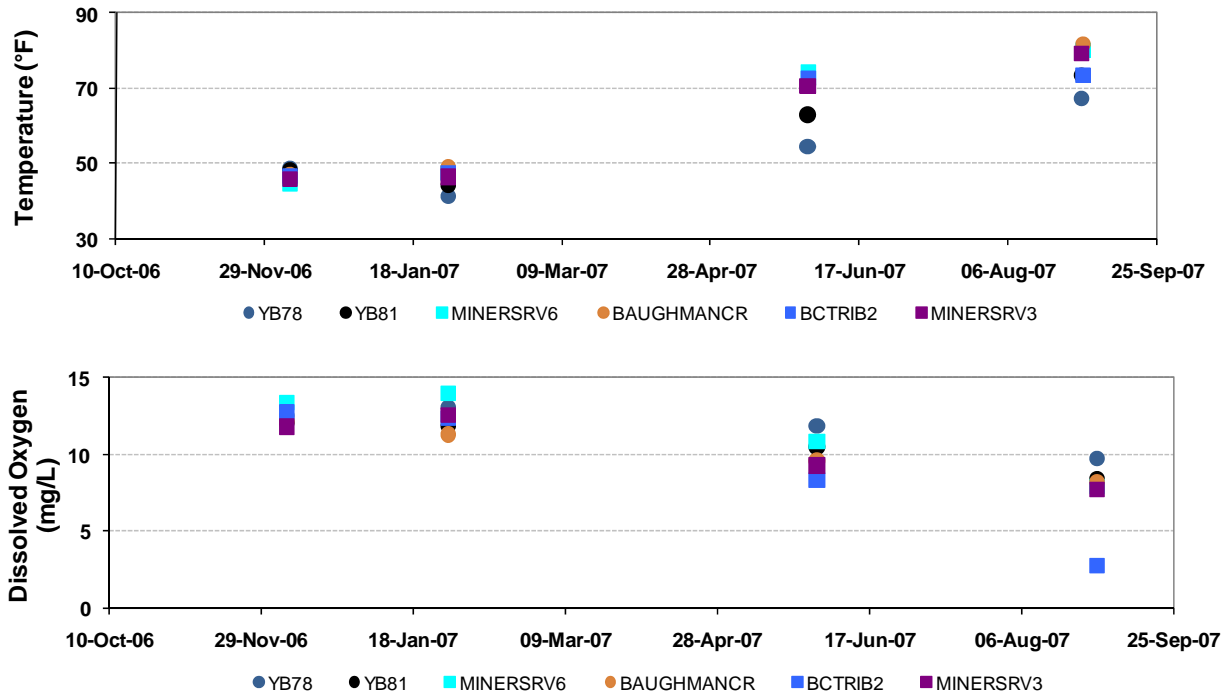
Miners Ravine, similar to Secret Ravine, contributes to flows in Dry Creek. Miners Ravine has topography similar to Secret Ravine; its upper reaches are distinguished by higher elevation steep terrain, and lower reaches consist of flat valleys. Also similar to Secret Ravine, canal system contributions comprise most of the dry weather flows in Miners Ravine. These contributions include customer return flows and unregulated releases from multiple canals. Various tributaries also contribute flows to Miners Ravine. Land uses in the watershed include agricultural, residential, commercial, industrial, and open space (Placer County Planning Department 2007).

Water quality monitoring was conducted at several canal and stream sites within the Miners Ravine watershed:

- **Boardman Canal at Powerhouse Road (YB78):** Located near the town of Auburn at an elevation of 1,300 feet. This site is the next monitoring location downstream from Boardman Canal below Lake Alta (YB96).
- **Boardman Canal below Mammoth Reservoir (YB81):** PCWA regulates flow releases from Mammoth Reservoir to the Boardman Canal, and lower portions of the PCWA raw water distribution system (East Loomis basin).
- **Baughman Canal Outlet Release (BAUGHMANCR):** A canal south of Mammoth Reservoir that stems from the Boardman Canal to the north. Unregulated releases from this canal flow into an unnamed tributary that contributes flows to Miners Ravine.
- **Miners Ravine at Dick Cook Road (MINERSRV6):** Located in the Town of Loomis upstream from two other monitoring locations for baseline sampling in the Miners Ravine watershed. The site is just south of the Placer County SMD No. 3. Plant.
- **Tributary to Miners Ravine from Baughman Canal (BCTRIB1):** Located along the unnamed tributary receiving unregulated releases from the Baughman Canal Outlet near Cavitt-Stallman Road, immediately upstream from its confluence with Miners Ravine.
- **Miners Ravine at North Sunrise Avenue (MINERSRV3):** Located near a bike path bridge, upstream from the confluence with Secret Ravine.

Water Temperature and Dissolved Oxygen

Water temperature and DO data for the six baseline monitoring sites in the Miners Ravine watershed are shown in **Figure 3-79**. Seasonal water temperature results for all the sites ranged from 41.2 °F during the winter monitoring event to 81.5°F during summer. DO levels follow an inverse trend compared to water temperature. DO levels at the six sites ranged from 2.7 mg/L during summer to 14.0 in the winter.



**FIGURE 3-79
TEMPERATURE AND DISSOLVED OXYGEN RESULTS FROM SEASONAL
MONITORING EVENTS IN MINERS RAVINE WATERSHED**

Hourly water temperature data was collected by Bailey Environmental from May to August 2003 at the Miner Ravine Road crossing, Barton Road crossing, Cavitt-Stallman Road crossing, and the Olympus Point development in Roseville behind the United Artists complex (Sierra Business Council 2003). Water temperatures collected at Miner Ravine Road crossing between May 31 and August 5, 2003, ranged from 54 °F in late June 2003 to 86 °F in late July 2003. At Barton Road crossing, water temperatures ranged from 64 °F in mid-June 2003 to 81 °F in late July 2003, and between 66 °F in mid-June 2003 to 84 °F in mid-July 2003 at Cavitt-Stallman Road crossing. Finally, water temperatures at the Olympus Pointe site between June 18 and July 24, 2003, ranged from 68 °F in late June to 86 °F in late July 2003. DFG collected water temperature data from 1999 to 2003 at a monitoring site near Dick Cook Road (Sierra Business Council 2003) Water temperatures measured in the fall (September 1 to December 31, 2002) ranged from 80 °F to 43 °F, in the winter (January 1 to April 27, 2003) ranged from 42 °F to 67 °F, and in the summer (May 1 to August 25, 2003) ranged from 54 °F to almost 88 °F (Sierra Business Council 2003).

DO results from a 2000 to 2002 Central Valley RWQCB study at Miners Ravine ranged from 5.4 mg/L to 8.5 mg/L during the summer and 3.4 mg/L to 6.9 mg/L during the winter (Placer and Sacramento Counties 2003).

pH, Alkalinity, and Hardness

Baseline water quality results for pH, alkalinity, and hardness from sites monitored in the Miners Ravine watershed are shown in **Figure 3-80**. Results for pH at MINERSRV3 were consistently

higher compared to the other five monitoring locations. Overall, pH results ranged at the six sites from 7.1 to 8.9. Measured alkalinity and calculated hardness values were consistently higher at the stream sites than the canal sites. Alkalinity levels ranged from 31.0 to 151.0 mg/L CaCO₃ at the stream sites and ranged from 15.0 to 20.0 mg/L CaCO₃ at the canal sites. Hardness ranged from 25.4 to 70.4 mg/L CaCO₃ at the stream sites and 14.0 to 16.1 mg/L CaCO₃ at the canal sites.

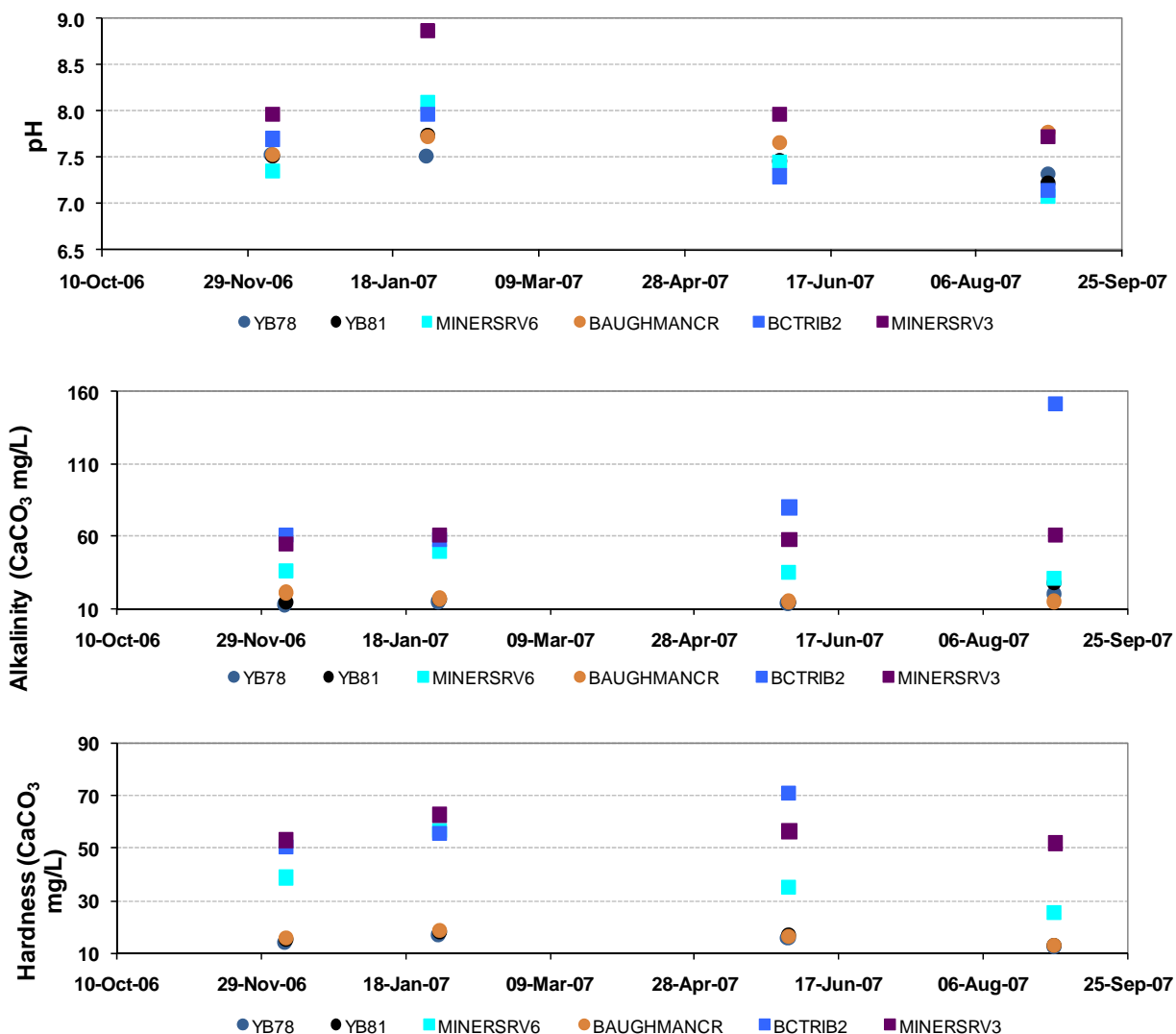
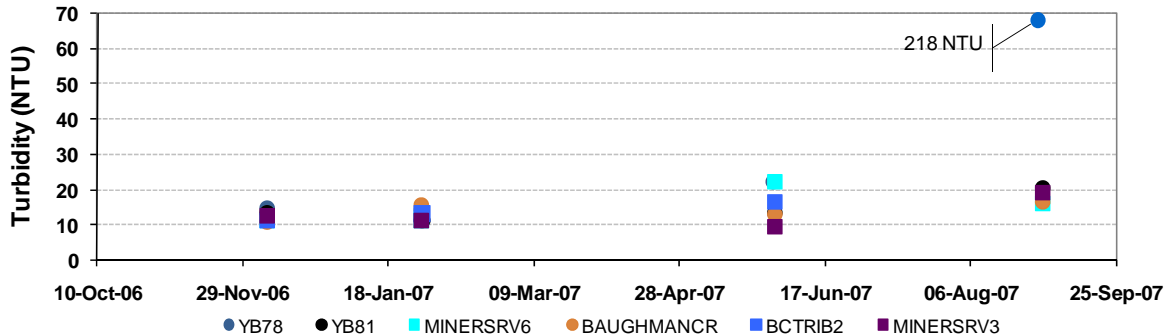


FIGURE 3-80
PH, ALKALINITY, AND HARDNESS RESULTS FROM SEASONAL MONITORING
EVENTS IN THE MINERS RAVINE WATERSHED

A 2000 to 2002 Central Valley RWQCB study found pH values ranging from 6.2 to 7.8 during summer and 6.2 to 8.2 during winter within the Miners Ravine watershed (Sierra Business Council 2003). An Administrative Civil Liability (ACL) complaint and fine were recently issued to Placer County SMD No. 3 by the Central Valley RWQCB for violations in effluent limitations to Miners Ravine for pH from January 2000 to December 2007 (RWQCB 2008).

Total Suspended Solids and Turbidity

TSS values were below detection limits (10 mg/L) at locations monitored in the Miners Ravine watershed during baseline monitoring events, with three exceptions: 13 mg/L at MINERSRV6 during the spring monitoring event, and 17 mg/L at BCTTRIB1, and 218 mg/L at YB78 during the summer monitoring event. As shown in **Figure 3-81**, turbidity values at the six sites were similar, ranging between 9.4 and 21.9 NTUs, with the exception of a measurement of 218 NTUs at YB78, which may be an outlier due to sampling procedures or a large object signaling the optical turbidity probe.



**FIGURE 3-81
TURBIDITY RESULTS FROM SEASONAL MONITORING EVENTS IN THE MINERS RAVINE WATERSHED**

The 2000 to 2002 Central Valley RWQCB study found turbidity values ranging from 3.7 to 5.5 NTUs during summer and 3.4 to 6.9 NTUs during winter within the Miners Ravine watershed (Placer and Sacramento Counties 2003). The Central Valley RWQCB recently issued an ACL complaint and fine to Placer County SMD No. 3 for violations in effluent limitations to Miners Ravine for turbidity from January 2000 to December 2007 (RWQCB 2008).

Specific Conductivity and Ions

SC results at stream monitoring sites in the Miners Ravine watershed (MINERSRV6, BCTTRIB1, and MINERSRV3) are higher than those at the canal monitoring sites, and among the highest levels compared to other stream monitoring sites. As shown in **Figure 3-82**, the greatest SC value among the stream sites was measured at 0.31 mg/L at the BCTTRIB1 site during the summer monitoring event, and the lowest value (0.1 mg/L) occurred at MINERSRV6. SC values at the canal monitoring locations were similar across sites, and ranged from 0.04 to 0.05 mg/L.

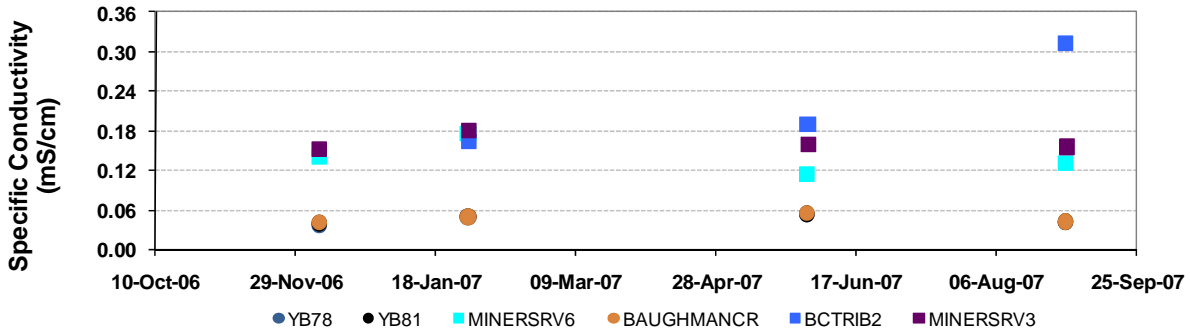


FIGURE 3-82
SPECIFIC CONDUCTIVITY RESULTS FROM SEASONAL MONITORING EVENTS IN THE MINERS RAVINE WATERSHED

The 2000 to 2002 Central Valley RWQCB study found SC values ranging from 0.075 to 0.145 mS/cm during the summer and 30.2 to 0.200 mS/cm during the winter within the Miners Ravine watershed (Placer and Sacramento Counties 2003).

Trends in calcium baseline water quality monitoring were very similar to those described for specific conductivity (**Figure 3-83**). The highest concentrations of calcium were observed during the summer monitoring event at BCTRIB1.

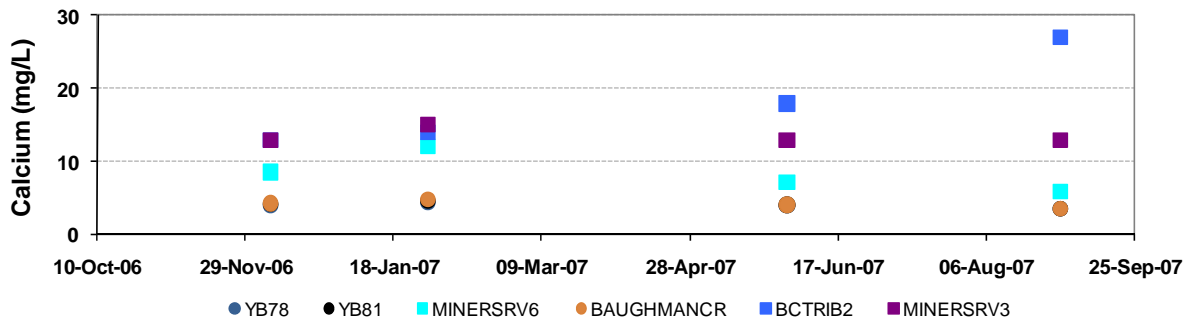


FIGURE 3-83
CALCIUM RESULTS FROM SEASONAL MONITORING EVENTS IN THE MINERS RAVINE WATERSHED

Iron results for baseline water quality monitoring at sites in Miners Ravine watershed are shown in **Figure 3-84**. BCTRIB1 had an iron concentration of 2.3 mg/L during the summer monitoring event, which is particularly high compared to all other monitoring sites during seasonal monitoring events.

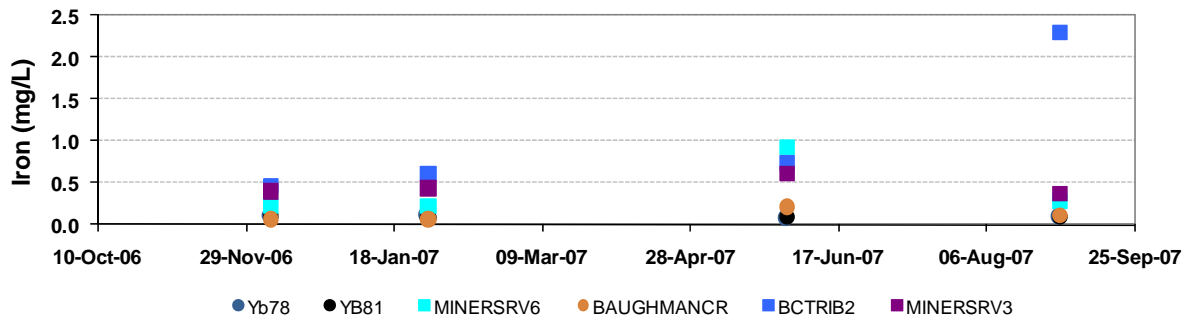


FIGURE 3-84
IRON RESULTS FROM SEASONAL MONITORING EVENTS IN THE MINERS RAVINE WATERSHED

Trends in seasonal magnesium concentrations were similar to those described for SC and calcium (Figure 3-85).

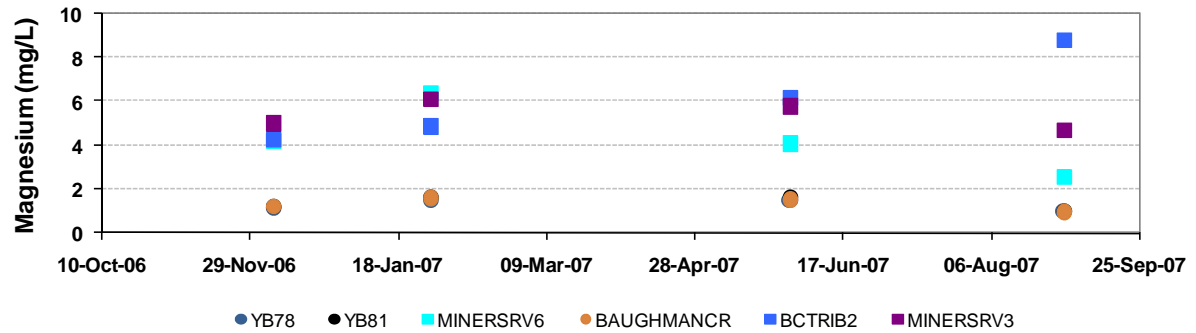


FIGURE 3-85
MAGNESIUM RESULTS FROM SEASONAL MONITORING EVENTS IN THE MINERS RAVINE WATERSHED

Potassium levels were consistently higher at stream sites than at canal monitoring sites. No notable seasonal trends were observed in potassium concentrations at baseline sampling sites in the Miners Ravine watershed (Figure 3-86).

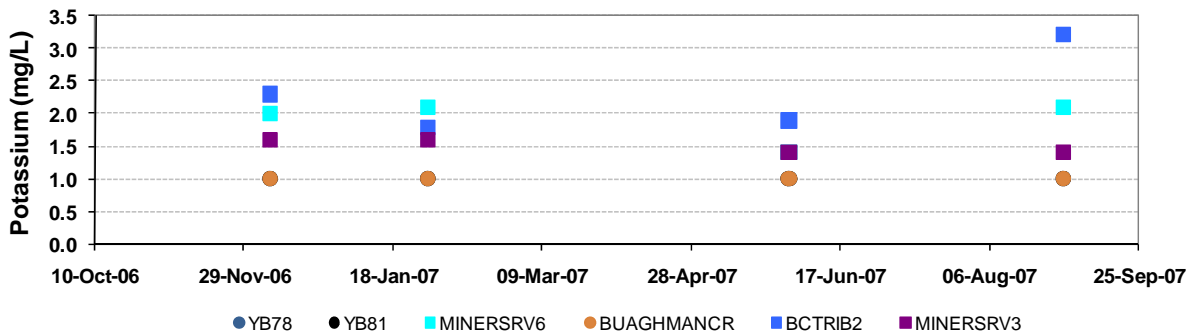


FIGURE 3-86
POTASSIUM RESULTS FROM SEASONAL MONITORING EVENTS IN THE MINERS RAVINE WATERSHED

Sodium concentrations in the Miners Ravine watershed displayed similar seasonal trends as those observed for SC, calcium, and magnesium, in which the BCTRIB1 monitoring location had the highest values during the spring and summer monitoring events (**Figure 3-87**). In addition, most variation across sites occurred during the summer monitoring event.

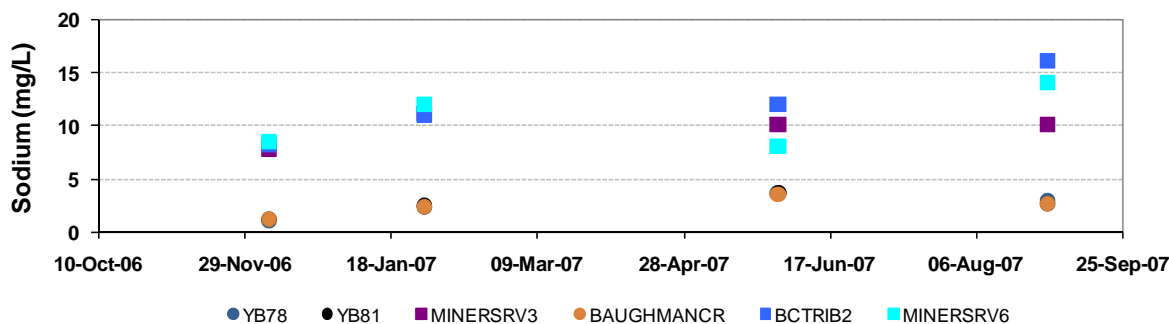


FIGURE 3-87
SODIUM RESULTS FROM SEASONAL MONITORING EVENTS IN THE MINERS RAVINE WATERSHED

Although chloride results at stream monitoring locations are consistently higher than those at canal monitoring sites, as with other ions, chloride was not consistently high at BCTRIB1. As shown in **Figure 3-88**, chloride results varied from 7.7 to 14.0 mg/L at stream monitoring sites and from 1.0 to 4.0 mg/L at canal monitoring locations.

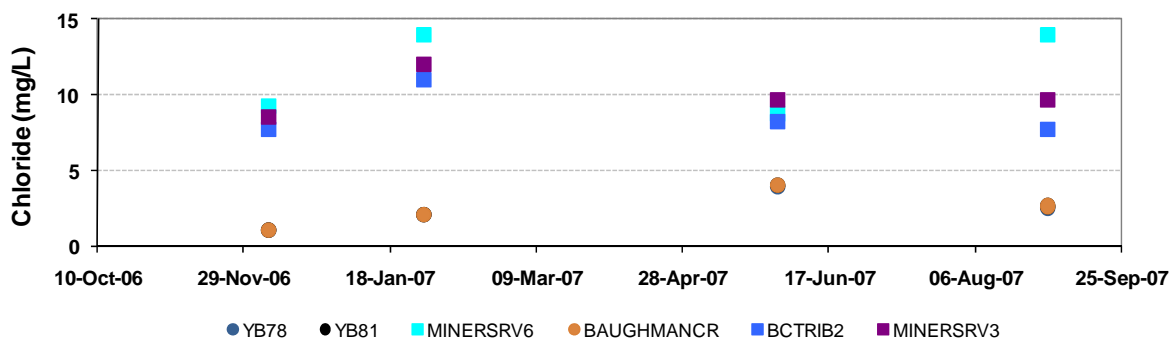


FIGURE 3-88
CHLORIDE RESULTS FROM SEASONAL MONITORING EVENTS IN THE MINERS RAVINE WATERSHED

An ACL complaint and fine were recently issued to Placer County SMD No. 3 by the Central Valley RWQCB for violations in effluent limitations to Miners Ravine for chlorine residual from January 2000 to December 2007 (RWQCB 2008).

Nitrate concentrations at MINERSRV6 were consistently higher than at other monitoring locations (**Figure 3-89**). MINERSRV6 is downstream from the Placer County SMD No. 3 WWTP. The Central Valley RWQCB recently issued an ACL complaint and fine to Placer County SMD No. 3 for violations in effluent limitations to Miners Ravine for nitrate from January 2000 to December 2007 (RWQCB 2008).

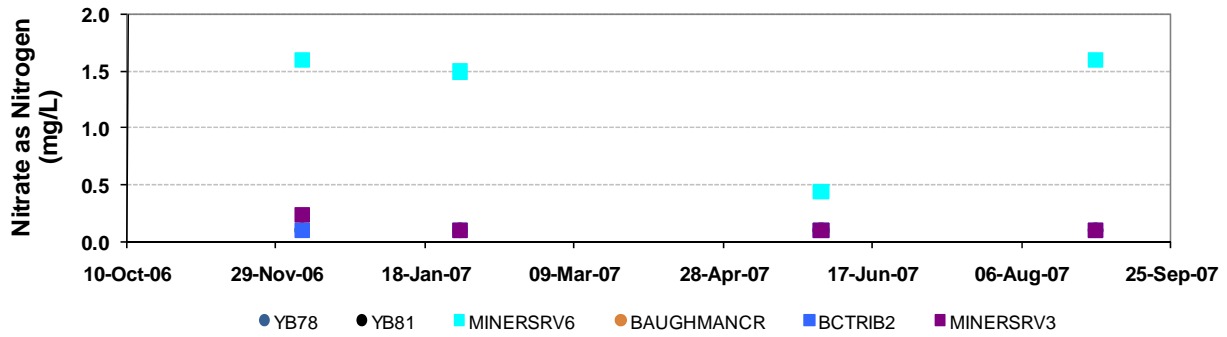


FIGURE 3-89
NITRATE RESULTS FROM SEASONAL MONITORING EVENTS IN THE MINERS RAVINE WATERSHED

Sulfate results for Miners Ravine watershed sites during baseline sampling events were generally higher at the stream sites than at the canal sites, and higher streams in other watersheds monitored. Sulfate was measured at 250 mg/L at MINERSRV6 during the summer monitoring event (Figure 3-90). This data point is likely an outlying result that is due to potential changes in analytical methods, or a temporary source of increased sulfate upstream from MINERSRV6, such as wastewater discharges from Placer County SMD No. 3. Data on nitrate and phosphate were also collected during the 2001 to 2005 DCC study. While overall nitrate and phosphorus concentrations were not very high, no nutrients were measured during summer, when nutrient loads are typically highest. The data indicate that the biologically desirable 10:1 ratio of nitrate to phosphate was met only certain times of the year.

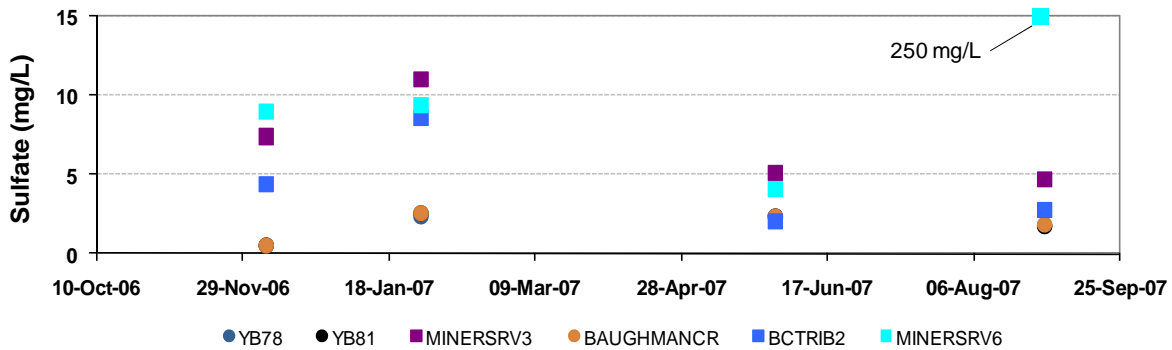


FIGURE 3-90
SULFATE RESULTS FROM SEASONAL MONITORING EVENTS IN THE MINERS RAVINE WATERSHED

Trace Elements

Aluminum concentrations were low at sites evaluated in the Miners Ravine watershed compared to monitoring sites in other watersheds. As shown in Figure 3-91, aluminum results at all six monitoring sites ranged from the detection limit (25 µg/L) during the fall monitoring event to 80 µg/L during the summer monitoring event.

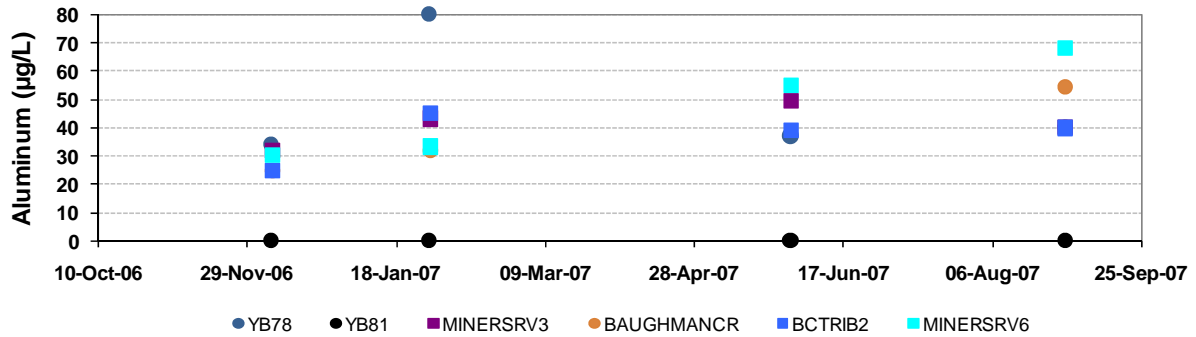


FIGURE 3-91
ALUMINUM RESULTS FROM SEASONAL MONITORING EVENTS IN THE MINERS RAVINE WATERSHED

Figure 3-92 shows barium concentrations from sites monitored within the Miners Ravine watershed during seasonal baseline sampling events. Barium levels at canal monitoring sites were consistently lower compared to those at stream sites, and ranged from below the detection limit of 2 µg/L to 11 µg/L. Barium results at the stream sites ranged from 11 to 42 µg/L, with the exception of one very high value (190 µg/L) measured at BCTTRIB1 during the summer monitoring event.

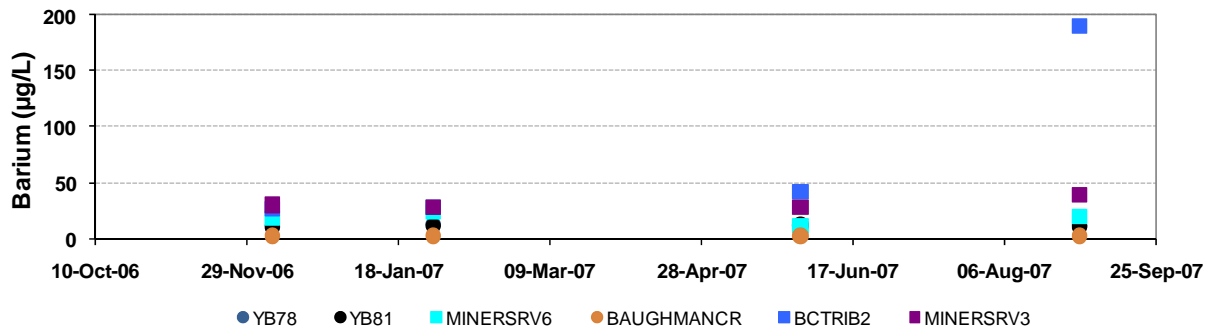


FIGURE 3-92
BARIUM RESULTS FROM SEASONAL MONITORING EVENTS IN THE MINERS RAVINE WATERSHED

Cadmium concentrations at sites monitored in the Miners Ravine watershed were below detection limits for baseline sampling events.

Copper concentrations at the six sites range from below the detection limit of 2 µg/L to 7.5 µg/L (**Figure 3-93**). The 2000 to 2002 Central Valley RWQCB study measured a copper value of 11 µg/L and a zinc value of 1.0 µg/L within the Miners Ravine watershed (Sierra Business Council 2003). Copper exceeded the CTR at 8.0 µg/L at Dick Cook Road during November 2001 (Sierra Business Council 2003).

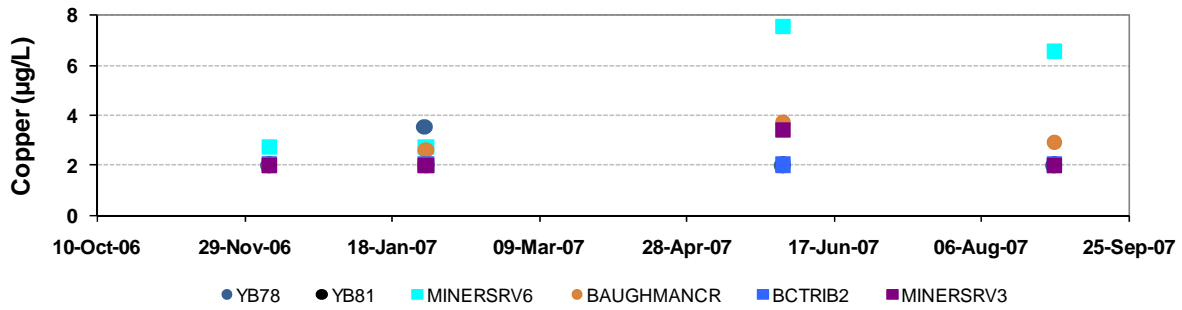


FIGURE 3-93
COPPER RESULTS FROM SEASONAL MONITORING EVENTS IN THE MINERS RAVINE WATERSHED

Mercury concentrations at sites monitored in the Miners Ravine watershed were below detection limits for baseline sampling events. CVCWA monitored methylmercury from August 2004 through April 2005 at Miners Ravine below the discharge of the Placer County SMD No. 3 WWTP. Methylmercury levels at this site ranged from 0.01 grams per year (grams/year) to 1.29 grams/year, averaging 0.23 grams/year. Mercury pollution in California watersheds originates primarily from historical mining operations and from atmospheric deposition (CVCWA 2005).

Zinc concentrations for seasonal baseline monitoring events at the six monitoring sites are shown in **Figure 3-94**. In general, zinc concentrations were measured close to or below the detection limits during monitoring events, except during the spring monitoring event. Zinc was measured to be 460 µg/L at MINERSRV6 during the spring monitoring event. This is likely an outlier due to methodological errors or a temporary source of increased zinc concentrations during sampling at that location.

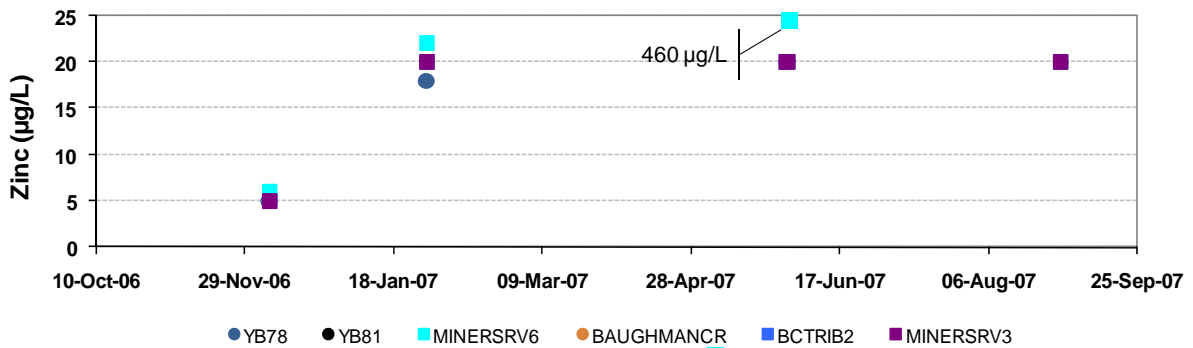


FIGURE 3-94
ZINC RESULTS FROM SEASONAL MONITORING EVENTS IN THE MINERS RAVINE WATERSHED

3.2.2.3 Zone 5

Zone 5 comprises the lower portion of the Auburn Ravine watershed where agricultural water deliveries are made to PCWA customers through the Moore and Pleasant Grove canals.

Although water quality measurements were not taken in the Auburn Ravine watershed during this study, some data were collected by other sources and are summarized below.

Water Temperature and Dissolved Oxygen

Water temperature data collected from other sources include hourly temperature monitoring conducted by Bailey Environmental between April 1999 and August 2003 at Fowler Road, the NID gaging station near Highway 65 in Lincoln, Moore Road, and the Aitken Ranch.

Temperature data from this project show summer values (May 28 to August 4, 2003) ranging from approximately 62 °F to 82 °F, fall values (September 9 to December 28, 2002) ranging from 48 °F to 69 °F, winter values (January 1 to April 27, 2003) ranging from 43 °F to 64 °F, and spring values (May 1 to July 31, 2003) ranging from 50 °F to 73 °F (Sierra Business Council 2003).

pH, Alkalinity, and Hardness

Data on pH were collected monthly by the DWR in the lower portion of the Auburn Ravine watershed. The data reveal a wide range of pH values (5.6 to 7.7), but the lower end of this range is considered extremely low for the types of streams found in the Sierra Nevada Foothills (Placer County Planning Department 2003).

Results for pH were also measured by the Lincoln High School Water Quality Monitoring Program (funded by NID, Placer County, and the City of Lincoln) at three sites along the Auburn Ravine: Mackenroth Property (September 21, 2002), the Highway 193 Bridge crossing (October 7, 2002) and the Joiner Parkway Bridge crossing (September 23, 2001). Results for pH were 7.7, 7.7, and 7.16, respectively (Placer County Planning Department 2003).

Turbidity and Total Suspended Solids

Turbidity and TSS in the Auburn Ravine were measured at the Lincoln and Auburn WWTPs under NPDES permit requirements. TSS loads were observed to significantly increase in winter and spring, likely from stormwater runoff. During low flows in Auburn Ravine, turbidity was measured at less than 1 NTU. Turbidity loads of greater than 2 NTUs were measured in the effluent from the Lincoln WWTP during this time (Placer County 2002). Turbidity was also measured in the Auburn Ravine by DWR between January 2001 and January 2002. Turbidity results ranged from 5 to 33 NTUs, with one higher value of 136 NTUs in December 2001.

Specific Conductivity and Ions

Previous water quality studies characterizing SC values within the Auburn Ravine watershed in Zone 5 were not identified for this study. Electrical conductivity, not SC, which is normalized to a temperature of 77 °F (25 °C), was measured by the Lincoln High School Water Quality Monitoring Program at three sites along the Auburn Ravine: Mackenroth Property (September 21, 2002), the Highway 193 Bridge crossing (October 7, 2002) and the Joiner Parkway Bridge

crossing (September 23, 2001). Electrical conductivity was measured at 0.152, 0.056, and 0.072 mS/cm, respectively (Sierra Business Council 2003).

Nitrogen and phosphorus were measured at the Auburn WWTP in 1995 (Placer County 2002). Although nitrogen and phosphorus levels in Auburn WWTP effluent averaged 0.5 mg/L, Auburn Ravine downstream from the Auburn WWTP did not show evidence of eutrophication. However, Auburn Ravine downstream from the Lincoln WWTP was observed to be influenced by both wastewater effluent and stormwater runoff.

Nitrates were also measured by the Lincoln High School Water Quality Monitoring Program at three sites along the Auburn Ravine: Mackenroth Property (September 21, 2002), the Highway 193 Bridge crossing (October 7, 2002) and the Joiner Parkway Bridge crossing (September 23, 2001). Nitrates were measured at 0.7 mg/L, 1.1 mg/L, and 1.9 mg/L, respectively (Placer County Planning Department 2003).

Trace Elements

Data collected by Placer County for the Auburn Ravine/Coon Creek Ecosystem Restoration Plan in 1999 and 2000 show cadmium, copper, and zinc levels in the Auburn Ravine all exceed the CTR standards for aquatic life at various times throughout the year (Placer County 2002). Copper exceeded CTR standards in June, July, and October 1999 and in January, February, and April 2000.

3.2.3 Soil and Sediment Quality

The USDA-NRCS soil data indicate that 39 different soil classes and combinations of soil classes are present in PCWA Zones 1, 3, and 5. To facilitate mapping, these soil classes have been generalized into six different soil textures. Details about the distribution of these soil textures and classes are discussed by zone below. Soil permeability for Zones 1 and 3 is also discussed based on a previously published report by PCWA (2005).

3.2.3.1 Zone 3

Zone 3 is dominated by gravelly, cobbly, and stony loams of the Mariposa, Mariposa-Josephine, Cohasset, and Dubakella soil types. These coarse loams are found particularly at the heads of the steep ravines that characterize the zone. Other types of loams including sandy loam, coarse sandy loam, and silt loam are also common. Xerorthents, which include various soil textures, are found in old placer areas and cut-and-fill sites. Soils are listed by texture and classification in the order of their prevalence in **Table 3-9**. **Figure 3-95** is a map of soils by texture in Zone 3.

TABLE 3-9
ZONE 3 SOILS BY GENERALIZED TEXTURE AND CLASSIFICATION

Soil Texture ¹	Soil Classifications ²
Gravelly, cobbly, and stony loam	Mariposa, Mariposa-Josephine, Cohasset, Dubakella
Loam	Sites, Josephine, Boomer, Cohasset
Sandy loam and coarse sandy loam	Maymen, Boomer
Variable	Xerorthents
Silt loam	Auburn-Sobrante

Source: Soil Survey Staff, Natural Resources Conservation Service (USDA-NRCS). 2008.

Note:

¹ Soil textures provided in order of prevalence

² The soil classifications listed in this table account for 95 percent of the total area of Zone 3. The remaining 5 percent of the area is covered by eight additional classes.

Soil permeability is moderate to high (26 to 480 inches per day) within much of lower Zone 3 (PCWA 2005).

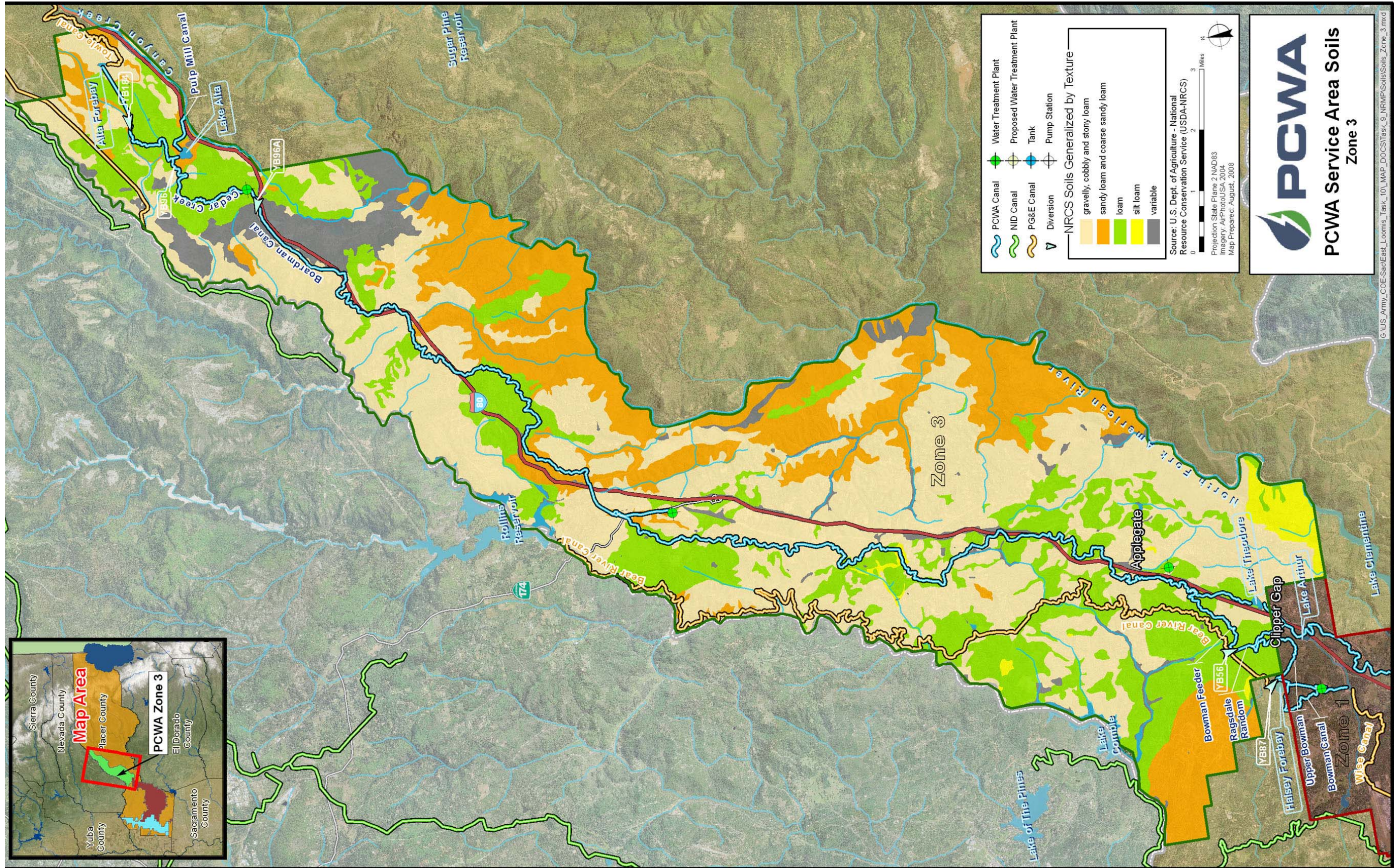


FIGURE 3-95
ZONE 3 SOILS MAP

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3.2.3.2 Zone 1

Much of Zone 1 is underlain by the Rocklin Pluton, an igneous formation intruded during the Lower Cretaceous period¹. The Rocklin Pluton is composed of quartz-diorite (Olmsted 1961, Swanson 1978, Wagner et al. 1987). In southwestern Zone 1, the sedimentary Mehrten Formation overlies the Rocklin Pluton. The Mehrten is a groundwater-bearing formation composed of moderately to well-indurated andesitic sand to sandstone interbedded with conglomerate, tuffaceous siltstone, and claystone. It was deposited in the mid-Cenozoic era² (DWR 2006).

The minerals composing the parent material for soils throughout the Zone 1 service area include quartz, plagioclase feldspar, alkali feldspar, biotite, and hornblende. Common chemical constituents in these minerals include aluminum, oxygen, and silica. Additional chemical constituents, depending on the parent material, may include calcium, iron, magnesium, potassium, and sodium.

Upper Zone 1 is characterized by silt loams, while lower Zone 1 is dominated by the coarser Andregg and other sandy loams. Gravelly, cobbly, and stony loams are found in western Zone 1, along with small areas of Alamo clay soil. Xerofluvents with variable textures are located along unlined canals, drainages, and along Auburn, Secret and Miners ravines. Xerorthents, also with variable textures, are present in cut and fill areas in western Zone 1. Soils in Zone 1 are listed by texture and classification in the order of their prevalence in **Table 3-10**. Zone 1 soils are mapped by texture in **Figures 3-96** and **3-97**.

TABLE 3-10
ZONE 1 SOILS BY GENERALIZED TEXTURE AND CLASSIFICATION

Soil Texture ¹	Soil Classifications ²
Sandy loam and coarse sandy loam	Andregg, Sierra, Cometa-Ramona, Caperton-Andregg, Boomer
Gravelly, cobbly, and stony loam	Exchequer, Inks, Inks-Exchequer,
Loam	Fiddymment-Kaseberg, Boomer, Cometa-Fiddymment
Silt loam	Auburn, Auburn-Sobrante
Clay	Alamo
Variable	Xerorthents, Xerofluvents

Source: Soil Survey Staff, *Natural Resources Conservation Service (USDA-NRCS)*. 2008.

Notes:

¹ Soil textures provided in order of prevalence

² The soil classifications listed in this table account for 85 percent of the total area of Zone 1. The remaining 15 percent of the area is covered by 18 additional classes.

Soil permeability is moderate to high (26 to 480 inches per day) within much of lower Zone 1. Soils of moderately low permeability (9 inches per day) to low permeability (1 to 3 inches per day) lie along the center of lower Zone 1, from the northeast head of the system to the head of Dry Creek in the southwest (PCWA 2005).

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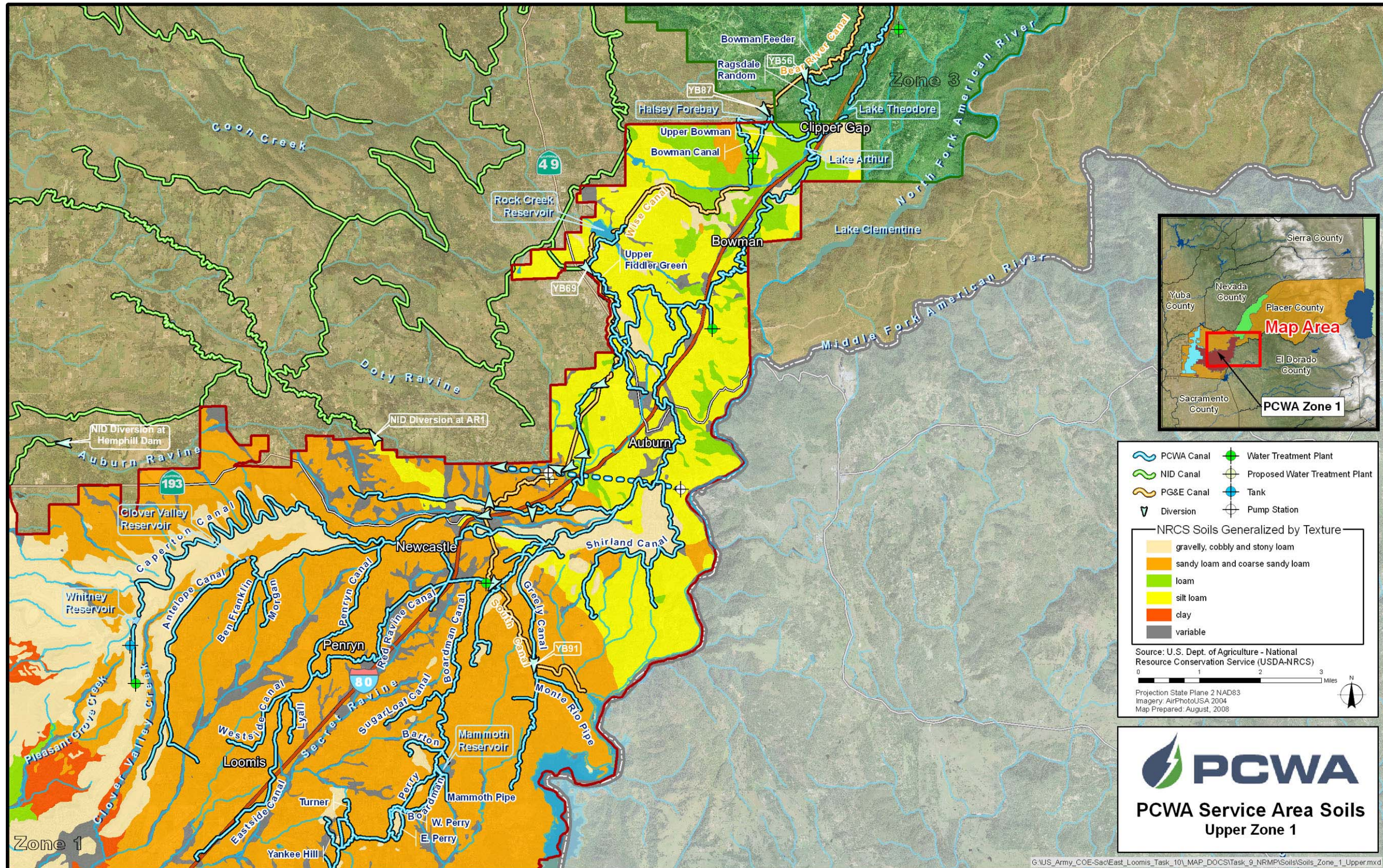


FIGURE 3-96
UPPER ZONE 1 SOILS MAP

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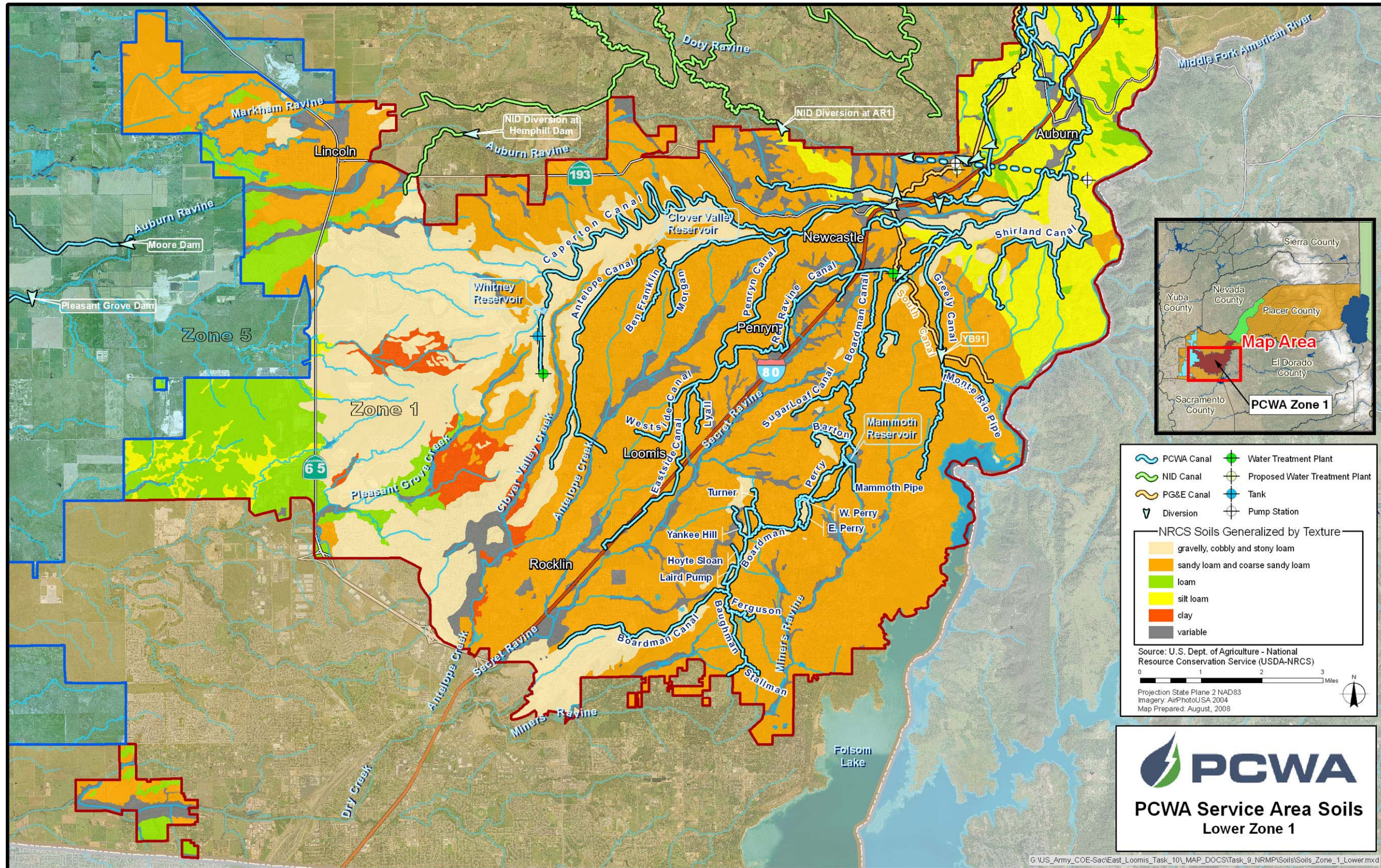


FIGURE 3-97
LOWER ZONE 1 SOILS MAP

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3.2.3.3 Zone 5

Zone 5 is dominated by Cometa-Fiddymment, Kilaga, and Fiddymment loams, which are found in the southern part of the zone. Sandy loam and coarse sandy loams are present in central Zone 5, and gravelly, cobbly, and stony loams make up the majority of soils in the northern part of the zone. Xerofluvents with variable textures are found at the bottoms of the major drainages, including Auburn and Doty ravines and Pleasant Grove Creek. Soils in Zone 5 are listed by texture and classification in the order of their prevalence in **Table 3-11**. Zone 5 soils are mapped by texture in **Figure 3-98**.

**TABLE 3-11
ZONE 5 SOILS BY GENERALIZED TEXTURE AND CLASSIFICATION**

Soil Texture ¹	Soil Classifications ²
Loam	Cometa-Fiddymment, Kilaga, Fiddymment
Sandy loam and coarse sandy loam	San Joaquin-Cometa, Cometa-Ramona
Gravelly, cobbly, and stony loam	Redding-Corning
Silt loam	Alamo-Fiddymment
Variable	Xerofluvents

Source: Soil Survey Staff, Natural Resources Conservation Service (USDA-NRCS). 2008.

Note:

¹ Soil textures provided in order of prevalence

²The soil classifications listed in this table account for 95 percent of the total area of Zone 5. The remaining 5 percent of the area is covered by eight additional classes.

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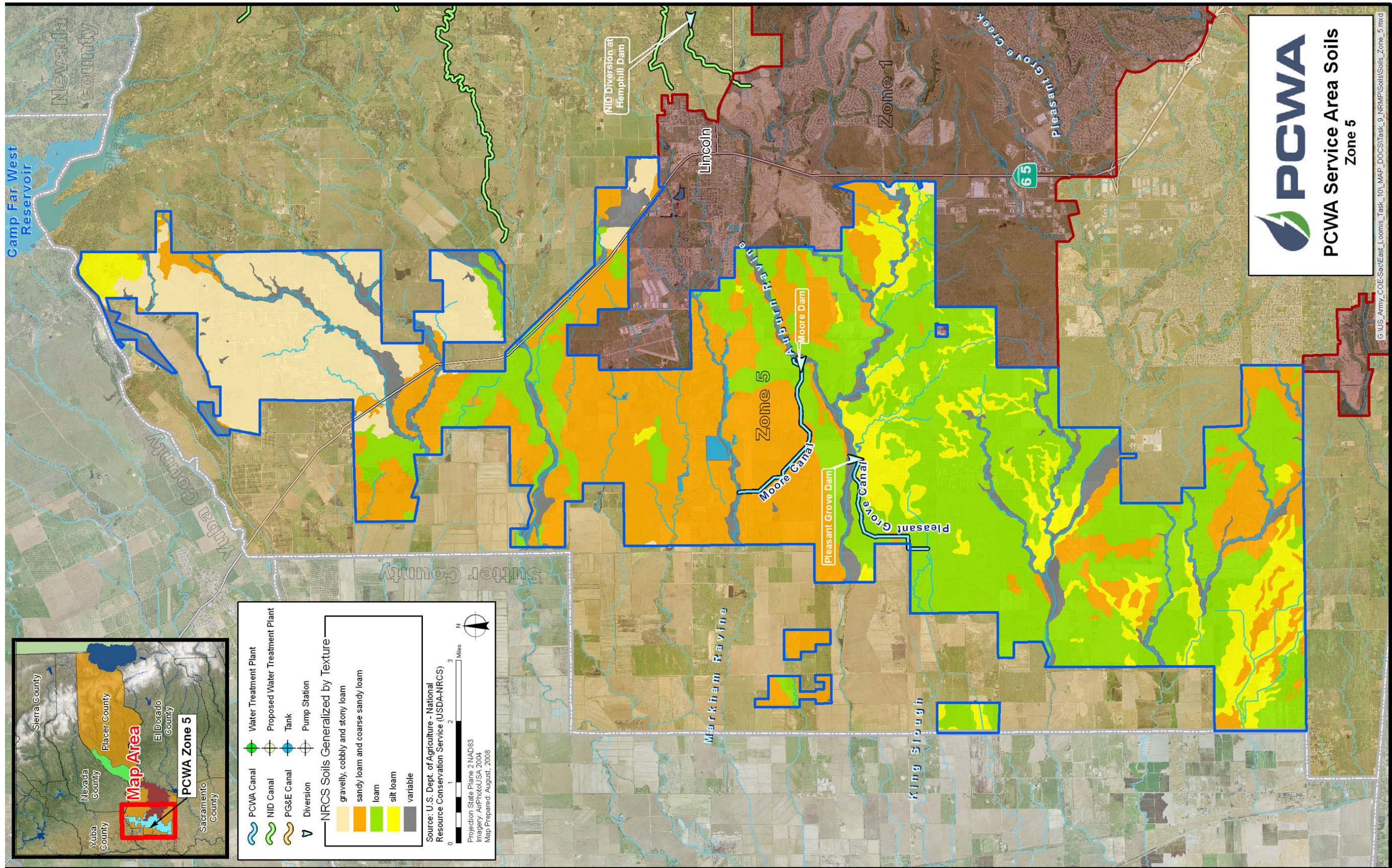


FIGURE 3-98
ZONE 5 SOILS MAP

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3.3 BIOLOGICAL RESOURCES SETTING

The following sections describe terrestrial and aquatic habitat and species within the PCWA raw water distribution system area during routine canal operations.

3.3.1 Terrestrial Habitat and Species

Habitat types in the study area vary in structure and composition throughout the study area. The study area ranges from Lake Alta in the Sierra Nevada foothills at an elevation greater than 3,000 feet msl down to nearly sea level at the western boundary of Zone 3, approximately 50 miles to the southwest. In general, forested habitat types are more common in the higher elevations in the eastern portions of Zone 3. Moving west through Zones 1 and 5, agricultural, urban (including rural residential), and herbaceous habitat types become more common. The following sections describe habitats in the areas that may be directly or indirectly affected by O&M activities. Refer to **Section 3.1** for a description of habitat types, including discussions of associated species.

3.3.1.1 Zone 3

Habitat types along canals in Zone 3 (primarily Boardman Canal) are generally forested, with montane hardwood being the most common (**Figure 3-99**). Douglas-fir and ponderosa pine habitats also frequently occur. Less common habitats include urban (forested and rural residential) and annual grassland.

Reservoirs in Zone 3 that could be directly affected by O&M activities include Lake Alta, Lake Theodore, and Lake Arthur. Lake Alta is located within Sierra Nevada montane forest habitat dominated by Douglas-fir. Oaks and incense cedar also occur in the canopy. Habitat surrounding Lake Theodore is mapped as an urban, oak woodland, and annual grassland. The area around Lake Arthur is mapped as oak woodland, montane hardwood, and montane hardwood conifer.

Canyon Creek traverses a variety of habitats, predominately montane hardwood, montane hardwood conifer, ponderosa pine, urban, and barren.

3.3.1.2 Zone 1

Zone 1 contains the largest number and extent of canals in the study area. Canals traverse a number of different habitat types (**Figures 3-100** and **3-101**). Urban habitats are the most common along canals, specifically rural residential, suburban, and forested urban areas. Forested habitat types are also very common and are largely dominated by oaks. Other less common habitat types include wetlands, agricultural areas, and chaparral.

Five reservoirs have been identified in Zone 1 that may be directly impacted by O&M activities. McCrary Reservoir occurs in a rural residential area. Mammoth Reservoir is surrounded by several habitat types including rural residential, rural residential forested, annual grassland, and agricultural. Clover Valley Reservoir occurs in an oak woodland area, with valley foothill riparian forests bordering the Antelope Canal, which drains into and out of the reservoir. Caperton Reservoir is bordered by rural residential, oak woodland, and annual grassland habitat types. Whitney Reservoir is bordered by oak savannah and oak woodland habitats.

Auburn Ravine in Zone 1 lies within the City of Lincoln. In this area, Auburn Ravine is predominately forested, composed of mature trees with canopy cover generally more than 50 percent. Tree species include Fremont cottonwood, Oregon ash, and willow (Placer County Planning Department 2002).

3.3.1.3 Zone 5

Two canals that could be affected by O&M activities fall within Zone 5: Pleasant Grove Canal and Moore Canal. Habitat types along these canals are primarily disturbed, agricultural lands, generally grasslands and croplands, including rice fields (**Figure 3-102**). Some grassland areas adjacent to these canals have been identified as containing vernal pool complexes.

Auburn Ravine in Zone 5 is predominately forested and supports Fremont cottonwood, Oregon ash, and willow. The eastern portion of Auburn Ravine in Zone 5 is more densely forested, with canopy cover generally greater than 50 percent. Canopy cover decreases to less than 50 percent in the western portion of Zone 5 (Placer County Planning Department 2002).

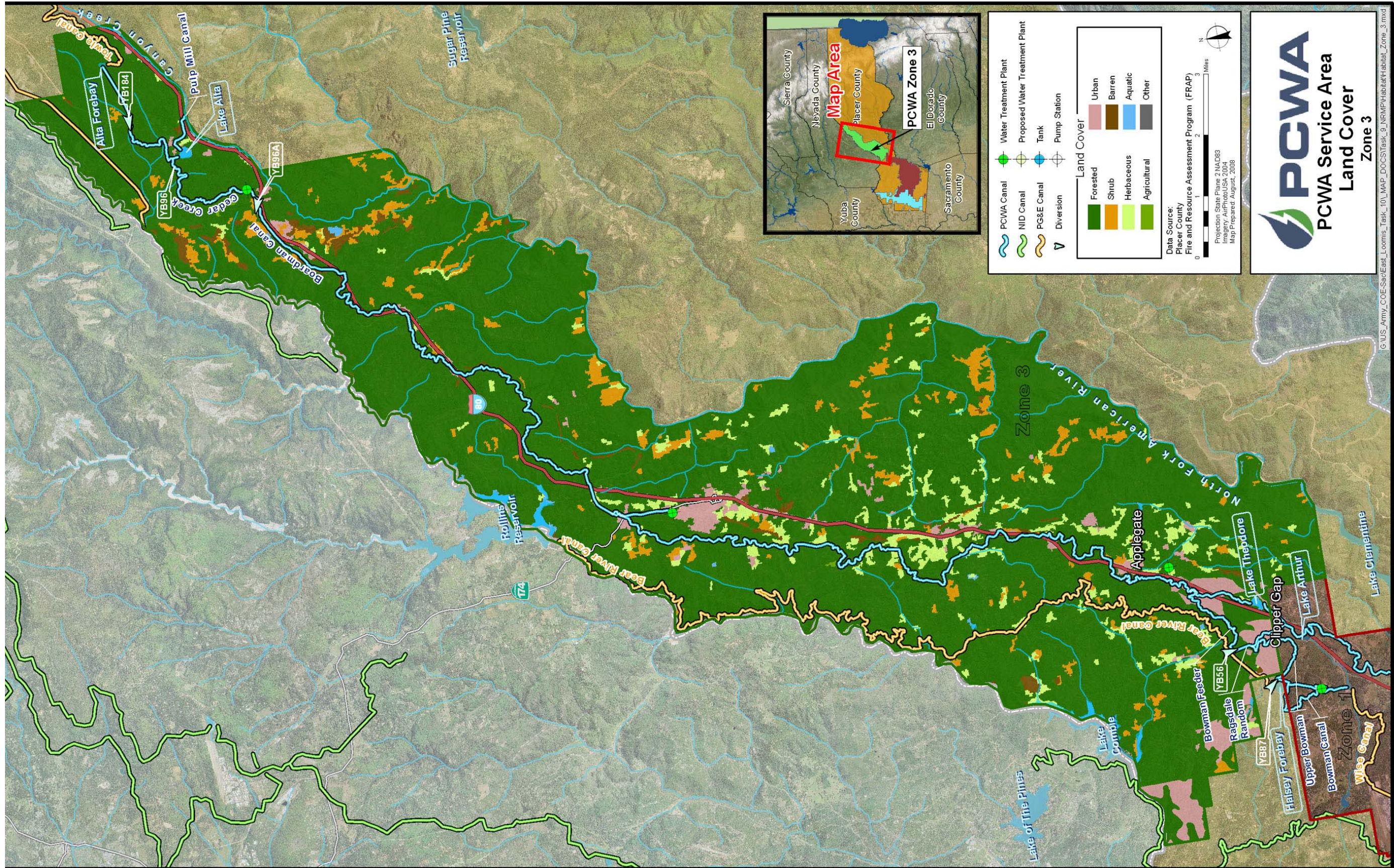


FIGURE 3-99
 ZONE 3 LAND COVER TYPES

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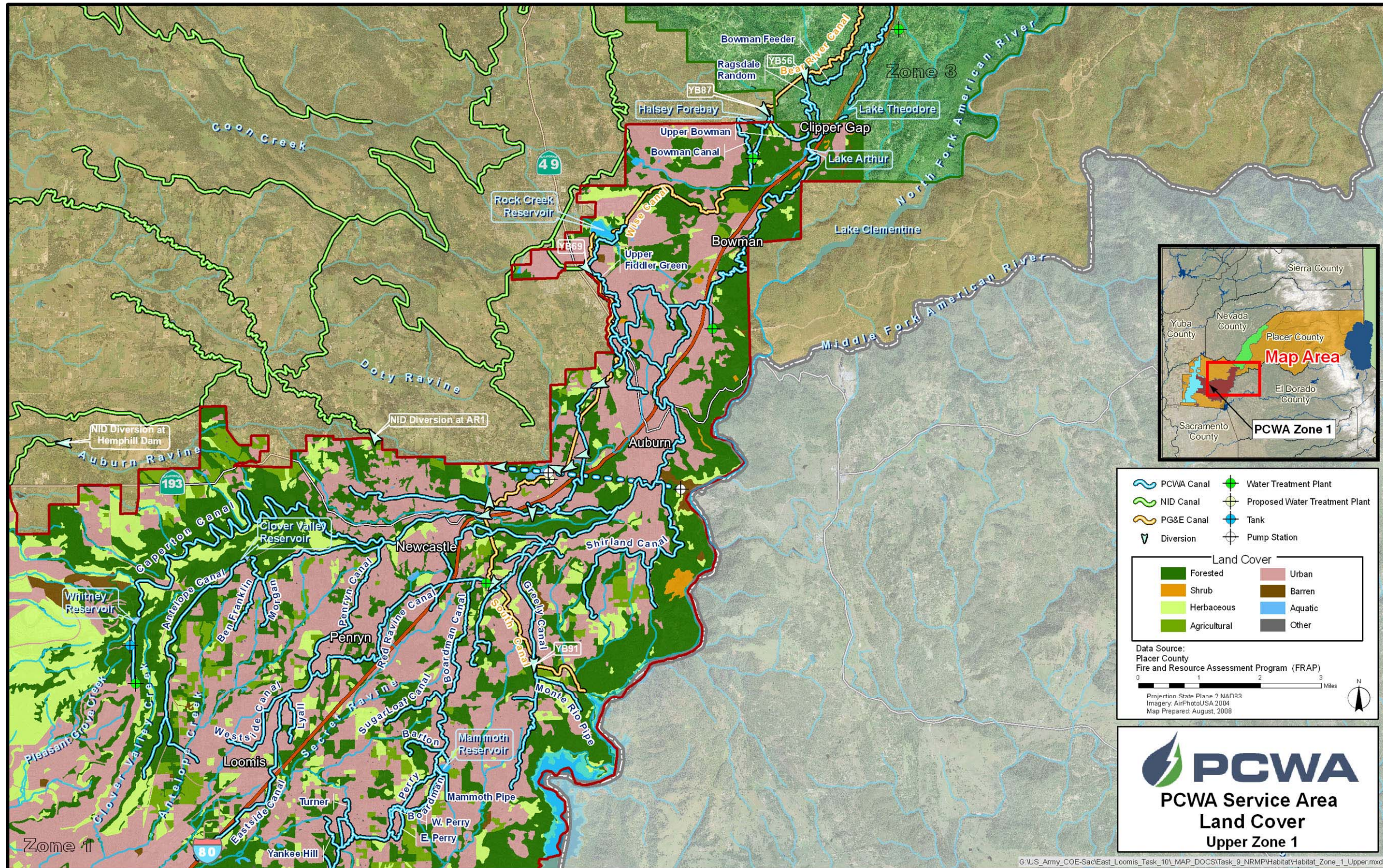


FIGURE 3-100
UPPER ZONE 1 LAND COVER TYPES

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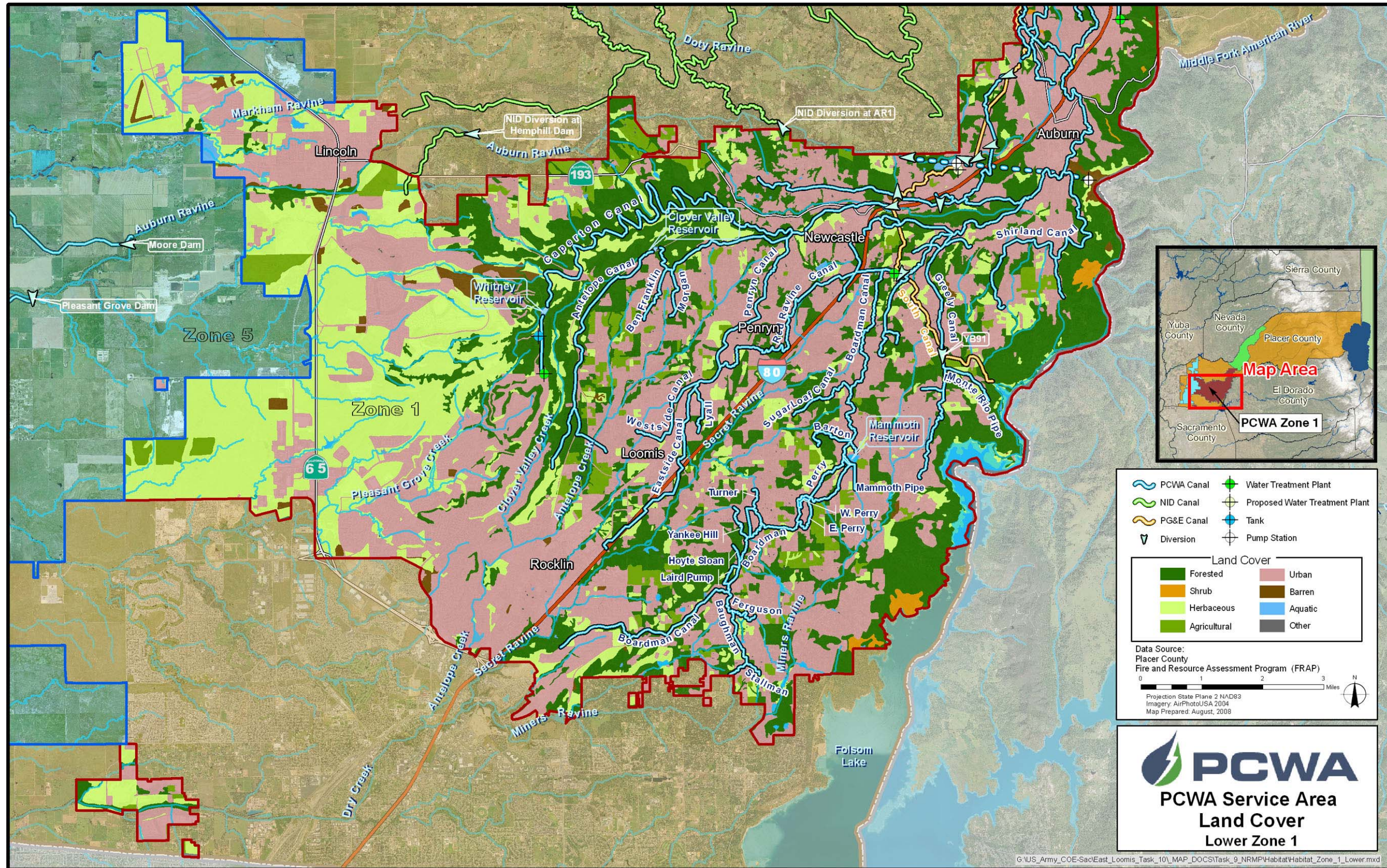


FIGURE 3-101
LOWER ZONE 1 LAND COVER TYPES

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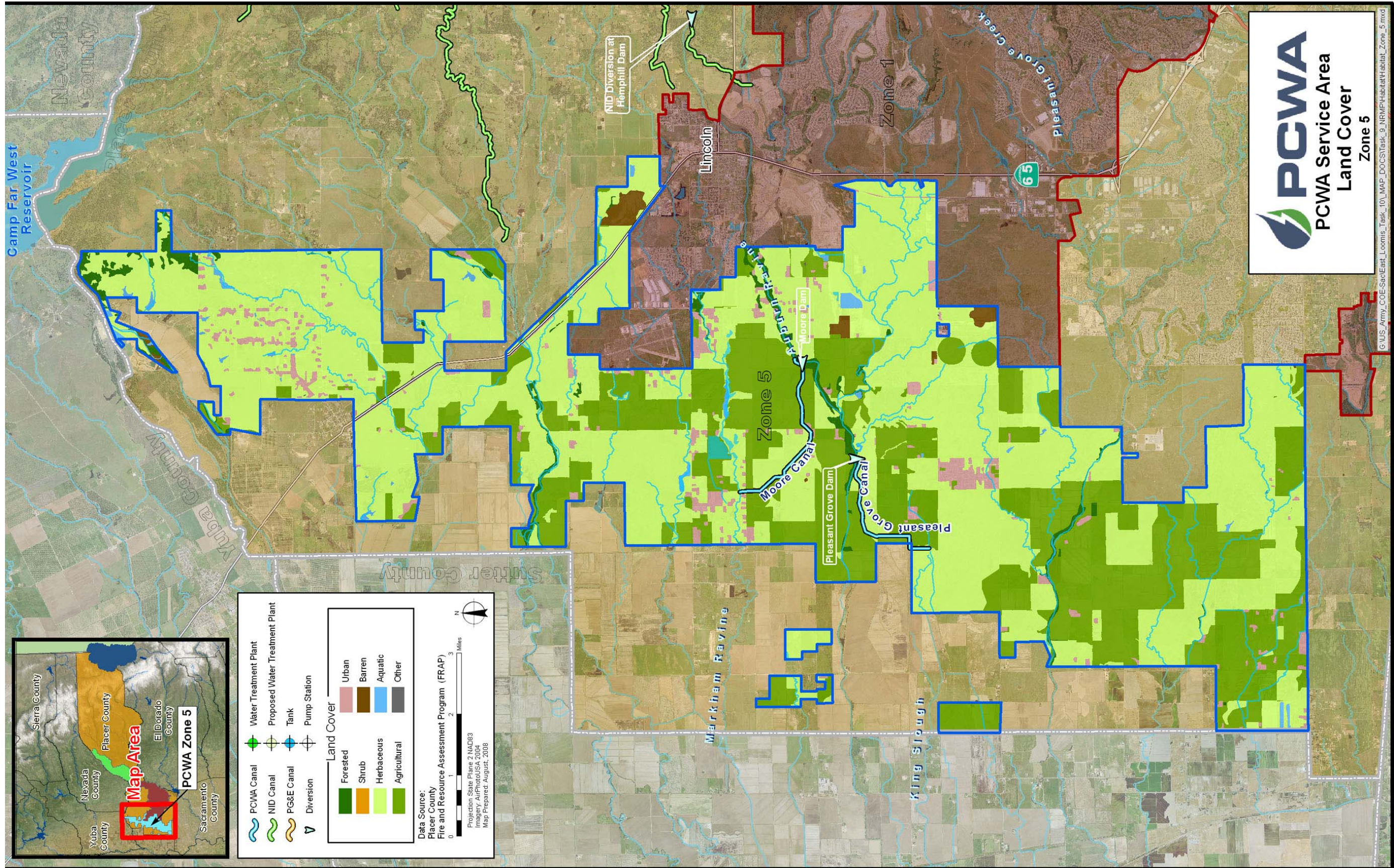


FIGURE 3-102
 ZONE 5 LAND COVER TYPES

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3.3.2 Aquatic Habitat and Species

Studies in Zones 1, 3, and 5 of the PCWA regarding aquatic habitat conditions and species evaluations have primarily focused on fish communities, including anadromous fall-run Chinook salmon and Central Valley steelhead. Fish observed in the canal system by PCWA enter the canals from the PG&E reservoirs and canals that supply PCWA, and include brown trout (*Salmo trutta*), rainbow trout (*Oncorhynchus mykiss*), catfish (*Ictalurus* or *Ameiurus* sp.), Sacramento sucker (*Catostomus occidentalis*), and Sacramento pikeminnow (*Ptychocheilus grandis*) (PCWA 2004). The canals within PCWA's raw water distribution system, however, are not believed to provide consistent suitable habitat for these species.

3.3.2.1 Zone 3

Although no substantial data was found on aquatic habitat and species conditions specific to Canyon Creek, the creek may include aquatic habit and species common to Sierra Nevada montane hardwood streams. Canyon Creek is at approximately 3,543 feet msl in a relatively rural area composed of hiking trails and campgrounds. Several large dams located downstream (Nimbus and Folsom dams on the Lower American River) prohibit potential access to Canyon Creek by Chinook salmon or steelhead. Fish observed in the North Fork American River would likely be found in Canyon Creek, such as the rainbow trout, riffle sculpin, Sacramento sucker, and speckled dace. Nonnative brown trout may also be found in Canyon Creek. The elevation of the creek is too high for fish such as pikeminnow to be present.

3.3.2.2 Zone 1

Unregulated outlet releases and seepage along the canal system may contribute to flows in natural watercourses in the basin. Secret Ravine and Miners Ravine are recognized by DFG as the primary production areas in the Dry Creek drainage for fall-run Chinook salmon and Central Valley steelhead (DFG 2001). In the Dry Creek watershed, these ravines appear to be especially important for spawning and rearing of these anadromous fishes (DFG 2001).

Auburn Ravine Watershed

The artificially high flows in Auburn Ravine during summer months due to water supply conveyances from PCWA, PG&E, and NID support more aquatic habitat than would be maintained under natural hydrologic conditions (Placer County Planning Department 2002). Portions of Auburn Ravine are designated as Critical Habitat for Central Valley steelhead (70 Code of Federal Regulations (CFR) 52488, September 2, 2005). Efforts are currently underway to improve habitat conditions in Auburn Ravine for salmonids and other native fishes.

Auburn Ravine's characteristics dramatically vary between its headwaters and the East Side Canal. Fall-run Chinook salmon and Central Valley steelhead spawn and rear in upstream reaches (between its headwaters at the City of Auburn to the City of Lincoln), but the quality of migration habitat for salmonids has been substantially reduced by beaver dams, numerous water diversions, and their associated diversion structures (Placer County Planning Department 2002). On behalf of PCWA, South Sutter District installs two seasonal diversion dams in Auburn

Ravine, Moore Dam and Pleasant Grove Dam, where flows are diverted to the Moore and Pleasant Grove canals, respectively. NID Auburn Ravine 1 Dam is a year-round barrier to migration. Also, NID Hemphill Dam (a seasonal diversion dam) and NID gaging station impair migration of salmonids during most flow conditions. Since water deliveries to agricultural water users are curtailed during the fall, generally before fall-run Chinook salmon attempt to migrate upstream to spawn, the depth of water in the stream channel below some flow-control structures is often insufficient to facilitate adult fish passage.

Table 3-12 lists fish species reported to be present in Auburn Ravine. American River and Feather River hatchery-raised juvenile fall- and spring-run Chinook salmon have been released to Auburn Ravine infrequently since the 1980s. Typically, about 100,000 fall-run Chinook salmon from Nimbus Fish Hatchery were released to Auburn Ravine (Placer County Planning Department 2002, Barngrover pers. comm.), with 140,000 fall-run Chinook salmon released in Auburn Ravine during March 1998 (Placer County Planning Department 2002).

**TABLE 3-12
FISH SPECIES PRESENT IN AUBURN RAVINE**

Native		Introduced	
Common Name	Scientific Name	Common Name	Scientific Name
Chinook salmon	<i>Oncorhynchus tshawytscha</i>	Black bullhead	<i>Ameiurus melas</i>
Sacramento pikeminnow	<i>Ptychocheilus grandis</i>	Common carp	<i>Cyprinus carpio</i>
Steelhead	<i>Oncorhynchus mykiss</i>	Green sunfish	<i>Lepomis cyanellus</i>
Bluegill	<i>Lepomis macrochirus</i>	Largemouth bass	<i>Micropterus</i> spp.
Spreckled dace	<i>Rhinichthys osculus</i>	Pumpkin seed	<i>Lepomis gibbosus</i>
Sacramento sucker	<i>Catostomus occidentalis</i>	Redear sunfish	<i>Lepomis microlophus</i>
California roach	<i>Hesperoleucus symmetricus</i> ,	Golden shiner	<i>Notemigonus crysoleucas</i>
Lamprey spp	<i>Lamperta</i> spp.	Mosquitofish	<i>Gambusia affinis</i>
Prickly Sculpin	<i>Cottus asper</i>	Brown trout	<i>Salmo trutta</i>
Hardhead	<i>Mylopharodon conocephalus</i>		

Source: Placer County Planning Department 2003, 2005b

Fish communities and associated aquatic habitat were assessed in the Auburn Ravine by DFG in fall 2004 and spring 2005. Fish community IBI scores for Auburn Ravine were approximately 80 out of 100 (Titus et al. 2005). The gross ecological health of Auburn Ravine was rated “good to very good” based on its IBI score (Titus et al. 2005).

Summary results of BMI population analyses and B-IBI results, along with physical habitat characteristics during BMI analyses, are shown in **Tables 3-13** and **3-14** respectively. Detailed results of BMI population and B-IBI analyses at Auburn Ravine below Auburn Ravine Tunnel Outlet are provided in **Appendix A**. **Figure 3-103** compares B-IBI results for Auburn Ravine to other stream sites evaluated by DCC in the PCWA service area for this NRMP in 2007, and sites previously evaluated by DCC from 2000 through 2006.

Based on BMI and B-IBI analyses described in **Appendix A**, aquatic habitat quality at Auburn Ravine below Auburn Ravine Tunnel Outlet appeared to better than Miners Ravine below Sierra

College Boulevard, as shown in **Table 3-13**. The Auburn Ravine below the Auburn Ravine Tunnel Outlet had a B-IBI score of 41, which is considered to be “fair,” as shown in **Figure 3-103**.

**TABLE 3-13
BENTHIC INDEX OF BIOTIC INTEGRITY FOR SITES AT AUBURN RAVINE, SECRET RAVINE, AND MINERS RAVINE**

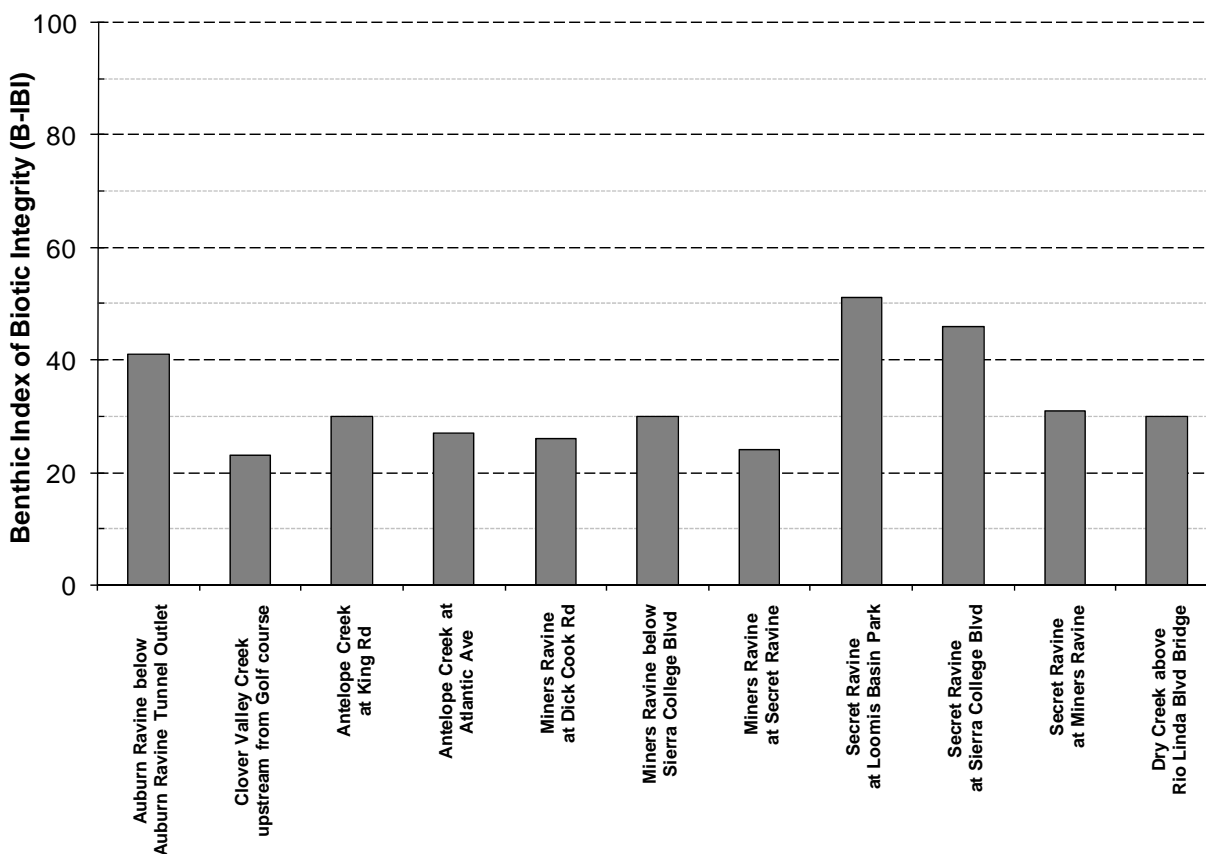
	Auburn Ravine below Auburn Ravine Tunnel Outlet	Secret Ravine at Loomis Basin Park	Miners Ravine below Sierra College Blvd
Coleoptera taxa	4	4	0
EPT taxa	5	6	5
Predator Taxa	2	5	4
Collectors (%)	5	5	4
Intolerant (%)	1	2	1
Non-Insect (%)	4	7	2
Tolerant (%)	8	7	5
Total	29	36	21
B-IBI Score	41	51	30
Ranking	Fair	Fair	Poor

**TABLE 3-14
PHYSICAL HABITAT SCORES FOR BENTHIC MACROINVERTEBRATE ANALYSES AT AUBURN RAVINE, SECRET RAVINE, AND MINERS RAVINE**

	Auburn Ravine below Auburn Ravine Tunnel Outlet	Secret Ravine at Loomis Basin Park	Miners Ravine below Sierra College Blvd
Flow (cfs)	9.6	3.0	1.7
Temperature (°F)	57.4	55.8	55.2
Habitat Types, % Riffle	41	15	11
Slope (average %)	2.5	0.5	1.4
Instream Habitat ¹	14	11	5
Sediment Deposition ¹	19	11	5
Channel Alteration ¹	15	11	18

Note:

¹Score is out of possible 20.



**FIGURE 3-103
COMPARISON OF BENTHIC INDEX OF BIOTIC INTEGRITY SCORES AT STREAM SITES IN THE PCWA SERVICE AREA**

As for physical habitat, there is a high percentage of riffle habitat, and the cobble and gravel substrate within the segment sampled had very little sediment, as shown in **Table 3-14**. Detailed results of physical habitat analyses at Auburn Ravine below Auburn Ravine Tunnel Outlet are provided in **Appendix A**.

Clover Valley Creek Watershed

Studies of aquatic habitat and species conditions in Clover Valley Creek are very limited. Clover Valley Creek is not included in the designated Critical Habitat for Central Valley steelhead (Placer County 2006). An impassable culvert blocks access of salmonids to Clover Valley Creek (Placer and Sacramento Counties 2003). The lack of deep pools and clean riffle habitat limits the potential for biodiversity, which tends to limit food and preferred habitat for rearing salmonids. The potential for salmonid rearing is considered to exist in lower portions of the creek.

In general, substrate and habitat conditions in Clover Valley Creek are considered unsuitable for rearing salmonids (Placer County 2006). Common substrate in the creek consists of fine sediments (sand and silt) with very little gravel and cobbles, particularly in downstream areas. High sediment loads and sediment deposition, degraded water quality, invasive species, and lack

of riparian vegetation contribute to degraded aquatic habitat conditions in Clover Valley Creek. Lower Clover Valley Creek is highly channelized and sometimes impounded.

Although suitable habitat conditions for some salmonid life stages may exist in Clover Valley Creek, there are many significant barriers to upstream passage of anadromous salmonids (City of Rocklin 2006), including an impassable culvert just upstream of its confluence with Antelope Creek (Placer and Sacramento Counties 2003). The Argonaut Bridge crossing, an impoundment structure at Cimarron Court, and an instream impoundment downstream of Midas Way and Rawhide Drive Bridge are all barriers along Clover Valley Creek (City of Rocklin 2006). The total flow of the creek passes through a 30-foot-long culvert, approximately 2 feet in height, and about 3 feet wide. On the downstream side, the culvert hangs 2 feet over the streambed. Migrating salmonids reportedly cannot swim through the flow from the culvert because of its relatively small opening and high flow velocity (Placer and Sacramento Counties 2003).

Because Clover Valley Creek is a tributary to Antelope Creek, fish species present in Clover Valley Creek are likely comparable to the fish species present in Antelope Creek, described below. An Aquatic Habitat Survey and Fisheries Assessment was conducted by ECORP Consulting, Inc. on Clover Valley Creek on June 16 and 19, 2006 (ECORP 2006). The fish community in Clover Valley Creek was found to be dominated by native minnow and hitch (*Lavinia exilicauda*), particularly in the upper portion of the creek. The nonnative western mosquitofish (*Gambusia affinis*) and green sunfish (*Lepomis cyanellus*) were observed in the lower portions of the creek. No salmonids were observed during the survey. The native Sacramento sucker was also found along Clover Valley Creek. Hitch and Sacramento sucker both prefer low-gradient streams with slow water velocities and sandy to gravel substrates, as do green sunfish and mosquitofish. All four species are tolerant of the warm water temperatures characteristic of Clover Valley Creek, particularly during summer and fall.

Based on BMI analyses conducted by DCC (**Figure 3-103**), the site at Clover Valley Creek upstream from the Sunset Whitney Country Club on Midas Avenue in Rocklin had a B-IBI score of 23, which is considered to be “poor,” likely due to presence of organisms tolerant to water quality pollutants and a general lack of benthic macroinvertebrate species diversity.

Antelope Creek Watershed

Antelope Creek is not as well studied as other headwater tributaries of Dry Creek (Secret Ravine and Miners Ravine). Although fall-run Chinook have been periodically documented over the past 40 years to use parts of the watershed for spawning, there is no reliable data on whether steelhead are currently present in the watershed. Similar to Clover Valley Creek, Antelope Creek is not designated as critical habitat for Central Valley steelhead.

Aquatic habitat in Antelope Creek is characterized as low in diversity, generally consisting of flatwater (i.e., shallow run and shallow glide) habitat (Placer and Sacramento Counties 2003). Use of Antelope Creek by anadromous salmonids is generally considered to be limited to occasional stray adults during years of at least moderate streamflow during the migration period. Two potential spawning areas have been identified in Antelope Creek, but the associated habitat is generally not favorable to salmonids (Placer and Sacramento Counties 2003). Juvenile

salmonid habitat is generally limited to shallow pool habitat during years of at least moderate streamflow. Low streamflows in Antelope Creek could impede adult anadromous fish passage during critical periods of the year (Sierra Business Council 2003).

Antelope creek is located in a primarily urban and suburban area. Past and ongoing construction activities adjacent to the creek have resulted in significant upland disturbance and sediment contribution to the stream. Accumulated sediment is common in the lower portion of Antelope Creek. Several portions of the creek are incised (City of Roseville 2005), and vulnerable to erosion. Accumulated sediments, such as sand, small cobbles, and exposed granite, are common in the lower portion of Antelope Creek (Placer and Sacramento Counties 2003). A spawning gravel study conducted by Jones & Stokes in 2004 found that 77 percent of substrate in Antelope Creek was fine sediment, in which fish eggs and larvae would unlikely survive (Placer County Planning Department 2005b).

With the exceptions of wide variations in pH, high nutrient levels, and observed copper concentrations in Antelope Creek, most of the watershed's water quality conditions are capable of supporting anadromous fish year-round (Placer and Sacramento Counties 2003). Water temperatures measured in the creek show that approximately 25 to 50 percent of the channel length is suitable for summer rearing for steelhead (**Table 3-15**). However, some sites along the creek have water temperatures too high for salmonid egg incubations and juvenile rearing (Placer and Sacramento Counties 2003).

TABLE 3-15
WATER TEMPERATURE CRITERIA FOR CHINOOK SALMON AND STEELHEAD

Life Stage	Chinook Salmon	Steelhead
Adult Migration	Less than 57°F	Less than 52°F
Spawning	Less than 57°F	Less than 54°F
Incubation	Less than 55°F	Less than 54°F
Juvenile Rearing	Less than 61°F	Less than 65°F

Sources: A. A. Rich and Associates 2007; Bell 1990; DFG 2007 a and 2007b; Marine 1992; McCullough et al. 2001; NMFS 2002 and 2003; Reiser and Bjornn 1979;

Riparian development has also affected instream habitat, and is generally characterized as poor to fair for aquatic resources (Placer and Sacramento Counties 2003). Large riparian trees are sparse and the floodplain is constrained by the Union Pacific railroad tracks, Interstate 80 to the east, and an old landfill to the west (City of Roseville 2005). The riparian corridor of Antelope Creek consists largely of overhanging vegetation, such as Himalayan blackberry, and remnant oak woodland. Nonnative and native grassland uplands are present, as are wetland swales.

Rock dams, beaver dams, diversion dams, and culverts provide barriers to fish passage (Placer and Sacramento Counties 2003). Asphalt-bottomed culverts underneath Sunset Boulevard and a dam at a large wetlands complex upstream of the railroad bridge in Rocklin are particular fish passage concerns (Placer and Sacramento Counties 2003).

Fish species present in Antelope Creek are provided in **Table 3-16**.

**TABLE 3-16
FISH SPECIES PRESENT IN ANTELOPE CREEK**

Native		Introduced	
Common Name	Scientific Name	Common Name	Scientific Name
Fall-run Chinook salmon	Oncorhynchus tshawytscha	Black bullhead	Ameiurus melas
Hitch	Oncorhynchus mykiss	Brown bullhead	Ameiurus nebulosus
Sacramento sucker	Lavinia exilicauda	Common carp	Cyprinus carpio
Sacramento pikeminnow	Catostomus occidentalis	Mosquitofish	Gambusia affinis
Speckled dace	Ptychocheilus grandis	Green sunfish	Lepomis cyanellus
	Rhinichthys osculus	Golden shiner	Notemigonus crysoleucas
			Micropterus spp.

Source: Sierra Business Council, 2003

Note: A general siting of both Trout and Bass was reported during the 1959 DFG survey, but specific species were not identified (DFG, 1959)

The BMI community observed at Antelope Creek during previous studies was primarily composed of organisms that are moderately to highly tolerant of impaired water quality conditions. BMI analyses were conducted at two sites (King Road and Atlantic Avenue) along the Antelope Creek by the DCC in 2000. As shown in **Figure 3-103**, the I-IBI score for the upstream site at King Road was 30, and the score for the downstream site at Atlantic Avenue was 27, both of which are considered to be “poor.” The limited aquatic insect populations found resulted in the “poor” rating at both sites. The data also indicate a high percentage of pollutant-tolerant organisms, with few BMI taxa associated with cleaner waters (Placer and Sacramento Counties 2003). The combination of high seasonal flow fluctuations, water quality conditions, and high sediment loads in the creek may have contributed to the observed results (Placer and Sacramento Counties 2003).

Secret Ravine Watershed

Secret Ravine is a major tributary of Dry Creek, and is designated as Critical Habitat for Central Valley steelhead (70 CFR 52488, September 2, 2005). Secret Ravine is said to be the most productive stream within the Dry Creek watershed for Central Valley fall-run Chinook salmon and Central Valley steelhead, despite urban encroachment and other human-influenced impacts (Fields 1999). Surveys conducted for steelhead in the Dry Creek watershed have shown that most of the suitable spawning and rearing habitat occurs in Secret Ravine (Placer County Planning Department 2005b).

Both fall-run Chinook salmon and steelhead have been documented spawning in Secret Ravine (Placer County Planning Department 2005b). Based on a 2005 survey, estimated spawning habitat area for spawning in Secret Ravine totaled 1,175 square feet, with the capacity for 21 potential redds (nests) for steelhead and 12 potential redds for Chinook salmon (Placer County Planning Department 2005b). Since the late 1990s, an average of 160 adult fish per year have been observed in Secret Ravine (Placer and Sacramento Counties 2003). Juvenile steelhead have

been observed rearing in Secret Ravine near the headwaters around Gilardi Road and downstream to the Brace Road crossing (Sierra Business Council 2003).

Water temperatures in Secret Ravine have been documented as warmer than ideal and suitable ranges for steelhead rearing (**Table 3-15**), which would have a particular effect on juvenile steelhead (Placer County Planning Department 2005b). Water temperatures measured at Gilardi Road during October 2003 to March 2004 (incubation period) were generally lower than criteria identified in **Table 3-15** for sensitive life stages (Sierra Business Council 2003b). Rearing habitat is limited around Sierra College because of high water temperatures and limited thermal refugia are present in the summer. Chinook salmon, however, typically leave within a few months of hatching.

The 2004 spawning gravel study found the amount of fines measured to range from 51 to 82 percent for Secret Ravine (Placer County Planning Department 2005). Adult Chinook salmon and steelhead clean fine sediments from the gravel with their caudal fins during spawning, and as long as fine sediment does not overwhelm the redd, egg and larvae survival is possible.

Well-established beaver dams, from 0.6 to 1.2 meters (2 to 4 feet), were observed during salmonid spawning gravel surveys in Secret Ravine (Placer County Planning Department 2005b). If these observed dams remain intact during the salmonid migration period, then they could represent significant passage impediments or complete passage barriers. Steelhead, however, tend to migrate in winter months when flows are higher, and obstacles are less of a factor to passage. There is also at least one permanent barrier created by a pipeline, and several utility pipe crossings that may be additional obstacles to fish migration (Placer and Sacramento Counties 2003).

Additional fish species that can be found in Secret Ravine (mostly the lower reaches) are listed in **Table 3-17**. The impact of introduced fishes on fall-run Chinook salmon and steelhead in Secret Ravine is not known. However, bass and sunfish (especially spotted bass) are highly predatory species and could be expected to opportunistically feed on rearing and emigrating juvenile Chinook salmon and steelhead. The degree to which this occurs in Secret Ravine, however, is unknown.

**TABLE 3-17
FISH SPECIES PRESENT IN SECRET RAVINE AND MINERS RAVINE**

Native		Introduced	
Common Name	Scientific Name	Common Name	Scientific Name
Sacramento sucker	Catostomus occidentalis	White catfish	Ameiurus catus
Roach	Hesperoleucus symmetricus	Black bullhead	Ameiurus melas
Pacific lamprey	Lampetra tridentate	Brown bullhead	Ameiurus nebulosus
Hitch	Lavinia exilicauda	Common carp	Cyprinus carpio
Hardhead	Mylopharodon conocephalus	Mosquitofish	Gambusia affinis
Steelhead	Oncorhynchus mykiss	Green sunfish	Lepomis cyanellus
Fall-run Chinook salmon	Oncorhynchus tshawytscha	Warmouth	Lepomis gulosus
Sacramento pikeminnow	Ptychocheilus grandis	Bluegill	Lepomis macrochirus
		Redear sunfish	Lepomis microlophus
		Smallmouth bass	Micropterus dolomieu
		Spotted bass	Micropterus punctulatus
		Largemouth bass	Micropterus salmoides
		Fathead minnow	Pimephales promelas
		White crappie	Pomoxis annularis

Source: DFG 2003.

Fish communities and associated aquatic habitat were assessed in the Secret Ravine by DFG in fall 2004 and spring 2005. Although not as high as Auburn Ravine, both fish IBI scores for Secret Ravine were fairly high, with scores of approximately 75 out of 100 (Titus et al. 2005). The gross ecological health of Secret Ravine was rated “good to very good” by Titus et al. (2005) based on its IBI score.

BMI surveys have been performed in Secret Ravine, including studies by de Barruel et al. (2003), Fields (1999), and DCC (data collected in 1997, 1998, and 2000 through 2006). Although BMI populations reflecting pollution and high water temperatures within Secret Ravine were found in all three studies, overall results suggest that Secret Ravine provides the highest quality fisheries habitat in the Dry Creek watershed (Placer and Sacramento Counties 2003).

Data studies with upstream and downstream sites found more pollutant-tolerant organisms near the confluence with Miners Ravine than at upstream locations. As shown in **Table 3-13** and **Figure 3-103**, the 2007 DCC BMI study found the site at Secret Ravine at Loomis Basin Park to have a B-IBI score of 51, which is considered “fair” (Titus et al. 2005). This score was higher than any previous score recorded for BMI sites in the Dry Creek watershed. During this BMI assessment, physical habitat at Secret Ravine at Loomis Basin Park exhibited low slopes and low flow velocities, and a fairly low percentage of riffle habitat compared to Auburn Ravine (**Table 3-14**). However instream habitat was fairly high for these conditions, and was measured at 11 out of 20. Sediment deposition and channel alteration results were lower at this site than at Auburn Ravine. Detailed results of BMI population, B-IBI, and physical habitat analyses for Secret Ravine at Loomis Basin Park are provided in **Appendix A**.

DCC also conducted BMI sampling in 2000 and 2001 at two downstream locations along the creek: Secret Ravine at Sierra College Boulevard and Secret Ravine at its confluence with Miners Ravine. The Sierra College Boulevard site received a B-IBI score of 46, which is considered “fair,” and the Secret Ravine at Miners Ravine received a rating of 31, which is considered “poor.” Results from these studies indicated a high percentage of pollutant-tolerant organisms with almost no taxa associated with cleaner waters. A BMI survey was conducted at Secret Ravine just downstream from Sierra College (upstream site) and at Secret Ravine just upstream from its confluence with Miners Ravine (downstream site) (de Barruel and West 2003). In this study, the percentage of pollutant-tolerant BMI organisms at the downstream site were found to be significantly higher than at the upstream site, indicating higher perturbation and pollution at the downstream site (de Barruel and West 2003).

Miners Ravine Watershed

Like Secret Ravine, Miners Ravine is a major tributary of Dry Creek, and is also designated as Critical Habitat for Central Valley steelhead (70 CFR 52488, September 2, 2005). Both fall-run Chinook salmon and steelhead have been observed spawning in Miners Ravine (DWR 2002). In the 1950s, up to 100 adult Chinook salmon were estimated to occur in Miners Ravine; however, there is little current information regarding the spawner abundance of Chinook salmon in Miners Ravine, though the Dry Creek Conservancy conducts spawning surveys on up to several days per season (Bates pers. com). During some years in the 1980s and 1990s, DFG planted as many as 100,000 juvenile Chinook salmon from the Feather River hatchery in the lower reaches of Miners Ravine. Although mostly inaccessible to salmonids, aquatic habitat along Miners Ravine was observed to be of highest quality upstream of Cottonwood Dam, near Dick Cook Road, where there is a high canopy cover, deep pools, and higher concentrations of spawning gravel (DWR 2002).

Summer water temperatures in Miners Ravine have been documented as higher than the suitable ranges for steelhead rearing (**Table 3-15**). However, deep pools and cool groundwater accretion could provide thermal refugia for juvenile steelhead. Water temperature data was not recorded during the periods when Chinook salmon would be present in Miners Ravine.

Livestock grazing and riparian vegetation removal have caused increased erosion along banks. Substrate found in Miners Ravine was dominated by fines, such as silt, and clay (DWR 2002), with fine sediment measured between 50 and 75 percent. With the ability of adult Chinook salmon and steelhead to clean fine sediments from the gravel during spawning, egg and larvae survival is still possible if the fines are not reintroduced into the redd.

Many barriers in Miners Ravine reduce the quality of migration habitat. These barriers include six road crossings, one culvert, eight dams, and three natural barriers. Cottonwood Dam, built in the 1950s, is considered to be the uppermost limit to anadromous species in Miners Ravine, but steelhead may be able to pass during flood flows (Placer County Planning Department 2005a, Placer and Sacramento Counties 2003). Additionally, 80 beaver dams were observed in Miners Ravine in one survey (DWR 2002).

Miners Ravine is dominated by spotted bass, a predatory species. As described for Secret Ravine, introduced fishes, such as bass and sunfish, may opportunistically feed upon juvenile salmon and steelhead. Additional fish species that can be found in Miners Ravine (mostly in the lower reaches) are listed in **Table 3-17**.

Fish communities and associated aquatic habitat were assessed in the Miners Ravine by DFG in fall 2004 and spring 2005. Both IBI scores for Miners Ravine were relatively low compared to those of Auburn Ravine and Secret Ravine, with scores of approximately 53 out of 100 (Titus et al. 2005). The gross ecological health of Miners Ravine was rated “fair” based on its IBI score. This low score is due, in part, to the dominant presence of golden shiners (considered an environmentally tolerant species) in the upper reaches of Miners Ravine.

DCC conducted BMI investigations in Miners Ravine from 2000 to 2006 at sites upstream and downstream from the Placer County SMD No. 3 WWTP (DCC 2006). Results of these studies indicate more diversity and more sensitive macroinvertebrates in upstream reaches, and a high proportion of pollution-tolerant organisms farther downstream. Overall, the B-IBI scores at Miners Ravine were considered to be “poor,” with a score of about 26 at Miners Ravine at Dick Cook Road, 30 at Miners Ravine downstream from Sierra College Boulevard, and 24 at Miners Ravine at its confluence with Secret Ravine (**Figure 3-103**). The lack of aquatic habitat complexity and high sediment loads in the ravine also contribute to low B-IBI scores. The Miners Ravine site downstream of Sierra College Boulevard was assessed by DCC in 2007, during which physical habitat exhibited fairly low slopes and very low-flow velocities, as well as the lowest percentage of riffle habitat compared to Auburn Ravine and Secret Ravine (**Table 3-14**). Instream habitat was also the lowest of the three sites, and was measured at 5 out of 20, and channel alteration results exhibited the highest value, at 18 out of 20 (**Table 3-14**). Detailed results of BMI population, B-IBI, and physical habitat analyses for Miners Ravine below Sierra College Boulevard are provided in **Appendix A**.

3.3.2.3 Zone 5

As described earlier, portions of Auburn Ravine are designated as Critical Habitat for Central Valley steelhead (70 CFR 52488, September 2, 2005). Auburn Ravine, downstream from Highway 65, conveys water from the PCWA raw water distribution system to Zone 5 customers. The Zone 5 portion receives treated effluent from the City of Lincoln’s WWTP. Rice farms contribute return flows in this area as well.

Spawning gravels in the Auburn Ravine contain high levels of sediment. High erosion within this portion of the ravine is likely due to grazing, other land-use practices, and channel instability. The reaches of Auburn Ravine within Zone 5 have predominantly sandy and fine sediment, which makes egg and larvae survival difficult. As a result, there is minimal spawning habitat available to salmonids in Zone 5.

Riparian habitat varies along the Zone 5 portion of Auburn Ravine. Within Zone 5, Auburn Ravine is characterized as having primarily low levels of shade (Placer County Planning Department 2005b).

Barriers to salmonid migration exist along the Zone 5 portion of Auburn Ravine. Auburn Ravine is seasonally dammed by South Sutter Irrigation District on behalf of PCWA at two locations: Moore Dam and Pleasant Grove Dam. Auburn Ravine flows at Moore Dam are diverted to Moore Canal. Further downstream, flows are diverted from Auburn Ravine at the Pleasant Grove Dam to the Pleasant Grove Canal.

3.3.3 Special Status Species

Threatened and Endangered Species Critical Habitat designations in the study area, as well as CNDDDB records of occurrence, are shown in **Figures 3-104 to 3-107** (USFWS 2008, CNDDDB 2008). **Table 3-18** summarizes known special status species occurrences within Zones 3, 1, and 5 (CNDDDB 2008). PCWA canals, reservoirs, and conveyances in the study area cross a number of habitat types. Although these water bodies may traverse habitats that are used by special status species, O&M activities may not directly affect these habitats and/or species might not be present throughout the study area. Surveys should be conducted before O&M activities to determine which habitat types would be affected and whether special status species are present.

In addition to known species occurrences, a number of special status species have been identified as having the potential to occur. These are summarized in **Table 3-19**, along with their habitat preferences.

Special status species known to occur in the area that could be affected indirectly by impacts to hydrology, water quality, and/or sedimentation in Auburn Ravine, Clover Valley Creek, Antelope Creek, Secret Ravine, Miners Ravine, or connected downstream areas include Central Valley steelhead, fall-run Chinook salmon, western pond turtle, and foothill yellow-legged frog.

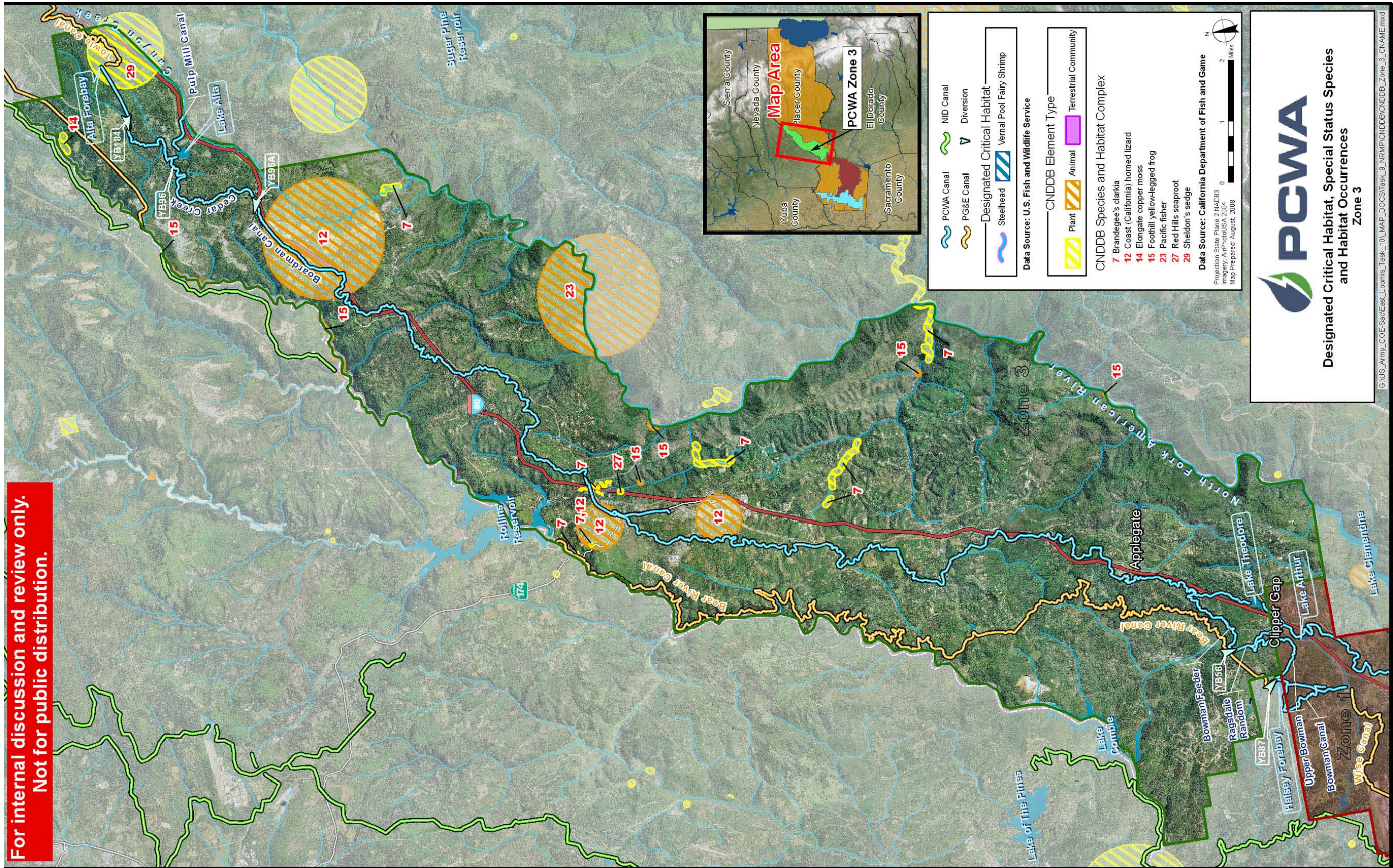


FIGURE 3-104
ZONE 3 DESIGNATED CRITICAL HABITAT, CALIFORNIA NATURAL DIVERSITY DATABASE SPECIAL STATUS SPECIES OCCURRENCES, AND HABITAT COMPLEXES

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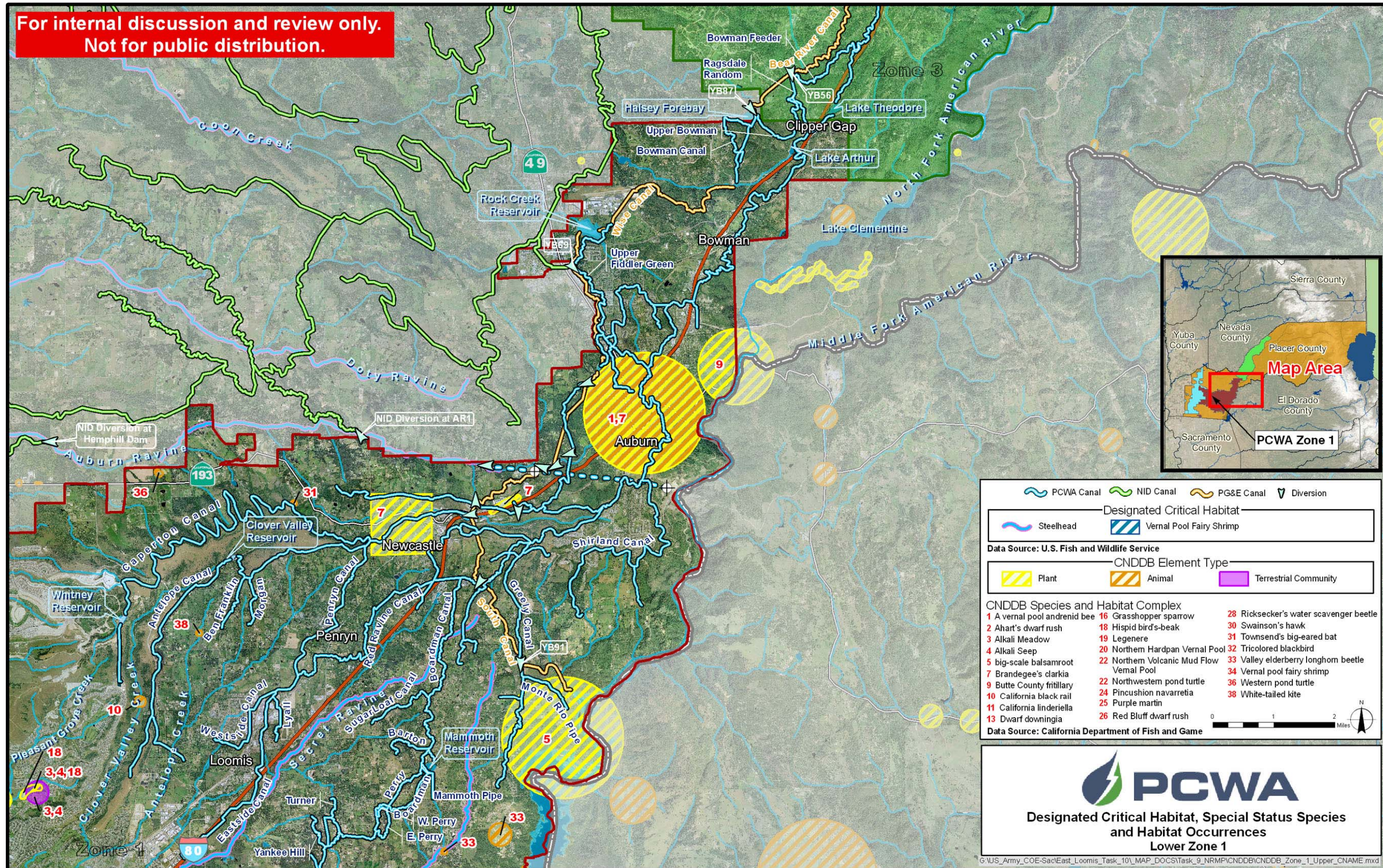


FIGURE 3-105

UPPER ZONE 1 DESIGNATED CRITICAL HABITAT, CALIFORNIA NATURAL DIVERSITY DATABASE SPECIAL STATUS SPECIES OCCURRENCES, AND HABITAT COMPLEXES

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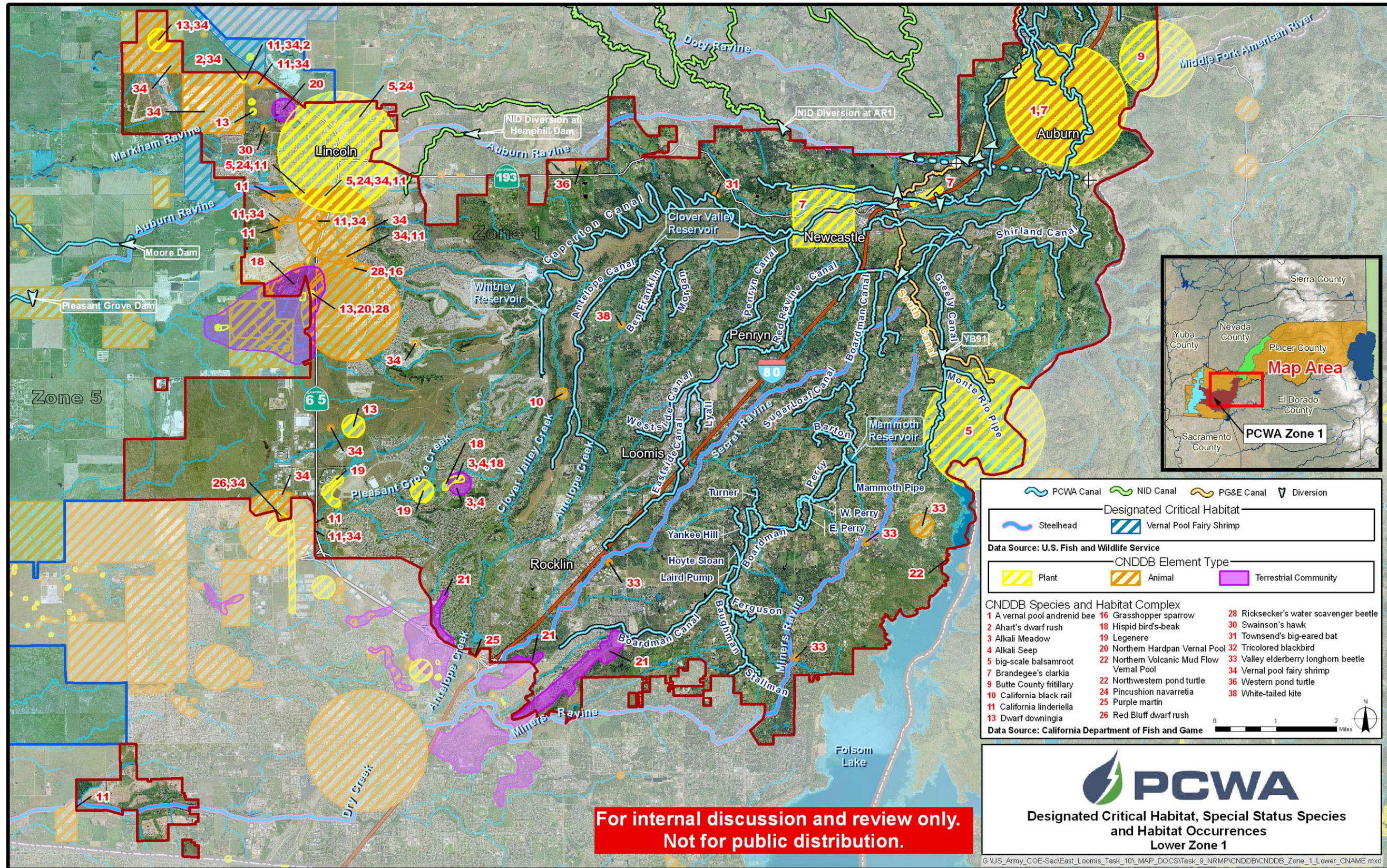


FIGURE 3-106

LOWER ZONE 1 DESIGNATED CRITICAL HABITAT, CALIFORNIA NATURAL DIVERSITY DATABASE SPECIAL STATUS SPECIES OCCURRENCES, AND HABITAT COMPLEXES

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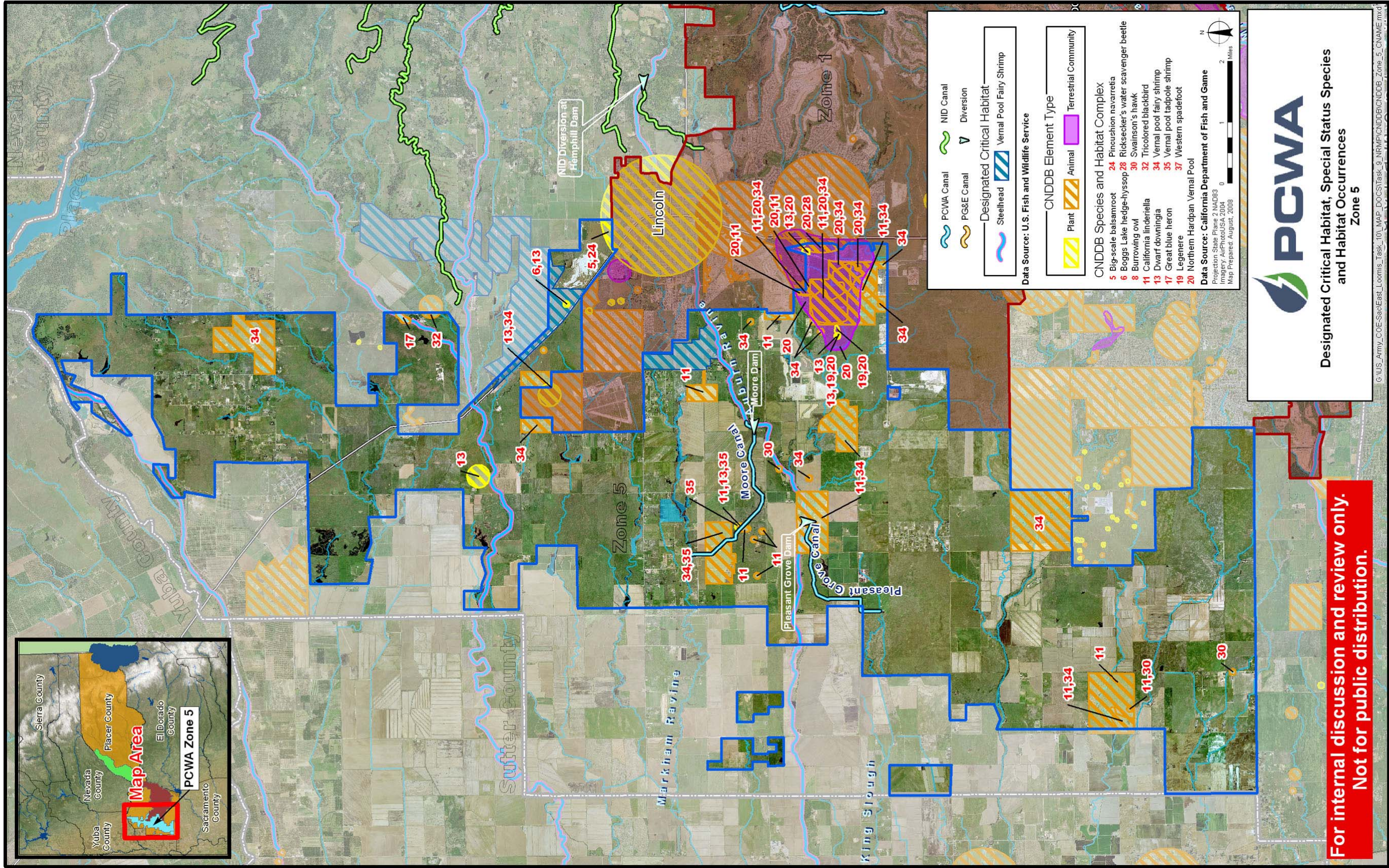


FIGURE 3-107

ZONE 5 DESIGNATED CRITICAL HABITAT, CALIFORNIA NATURAL DIVERSITY DATABASE SPECIAL STATUS SPECIES OCCURRENCES, AND HABITAT COMPLEXES

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**TABLE 3-18
KNOWN SPECIAL STATUS SPECIES OCCURRENCES IN ZONES 1, 3, AND 5 (CNDDDB 2008)**

Common Name	Scientific Name	Federal Status	State Status	CNPS List	Habitat	Occurrence	Notes
Wildlife							
Hardhead	<i>Mylopharodon conocephalus</i>	--	WL		Undisturbed areas of larger middle-and low-elevation streams	Zones 1 and 5	
Central Valley steelhead	<i>Oncorhynchus mykiss</i>	T	T		Riverine (not known to occur in canals)	Zones 1 and 5	
Fall-run Chinook salmon	<i>Oncorhynchus tshawytscha</i>	SC	SSC		Riverine (not known to occur in canals)	Zones 1 and 5	
vernal pool fairy shrimp	<i>Branchinecta lynchi</i>	T	--		vernal pools	Zones 1 and 5	
vernal pool tadpole shrimp	<i>Lepidurus packardii</i>	E	--		vernal pools	Zone 5	
California linderella	<i>Linderella occidentalis</i>	--	--		vernal pools	Zones 1 and 5	
valley elderberry longhorn beetle	<i>Desmocerus californicus dimorphus</i>	T	--		valley foothill riparian and oak savanna in elderberry shrubs	Zone 1	
A vernal pool andrenid bee	<i>Andrena subapasta</i>	--	--		vernal pools	Zone 1	
Ricksecker's water scavenger beetle	<i>Hydrochara rickseckeri</i>	--	--		vernal pools, wetlands	Zones 1 and 5	
coast (California) horned lizard	<i>Phrynosoma coronatum</i> (frontale population)	--	SSC		various habitats, including annual grassland, shrubland, forested habitats, and wetlands	Zone 3	lays eggs May-June
western pond turtle	<i>Actinemys marmorata</i>	--	SSC		annual grassland, wetland, forested, river, streams, lake and river margins	Zone 1	

**TABLE 3-18
KNOWN SPECIAL STATUS SPECIES OCCURRENCES IN ZONES 1, 3, AND 5 (CNDDDB 2008) (CONTINUED)**

Common Name	Scientific Name	Federal Status	State Status	CNPS List	Habitat	Occurrence	Notes
Wildlife (continued)							
Foothill yellow-legged frog	<i>Rana boylei</i>	--	SSC		forest and shrubland with slow-moving stream/river	Zone 3	breeds in water March-May
western spadefoot	<i>Spea hammondi</i>	--	SSC		annual grassland, wetland, lake and river margins	Zone 5	
burrowing owl	<i>Athene cunicularia</i>	--	SSC		agricultural, annual grassland, oak woodland	Zone 5	
grasshopper sparrow	<i>Ammodramus savannarum</i>	--	SSC		Annual grassland, oak woodland	Zone 1	
great blue heron	<i>Ardea herodias</i>	--	--		wetlands, agricultural	Zone 5	
purple martin	<i>Progne subis</i>	--	SSC		Annual grassland, oak woodland, urban	Zone 1	
white-tailed kite	<i>Elanus leucurus</i>	--	FP		annual grassland, agricultural, open woodlands	Zone 1	
California black rail	<i>Laterallus jamaicensis coturniculus</i>	--	T, FP		fresh emergent wetland	Zone 1	
tricolored blackbird	<i>Agelaius tricolor</i>	--	SSC		agricultural, wetland, annual grassland, urban	Zones 1 and 5	
Swainson's hawk	<i>Buteo swainsoni</i>	--	T		agricultural, annual grassland, forested	Zones 1 and 5	Nesting period is generally March 1 to August 15

**TABLE 3-18
KNOWN SPECIAL STATUS SPECIES OCCURRENCES IN ZONES 1, 3, AND 5 (CNDDDB 2008) (CONTINUED)**

Common Name	Scientific Name	Federal Status	State Status	CNPS List	Habitat	Occurrence	Notes
Plants							
Townsend's big-eared bat	<i>Corynorhinus townsendii</i>	--	SSC		woodlands, urban areas, requires roosting areas (caves, mines, etc.)	Zone 1	
Pacific fisher	<i>Martes pennanti (pacifica)</i>	C	SSC		mature coniferous and riparian forest	Zone 3	
Boggs Lake hedge-hyssop	<i>Gratiola heterosepala</i>	--	E	1B	vernal pools, marshes and swamps	Zone 5	blooms April-August
Red Bluff dwarf rush	<i>Juncus leiospermus var. leiospermus</i>	--	--	1B	vernal pools	Zone 1	blooms March-May
Ahart's dwarf rush	<i>Juncus leiospermus var. ahartii</i>	--	--	1B	vernal pools, wetlands	Zone 1	blooms March-May
big-scale balsamroot	<i>Balsamorhiza macrolepis var. macrolepis</i>	--	--	1B	chaparral, woodland, grasslands	Zones 1 and 5	blooms March-June
Brandege's clarkia	<i>Clarkia biloba ssp. brandegeee</i>	--	--	1B	chaparral, forest, disturbed areas	Zones 1 and 3	blooms May-July
Butte County fritillary	<i>Fritillaria eastwoodiae</i>	--	--	3	chaparral, woodland, montane coniferous forest	Zone 1	blooms March-May
dwarf downingia	<i>Downingia pusilla</i>	--	--	2	vernal pools, marshes and swamps	Zones 1 and 5	blooms March-May
elongate copper moss	<i>Mielichhoferia elongata</i>	--	--	2	woodlands, moist rocky areas	Zone 3	
hispid bird's-beak	<i>Cordylanthus mollis ssp. hispidus</i>	--	--	1B	wetlands	Zone 1	blooms June-September
legenere	<i>Legenere limosa</i>	--	--	1B	vernal pools, wetlands, drainages	Zones 1 and 5	blooms May-September

**TABLE 3-18
KNOWN SPECIAL STATUS SPECIES OCCURRENCES IN ZONES 1, 3, AND 5 (CNDDDB 2008) (CONTINUED)**

Common Name	Scientific Name	Federal Status	State Status	CNPS List	Habitat	Occurrence	Notes
Plants (continued)							
pincushion navarretia	<i>Navarretia myersii</i> ssp. <i>myersii</i>	--	--	1B	wetlands, vernal pools	Zones 1 and 5	blooms in May
Red Hills soaproot	<i>Chlorogalum grandiflorum</i>	--	--	1B	chaparral, woodland on serpentine or gabbroic soils	Zone 3	blooms May-June
Sheldon's sedge	<i>Carex sheldonii</i>	--	--	2	coniferous forest, wetlands, riparian scrub	Zone 3	blooms May-August
Habitats							
Alkali Meadow						Zone 1	
Alkali Seep						Zone 1	
Northern Hardpan Vernal Pool						Zones 1 and 5	
Northern Volcanic Mud Flow Vernal Pool						Zone 1	

Key:

- Federal Status:
- C = Candidate
- E = Endangered
- SC = Species of Concern
- T = Threatened
- State Status:
- E = Endangered
- FP = Fully Protected
- R = Rare
- SSC = Species of Special Concern
- T = Threatened
- WL = Watch List
- California Native Plant Society
- 1B = List 1B species: rare, threatened, or endangered in California and elsewhere
- 2 = List 2 Species: rare, threatened, or endangered in California but more common elsewhere
- 3 = plant that need more information to determine their status

**TABLE 3-19
SPECIAL STATUS SPECIES POTENTIALLY OCCURRING IN ZONES 1, 3, AND 5***

Common Name	Scientific Name	Federal Status	State Status	CNPS List	Habitat	Potential Occurrence	Notes
California red-legged frog	<i>Rana aurora draytonii</i>	T	SSC		valley foothill riparian, wetland, lake and river margins with permanent deep water	Zones 1, 3, 5	breeds in water November-March
giant garter snake	<i>Thamnophis gigas</i>	T	T		marshes, wetlands, canals, rice field	Zones 1 and 5	fs
Western yellow-billed cuckoo	<i>Coccyzus americanus occidentalis</i>	C	E		dense riparian forest	Zone 5	
Stebbins' morning glory	<i>Calystegia stebbinsii</i>	E	E	1B	chaparral or woodland on gabbroic or serpentinite soils	Zone 1	blooms May-June
Pine Hill ceanothus	<i>Ceanothus roderickii</i>	E	R	1B	chaparral or woodland on gabbroic or serpentinite soils	Zone 1	blooms May-June
El Dorado bedstraw	<i>Galium californicum</i> ssp. <i>Sierrae</i>	E	R	1B	chaparral or forestland on gabbroic soils	Zone 1	blooms May-June
Layne's ragwort	<i>Packera layneae</i>	T	R	1B	chaparral or woodland on gabbroic or serpentinite soils	Zone 1	blooms April-July
Jepson's onion	<i>Allium jepsonii</i>	--	--	1B	chaparral or forestland on gabbroic or volcanic soils	Zones 1 and 3	blooms April-August
dubious pea	<i>Lathyrus sulphureus</i> var. <i>argillaceus</i>	--	--	3	chaparral or forest	Zones 1 and 3	blooms April-May
oval-leaved viburnum	<i>Viburnum ellipticum</i>	--	--	2	chaparral or forest	Zones 1 and 3	blooms May-June

**TABLE 3-19
SPECIAL STATUS SPECIES POTENTIALLY OCCURRING IN ZONES 1, 3, AND 5* (CONTINUED)**

Common Name	Scientific Name	Federal Status	State Status	CNPS List	Habitat	Potential Occurrence	Notes
red-anthered rush	<i>Juncus marginatus</i> var. <i>marginatus</i>	--	--	2	marshes and swamps at elevation over 2,400	Zone 3	blooms in July
brownish beaked-rush	<i>Rhynchospora capitellata</i>	--	--	2	coniferous forest, wetlands	Zone 3	blooms July-August
Scadden Flat checkerbloom	<i>Sidalcea stipularis</i>	--	E	1B	marshes and swamps	Zone 3	blooms July-August
Bisbee Peak rush-rose	<i>Helianthemum suffrutescens</i>	--	--	3	chaparral (often serpentinite, gabbroic, or lone soil)	Zone 1	blooms April-June
El Dorado County mule ears	<i>Wyethia reticulata</i>	--	--	1B	chaparral, woodland, montane coniferous forest on clay or gabbroic soils	Zone 1	blooms May-July

Notes:

* Excludes those species known to occur that are listed in Table 3-12

Key:

Federal Status:

C = Candidate

E = Endangered

T = Threatened

State Status:

E = Endangered

FP = Fully Protected

R = Rare

SSC = Species of Special Concern

T = Threatened

California Native Plant Society

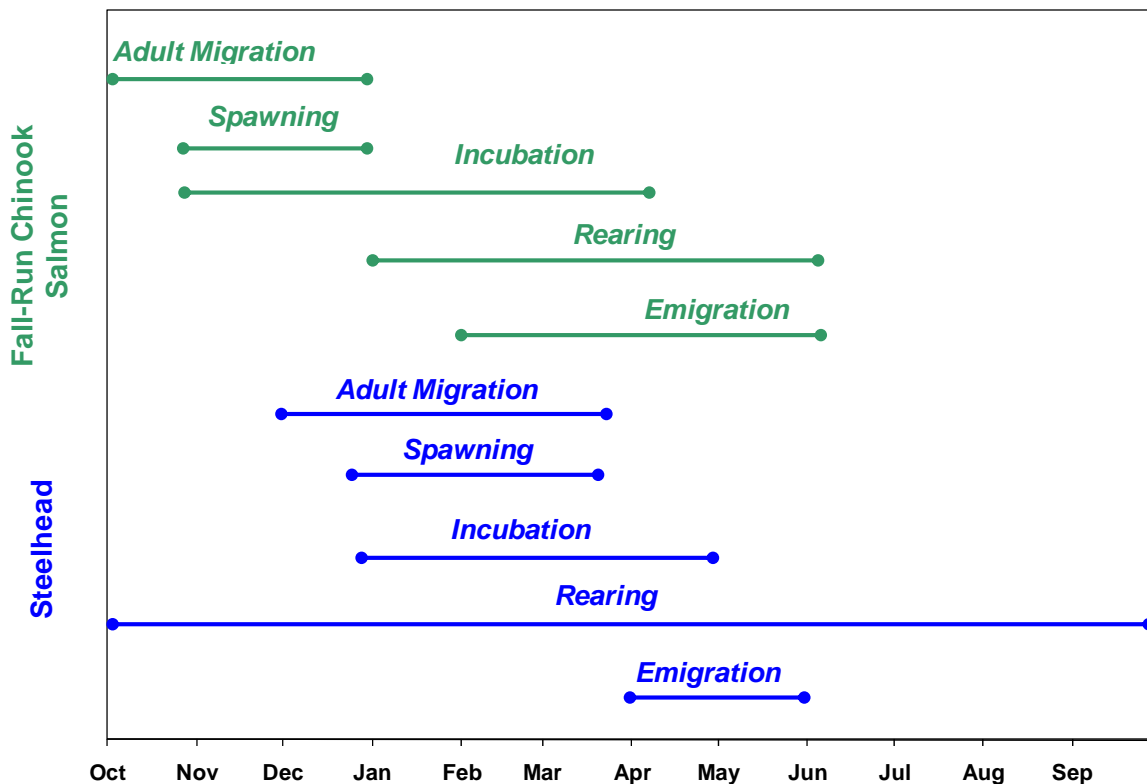
1B = List 1B species: rare, threatened, or endangered in California and elsewhere

2 = List 2 Species: rare, threatened, or endangered in California but more common elsewhere

3 = plant that need more information to determine their status

Auburn Ravine, Secret Ravine and Miners Ravine are federally designated Critical Habitat for Central Valley steelhead. Secret Ravine and Miners Ravine and are recognized by DFG and NMFS as the primary production areas in the Dry Creek drainage for Central Valley steelhead and fall-run Chinook salmon (DFG 2001). These ravines appear to be especially important for spawning and rearing of these anadromous fishes (DFG 2001).

Major life stages of fall-run Chinook salmon and Central Valley steelhead in the Auburn Ravine and Dry Creek watershed during a water year (October through September) are shown in **Figure 3-108**.



**FIGURE 3-108
MAJOR LIFE STAGES OF FALL-RUN CHINOOK AND CENTRAL VALLEY STEELHEAD IN AUBURN RAVINE AND DRY CREEK WATERSHED DURING A WATER YEAR**

The timing of migration of adult fall-run Chinook salmon is determined primarily by flows and water temperatures, and migration can occur in the Auburn Ravine and Dry Creek watershed anywhere from October through December. Spawning usually occurs from November through December. From January to mid-April, fry emerge (incubation), and rearing occurs from January to June. Smolts tend to emigrate from the watershed during February through June, peaking in March to May (DFG 2003, Placer and Sacramento Counties 2003).

Central Valley steelhead migration occurs from December through March. Spawning depends on flows and water temperatures, but typically occurs from January through March. Steelhead

incubation typically occurs between January and mid-April. Steelhead rearing can occur year-round. Juvenile emigration takes place from late March through May (DFG 2003, Placer and Sacramento Counties 2003).

Substrate composition refers to the suitability of a particular sized gravel substrate (USDA 1979). Fine substrate, such as silt and suspended solids, can clog fish gills or reduce feeding, and migrating salmon will avoid or cease migration in waters with high silt loads or high turbidity. Excessive sediment loads can also decrease the fish spawning capacity of streams by clogging gravel redds.

Important habitat elements for anadromous salmonids include cover, substrate composition, and water quality and quantity (USDA 1979). Cover for fish can consist of overhanging vegetation, undercut banks, submerged vegetation, large submerged objects (i.e., logs and rocks), and water depth and turbulence. Adequate cover is most important to anadromous salmonids during rearing because they are most susceptible to predation from other fish and terrestrial animals during this time (USDA 1979).

One of the primary water quality parameters that affect fish habitat conditions is water temperature. Salmonids are cold water fish with optimum temperature requirements at different life stages. There is some debate in scientific literature on the definitive temperature range requirements for various life cycle phases of salmon and steelhead. Temperature targets for the life cycle stages of steelhead and Chinook salmon in the study area consistent with values reported in scientific literature are shown in **Table 3-15**.

Adequate water depth and streamflow are necessary for fish passage. Migration can be hampered by too little streamflow and resulting shallow water (USDA 1979). To allow for fish passage, minimum streamflows must be met. In addition, low streamflows can often result in warmer waters.

CHAPTER 4.0 REGULATORY REQUIREMENTS FOR PCWA CANAL SYSTEM OPERATIONS AND MAINTENANCE ACTIVITIES

This chapter summarizes the regulatory requirements for PCWA canal system O&M activities.

4.1 FEDERAL REGULATIONS

The following sections describe Federal regulatory requirements associated with O&M activities carried out by PCWA.

4.1.1 Clean Water Act

Growing public awareness and concern for controlling water pollution led to enactment of the Federal Water Pollution Control Act Amendments of 1972. As amended in 1977, this law became commonly known as the Clean Water Act (CWA) (33 U.S.C. §1251 et seq.). The CWA is the primary Federal law that protects the quality of the nation's surface waters. The Act established the basic structure for regulating discharges of pollutants into the "waters of the United States." Waters of the United States and their lateral limits are defined in CFR Title 33, Part 328.3(a), to include the following:

1. All waters which are currently used, or were used in the past, or may be susceptible to use in interstate or foreign commerce, including all waters which are subject to the ebb and flow of the tide.
2. All interstate waters including interstate wetlands.
3. All other waters such as intrastate lakes, rivers, streams (including intermittent streams), mudflats, sandflats, wetlands, sloughs, prairie potholes, wet meadows, playa lakes, or natural ponds, the use, degradation or destruction of which could affect interstate or foreign commerce including any such waters:
 - i. Which are or could be used by interstate or foreign travelers for recreational or other purposes; or
 - ii. From which fish or shellfish are or could be taken and sold in interstate or foreign commerce; or
 - iii. Which are used or could be used for industrial purpose by industries in interstate commerce.
4. All impoundments of waters otherwise defined as waters of the United States under the definition.
5. Tributaries of waters identified in paragraphs (a)(1)-(4) of this section.
6. The territorial seas.

7. Wetlands adjacent to waters (other than waters that are themselves wetlands) identified in paragraphs (a)(1)-(6) of this section. Waste treatment systems, including treatment ponds or lagoons designed to meet the requirements of CWA (other than cooling ponds as defined in 40 CFR 123.11(m) which also meet the criteria of this definition) are not waters of the United States.
8. Waters of the United States do not include prior converted cropland. Notwithstanding the determination of an area's status as prior converted cropland by any other federal agency, for the purposes of the CWA, the final authority regarding CWA jurisdiction remains with the U.S. Environmental Protection Agency (EPA).

Considering this definition of waters of the United States, essentially all natural water bodies are included under the definition of waters of the United States. In addition, several artificial or disturbed water bodies have the potential to fall under this definition, such as:

- Reservoirs
- Farm or stock ponds fed by direct rainfall or impoundment of a stream (not by pumped water)
- Artificial wetlands that receive water without artificial controls (i.e., pumps, valves, or gates)
- Farmed wetlands

Some water bodies that may be excluded from this definition include the following (Cylinder et al., 2004):

- Irrigation ditches that are not considered tributaries of waters of the United States
- Drainage ditches excavated in uplands
- Temporary sediment basins on construction sites
- Reflecting pools
- Wastewater systems, including treatment ponds and lagoons
- Ponds and wetlands created as part of an ongoing mining operation (unless created as mitigation for past impacts)
- Isolated ponds and wetlands that do not have a nexus to interstate commerce

As mentioned above, artificial channels that convey only irrigation water usually are not included under the definition of waters of the United States, unless they connect directly to jurisdictional waters of the United States. However, if the PCWA canal system is deemed

“Waters of the United States” by USACE, Section 404 and all associated regulations under the CWA are applicable.

The CWA authorizes the EPA to set national standards and restrictions on quantities, discharge rates, and concentrations of pollutants discharged into the waters of the United States. Many actions that result in the discharge of pollutants into the waters of the United States require a permit as authorized by sections of the CWA. The permit process is the CWA’s primary regulatory tool.

4.1.1.1 Section 303

Under Section 303(c)(2)(B) of the CWA, states must adopt numeric criteria for the priority toxic pollutants listed under Section 307(a) if those pollutants could be reasonably expected to interfere with the designated uses of states' waters. The EPA requires numeric water quality criteria for priority toxic pollutants and other water quality standards provisions to be applied to waters in California. Today's final rule promulgates (1) ambient aquatic life criteria for 23 priority toxics, (2) ambient human health criteria for 57 priority toxics, and (3) a compliance schedule provision that authorizes the state to issue schedules of compliance for new or revised NPDES permit limits based on the Federal criteria when certain conditions are met. The State must use the criteria together with the State's existing water quality standards when controlling pollution in inland waters and enclosed bays and estuaries. The numeric water quality criteria contained in the final rule are identical to EPA's recommended CWA Section 304(a) criteria for these pollutants published in December 1998 (see 63 Federal Register (FR) 68353).

4.1.1.2 Section 404

Section 404 of the CWA establishes a requirement to obtain a permit before any activity that involves any discharge of dredged or fill material into waters of the United States. “Fill” is defined as any material that replaces any portion of a water of the United States with dry land, or that changes the bottom elevation of any portion of a water of the United States. Actions typically subject to Section 404 requirements are those that would take place in wetlands or stream channels that convey natural runoff, including intermittent streams, even if they have been realigned. Per 33 CFR 323.4, maintenance or construction of irrigation ditches, and maintenance (not construction) of drainage ditches are not subject to the Section 404 Regulatory Program.

The Section 404 permit issuance process is conducted in compliance with guidelines developed by EPA that require that there be a demonstration that no alternative is available to meet the project purpose and need that does not result in a discharge of fill in waters. Once this first test has been satisfied, the project that is permitted must be the least environmentally damaging practical alternative before the USACE may issue a permit for the proposed activity.

The USACE issues two broad categories of permits under Section 404: general permits and standard permits. General permits, which include nationwide permits and regional permits, are issued by USACE to streamline the permit process for nationwide, statewide, or regional activities that have minimal environmental impacts (CALFED 2001). Projects that meet specific

criteria, including certain PCWA O&M activities, may proceed under the authorization of a general permit once the conditions specified in the general permit are met (Cylinder et al. 2004). Many general permits may require notification to USACE before the start of an activity in the form of a Preconstruction Notification. Typically the USACE will provide the applicant with a written confirmation that the work can be authorized under the applicable permit. It is important to note that the use of more than one nationwide permit for a single and complete project is prohibited (72 FR 11196) and that all general permits must be reviewed every 5 years by USACE, at which time they may be reissued, modified, or revoked. Nationwide Permits have been issued for a variety of activities that may apply to PCWA, including:

- NW-03: Maintenance
- NW-07: Outfall Structures and Maintenance
- NW-13: Bank Stabilization
- NW-18: Minor Discharges
- NW-23: Approved Categorical Exclusions
- NW-41: Reshaping Existing Drainage Ditch
- NW-46: Discharge into Ditches

Regional conditions for nationwide permits to be applied across the entire Sacramento District include, but are not limited to, the following:

- Nationwide Permits 14, 29, 33, 39, 40, 41, 42, 43, and 44 are withdrawn from use in histosols, including fens (wetlands with organic/peat soils). For the use of all other nationwide permits in fens, project proponents are required to notify the USACE using the notification or preconstruction notification procedures of the nationwide permit program (General Condition 13). This will be a "USACE only" notification.
- For all activities using any existing and proposed nationwide permits, mitigation that is required by special condition must be completed before or concurrent with project construction. Where project mitigation involves the use of a mitigation bank or in-lieu fee, payment must be made to the bank or fee-in-lieu program before starting construction of the permitted activity.
- For all nationwide permits requiring notification, except 27, the applicant must provide a written statement to the district engineer explaining how avoidance and minimization of losses of waters of the United States were achieved on the project site.

Standard permits, which include letters of permission and individual permits, are issued for activities that may have more than a minimal adverse environmental impact and do not qualify for a general permit. A letter of permission is a type of standard permit for an individual action, designed to expedite the permitting process for activities having a minimal impact on the aquatic ecosystem (CALFED 2001). Projects not eligible for a general permit or a letter of permission

must obtain an individual permit. A standard permit for a specific activity may be issued only after an individual application is submitted to USACE and the formal review process is complete.

4.1.1.3 Section 401

Section 401 of the CWA specifies that any applicant for a Federal license or permit to conduct any activity that may result in any discharge into waters of the United States will provide the Federal licensing or permitting agency a certification that any such discharge will not violate State water quality standards. Although this is a federal law, it is state enforced. In California, the authority to grant water quality certification is delegated by the SWRCB to the nine RWQCB. The RWQCB is responsible for issuing water quality certifications indicating that the project will uphold State water quality standards. The RWQCB administers the Section 401 program with the intent of prescribing measures for the applicant's project that are necessary to avoid, minimize, and mitigate adverse impacts on water quality and the ecosystems. Projects that require a Section 404 permit from USACE must also file an application to obtain water quality certification from the RWQCB, and should be filed with the RWQCB at the same time that PCWA files the Section 404 permit application with USACE.

The PCWA service area falls under the jurisdiction of the Central Valley RWQCB. Applications for a 401 certification must be filed with the Central Valley RWQCB and must include: a full, technically accurate description of the entire proposed activity; an alternatives analysis; copies of any draft or final Federal, State, and local licenses, permits, and agreements required for actions associated with the proposed activity; a copy of the CEQA document and notice of determination; and a list of agencies that participated in the CEQA process (CALFED 2001). For projects that require a Section 404 permit from USACE, an application should be filed with the RWQCB at the same time that PCWA files the Section 404 permit application with USACE. The SWRCB has issued Section 401 water quality certifications for select Section 404 nationwide permits.

4.1.1.4 Section 402

Section 402 of the CWA authorized the NPDES program, which states that all discharges into the nation's waters are unlawful, unless specifically authorized by a permit. The primary objective of the NPDES is to restore and maintain the chemical, physical, and biological integrity of the nation's waters. The NPDES Permit Program establishes waste discharge requirements, including specific pollution limits and monitoring and reporting requirements, for permitted wastewater and stormwater discharges into waters of the United States. The U.S. EPA or the approved State environmental control agency has responsibility for administering NPDES permits for discharges to surface waters, which must be renewed every 5 years. In California, the SWRCB is responsible for permit administration, and the vast majority of NPDES permits are issued by the nine RWQCBs.

The SWRCB and RWQCBs issue both general and individual NPDES permits. A general permit covers multiple facilities within a specific category, industry facilities with similar operation

types, and facilities with similar wastewater discharge types. General permits may only be issued to dischargers within specific geographical areas, such as a designated planning area, sewer district, city, county, or State boundary. Stormwater, or non-point source, discharges are regulated by the RWQCBs under Stormwater Program General Permits. The following are some stormwater permits that may apply to PCWA raw water distribution system O&M activities:

1. General Permit for Discharges of Storm Water Associated with Construction Activity (Construction General Permit, 99-08-DWQ) is required for construction activities, including clearing, grading, and disturbances to the ground such as stockpiling, or excavation that results in soil disturbances of at least 1 acre of total land area. The general permit requires development of a Stormwater Pollution Prevention Plan (SWPPP) and annual monitoring reports for compliance with effluent limitations. The SWPPP will specify the implementation of site-specific BMPs using the best available technology economically achievable and best conventional pollutant control technology.
2. Municipal Separate Storm Sewer System Permits (MS4) require the discharger, or a municipality, to develop and implement a Storm Water Management Plan/Program with the goal of reducing the discharge of pollutants to the maximum extent practicable. Phase I MS4 permits apply to medium (serving between 100,000 and 250,000 people) and large (serving 250,000 people) municipalities. Phase II MS4 permits apply to smaller municipalities, including nontraditional Small MS4s, which are governmental facilities such as military bases, public campuses, and prison and hospital complexes. Placer County has a Phase II MS4 permit with the Central Valley RWQCB.

The SRWCB also issues several point-source general permits. Of them, the following two are most relevant to irrigation canal systems:

1. A General Permit for Dewatering and Other Low Threat Discharges (NPDES No. CAG995001) is required by the Central Valley RWQCB for temporary discharges of clean or relatively pollutant-free wastewater that poses little or no threat to water quality. Temporary discharges include well development water; construction dewatering; pump/well testing; pipeline/tank pressure testing; pipeline/tank flushing or dewatering; condensate discharges; water supply system discharges; and miscellaneous dewatering/low threat discharges.
2. A General Permit for Discharges of Aquatic Pesticides (WQ Order No. 2001-12-DWQ) is typically obtained by irrigation districts, municipal supply districts, and mosquito abatement districts. On November 27, 2007, the EPA issued a Final Rule concluding that pesticides applied in accordance with the FIFRA are exempt from the CWA's permitting requirements (40 CFR §122.3(h)). On January 7, 2009, an appeals court vacated the rule under the CWA, 33 U.S.C. § 1251 et seq., in response to a lawsuit by Baykeeper and supporting environmental groups (U.S. Sixth Circuit Court of Appeals 2009). An NPDES permit is now required even if the application of a pesticide is in compliance with the FIFRA. PCWA is in compliance with FIFRA regulations, has an active General

Permit for discharges of Aquatic Pesticides, and has an extensive Aquatic Weed Management Program.

4.1.2 Endangered Species Act

The Federal ESA was enacted by Congress in 1973 (16 U.S.C. §1531 et seq.). It combined and strengthened the provisions of the 1966 Endangered Species Preservation Act and the 1969 Endangered Species Conservation Act. Currently, the Federal ESA provides broad protection for species of fish, wildlife, and plants that are listed as threatened or endangered in the United States or elsewhere. The purposes of the Federal ESA are to provide a means of conserving the ecosystems on which endangered and threatened species depend; provide a program for conserving those species; and take steps necessary to achieve the purposes of international treaties and conventions (Federal ESA, Section 2).

USFWS and National Marine Fisheries Service (NMFS) share responsibility for implementing the Federal ESA, have authority over projects that may result in the take of a federally listed endangered species, and are required to maintain lists of threatened and endangered species. Both agencies ensure that ESA requirements are followed, and evaluate projects that may affect the continued existence of a federally listed (threatened or endangered) species. Generally, USFWS manages land and freshwater species, while NMFS manages marine and "anadromous" species, such as Chinook salmon.

4.1.2.1 Section 9

Section 9 of the ESA prohibits the "take" of federally listed species. Take is defined under the ESA, in part, as killing, harming, or harassment. Under Federal regulations, take is further defined to include habitat modification or degradation when it results in death or injury to wildlife by significantly impairing essential behavioral patterns, including breeding, feeding, or sheltering. The federally listed species that may occur in, or may be affected by PCWA raw water distribution system O&M activities are described in **Chapter 3**. If an activity may affect a federally listed species, either an incidental take permit, under Section 10 of the Federal ESA, or a Federal interagency consultation, under Section 7 of the Federal ESA is required.

4.1.2.2 Section 7

If a PCWA project is funded by a Federal agency or would require a permit or approval from a Federal agency (federal nexus), PCWA would be required to comply with Section 7 of the Federal ESA rather than obtain an incidental take permit under Section 10. Under Section 7, all Federal agencies must ensure that any actions they authorize, fund, or carry out are not likely to jeopardize the continued existence of a listed species, or destroy or adversely modify its designated Critical Habitat. These requirements apply only to Federal agency actions, and the latter only to habitat that has been designated as Critical.

Critical Habitat is defined as "the specific areas within the geographical area occupied by the species, at the time it is listed . . . that are essential to the conservation of the species and which may require special management considerations or protection" (Federal ESA, Section 3).

Critical Habitat is determined using the best available scientific information about the physical and biological needs of the species. These needs include: space for individual and population growth and for normal behavior; food, water, light, air, minerals, or other nutritional or physiological needs; cover or shelter; sites for breeding, reproduction, and rearing of offspring; habitat that is protected from disturbance or is representative of the historical geographic and ecological distribution of a species. A Critical Habitat designation does not set up a preserve or refuge, and applies only when federal funding, permits, or projects are involved. Critical Habitat requirements do not apply to citizens engaged in activities on private land that do not involve a federal agency. The required steps in the Section 7 consultation process are as follows:

1. Agencies must request information from USFWS and/or NMFS on the existence in a project area of listed species or species proposed for listing.
2. Following receipt of the USFWS/NMFS response to this request, agencies generally prepare a Biological Assessment to determine whether any listed species or species proposed for listing are likely to be affected by a proposed action.
3. Agencies must initiate formal consultation with USFWS and/or NMFS if the proposed action might adversely affect listed species.
4. USFWS and/or NMFS must prepare a Biological Opinion (BO) to determine whether the action would jeopardize the continued existence of listed species or adversely modify their Critical Habitat.
5. If a finding of jeopardy or adverse modifications is made in the BO, USFWS and/or NMFS must recommend reasonable and prudent alternatives that would avoid jeopardy, and the federal agency must modify the project to ensure that listed species are not jeopardized and that their Critical Habitat is not adversely modified (unless an exemption from this requirement is granted) (USFWS and NMFS 1998).

4.1.2.3 Section 10

If a PCWA project is not funded by, or does not need a permit from, a Federal agency, actions that would result in the take of a listed species require a permit issued under Section 10 of the Federal ESA. The most common permit is an “incidental take permit.” Section 10 allows USFWS or NMFS, under certain conditions, to issue incidental take permits for actions in which a take of the species is incidental to, and not the purpose of, the action. To obtain an incidental take permit, PCWA would have to meet certain requirements, including preparation of a Habitat Conservation Plan (HCP). A complete application package consists of a permit application form, fee (if required), a completed HCP, a draft National Environmental Policy Act (NEPA) document (if required), and in some cases, an Implementing Agreement (USFWS and NMFS 1996, USFWS 2005). The HCP also must analyze and explain an action’s impacts on listed species and discuss measures to minimize and mitigate impacts, identify funding, and include a Mitigation Monitoring Plan (USFWS and NMFS 1996, USFWS 2005).

In 1994, the “No Surprises” Policy was issued to provide sufficient incentives for the private sector to participate in the development of long-term conservation plans. The No Surprises

Policy provides regulatory assurances to the permittee, that if "unforeseen circumstances" arise, USFWS and NMFS will not require the commitment of additional land, water, or financial compensation or additional restrictions on the use of land, water, or other natural resources beyond the level otherwise agreed to in the HCP without the consent of the permittee (63 FR 8859). The government will honor these assurances as long as a permittee is implementing the terms and conditions of the HCP, permit, and other associated documents in good faith.

4.1.3 Magnuson-Stevens Fishery Conservation and Management Act and the 1996 Sustainable Fisheries Act

Essential Fish Habitat (EFH) was established under the 1996 amendments to the Magnuson-Stevens Fishery Conservation and Management Act. Under this act, suitable habitat is considered essential for the sustenance of commercial fisheries. Although the concept of EFH is similar to that of "critical habitat" under the Federal ESA, measures recommended to protect EFH by NMFS are advisory, not prescriptive. EFH includes all habitats necessary to allow commercially valuable aquatic species production needed to support a long-term sustainable fishery and contributions to a healthy ecosystem, and is defined in the Magnuson-Stevens Act as "...those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity." EFH is further clarified by defining "waters" to include aquatic areas and their associated physical, chemical, and biological properties used by fish, and may include aquatic areas historically used by fish where appropriate; defining "substrate" to include sediment, hard bottom, structures underlying the waters, and associated biological communities; defining "necessary" to mean the habitat required to support a sustainable fishery and the managed species' contribution to a healthy ecosystem; and defining "spawning, breeding, feeding, or growth to maturity" to cover a species' full life cycle.

In response to growing concern about the status of fisheries in the U.S., the Sustainable Fisheries Act of 1996 (Public Law 104-297) was passed by Congress to amend the Magnuson-Stevens Fishery Conservation and Management Act (Public Law 94-265), the primary law governing marine fisheries management in the waters of the United States. Under the Sustainable Fisheries Act, consultation is required by NMFS on any activity that might adversely affect EFH. EFH includes those habitats that fish rely on throughout their life cycles. EFH encompasses habitats necessary to allow sufficient production of commercially valuable aquatic species to support a long-term sustainable fishery and contribute to a healthy ecosystem. The EFH mandate applies to all species managed under a Federal Fishery Management Plan. In California, estuarine species covered under the Sustainable Fisheries Act that occur in the San Francisco Bay/Sacramento-San Joaquin Delta (Bay-Delta), and could be affected by PCWA raw water distribution system O&M activities, include Pacific salmon (includes winter-run, spring-run, and fall-run/late fall-run Chinook salmon), Central Valley steelhead, northern anchovy, Pacific sardine, and starry flounder.

4.1.4 The Migratory Bird Treaty Act

The Migratory Bird Treaty Act (MBTA), first enacted in 1918, domestically implements a series of treaties among the United States and Great Britain (on behalf of Canada), Mexico, Japan, and the former Soviet Union that provide for international migratory bird protection. The MBTA authorizes the Secretary of Interior to regulate the taking of migratory birds; the act provides that it will be unlawful, except as permitted by regulations, “to pursue, take, or kill any migratory bird, or any part, nest or egg of any such bird...” (United States Code (USC) Title 16, Section 703). This prohibition includes both direct and indirect acts, although harassment and habitat modification are not included unless they result in direct loss of birds, nests, or eggs. The current list of birds protected by the MBTA contains several hundred species and essentially includes all native birds. The act offers no statutory or regulatory mechanism for obtaining an incidental take permit for the loss of nongame migratory birds.

4.2 STATE REGULATIONS

The following sections describe state regulatory requirements for O&M activities carried out by PCWA.

4.2.1 California Environmental Quality Act

The CEQA was enacted in 1970 as California’s counterpart to the NEPA. CEQA requires State and local agencies to identify significant environmental impacts of their actions and to avoid or mitigate those impacts, if feasible. The objectives of CEQA are to:

- Disclose to decision makers and the public the significant environmental effects of proposed activities; identify ways to avoid or reduce environmental damage
- Prevent environmental damage by requiring implementation of feasible alternatives or mitigation measures
- Disclose to the public reasons for agency approval of projects with significant environmental effects; foster interagency coordination in the review of projects
- Enhance public participation in the planning process (CALFED 2001)

CEQA requires State and local agencies to prepare multidisciplinary environmental impact analysis. By requiring agencies to make decisions based on multidisciplinary studies, CEQA encourages the protection of all aspects of the environment. Depending on the potential impacts of a proposed project, the environmental information is presented in one of three CEQA documents: a notice of exemption (optional), an initial study supporting either a negative declaration or mitigated negative declaration, or an environmental impact report (EIR). A project is defined by CEQA as an activity undertaken by a public agency, or an activity undertaken by a private entity that must receive some discretionary approval from a government

agency, and may cause either a direct physical change in the environment or a reasonably foreseeable indirect change in the environment (CEQA Guidelines, Section 15378).

CEQA documents should be prepared during the agency planning process and must be completed and certified before project approval, which is the decision committing an agency to a definite course of action on the project (Bass et al., 1999). The two State agencies responsible for CEQA administration are the Governor's Office of Planning and Research and the Resources Agency.

The first phase of the CEQA process is a preliminary review of a project to determine whether it is subject to CEQA. A project may not be segmented into small parts for the purpose of avoiding full disclosure of environmental impacts; therefore, a project is the whole of an action which has the potential for resulting in physical change in the environment. The preliminary review is initiated when the project is ready for CEQA consideration. If there is no possibility of a significant impact, or if the activity is outside of the definition of a project, then the activity is outside the jurisdiction of CEQA. Additionally, if the project is described in either a Statutory Exemption or a Categorical Exemption, an optional notice of exemption may be written, and there is no need to continue with the CEQA process.

If the project is under the jurisdiction of CEQA, and not exempt, then an initial study will be conducted to determine whether the project may have significant environmental effects. A significant effect is generally defined as a substantial, or potentially substantial, adverse change in the physical environment, and may be direct, indirect, or cumulative (Bass et al. 1999). When there is evidence that a project may have a significant effect, an EIR is required. The agency must provide public notice of intent to prepare an EIR in the form of a notice of preparation (NOP). If there is no substantial evidence that a project may have a significant environmental impact, or if the project as mitigated or revised will have no significant impact on the environment, then a Negative Declaration (ND) or a Mitigated Negative Declaration (MND) may be prepared. As with an NOP during the EIR process, the agency must provide public notice of intent to adopt an ND or MND.

4.2.2 Porter-Cologne Water Quality Control Act (Title 23, California Water Code)

The Porter-Cologne Water Quality Control Act is the primary state law protecting the quality of California's waters. Enacted by the State Legislature in 1969, the act established the SWRCB and nine RWQCBs. The act gives the RWQCBs the authority to regulate discharges of waste into "waters of the State." "Waters of the State" are defined as "any surface or groundwater, including saline water, within the boundaries of the state" (California Water Code, Section 13050). Under this definition, surface watercourses and water bodies include lakes, bays, ponds, impounding reservoirs, springs, wells, rivers, streams, creeks, marshes, inlets, canals, and all other bodies of surface waters. This definition includes, but is broader than, "waters of the United States."

Section 13240 of the act requires each RWQCB to adopt water quality control plans (basin plans), for all areas within the region. Each basin plan establishes narrative and numerical water

quality objectives to ensure the protection of beneficial uses, and a program of implementation for achieving water quality objectives within the basin. In California, the beneficial uses and water quality objectives are the State's water quality standards. The NPDES permitting system is the primary process by which waste discharges are regulated and water quality objectives are met.

Although it is not explicitly part of the basin plans, the EPA rule established CFR Part 131, Water Quality Standards; Establishment of Numeric Criteria for Priority Toxic Pollutants for the State of California, which is regulated by the RWQCBs to protect aquatic life from exposure to toxic pollutants. These criteria are designed to protect human health and welfare and aquatic life from pollutants in freshwater and marine surface waters. The Central Valley RWQCB's staff report, A Compilation of Water Quality Goals, was last updated in July 2008. The report contains several tables of updated numerical water quality limits compiled from various sources, including EPA's National Recommended (Ambient) Water Quality Criteria, the NTR (**Table 3-5**), and the CTR (**Table 3-6**).

The PCWA raw water distribution system area is situated within the jurisdiction of the Central Valley RWQCB. Of the two water quality control plans, or basin plans, adopted by the Central Valley RWQCB, the PCWA raw water distribution system area is covered within the Water Quality Control Plan for the Sacramento River and San Joaquin River Basins. As stated in the Basin Plan for the Sacramento River and San Joaquin River Basins, it is impractical to list beneficial uses for every surface water body in the region. Therefore, beneficial uses of the unidentified water bodies are evaluated on a case-by-case basis. Often the beneficial uses of a smaller tributary of a river are considered to be the same as those for the larger river. In this case, beneficial uses for study area streams are considered to be the same as those for the Sacramento River described in **Chapter 3**. Although water quality objectives are achieved primarily through the adoption of waste discharge requirements (including permits) and enforcement actions, they are intended to generally govern levels of constituents and characteristics in the water body.

4.2.3 California Endangered Species Act

The California ESA was enacted in 1970 to conserve, protect, restore, and enhance any endangered or threatened species and its habitat (California Fish and Game Code, Section 2052). California ESA Section 2080 prohibits the take of any threatened or endangered species within the state. Take is defined in Section 86 of the Fish and Game Code as "hunt, pursue, catch, capture, or kill, or attempt to hunt, pursue, catch, capture, or kill." This definition does not include harm or harass, as the Federal act does. As a result, habitat modification is not necessarily considered take under California ESA. The DFG administers the California ESA for all native species of fish, plants, and wildlife. California ESA requires that DFG maintain lists of threatened and endangered species and provides for protection of species on these lists. The official California listing of endangered and threatened animals is contained in the California Code of Regulations, Title 14. The State-listed species that may be affected by PCWA raw water distribution system O&M activities are listed **Chapter 3**.

Section 2801 of California ESA requires that an incidental take permit be obtained for any project that would result in the take of a listed species. California ESA does not specifically require the preparation of an HCP, but requires an applicant to analyze and explain the project's impacts on listed species, identify measures to mitigate the impacts of taking the listed species, identify funding for implementation, and include a monitoring plan (CALFED 2001). The specific criteria for issuing an incidental take permit are as follows:

- The authorized take is incidental to an otherwise lawful activity.
- The impacts of the authorized take are minimized and fully mitigated.
- The measures required to minimize and fully mitigate the impacts of the authorized take are roughly proportional in extent to the impact of the taking on the species, maintain the applicant's objectives to the greatest extent possible, and are capable of successful implementation.
- Adequate funding is provided to implement the required minimization and mitigation measures and to monitor compliance with the effectiveness of the measures.
- Issuance of the permit will not jeopardize the continued existence of a State-listed species.

In addition, DFG cannot issue a permit for the take of a fully protected species. Ordinarily, Federal agencies are not subject to California ESA and are not required to obtain California ESA incidental take permits for Federal agency actions. The incidental take permit process is normally initiated in the region where the permitted activity will take place by contacting the appropriate regional office.

Under Section 2800.1, if PCWA obtains a Section 10 incidental take permit under the Federal ESA, they are not required to obtain a separate California ESA incidental take permit, so long as PCWA notifies the Director of DFG in writing that PCWA has received an incidental take permit, and includes in the notice to the Director, a copy of the incidental take permit. The Director must determine that the Federal document is "consistent" with the California ESA. If DFG determines that the Federal permit is not consistent with the California ESA, then the applicant must apply for a State incidental take permit under Section 2801.

4.2.4 California Fish and Game Code – Fully Protected Species

Protection of fully protected species, such as birds, mammals, reptiles, amphibians, and fish, is described in Sections 3511, 4700, 5050, and 5515 of the DFG. These statutes prohibit take or possession of fully protected species. DFG is unable to authorize incidental take of fully protected species when activities are proposed in areas inhabited by those species. DFG has informed non-Federal agencies and private parties that they must avoid take of any fully protected species in carrying out projects.

4.2.5 California Fish and Game Code Section 1602 – Lake and Streambed Alteration Program

California Fish and Game Code (Section 1602) requires an entity to notify DFG of any proposed activity that may substantially modify a river, stream, or lake that flows at least intermittently through a bed or channel. The types of activities that require notification include an activity that will substantially divert or obstruct the natural flow of any river, stream or lake; substantially change or use any material from the bed, channel, or bank of, any river, stream, or lake; or deposit or dispose of debris, waste, or other material containing crumbled, flaked, or ground pavement where it may pass into any river, stream, or lake. If DFG determines that an activity may substantially adversely affect fish and wildlife resources, a Lake or Streambed Alteration Agreement is prepared by DFG in compliance with CEQA. The agreement include measures to protect fish and wildlife resources while conducting the activity.

4.2.6 California Native Plant Protection Act

In addition to the California ESA, the California Native Plant Protection Act (NPPA) provides protection to endangered and “rare” plant species, subspecies, and varieties of wild native plants in California. The NPPA’s definition of “endangered” and “rare” closely parallels the California ESA definitions of “endangered” and “threatened” plant species.

4.3 LOCAL REQUIREMENTS AND CONSIDERATIONS

The following sections describe local requirements and considerations for O&M activities carried out by PCWA.

4.3.1 Placer County Conservation Plan

Placer County has shown an active interest in the county’s resources. Placer Legacy is a Placer County program designed to implement the goals of the 1994 Placer County General Plan. Placer Legacy will result in a comprehensive open space and habitat protection plan for Placer County that preserves the diversity of plant and animal communities in the county and addresses a variety of other open space needs, from agriculture and recreation to urban edges and public safety. Placer Legacy is intended to help maintain the county's high quality of life and promote economic vitality.

In June 2000, the Placer County Board of Supervisors directed staff to initiate implementation of the Placer Legacy Program. As part of that direction, staff began preparing an ambitious, large-scale habitat and wetland conservation plan to achieve a number of environmental, economic, and administrative objectives (Placer County Planning Department 2008). This effort, now referred to as the Placer County Conservation Plan (PCCP), is developing the first phase of Placer Legacy Program implementation, which will balance the needs of endangered species and wetlands with a wide variety of stakeholder issues. The PCCP will address the impacts associated primarily with unincorporated growth in western Placer County and growth associated

with the build-out of Lincoln's updated General Plan (Placer County Planning Department 2005c).

The PCCP includes two integrated programs intended to combine State and Federal regulatory requirements into a comprehensive and locally controlled program that will streamline permitting under State and Federal ESAs and other State and Federal environmental laws (Placer County Planning Department 2008). These programs include: (1) a joint Natural Community Conservation Plan (NCCP) and HCP that will protect fish and wildlife and their habitat, and (2) a County Aquatic Resources Program (CARP) that will protect streams, wetlands and other water resources (Placer County Planning Department 2008).

According to the Placer County Planning Department, the NCCP/HCP is intended to:

- Conserve threatened and endangered species in western Placer County
- Avoid or resolve potential conflicts between species conservation and the construction of new urban, suburban, and rural infrastructure and development
- Fulfill the requirements of State and Federal ESAs

The CARP is intended to:

- Protect streams, wetlands, and other water resources
- Avoid or resolve potential conflicts between water resources protection and the construction of new urban and rural infrastructure and development
- Fulfill the requirements of the Federal CWA and analogous State laws

PCWA is a participating entity in the PCCP, along with Placer County, City of Lincoln, and Placer County Transportation Authority on behalf of the South Placer Regional Transportation Authority for the Placer Parkway project. Participating entities will ensure that the PCCP's conservation program is implemented successfully and ensure that projects covered by the PCCP fulfill PCCP mitigation and conservation requirements (Placer County Planning Department 2008).

The PCCP is also intended to provide coverage under the following environmental permits and authorizations to be issued to Participating Entities and extended to projects encompassed by the PCCP (Placer County Planning Department 2008):

- A renewable, 50-year, incidental take permit for 31 species issued by the USFWS under the Federal ESA
- A renewable, 50-year, incidental take permit for three species issued by the NMFS under the Federal ESA

- A renewable, 50-year, incidental take authorization for 34 species issued by the DFG under the NCCP (which also fulfills the requirements of the California ESA)
- A renewable, 5-year, Programmatic Section 404 permit issued by the USACE under the CWA
- A renewable, 5-year, Section 401 certification for the Section 404 permit issued by the Central Valley RWQCB under the CWA
- “Joint Procedures” approved by the USACE that may be used by the Participating Entities for aquatic resource permit processing under the CWA
- A 50-year, programmatic master streambed alteration agreement issued by the DFG.

4.3.2 Placer County Stormwater Management Plan

As part of the NPDES MS4 program, municipalities are required to obtain a permit to develop and implement a Stormwater Management Plan (SWMP) with the goal of reducing the discharge of pollutants to the maximum extent practicable. The Placer County SWMP (2004) provides a comprehensive plan to reduce pollution in stormwater runoff in portions of western Placer County, and is designed to comply with the CWA and meet Federal and State NPDES stormwater regulations for small MS4s. In 2004, the Central Valley RWQCB issued an NPDES permit to Placer County for stormwater management program activities upon receipt of the Placer County SWMP for 2003 to 2008. The permit must be renewed every 5 years. Portions of the PCWA raw water distribution area fall within the NPDES stormwater permit area for western Placer County, and include the Dry Creek, Pleasant Grove Creek, and Auburn Ravine watersheds (Placer County 2004). Placer County’s SWMP includes activities to improve and protect the quality of stormwater runoff, including the following control measures:

- Public education and outreach on stormwater impacts
- Public involvement/participation
- Illicit discharge detection and elimination
- Construction site stormwater runoff control
- Postconstruction stormwater management in new development and redevelopment
- Pollution prevention/good housekeeping for municipal operations

The SWMP provides guidance in establishing BMPs before, during, and after construction activities, as well as long-term maintenance BMPs. Placer County reviews and evaluates each program activity at least once a year to assure their BMPs are effective to the maximum extent practicable. Annual reports on Placer County’s SWMP are provided to the Central Valley RWQCB.

4.3.3 Placer County Code, Tree Preservation Ordinance

The Tree Ordinance adopted by Placer County is contained within the Placer County Code, under Article 12.16. The ordinance sets a policy for the county to preserve trees through the review of all proposed development activities where trees are present on either public or private property, wherever feasible, while at the same time recognizing individual rights to develop private property in a reasonable manner (Placer County, No Date (ND)). The ordinance article does not categorically prohibit tree removal, and contains numerous exemptions for specific types of activities.

Placer County's tree ordinance sets county-wide requirements for projects within riparian zones, permit requirements for removal of landmark trees, removal of more than 50 percent of trees, and commercial firewood cutting, and establishes tree preservation zones (Placer County, ND).

In addition to the tree ordinance established by Placer County, localities within the county have established their own ordinances, including the City of Rocklin.

4.3.4 Placer County Oak Woodland Management Plan

The Placer County Oak Woodland Management Plan was developed through the Oak Woodlands Conservation Act of 2001, which recognizes the importance of California's oak woodlands, how they enhance the natural and scenic beauty of California, the critical role of the private landowner and the importance of private land stewardship (McCreary, 2004). Placer County's plan provides a consistent policy for oak woodland habitats throughout the county and compliments existing programs and policies including: (1) projects subject to an environmental assessment under the CEQA, (2) projects subject to the Placer County Tree Ordinance, and (3) projects evolving out of the Placer Legacy (Placer County Planning Department, ND).

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CHAPTER 5.0 POTENTIAL EFFECTS, REGULATORY FRAMEWORK, AND BEST MANAGEMENT PRACTICES FOR SYSTEMWIDE OPERATIONS

This chapter provides an overview of the potential effects of PCWA raw water distribution systemwide operations on natural resource conditions in the study area, the regulatory framework for effects, and potential BMPs to reduce effects of operations' activities on natural resources.

5.1 POTENTIAL EFFECTS OF SYSTEMWIDE OPERATIONS ON NATURAL RESOURCES

The potential effects of the PCWA canal system operations on physical and biological resources in the study area are described below.

5.1.1 Yearly Outages

The yearly outages that occur within the PCWA canal system, typically from mid-October to mid-November, result in reductions in the amount of water available to PCWA's Zone 1 customers. The following sections describe potential effects of the yearly canal outages on natural resources.

5.1.1.1 Physical Resources

Potential effects of PCWA canal system operations during yearly PG&E outages on hydrology, water quality, and soils and sediment quality conditions in the study area are described in the following sections.

Hydrology

PCWA operations during yearly outages do not affect hydrologic conditions in Canyon Creek or Auburn Ravine. During the yearly outages, PCWA canal system contributions to streamflow in Canyon Creek and Auburn Ravine, and/or diversions from Canyon Creek and Auburn Ravine do not change as a result of PCWA operations.

Continuous flow data collected from canal and stream sites within PCWA's lower Zone 1 service area during 2006 were evaluated to determine the effects of yearly outages on hydrologic conditions in Clover Valley Creek, Antelope Creek, Secret Ravine, and Miners Ravine. Continuous flow monitoring locations used for operations' evaluations, and their respective watersheds, are listed in **Table 5-1**.

**TABLE 5-1
CONTINUOUS FLOW MONITORING STATIONS IN ZONE 1 FOR OPERATIONS**

Secret Ravine Watershed	Miners Ravine Watershed
Secret Ravine at Horseshoe Bar Road	Miners Ravine at Lomida Lane
Tributary to Secret Ravine from Yankee Hill Canal Outlet	Tributary to Miners Ravine from Ferguson Canal Outlet
Tributary to Secret Ravine from Turner Canal Outlet	Tributary to Miners Ravine Stallman Canal Outlet
Boardman Canal Outlet	Tributary to Miners Ravine Baughman Canal Outlet
Secret Ravine at Rocklin Road	Miners Ravine near North Sunrise Avenue

Average daily flows for canal and stream sites evaluated during 2006 outages are shown in **Figure 5-1** for sites within the Secret Ravine watershed, and in **Figure 5-2** for sites within the Miners Ravine watershed.

Based on the average daily flows for sites shown in **Figures 5-1** and **5-2**, streamflow within Secret and Miners ravines is substantially decreased during the yearly outages. Effects on flow conditions in Antelope and Clover Valley creeks are likely similar to conditions shown for Secret and Miners ravines. These data further demonstrate that canal system contributions (including unregulated releases and customer return flows) dominate dry season flows in Secret and Miners ravines. These historic reductions in canal system contributions, and resultant historic decreases in streamflow, are dictated by the PG&E annual water delivery outages.

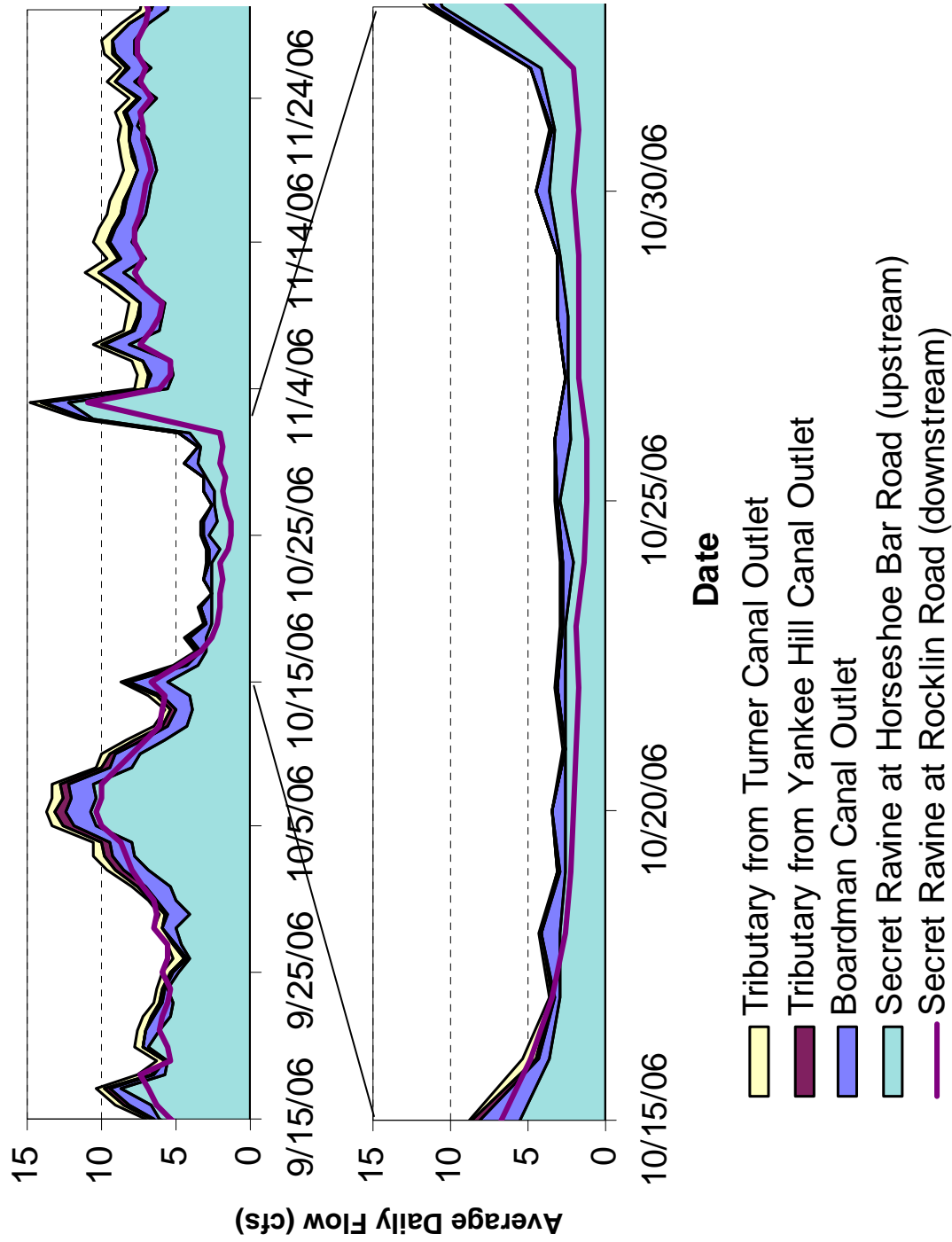


FIGURE 5-1
CANAL OUTLET AND SECRET RAVINE RESPONSES TO YEARLY OUTAGES

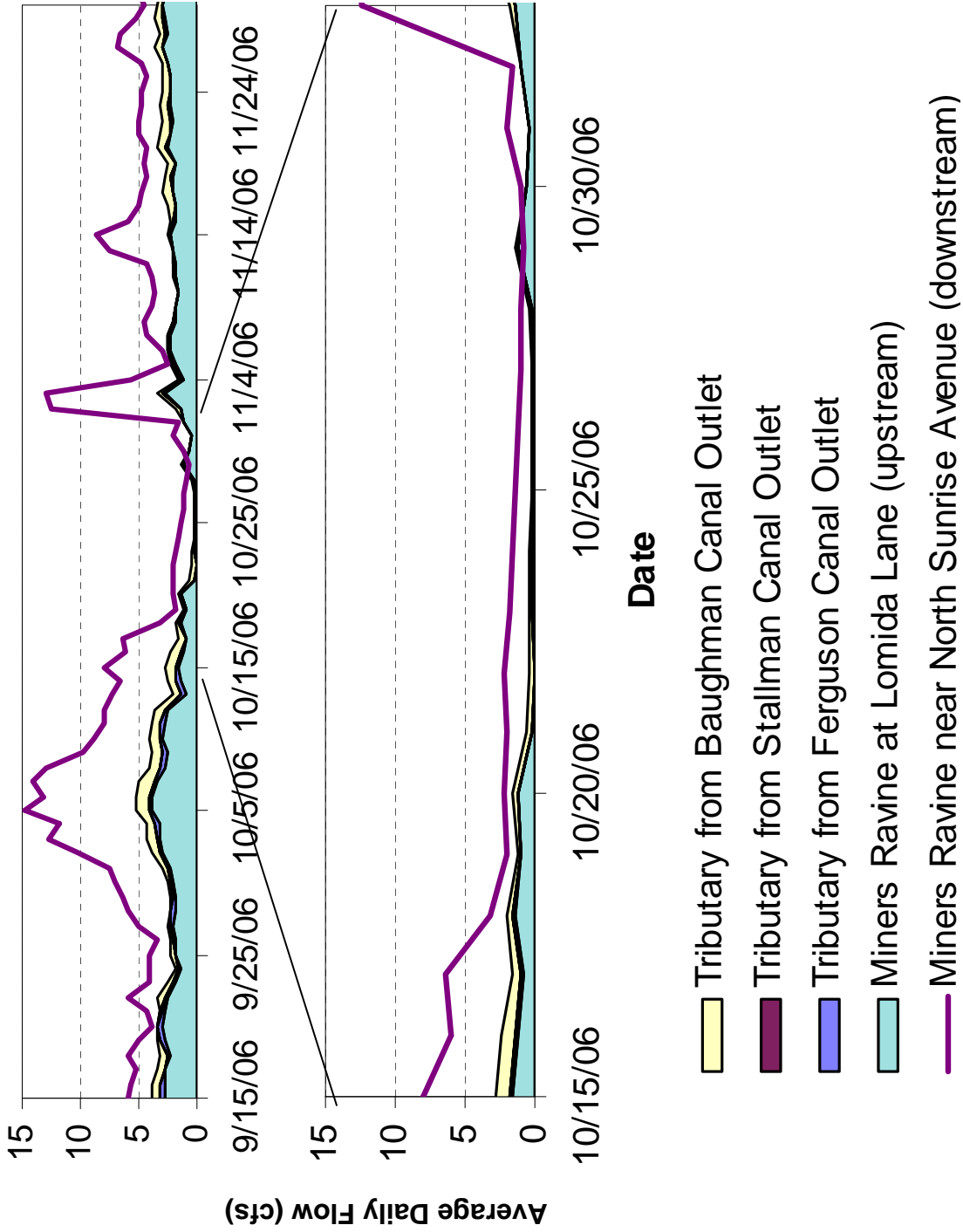


FIGURE 5-2
CANAL OUTLET AND MINERS RAVINE RESPONSES TO YEARLY OUTAGES

Water Quality

The locations listed in **Table 5-2** and shown in **Figures 5-3** and **5-4** were selected to identify potential effects of canal system contributions on water quality conditions in study area streams during yearly outages. The monitoring events targeted outages that occurred at Clover Valley and Mammoth reservoirs, and associated monitoring sites were located in PCWA's Zone 1 service area, within the Antelope Creek, Clover Valley Creek, Secret Ravine, and Miners Ravine watersheds. Outages below the reservoirs occurred on alternate days between the two reservoirs, with outages typically starting at 9:00 a.m., and ending at 9:00 a.m. the following day. Samples were obtained at upstream and downstream locations within the canal system, as well as within the receiving water tributaries and streams downstream of the canal outlets. Monitoring events spanned 2 days for each event. Samples were often collected at each location before, during, and after outage events. Measured water quality parameters are the same as those presented in **Table 3-3** for baseline sampling events, with the exception of mercury. Canal and stream monitoring sites are discussed within their associated watersheds.

Clover Valley Creek Watershed

Water quality monitoring was conducted within the Clover Valley Creek watershed on November 1 and 2, 2006, following the October 31, 2006, outage event. Flows were restored to the PCWA canal system below Clover Valley Reservoir at around 9:00 a.m. on November 1, 2006. The sites monitored within the Clover Valley Creek watershed during the outage event are described below, from the most upstream to the most downstream locations:

- **Clover Valley Reservoir release to Clover Valley Creek (CLVRESR)**
- **Clover Valley Creek at Midas Avenue (CLVRC3):** located at the Sunset Whitney Country Club on Midas Avenue in Rocklin.

The following section describes water quality conditions at sites in the Clover Valley Creek watershed monitored on November 1 and 2, 2006, during the yearly canal outage. Figures providing a comparison of water quality conditions within the PCWA raw water distribution system and Clover Valley Creek are included in **Appendix B**.

**TABLE 5-2
WATER QUALITY MONITORING LOCATIONS IN THE PCWA SERVICE AREA FOR YEARLY OUTAGE EVENTS**

Site Name	Site ID	Type	Watershed(s)	Outage Start / End Time	Weather
Mammoth Reservoir Outage					
Boardman Canal at Lubeck Road	YB69A	Canal	NA	Start: 10/30/2006, 9:00 a.m.	
Boardman Canal at Powerhouse Road	YB78	Canal	NA		
Boardman Canal below Mammoth Reservoir	YB81	Canal	Miners Ravine / Secret Ravine	End: 10/31/2006, 9:00 a.m.	11/01/2006: Clear and dry
Yankee Hill Canal Tributary	YHTRIB2	Stream	Secret Ravine		
Boardman Canal Outlet Release	BOARDMANCR	Canal	Secret Ravine		
Secret Ravine at Rocklin Road	SECRETREV3	Stream	Secret Ravine	Start: 11/01/2006, 9:00 a.m.	11/02/2006: Light rain at 11:22 a.m. Heavy rain at 3:38 p.m.
Secret Ravine at Roseville Parkway	SECRETREV2	Stream	Secret Ravine		
Baughman Canal Outlet Release	BAUGHMANCR	Canal	Miners Ravine		
Tributary to Miners Ravine from Baughman Canal	BCTRIB1	Drainage	Miners Ravine	End: 11/02/006, 9:00 a.m.	
Miners Ravine near N. Sunrise Avenue	MINERSRV3	Stream	Miners Ravine		
Clover Valley Reservoir Outage					
Clover Valley Reservoir release to Clover Valley Creek and Antelope Canal	CLVRESR	Canal	Clover Valley Creek	Start: 10/31/2006, 9:00 a.m.	11/01/2006: Clear and dry
Clover Valley Creek at Midas Avenue	CLVRC3	Stream	Clover Valley Creek		
Antelope Stub Canal near Antelope Canal	ANTSTUBCR	Canal	Antelope Creek	End: 11/01/2006 9:00 a.m.	11/02/2006: Light rain at 10:15 a.m.
Antelope Creek at Midas Avenue	ANTC3B	Stream	Antelope Creek		
Antelope Creek near Sierra College Blvd	ANTC3	Stream	Antelope Creek		
Mammoth Reservoir Outage					
Boardman Canal below Mammoth Reservoir	YB81	Canal	Miners Ravine / Secret Ravine	Start: 10/27/2007, 9:00 a.m.	10/27/2007: Clear and dry
Yankee Hill Canal Outlet Release	YANKEECR	Canal	Secret Ravine		
Boardman Canal Outlet Release	BOARDMANCR	Canal	Secret Ravine		
Yankee Hill Canal Tributary	YHTRIB2	Stream	Secret Ravine	End: 10/28/2007, 9:00 a.m.	10/28/2007: Clear and dry
Secret Ravine at Rocklin Road	SECRETREV3	Stream	Secret Ravine		
Secret Ravine at Roseville Parkway	SECRETREV2	Stream	Secret Ravine		

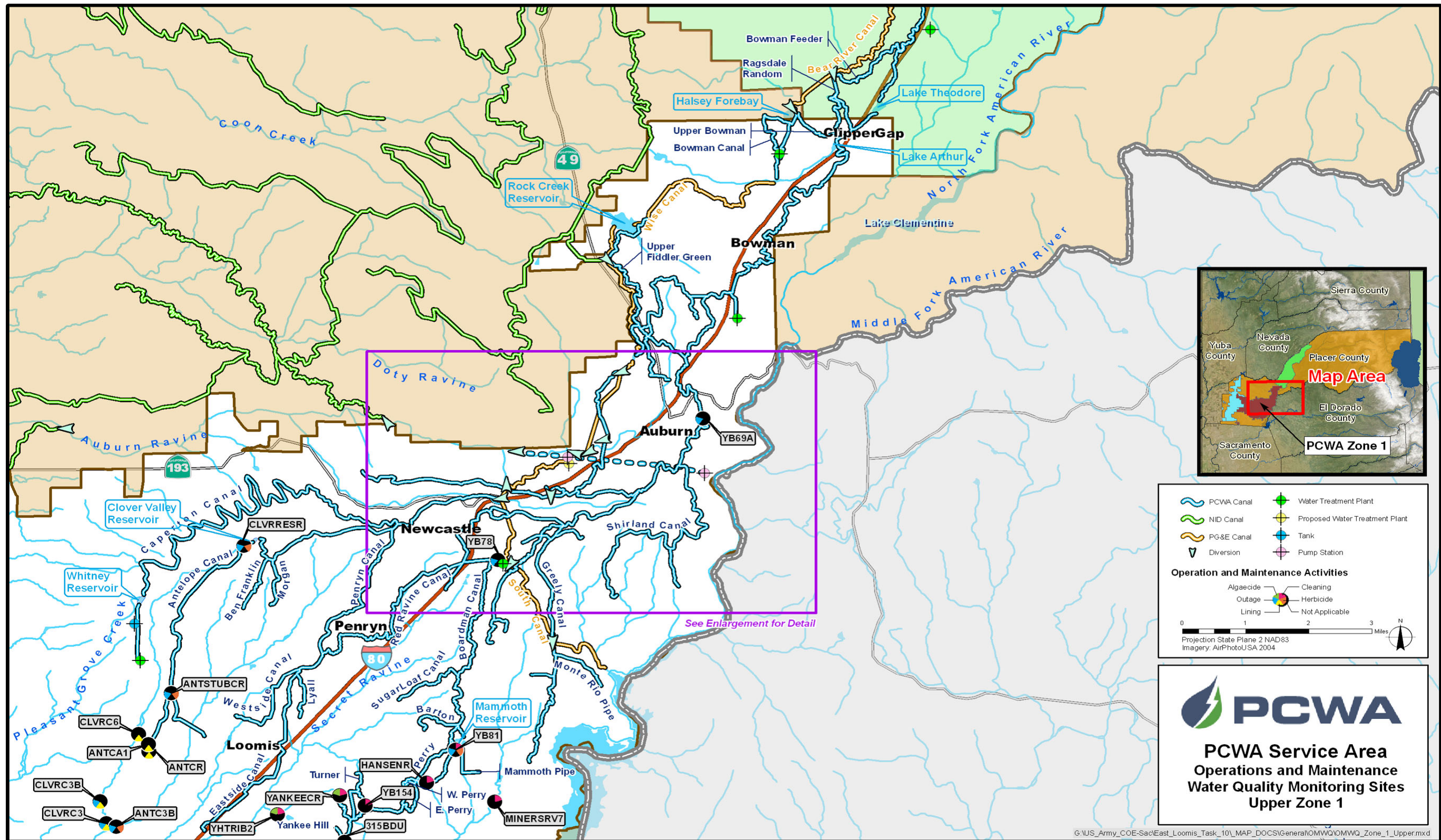


FIGURE 5-3
OPERATIONS AND MAINTENANCE ACTIVITY WATER QUALITY SAMPLING LOCATIONS WITHIN THE UPPER ZONE 1 SERVICE AREA

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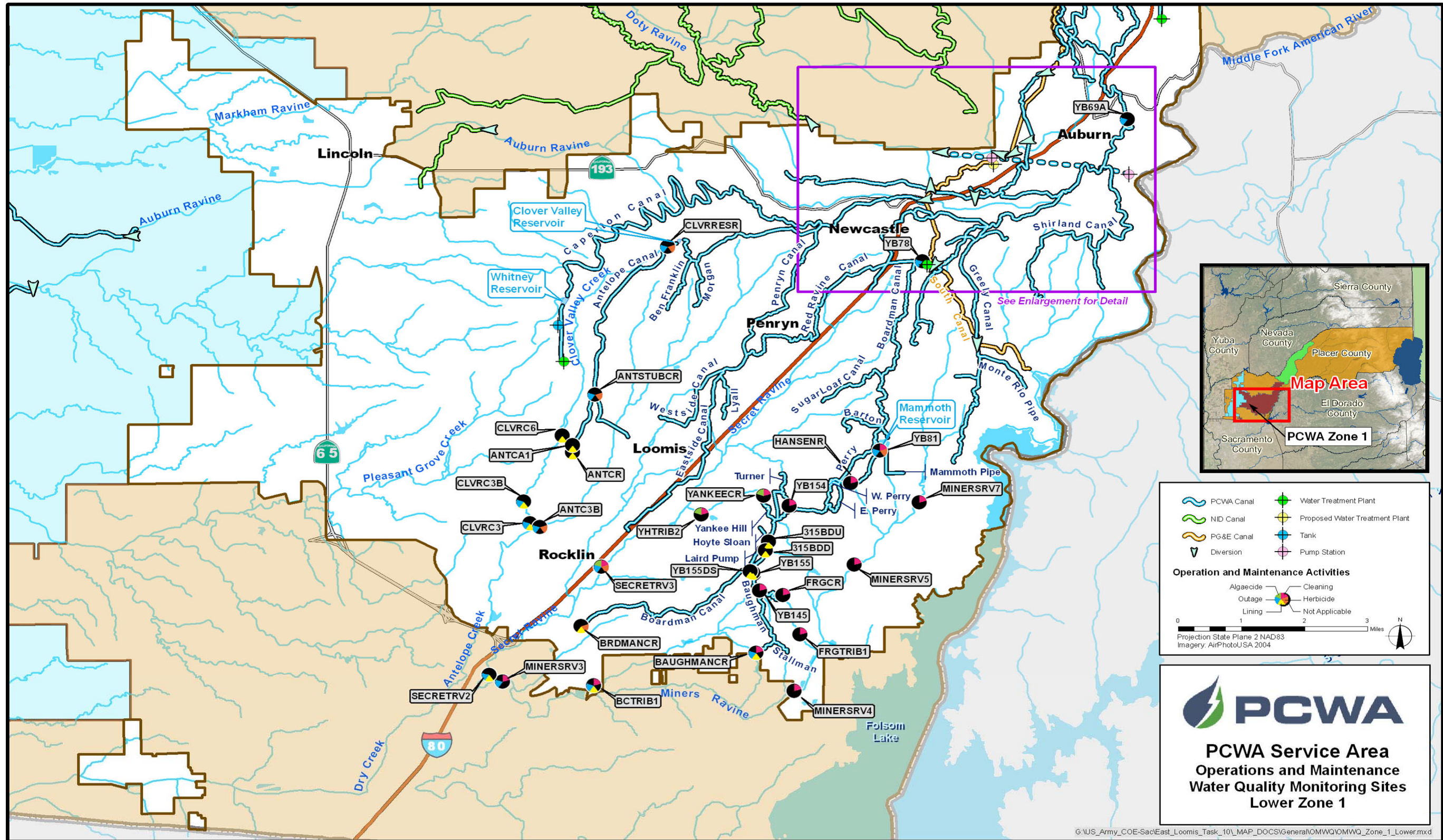


FIGURE 5-4
OPERATIONS AND MAINTENANCE ACTIVITY WATER QUALITY SAMPLING LOCATIONS WITHIN THE LOWER ZONE 1 SERVICE AREA

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Water Temperature and Dissolved Oxygen

PCWA operations during the yearly outages did not result in notable effects on water temperature in Clover Valley Creek. Water temperatures in the Clover Valley watershed were higher during the November 1 to 2, 2006, outage event compared to the fall baseline, collected on December 12, 2006. These temperature differences, however, are likely due to the gradual decreases in air temperature observed between the sampling dates.

DO levels across canal and stream sites monitored during the event were relatively high. Based on the water quality data collected before, during, and after the outage, DO levels in Clover Valley Creek did not appear to be affected by the yearly outage.

pH, Alkalinity, and Hardness

Values for pH across sites monitored in the Clover Valley Creek watershed were not affected by the outage. Alkalinity and calculated total hardness levels were generally higher at CLVRC3 than at CLVRESR, suggesting that canal system contributions may decrease alkalinity and hardness conditions in Clover Valley Creek.

Total Suspended Solids and Turbidity

Based on sampling results, TSS concentrations and turbidity in Clover Valley Creek did not appear to be affected by the canal system outage. TSS concentrations and turbidity did increase at Clover Valley Creek on November 2, 2006 (after canal flows were restored below Clover Valley Reservoir), most likely in response to runoff contributions to streamflow during the November 2, 2006, precipitation event.

Specific Conductivity and Ions

Based on water quality data collected across the Clover Valley Creek watershed, SC, calcium, iron, magnesium, sodium, chloride, and sulfate concentrations in Clover Valley Creek did not appear to be affected by the yearly canal outages. Some constituents, including SC, calcium, magnesium, and iron did have higher concentrations in samples collected from Clover Valley Creek on November 2, 2006, most likely in response to runoff contributions to streamflow during the November 2, 2006, precipitation event.

Nitrate and potassium concentrations are not affected by yearly outages. Nitrate levels were at or slightly above the nondetect level (0.1 mg/L) throughout the monitoring period, while potassium concentrations were either below the detection limit (1 mg/L) or very low across all sites. Potassium reached a maximum level of 2.5 mg/L at CLVRC3.

Trace Elements

Barium and zinc concentrations across sites in the Clover Valley Creek watershed showed similar trends as TSS and turbidity in samples obtained during the outage event, and did not appear to be affected by yearly outages. Barium levels at CLVRC3 ranged from 73 to 110 µg/L, compared to the maximum observed during routine canal operations, 42 µg/L. Concentrations of barium and zinc were higher at CLVRC3 on November 2, 2006, most likely in response to runoff contributions to streamflow during the to the November 2, 2006, precipitation event. Aluminum concentrations at canal and stream sites monitored during the yearly outage event were comparable for most samples. One sample obtained at Clover Valley Creek on November 2, 2006, had a substantially higher concentration of aluminum compared to previous samples and

samples obtained during baseline sampling events. Copper concentrations were consistently low across canal sites and slightly higher in Clover Valley Creek. The highest measured concentration of copper in Clover Valley Creek during yearly outage sampling event was 8.5 µg/L. All cadmium levels were below the detection limit (0.5 µg/L) at Clover Valley Creek watershed sites during the yearly outage monitoring event.

Antelope Creek Watershed

Water quality monitoring was conducted within the Antelope Creek watershed on November 1 and 2, 2006, following the October 31, 2006, outage event. Flows were restored to the PCWA canal system below Clover Valley Reservoir at around 9:00 a.m. on November 1, 2006. The sites monitored in the Antelope Creek watershed during the outage event are described below, from the most upstream to the most downstream locations:

- **Antelope Stub Canal near Antelope Canal (ANTSTUBCR):** located at the head of Antelope Stub Canal and Antelope Canal.
- **Antelope Creek at Midas Avenue (ANTC3B)**

The following section describes water quality conditions at sites in the Antelope Creek watershed monitored on November 1 and 2, 2006, during the yearly canal outage. Figures providing a comparison of water quality conditions within the PCWA raw water distribution system and Antelope Creek are included in **Appendix B**.

Water Temperature and Dissolved Oxygen

Based on measurements taken at sites, yearly outages did not appear to affect water temperature conditions in Antelope Creek. Little to no water temperature changes were observed at ANTSTUBCR and ANTC3/ANTC3B during monitoring for the November 1, 2006, outage event at Clover Valley Reservoir. Water temperatures measured within the Antelope Creek watershed ranged from 50.8 to 59.0 °F.

DO concentrations in Antelope Creek during and after the outage at Clover Valley Reservoir were comparable to conditions during baseline sampling events, and are not likely affected by PCWA operations during yearly outages. Overall, DO concentrations were higher at ANTSTUBCR than at ANTC3/ANTC3B.

pH, Alkalinity, and Hardness

Based on water quality data collected, yearly outages did not affect pH, alkalinity, and hardness in Antelope Creek. Results for pH, alkalinity, and hardness across sites in the Antelope Creek watershed were fairly invariable during and after the outage at Clover Valley Reservoir. Alkalinity and hardness values were consistently lower, and pH was consistently higher, within the canal system compared to Antelope Creek.

Total Suspended Solids and Turbidity

TSS concentrations and turbidity levels in samples collected from Antelope Creek were not affected by PCWA canal system operations during the yearly outage sampling event. TSS and turbidity values were consistently low across all sites monitored during the event.

Specific Conductivity and Ions

Based on water quality monitoring during the yearly outage event, SC and ion concentrations did not appear to be affected by PCWA operations during yearly outages. Little SC variation was observed across sites monitored in the Antelope Creek watershed during the yearly outage event. Overall, SC was higher in Antelope Creek compared to the canal system.

Calcium, iron, magnesium, sodium, chloride, and sulfate concentrations were also consistently higher in Antelope Creek, and demonstrated little variation during and after the outage event. Nitrate and potassium concentrations were low across all sites sampled during and after the outage at Clover Valley Reservoir.

Trace Elements

Barium and copper concentrations in samples collected from Antelope Creek increased after flows were restored to Antelope Canal following the Clover Valley Reservoir outage. These increases may be attributed to precipitation in the watershed and runoff contributions to streamflow, or to PCWA operations during the yearly outage. Aluminum concentrations in Antelope Creek also increased, but were comparable to concentrations measured during baseline sampling events. Zinc concentrations in samples were fairly constant during and after the outage, and were comparable across sites sampled in the Antelope Creek watershed. All samples collected had cadmium concentrations below the detection limit (0.5 µg/L).

Secret Ravine Watershed

As shown in **Table 5-2**, water quality monitoring in the Secret Ravine watershed was conducted during two different outage events at Mammoth Reservoir; November 1 and 2, 2006, following the November 1, 2006, outage, and October 28, 2007, following the October 27, 2007, outage. For the 2006 outage monitoring event, flows were restored to the PCWA canal system below Mammoth Reservoir at around 9:00 a.m. on October 31, 2006, and November 2, 2006. Flows were restored to the PCWA canal system below Mammoth Reservoir at around 9:00 a.m. on October 28, 2007, for the 2007 outage monitoring event. Water quality was monitored at three canal sites (Boardman Canal at Lubeck Road (YB69A), YB78, and YB81) and one stream site in Secret Ravine (SECRETRV3), for the November 1 to 2, 2006, monitoring event. On October 28, 2007, monitoring occurred at three canal sites (YB81, YANKEECR, Boardman Canal Outlet Release (BOARDMANCR)) and three stream sites (YHTRIB2, SECRETRV3, Secret Ravine at Roseville Parkway (SECRETRV2)). Only water temperature, DO, pH, SC, turbidity, alkalinity, sulfate, and copper were measured during the October 28, 2007, event. The sites monitored during the yearly outage events are described below, from the most upstream to the most downstream locations:

- **Boardman Canal at Lubeck Road (YB69A):** located east of the railroad tracks on Lubeck Road in Auburn. This is the most upstream monitoring site for yearly outage events.
- **Boardman Canal at Powerhouse Road (YB78)**
- **Boardman Canal below Mammoth Reservoir (YB81)**

- **Yankee Hill Canal Outlet Release (YANKEEER)**
- **Tributary to Secret Ravine from Yankee Hill Canal (YHTRIB2)**
- **Secret Ravine at Rocklin Road (SECRETRV3)**
- **Boardman Canal Outlet Release (BOARDMANCR):** located at the end of the Boardman Canal. Unregulated releases from the Boardman Canal currently flow through a planned residential development, and outflow directly to Secret Ravine. This is the most downstream terminal point within the PCWA raw water distribution system.
- **Secret Ravine at Roseville Parkway (SECRETRV2):** located just upstream from its confluence with Miners Ravine.

The following section describes water quality conditions during the yearly canal outage at sites in the Secret Ravine watershed monitored on November 1 and 2, 2006, and October 28, 2007. Figures providing a comparison of water quality conditions within the PCWA raw water distribution system and Secret Ravine are included in **Appendix B**.

Water Temperature and Dissolved Oxygen

Based on water quality data obtained during sampling events, water temperature and DO conditions in Secret Ravine do not appear to be affected by PCWA operations during yearly outages. Water temperature and DO values at sites monitored in Secret Ravine were comparable to conditions sampled during baseline sampling events. Water temperature and DO fluctuations at sites are likely attributed to natural variability due to diurnal effects, such as photosynthesis and respiration.

pH, Alkalinity, and Hardness

The yearly outages did not appear to affect pH within the PCWA canal system, but measured values for pH in Secret Ravine on November 1 and 2, 2006, fluctuated from 6.67 to 7.51. No effects on pH were observed at sites monitored in the Secret Ravine watershed during the October 28, 2007, sampling event. Alkalinity and hardness are not likely affected by yearly outages. Measured values for all sites in the Secret Ravine watershed were comparable to values measured during baseline sampling events.

Total Suspended Solids and Turbidity

Based on data collected on November 1 and 2, 2006, for the yearly outages, TSS levels in Secret Ravine are not affected by the yearly outages. One sample obtained at SECRETRV2 did have a high concentration of TSS, but the value is most likely associated with heavy rain and runoff contributions to streamflow at the time of sampling. TSS was not evaluated during the October 2007 sampling event.

The yearly outages may affect turbidity conditions in Secret Ravine. Measured values of turbidity at canal sites during the November 2006 sampling event fluctuated during sampling, but did not result in variation in turbidity at Secret Ravine sampling sites. During the October 2007 sampling event, turbidity values at canal and stream sites in the Secret Ravine watershed

increased after flows were restored to the canal system (**Figure 5-5**). These higher values were likely attributed to mobilization of fine sediment and organic material that had settled when canals were dewatered during the outage.

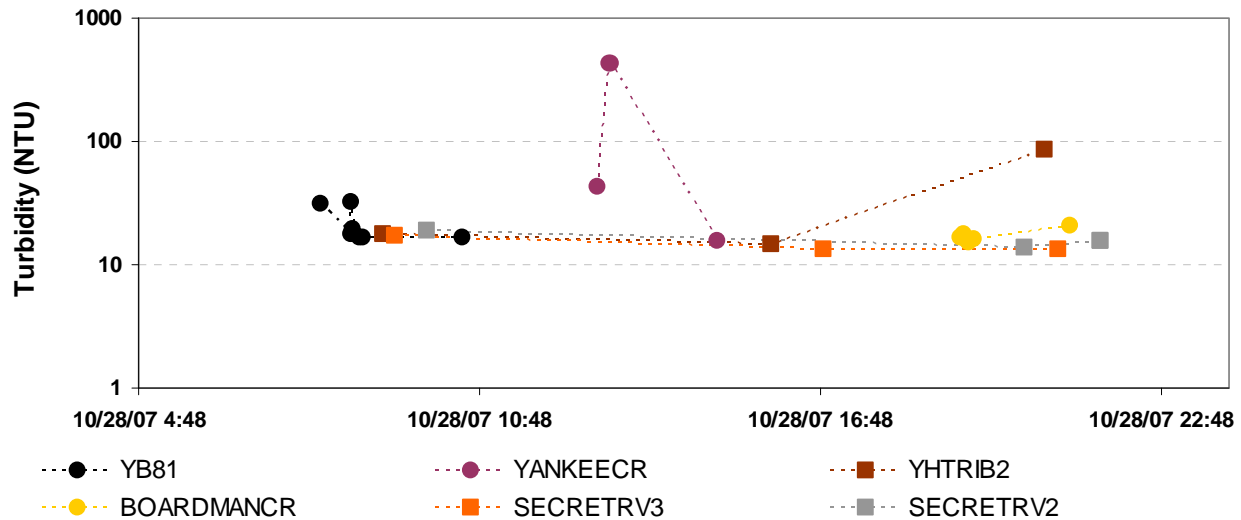


FIGURE 5-5
MEASURED TURBIDITY VALUES AT SECRET RAVINE WATERSHED SITES
DURING OCTOBER 2007 YEARLY OUTAGE SAMPLING EVENT

Specific Conductivity and Ions

Based on water quality monitoring during the yearly outage events, SC and ion concentrations at sites sampled in Secret Ravine did not appear to be affected by PCWA operations during yearly outages. Measured SC values remained relatively low at all sites sampled during the November 2006 and October 2007 outages, with Secret Ravine sites exhibiting higher values than canal sites. Calcium, magnesium, sodium, chloride, and sulfate concentrations were also consistently higher in Secret Ravine, and demonstrated little variation during and after the November 2006 outage event. Iron concentrations across canal and stream sites increased after heavy rainfall in the watershed, and are most likely associated with runoff contributions to streamflow at the time of sampling. Nitrate and potassium concentrations were low across all sites sampled in the Secret Ravine watershed during and after the November 2006 outages at Mammoth Reservoir.

Trace Elements

Based on water quality data collected, PCWA operations during the November 2007 yearly outage event did not affect barium, cadmium, copper, or zinc concentrations in Secret Ravine. Barium, copper, and zinc concentrations did increase at canal and stream sites on November 2, 2006, likely due to heavy rain and runoff contributions to streamflow. During the precipitation event, barium and copper concentrations reached 58 µg/L and 21 mg/L, respectively, at SECRETRV3, while zinc concentrations at YB69A and SECRETRV3 measured 71 and 60 µg/L, respectively. All samples had cadmium concentrations below the detection limit (0.5 µg/L) during the 2006 yearly outage monitoring event. Aluminum concentrations at canal sites monitored during the November 2006 yearly outage event were consistently higher than samples

obtained in Secret Ravine, and higher at all sites after heavy rain in the watershed, most likely due to heavy rain and runoff contributions to canal and streamflows at the time of sampling.

During the October 2007 sampling event, measured copper values at canal and stream sites in the Secret Ravine watershed increased after flows were restored to the canal system (**Figure 5-6**). These higher values were likely attributed to mobilization of copper associated with fine sediment and organic material that had settled when canals were dewatered during the outage.

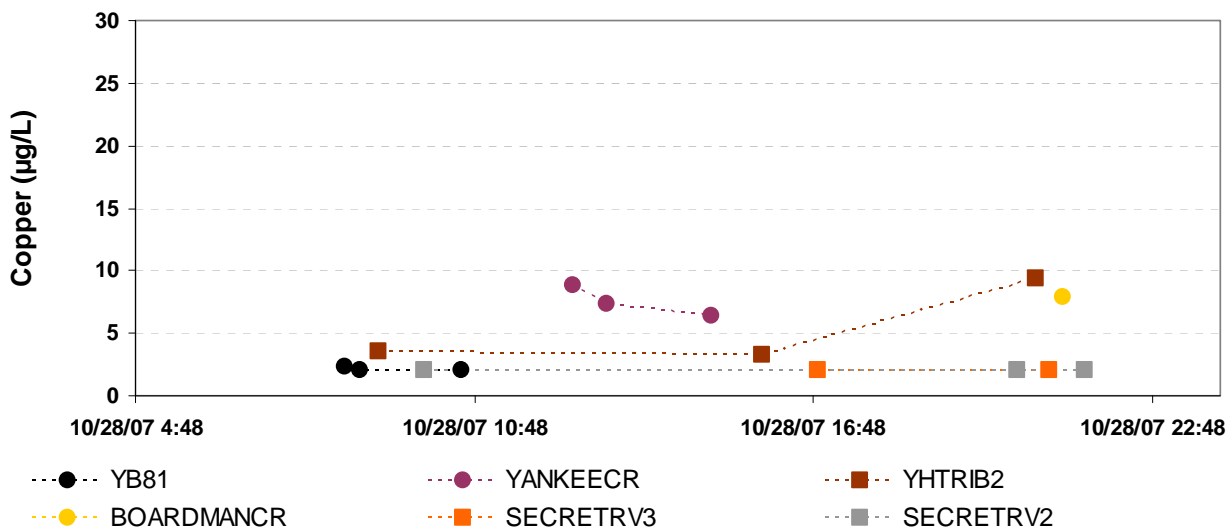


FIGURE 5-6
MEASURED COPPER CONCENTRATIONS AT SECRET RAVINE WATERSHED
SITES DURING THE OCTOBER 2007 YEARLY OUTAGE SAMPLING EVENT

Miners Ravine Watershed

As with the Secret Ravine watershed, water quality monitoring in the Miners Ravine watershed was conducted during two different outage events at Mammoth Reservoir; November 1 and 2, 2006, following the November 1, 2006 outage, and October 28, 2007, following the October 27, 2007, outage. For the 2006 outage monitoring event, flows were restored to the PCWA canal system below Mammoth Reservoir at around 9:00 a.m. on October 31, 2006, and November 2, 2006. Flows were restored to the PCWA canal system below Mammoth Reservoir at around 9:00 a.m. on October 28, 2007, for the 2007 outage monitoring event. BAUGHMANCR was monitored along with some canal monitoring sites also used for analysis within the Secret Ravine watershed (YB69A, YB78, and YB81). Water quality was monitored at two stream sites during this event (BCTTRIB1 and MINERSRV3). During the October 28, 2007, monitoring sites were located at YB81 and MINERSRV3. Only water temperature, DO, pH, SC, turbidity, alkalinity, sulfate, and copper were measured during the October 28, 2007, event. The sites monitored in the Miners Ravine watershed during the yearly outage events are described below, from the most upstream to the most downstream locations:

- **Boardman Canal at Lubeck Road (YB69A)**
- **Boardman Canal at Powerhouse Road (YB78)**
- **Boardman Canal below Mammoth Reservoir (YB81)**
- **Baughman Canal Outlet Release (BAUGHMANCR)**
- **Tributary to Miners Ravine from Baughman Canal (BCTRIB1)**
- **Miners Ravine near N. Sunrise Avenue (MINERSRV3)**

The following section describes water quality conditions during the yearly canal outage at sites in the Miners Ravine watershed monitored on November 1 and 2, 2006, and October 28, 2007. Figures providing a comparison of water quality conditions within the PCWA raw water distribution system and Miners Ravine are included in **Appendix B**.

Water Temperature and Dissolved Oxygen

Based on results of water quality monitoring, water temperature and DO conditions in Miners Ravine were not affected by PCWA operations during the yearly outages. Water temperature and DO values at BCTRIB1 and MINERSRV3 were comparable to values measured during baseline sampling events. Water temperature and DO fluctuations at sites were likely attributed to natural variability due to diurnal effects, such as photosynthesis and respiration.

pH, Alkalinity, and Hardness

Monitoring results suggest that Miners Ravine pH, alkalinity, and hardness values were not likely affected by PCWA operations during yearly outages. Measured values for pH and alkalinity decreased at BCTRIB1 and MINERSRV3 following the outage at Mammoth Reservoir. These fluctuations were not likely associated with the decreased canal flows because pH and alkalinity values at canal sites remained consistent. Values for pH, alkalinity, and hardness across canal and stream sites in the Miners Ravine watershed were comparable to values measured during baseline sampling events.

Total Suspended Solids and Turbidity

Measured TSS concentrations at stream sites monitored in the Miners Ravine watershed during the November 2006 event were not affected by PCWA operations during the yearly outages. TSS concentrations were close to or below detection limits at all sites monitored on November 1, 2006, and increased at sites sampled during and after heavy rain on November 2, 2006. Higher TSS concentrations at sites sampled on November 2, 2006, are likely associated with heavy rain and runoff contributions to flow at sites during sampling. TSS was not evaluated during the October 2007 sampling event.

Turbidity values measured at sites during the November 2006 outage event followed the same trends described for TSS, demonstrating no effects associated with PCWA operations during the yearly outages. Measured turbidity values during the October 2007 also suggest that the yearly outages are not likely to affect turbidity in Miners Ravine.

Specific Conductivity and Ions

Based on results of water quality monitoring, PCWA operations during yearly outages did not affect SC and ion concentrations in Miners Ravine. Measured SC and ion values at sites were comparable to values measured during baseline sampling events at sites in the Miners Ravine watershed. SC was consistently low (less than 0.2 mS/cm) across all sites during monitoring, with the exception of one sample obtained at the Baughman Canal Outlet Release on November 1, 2006 (0.5 mS/cm). Calcium, magnesium, sodium, chloride, and sulfate concentrations were also consistently higher in Miners Ravine during the November 2006 outage event, and demonstrated little variation during and after the outage event. Iron, nitrate, and potassium concentrations were low across all sites sampled in the Miners Ravine watershed, and had slightly higher concentrations in Miners Ravine during heavy rain. Measured sulfate concentrations during the October 2007 outage event were also consistently higher in Miners Ravine, and demonstrated little variation at canal and stream sites during and after the outage event.

Trace Elements

Barium, zinc, and copper concentrations were consistently low across canal and stream sites during the November 2006 yearly outage, but increased following heavy rain in the watershed. Aluminum concentrations were comparable to values measured during baseline sampling events, but also increased across sites after heavy rain. The higher concentrations of barium, zinc, copper, and aluminum follow the same trend as TSS, and are most likely due to high flows at sites during sampling, which may have mobilized sediments and metals bound in sediments. Copper concentrations across canal and stream sites were consistently low during the November 2006 and October 2007 yearly outage monitoring events. All cadmium concentrations were below the detection limit (0.5 µg/L) during the 2006 yearly outage monitoring event.

Soils and Sediment Quality

Soils and sediment quality in the study area are not likely to be affected by PCWA activities during the annual PG&E delivery outages. PCWA operations during the yearly outages do not disturb soils in the study area, or introduce constituents that may affect sediment quality.

5.1.1.2 Biological Resources

The following sections describe effects of PCWA operations during yearly outages to terrestrial and aquatic habitat and species.

Terrestrial Habitat and Species

Yearly outages are not expected to have substantial effects on terrestrial habitats and species. Historic decreases in water delivery during the PG&E outages could result in temporary minimal decreases in the extent of wetland habitats that may be indirectly supported by canal deliveries. This could have minimal effects on species that use wetland habitats such as foraging birds and amphibians by decreasing the amount of available habitat, but these effects are representative of historic conditions within the study area.

Other changes in water quality, such as increased water temperature, decreased DO, and increased pH and alkalinity could have some negative effects on plants and wildlife on the margins of canals and tributaries; however, any effects are expected to be very minimal because these changes are anticipated to be very small.

Aquatic Habitat and Species

PCWA's operations during yearly outages likely affect fish found in the canal system, potentially including brown trout (*Salmo trutta*), rainbow trout (*Oncorhynchus mykiss*), catfish (*Ictalurus* or *Ameiurus* sp.), Sacramento sucker (*Catostomus occidentalis*), Sacramento pikeminnow (*Ptychocheilus grandis*), black bass (*Micropterus* sp.), and mosquitofish (*Gambusia affinis*) (PCWA 2004; field observations, MWH). Potential effects to fish in the canal system are associated with canal system dewatering.

Aquatic habitat and species in Canyon Creek and Auburn Ravine are not affected by PCWA operations during the PG&E annual outages since the operations do not alter hydrologic and water quality conditions in Canyon Creek and Auburn Ravine.

As described above and shown in **Figure 5-2**, decreased and intermittent canal system flows during the PG&E yearly outages result in reduced flow contributions from the PCWA canal system and flow reductions in Clover Valley Creek, Antelope Creek, Secret Ravine, and Miners Ravine. These flow reductions likely affect aquatic habitat and species in these streams. The reduced canal system contributions, and resultant decreased flow in Clover Valley Creek, Antelope Creek, Secret Ravine, and Miners Ravine are dictated by the PG&E annual water delivery outages. PCWA's reliance on stored water in surface reservoirs and water delivered through the ARPS to supplement flow to WTPs and canal customers during the yearly outages limits PCWA's ability to maintain canal system flows. Antecedent hydrologic conditions may reduce or accentuate the effects of PCWA's operations during yearly outages on aquatic habitat and species in Clover Valley Creek, Antelope Creek, Secret Ravine, and Miners Ravine.

Special Status Species

PCWA operations during PG&E's yearly outages are not expected to have substantial effects on terrestrial special status species. Historic decreases in water delivery during the PG&E outages could result in temporary minimal decreases in the extent of wetland habitats that may be indirectly supported by the canal system. This could have minimal effects on species that use these habitats wetland habitats, such as foraging special status bird and amphibian species by decreasing the amount of available habitat, but these effects are representative of historic conditions within the study area. The typical timing of the outage period from mid-October to mid-November is outside of the breeding period for special status amphibians. California red-legged frog breeding occurs between late November and March, though most frogs lay eggs in March (USFWS 2002, Stebbins 2003). The foothill yellow-legged frog breeds mid-March through early June, and the western spadefoot toad breeds late January through July (Stebbins 2003).

Other changes in water quality, such as increased water temperature, decreased DO, and increased pH and alkalinity could have some negative effects on plants and wildlife on the

margins of canals and tributaries; however, any effects are expected to be minimal because these changes are anticipated to be small.

Fall-run Chinook salmon and Central Valley steelhead spawn in both Secret and Miners ravines. Because streamflows are typically lower, and water temperatures higher in the Dry Creek watershed, spawning often occurs later than in other Central Valley streams. Historic reductions in streamflow contributions from the canal system during PG&E's yearly outages may also delay the spawning migration.

Fall-run Chinook salmon may begin spawning activities from early November to December, which may, in some years, coincide with the tail end of PG&E's yearly outages and the resulting streamflow reductions. If the reduction of canal system contributions to streamflow occurs after spawning has begun, there is a potential for redd dewatering, providing the flow and stage decrease occurs where spawning has occurred.

Central Valley steelhead typically do not start their upstream migration until after a large storm event, typically after the PG&E yearly outages are completed. Spawning also occurs after the outages, so spawning and egg incubation would not be affected by the outages. Juvenile outmigration typically occurs before the PG&E outages. Steelhead do, however, rear year-round, especially in Secret Ravine, and may be affected by the PG&E yearly outages through the reduction or loss of rearing habitat, and the potential increase in predation rates. The level of effect to the rearing steelhead is dependent upon how low the flows drop during the annual outages, and if the water temperatures increase. If flows decrease too much, or if water temperatures rise too high, steelhead will move to locations more suitable, most likely downstream into Dry Creek.

5.1.2 Seasonal Customer Delivery Schedule Changes

The following sections describe potential effects of PCWA's seasonal customer delivery schedule changes on physical and biological resources in the study area. PCWA's customer delivery schedule changes typically take 1 week to complete, with minimal interruptions to service. Post-irrigation season customer delivery schedule changes coincide with yearly outages.

5.1.2.1 Physical Resources

Potential effects of PCWA seasonal delivery schedule changes on hydrology, water quality, and soils and sediment quality conditions in the study area are described in the below sections.

Hydrology

PCWA customer delivery schedule changes do not affect hydrologic conditions in Canyon Creek. Diversions from Canyon Creek to PCWA's Pulp Mill Canal, and resulting streamflow in Canyon Creek, are maintained during delivery schedule changes.

Hydrologic conditions in Auburn Ravine are not affected by customer delivery schedule changes. PCWA customer delivery schedule changes along Auburn Ravine and in the Zone 5 service area do not require any exchanges of orifices at customer delivery points. PCWA's water diversions to Auburn Ravine are limited to the irrigation season, when natural flows in Auburn

Ravine are low. Also, PCWA contributions to streamflow in Auburn Ravine during the irrigation season are a fairly small fraction of the flow augmentation that occurs through other irrigation conveyance and return flow, hydroelectric generation releases, and treated effluent discharges.

Delivery schedule changes after the irrigation season do not affect the hydrologic conditions in Clover Valley Creek, Antelope Creek, Secret Ravine, or Miners Ravine. As described above, post-irrigation season delivery schedule changes coincide with yearly outages.

Delivery schedule changes during the irrigation season also are not likely to affect hydrologic conditions in Clover Valley Creek, Antelope Creek, Secret Ravine, or Miners Ravine. The orifice changes at customer delivery points do not require canal dewatering and have minimal interruptions to service.

Water Quality

As described above, PCWA's activities associated with delivery schedule changes typically coincide with other O&M activities that require canal dewatering, such as yearly outages, canal lining/guniting, and canal cleaning and flushing. However, because delivery schedule changes do not require dewatering, water quality conditions in study area streams are not likely to be affected by PCWA operations during irrigation season delivery schedule changes. It is possible that sediment and/or debris could enter the canals from canal banks if PCWA personnel need to enter the canals to switch out orifice plates, but would not likely result in water quality effects at canal outlets. Effects of outages during the fall season delivery schedule changes are described above in the yearly outages section.

Soils and Sediment Quality

Soils and sediment quality in the study area are not likely to be affected by PCWA's seasonal customer delivery schedule changes. PCWA operations during seasonal customer delivery schedule changes do not disturb soils in the study area, or introduce constituents that may affect sediment quality.

5.1.2.2 Biological Resources

The following sections describe effects of PCWA operations during seasonal customer delivery schedule changes on terrestrial and aquatic habitat and species.

Terrestrial Habitat and Species

Very minimal effects are likely to occur to terrestrial habitats and species, mostly associated with trampling vegetation while orifices are being changed.

Aquatic Habitat and Species

Aquatic habitat and species are not affected by seasonal customer delivery schedule changes. As described above, hydrology and water quality conditions in study area streams are not likely affected by seasonal customer delivery schedule changes.

Special Status Species

Effects on special status plant species (see **Tables 3-12** and **3-13**) are unlikely to occur because they are not expected to be present along canal banks. Some potential negative effects could occur to special status raptors if they are nesting near work areas that may be disturbed by noise. Special status raptors potentially occurring in the study area include Swainson's hawk, Cooper's hawk (*Accipiter cooperi*), Northern Goshawk (*Accipiter gentiles*), White-tailed Kite, and Northern Harrier. As mentioned above, the nesting period for raptors is generally March 1 to August 15.

Because hydrology and water quality conditions in study area streams supporting salmonids are not altered, Central Valley steelhead and fall-run Chinook salmon are not affected by seasonal customer delivery schedule changes.

5.1.3 Seasonal Flood Management Practices

PCWA's use of selected outlet locations along canals to release stormwater during precipitation events with high canal flows for flood management has the potential to affect natural resource conditions in the study area. The following sections describe potential effects of PCWA's flood management practices on natural resources in the study area.

5.1.3.1 Physical Resources

Potential effects on hydrology, water quality, and soils and sediment quality conditions in the study area are described in the below sections.

Hydrology

PCWA's use of select canal outlets for stormwater releases during precipitation events likely results in temporary increases in streamflow in many unnamed drainages within the study area. Flow conditions in study area streams, however, are not expected to be affected by stormwater releases from PCWA's canal system due to the effects of other runoff contributions to streamflow within the watersheds of study area streams. Hydrologic conditions in study area streams during PCWA flood management activities are likely similar to conditions generally exhibited across study area streams during periods of high precipitation runoff.

Water Quality

As described previously, the tributaries and streams in the PCWA raw water distribution area are naturally prone to flooding. High flows during storm events can cause excessive erosion and may carry debris, such as tree branches and trash, into canals and streams. PCWA's flood management practices during these events likely have minimal effects on water quality conditions in study area streams. Additional flow releases from canal outlets may result in a short-term increase in erosion downstream from canal outlets in areas with soils of high erodibility and little riparian vegetation. The increased flows in many unnamed drainages within the study area may result in bank erosion near the canal outlet releases, and potential sediment loading to receiving waters. The potential for bank erosion near the canal outlets may result in increased sediment transport downstream, increased TSS and turbidity, and increased loading of

constituents associated with soils at eroded banks. Water quality conditions in study area streams during PCWA's flood management activities are likely similar to conditions generally observed during periods of high precipitation runoff.

Soils and Sediment Quality

PCWA flood management practices likely have minimal effects on soils and sediment quality in the study area. Unregulated releases from canal outlets during periods of high canal flows would reduce the effects of bank erosion along unlined canals, and the increased flows in unnamed drainages downstream from canal outlets may result in bank erosion near the canal outlet releases, and potential sediment loading to receiving waters.

5.1.3.2 Biological Resources

The following sections describe potential effects of PCWA's flood management practices on terrestrial and aquatic habitat and species, and special-status species.

Terrestrial Habitat and Species

Direct effects to terrestrial habitats and species are not expected. Stormwater releases would reduce the effects of bank erosion along canals and would therefore lessen potential negative impacts resulting from flood flows. The increased flows in many unnamed drainages within the study area may result in bank erosion near the canal outlet releases, and potential sediment loading to receiving waters. This would have the potential to wash away amphibian eggs, if present in the outlet areas, or bury wetland or riparian vegetation. These effects are expected to be minimal due to the limited area affected and similar to conditions generally exhibited across study area streams during periods of high precipitation runoff.

Aquatic Habitat and Species

PCWA's seasonal flood management practices are not likely to affect aquatic habitat and species in the study area. High flows within the PCWA canal system that occur as a result of precipitation runoff are indicative of high flows in study area streams.

Special Status Species

Direct effects to special status species are not expected to result from PCWA flood management practices. Stormwater releases from the canal system would reduce the effects of bank erosion along canals and would therefore lessen potential negative impacts resulting from flood flows. The increased flows in many unnamed drainages within the study area may result in bank erosion near the canal outlet releases, and potential sediment loading to receiving waters. This would have the potential to wash away special status amphibian eggs, if present in the drainages downstream from canal outlets, or bury any special status plant species that may be present. California red-legged frog breeding occurs between late November and March, though most frogs lay eggs in March (USFWS 2002, Stebbins 2003). The foothill yellow-legged frog breeds mid-March through early June, and the western spadefoot toad breeds in late January through July (Stebbins 2003). Special status species are not known to occur in the area of the canal

outlets, and these potential effects are expected to be similar to conditions generally exhibited across study area streams during periods of high precipitation runoff.

Steelhead and fall-run Chinook salmon are not likely affected by PCWA flood management practices. As described above, high flows in study area streams are more likely to affect aquatic habitat and species compared to PCWA operations during precipitation events.

5.1.4 Routine Operations

The following sections describe potential effects of PCWA's routine canal system operations on physical and biological resources in the study area.

5.1.4.1 Physical Resources

Potential effects on hydrology, water quality, and soils and sediment quality conditions in the study area are described in the below sections.

Hydrology

PCWA's routine raw water distribution system operations affect hydrologic conditions in Canyon Creek during summer and fall through direct diversions from the stream; however, these effects are negligible in comparison to effects of PG&E hydroelectric operations. During winter and spring, PCWA's routine operations are not likely to affect Canyon Creek hydrology due to potentially high streamflows associated with snowmelt and runoff in the watershed.

PCWA's water diversions to Auburn Ravine during the irrigation season have a positive effect on hydrologic conditions within portions of Auburn Ravine upstream from diversions to Zone 5 customers during late summer and early fall when natural flows in Auburn Ravine are low (Reclamation and PCWA 2002). As described in **Chapter 3**, natural flows in Auburn Ravine decline to very low levels during spring months, with no natural flow during summer months (Reclamation and PCWA 2002, City of Lincoln 1999). PCWA contributions to streamflow in Auburn Ravine during the irrigation season, however, are a fairly small fraction of the flow augmentation in Auburn Ravine during the dry season that occurs through other irrigation conveyance and return flow, hydroelectric generation releases, and treated effluent discharges. Routine PCWA operations do not affect hydrologic conditions in Auburn Ravine outside of the irrigation season.

Based on water balance results for the PCWA canal system and streams from the East Loomis Basin Canal Efficiency Study, routine canal system operations contribute to flows in Secret and Miners ravines year-round (USACE and PCWA 2008). The PCWA canal system provides direct contributions to flows within study area streams through regulated releases to streams used for conveyance and unregulated releases from canal outlets, and indirect contributions through customer return flows. These flow contributions have a positive effect on hydrologic conditions in study area streams.

Water Quality

PCWA's routine raw water distribution system operations likely have minimal effects on water quality conditions in Canyon Creek during summer and fall, such as water temperature, as a result of direct diversions from the stream. However, these effects are negligible in comparison to effects of PG&E hydroelectric operations on water quality. During winter and spring, PCWA's routine operations are not likely to affect water quality in Canyon Creek due to potentially dominating effect of high streamflows associated with snowmelt and runoff in the watershed.

Water quality conditions in Auburn Ravine are likely improved through PCWA's water diversions to Auburn Ravine during the irrigation season. As described in **Chapter 3**, water quality conditions measured at Auburn Ravine below the Auburn Ravine Tunnel outlet were generally better during spring and summer compared to fall and winter sampling events, exhibiting lower concentrations for many constituents in samples collected.

Based on water quality results obtained from canal and stream sites within the Clover Valley Creek, Antelope Creek, Secret Ravine, and Miners Ravine watersheds during baseline sampling events, water temperatures at canal sites were lower than stream sites during late spring and late summer. Water temperatures observed at canal and stream sites during winter and late fall were variable, but remained below 50 °F. DO concentrations measured at canal and stream sites inversely followed water temperature trends described above, exhibiting higher DO concentrations at canal sites during late spring and late summer.

TSS was very low, often below detection limits, and turbidity values were variable across all canal and stream sites monitored in the Clover Valley Creek, Antelope Creek, Secret Ravine, and Miners Ravine watersheds during baseline sampling events. These data suggest that PCWA routine operations do not affect TSS or turbidity in Clover Valley Creek, Antelope Creek, Secret Ravine, or Miners Ravine. Measured pH values were variable across canal and streams sites, while alkalinity and hardness were lower in canal sites compared to stream sites.

SC, ion, and trace element concentrations in samples obtained during baseline sampling events were also consistently lower at canal sites compared to stream sites. These lower constituent concentrations for ions and trace elements suggest that PCWA routine operations potentially provide a water quality benefit to Clover Valley Creek, Antelope Creek, Secret Ravine, and Miners Ravine through flow contributions to streamflow.

Figures providing a comparison of water quality conditions within the PCWA raw water distribution system and Clover Valley Creek, Antelope Creek, Secret Ravine, and Miners Ravine are included in **Appendix B**.

Soils and Sediment Quality

Soils and sediment quality in the study area are not likely to be affected by PCWA's routine operations. PCWA's routine operations do not disturb soils in the study area, or introduce constituents that may affect sediment quality.

5.1.4.2 Biological Resources

Studies conducted through the East Loomis Basin Canal Efficiency Study (USACE and PCWA 2008) suggest that the condition of existing aquatic and terrestrial resources in the study area are dependent on the canal system. While canal operations (including unregulated releases and customer return flows) contribute to flows in Secret Ravine and Miners Ravine, and their tributaries year-round, the canal system contributions dominate dry season flows.

Terrestrial Habitat and Species

Habitat would not be expected to be adversely affected by changes in flow. Some benefits may be experienced by amphibians and wetland/riparian vegetation from improvements in water quality. Some minor damage could be caused to habitats by placement of debris and soil near canals.

Aquatic Habitat and Species

Routine PCWA operations are not likely to affect aquatic habitat and species in Canyon Creek. Flow augmentation in Auburn Ravine by PCWA during spring and summer increases streamflows and supports greater habitat diversity, increased quantity and quality of habitats, and lower summer water temperatures that would be found under natural conditions (Reclamation and PCWA 2002, City of Lincoln 1999). Therefore, current water management practices in Auburn Ravine, including routine PCWA operations, enhance aquatic habitat conditions and potential anadromous salmonid production in Auburn Ravine (Reclamation and PCWA 2002, City of Lincoln 1999).

As described above, routine PCWA canal system operations contribute to flows in Clover Valley Creek, Antelope Creek, Secret Ravine, and Miners Ravine year-round. The PCWA canal system provides direct contributions to flows within these streams through unregulated releases from canal outlets, and indirect contributions through customer return flows, especially during the dry season. These flow contributions have a positive effect on aquatic habitat and species conditions in Clover Valley Creek, Antelope Creek, Secret Ravine, and Miners Ravine.

Special Status Species

Habitat would not be expected to be adversely affected by changes in flow. Some benefits may be experienced by special status amphibians and vegetation from improvements in water quality. Some minor damage could be caused to special status species plants, if present, by placement of debris and soil near canals.

Routine PCWA operations within the Auburn Ravine watershed are beneficial for Chinook salmon and steelhead (Reclamation and PCWA 2002). Increased flows in Auburn Ravine as a result of PCWA's streamflow augmentation (up to 50 cfs), especially during late summer and early fall, support more consistent habitat conditions to rearing steelhead.

As described above, hydrologic and water quality conditions in Clover Valley Creek, Antelope Creek, Secret Ravine, and Miners Ravine are generally improved through routine PCWA operations. Populations of fall-run Chinook salmon and Central Valley steelhead in Secret and

Miners ravines likely benefit from consistent contributions to streamflow from the PCWA canal system during routine operations.

The infrequent presence of special status fish in Clover Valley Creek and Antelope Creek, is likely affected by PCWA routine operations.

5.2 REGULATORY FRAMEWORK FOR POTENTIAL EFFECTS OF SYSTEMWIDE OPERATIONS

The following sections provide the regulatory framework for the potential effects of PCWA operations activities described above. The regulatory framework discussion is organized by Federal, State, and local regulations, and is summarized in **Table 5-3**.

5.2.1 Federal Regulations

Federal laws and regulations associated with the potential effects of PCWA operations activities are described below.

5.2.1.1 Clean Water Act

PCWA activities during yearly PG&E outages were found to have minimal effects on water quality conditions in study area streams. In particular, turbidity and copper levels temporarily increased at canal and stream sites after flows were restored to the canal system following reservoir outages. These increases may indicate the transport of fine sediments and potential mobilization of constituents bound to sediments, such as copper, into receiving waters of the U.S. In general, PCWA activities during yearly PG&E outages are subject to the provisions under the CWA, but they are not required to be permitted. Sections 101(a)(2) and 303(c) of the CWA state the national goal of working with states to establish water quality goals that provide for the protection of beneficial uses, such as the propagation of fish, shellfish, and wildlife and for recreation in and on the water, and agricultural, industrial, and other purposes including navigation. These water quality goals are explained further in **Chapter 4** under the Porter-Cologne Water Quality Control Act.

Seasonal PCWA delivery schedule changes potentially have minimal to no water quality effects, and would not likely result in water quality effects at canal outlets. Minimal effects are associated with the potential for sediment and/or debris to enter the canals from canal banks if PCWA personnel disturb soil along canal banks when entering them to switch out orifice plates. If this occurs, TSS and turbidity levels could temporarily increase. However, it is unlikely that these levels could exceed water quality standards promulgated in the CWA and identified in the Porter-Cologne Water Quality Control Act.

PCWA flood management practices may cause minimal effects on the water quality of receiving water tributaries and streams. Stormwater releases from intermediate canal outlets reduce the effects of bank erosion along canals and lessen potential negative effects along unlined canals resulting from flood flows. However, the canal releases and increased flows to unnamed drainages within the study area may result in bank erosion below the canal outlets, and potential sediment loading to receiving waters, and increased TSS and turbidity in study area streams.

Despite these minimal effects, these flood management practices are in compliance with State and Federal flood management requirements and it is unlikely that the effects would be considered an infringement of CWA regulations.

Routine/Daily PCWA operations may have minimal water quality effects. Water quality conditions in canals during routine/daily operations were observed to be generally better than stream water quality conditions. For example, water temperatures measured were lower and DO levels were higher at canal sites compared to stream sites during late spring and late summer. TSS, turbidity, SC, ion, and trace element levels measured were also generally lower year-round at canal sites compared to stream sites. Because these are overall positive potential effects, CWA is not likely to apply to PCWA's routine/daily operations.

**TABLE 5-3
SUMMARY OF REGULATORY FRAMEWORK AND POTENTIAL BEST MANAGEMENT PRACTICES THAT MAY APPLY TO PCWA OPERATIONS ACTIVITIES**

PCWA Operations Activity				Effect	Natural Resource Areas Potentially Affected										Relevant Regulations								Best Management Practices (BMP)	Type of BMP			
Yearly Outages	Delivery Schedule Change	Flood Management	Routine Operations		Physical		Biological						Federal				State			Local	Pre-Implementation	Implementation		Ongoing/Post-Implementation			
					Hydrology	Water Quality	Soils and Sediment Quality	Terrestrial Habitat and Species			Aquatic Habitat and Species	Special Status			Clean Water Act	Endangered Species Act	Magnuson-Stevens and Sustainable Fisheries Act	Migratory Bird Treaty Act	Porter Cologne	California Endangered Species Act					Fully Protected Species	Native Plant Protection Act	Placer County Conservation Plan
								Wetlands	Nesting birds	Other		Salmonids	Amphibians	Raptors													
✓		✓		Bank erosion along unlined canals and at canal outlets and sediment loading to receiving waters		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	Improve Canal Bank Stability and Install Sediment Traps in Areas of Soil Disturbance Install Erosion-Control Blankets Install Temporary Fiber Rolls Apply Spray-On Soil Binders Install Velocity Dissipaters at Canal Outlets Line Banks below Canal Outlets	✓			
		✓			✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	Avoid Potential Wet Weather Effects Patrol Canals and Remove Potential Obstructions to Prevent Erosion and Property Damage Minimize Water Purchases from PG&E Before and During High Precipitation Events Distribute Flood Releases from Canal System by Releasing Flows at Numerous Intermediate Outlets				
	✓		✓	Disturbance or damage to sensitive species and habitat potentially present in the area.			✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	Protect Sensitive Species and Sensitive Species Habitat Provide Staff with Species Identification Training Evaluate Sites with Sensitive Species and Mark/Protect Sensitive Species Habitat	✓				
		✓			✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	Avoid Species-Sensitive Areas Avoid Disturbance to Sensitive Species		✓		
✓				Constituent loading to receiving waters from O&M activities		✓	✓			✓	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓	Prevent Degraded Water from Entering Streams Modify Reservoir Operations to Gradually Restore Reservoir Releases to Canals at Slower Rate		✓			
✓	✓	✓	✓		All potential effects	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	Implement PCWA BMP Program			✓	

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5.2.1.2 Endangered Species Act

PCWA operations during annual PG&E outages potentially have minimal effects on special status species. PCWA's rotating outages at Clover Valley and Mammoth reservoirs, and resultant canal dewatering below the reservoirs, may result in minimal effects on special status terrestrial species, including slight decreases in the extent of wetland habitats for special status species. For special status aquatic species, canal dewatering during outages and resultant decreased canal system contributions to streamflow in Clover Valley Creek, Antelope Creek, Secret Ravine, and Miners Ravine may affect Central Valley steelhead and/or critical habitat for Central Valley steelhead. The Federal ESA, regulated by USFWS and NMFS, habitat modification or degradation could be considered a "take" of federally listed species. In which case, an incidental take permit, under Section 10 of the Federal ESA, or a Federal interagency consultation, under Section 7 of the Federal ESA, is required.

Seasonal PCWA customer delivery schedule changes are not likely to affect special status species. Special status plants, if present, may be trampled while PCWA personnel access delivery points, and special status raptors, if present, may be affected by PCWA access to canals. Because these effects are likely minimal and easily avoidable if special status species are present, it is unlikely that Federal ESA permits would be required.

PCWA flood management practices potentially have minimal effects on terrestrial special status species. High-flow releases from canal outlets could wash away amphibian eggs downstream from the outlets, if present, and sediment loading to receiving waters may bury wetland or riparian vegetation. Central Valley steelhead are not likely affected by PCWA flood management practices. High streamflows during precipitation events are more likely to affect aquatic habitat and species than PCWA operations. Because these effects are minimal, and easily avoidable, it is unlikely that Federal ESA permits would be required.

Routine/Daily PCWA operations likely have positive effects on special status species within the PCWA raw water distribution area. Contributions from the PCWA raw water distribution system typically augment streamflows in Auburn Ravine, Clover Valley Creek, Antelope Creek, Secret Ravine, and Miners Ravine, which benefits Central Valley steelhead. These streamflow contributions are particularly evident during summer months, and provide more consistent habitat conditions to rearing Central Valley steelhead. Some benefits to amphibians and wetland/riparian vegetation may also be realized through improvements to water quality as a result of canal system contributions to streamflow. Because the potential negative effects of daily routine operations are negligible and easily avoidable, it is unlikely that Federal ESA permits would be required.

5.2.1.3 Magnuson-Stevens Fishery Conservation and Management Act and the 1996 Sustainable Fisheries Act

PCWA operations during yearly PG&E outages have minimal effects on suitable habitat considered essential for the sustenance of commercial fisheries. Historic decreases in streamflow associated with canal dewatering during outages likely contribute to the delayed spawning

migration of fall-run Chinook salmon observed in the Dry Creek watershed, or may cause redd dewatering. Although the concept of EFH is similar to that of "Critical Habitat" under the Federal ESA, measures recommended to protect EFH by NMFS are advisory, not prescriptive.

5.2.1.4 Migratory Bird Treaty Act

PCWA operations during annual PG&E outages potentially have minimal effects on migratory bird species. Canal dewatering may cause slight decreases in the extent of wetland habitats and affect the species that use wetland habitats, such as foraging birds. However, it is unlikely that these effects would constitute a "take" of a migratory bird species or habitat (as defined by the MBTA) and therefore would not be subject to the MBTA.

5.2.2 State Regulations

Laws and regulations governed by the State of California and associated with the potential effects of PCWA operations activities are described below.

5.2.2.1 Porter-Cologne Water Quality Control Act

The regulatory framework for water quality effects resulting from PCWA operations during yearly PG&E outages, seasonal delivery schedule changes, flood management practices, and routine/daily operations, are similar to those described previously under the CWA.

Of the Criteria for Priority Toxic Pollutants in California, cadmium, copper, and zinc were three criteria parameters monitored for during PCWA outage activities. Neither cadmium nor zinc criteria were exceeded. The freshwater CCC for copper (9 µg/L) was exceeded at sites monitored during the PG&E yearly outages (November 2, 2006) within the Antelope Creek, Secret Ravine, and Miners Ravine watersheds, but the exceedances are likely associated with heavy rain and runoff contributions to flow at sites during sampling.

Of the water quality objectives associated with beneficial uses of the Sacramento River in the Sacramento-San Joaquin Basin Plan, barium, copper, iron, zinc, DO, pH, and turbidity were monitored during PCWA outage activities. The water quality objective for copper (based on specific levels of hardness calculated from measured calcium and magnesium levels) was exceeded at the Antelope Creek monitoring site on November 2, 2006 (10 µg/L for an objective of 9.3 µg/L based on the associated hardness of 70 mg/L), but the exceedance is likely associated with heavy rain and runoff contributions to flow at the site during sampling.

5.2.2.2 California Endangered Species Act

Under the California ESA, the effects on special status species from PCWA operations during PG&E yearly outages, seasonal delivery schedule changes, flood management practices, and routine/daily operations, are similar to those described previously under the Federal ESA. However, the California ESA addresses the incidental take of State-listed species as threatened or endangered. DFG is the enforcement agency of the California ESA.

5.2.2.3 California Fish and Game Code-Fully Protected Species

Under the Fish and Game Code-Fully Protected Species, the effects on special status species from PCWA operations of annual PG&E outages, seasonal delivery schedule changes, flood management practices, and routine/daily operations, are similar to those described previously under the Federal ESA. However, this code addresses the incidental take of fully protected species. DFG is unable to authorize incidental take of fully protected species, such as White-tailed Kite and the California Black Rail, when activities are proposed in areas inhabited by those species. Therefore, the take of any fully protected species for project implementation is prohibited.

5.2.2.4 California Native Plant Protection Act

This act applies to endangered and “rare” plant species, subspecies, and varieties of wild native plants in California. Annual PG&E outages, seasonal delivery schedule changes, and routine/daily operations may have minimal effects on endangered and “rare” plant species in the PCWA raw water distribution area if vegetation is damaged during fieldwork. However, these effects are easily avoidable through effective BMP implementation. Routine/daily operations are likely to benefit wetland/riparian vegetation from improvements in water quality and increased flows.

5.2.3 Local Requirements and Considerations

The following sections describe the framework for local requirements during PCWA maintenance activities.

5.2.3.1 Placer County Conservation Plan

As described in **Chapter 4**, the PCCP includes plans with goals to protect fish and wildlife and their habitat and protect streams, wetlands, and other water resources, as well as coverage under several environmental permits to be issued to Participating Entities. With PCCP long-term environmental permits, such as ESA and NCCP incidental take, Section 404, a renewable Section 401 certification, “Joint Procedures” approved by the USACE may be used by the Participating Entities for aquatic resource permit processing under the CWA, and a programmatic master streambed alteration agreement, PCWA will be covered for activity projects that require it.

The regulatory framework for PCWA operations activities related to the PCCP are the same as those described for CWA, ESA, Porter-Cologne Water Quality Control Act, California ESA, and California Fish and Game codes.

5.3 BEST MANAGEMENT PRACTICE OPTIONS TO ADDRESS POTENTIAL EFFECTS OF SYSTEMWIDE OPERATIONS ACTIVITIES

BMPs are measures designed to reduce or prevent potential effects of a particular activity on the surrounding environment. The term originated from rules and regulations in Section 208 of the CWA. The “best” practice is cost effective and site specific. BMPs can be both structural and nonstructural. Structural BMPs include facilities constructed to prevent or minimize effects, and nonstructural BMPs include changes in activities or operation management, such as scheduling around periods when potential effects are greatest, and often focus more on controlling pollutants at the source.

BMPs to address potential effects of PCWA operations can be applied during three different stages: (1) pre-implementation, (2) during implementation, and (3) ongoing or post-implementation. Some BMPs can be implemented during more than one stage. The list of BMP options is not comprehensive; instead, it provides examples of BMPs that may be implemented to minimize particular potential effects of PCWA canal operations activities. As part of these BMP recommendations, BMP monitoring and evaluation are recommended for determining BMP effectiveness. Potential BMPs to reduce potential effects of PCWA operations activities on natural resources are summarized in **Table 5-3**, and described below.

5.3.1 Pre-Implementation Best Management Practices

Pre-implementation BMPs are those that are applied in preparation for the activity because they may take more time to develop before they become effective or because they involve complex setup procedures. Below are potential pre-implementation BMPs for reducing potential effects of PCWA operations activities on natural resources in the study area.

5.3.1.1 Improve Canal Bank Stability and Install Sediment Control Measures at Canal Outlets

Canal bank erosion along unlined canals, which may occur after canal flows are restored following dewatering activities (such as PCWA operations during yearly PG&E outages) and by PCWA flood management practices, may be minimized through implementation of BMPs to improve canal bank stability. PCWA is already implementing BMPs to provide canal bank stability by lining canals with gunite. Stabilizing vulnerable or disturbed areas along unlined canal banks can decrease erosion and associated sediment transport and deposition. Areas vulnerable to erosion may be those with steep slopes, little to no vegetation, and loose soil. Areas along canal banks that have been disturbed by previous canal activities, recreation along canals, or storm events, are particularly vulnerable to erosion. Additionally, sediment-control measures may be installed at canal outlets, where possible, to reduce sediment and associated constituents, and loading to receiving waters during PCWA operations activities. Maintaining site stabilization should be implemented year-round by keeping wet season sediment-trapping devices available and operational. The following sections describe potential BMPs to improve canal bank stability and reduce sediment loading to receiving waters.

Install Velocity Dissipaters at Canal Outlets

Velocity dissipaters are strategically placed rock along the flow line in a stream or at a canal outlet to dissipate energy and slow the flow of water released at canal outlets, thereby reducing the potential for erosion and sediment loading downstream. Rocks are often set in mortar in a way that is designed to interrupt water passage and spread concentrated flows over and through protruding rock. For example, rocks could be set in a step pool formation based on natural channel design concepts. Dissipaters can be underlain with geotextile fabric to reduce the potential for eroding the underlying soil. Other types of dissipaters include solid concrete structures, riprap, baffles, pipe junctions, and drop boxes.

Line Banks below Canal Outlets

Through lining banks below canal outlets with gunite, where possible, bank stability is improved and the potential for erosion is decreased. Although lining is also addressed in this manual as an O&M activity, it is also considered a BMP as it is applied to areas along the canal system that have been disturbed by previous canal activities, recreation along canals, or storm events, are particularly vulnerable to erosion. PCWA is already implementing this type of BMP, where possible.

5.3.1.2 Avoid Potential Wet Weather Effects

Avoidance of potential adverse effects of PCWA operations activities during wet weather, when and where feasible, can be very effective. Avoided adverse effects may include canal bank erosion and sediment loading into receiving streams during wet weather events. Examples of BMP options are as follows:

Patrol Canals and Remove Potential Obstructions to Prevent Erosion and Property Damage

Large debris that gets into the canals, such as fallen tree limbs, may obstruct water flow within the canal system and may lead to canal bank erosion and/or property damage if not removed. Through implementing this BMP, PCWA staff would periodically patrol the canal system before the wet season and after heavy storm events and remove potential obstructions in a timely manner. PCWA is already implementing this type of BMP.

Minimize Amount of Water Purchased from PG&E During Periods of High Precipitation

Before and during precipitation events likely to cause in substantial precipitation runoff, PCWA may reduce water purchases from PG&E to increase canal capacity for conveyance of precipitation runoff. Through reducing the flow conveyed by PCWA's canal system during precipitation events, PCWA may decrease the potential for canal bank erosion. PCWA is already implementing this type of BMP.

Distribute Flood Releases from Canal System by Releasing Flows at Numerous Intermediate Outlets

During precipitation events when flows and water levels in the canals are high, water can be released from several intermediate canal outlets to dissipate flows throughout the system at lower

flow rates and reduce the potential for downstream erosion and sedimentation. PCWA is already implementing this type of BMP, where possible.

5.3.1.3 Protect Sensitive Species and Sensitive Species Habitat

Taking steps to ensure the protection of sensitive species and sensitive species habitat before an activity occurs involves both structural and nonstructural solutions.

Provide Staff with Species Identification Training

As a nonstructural solution to protecting sensitive species habitat in the PCWA raw water distribution system, PCWA personnel can be trained to recognize special status habitat and species before O&M activities. With this information, potential effects to species, such as trampling special status vegetation and habitat, and effects on raptor nests from noise disturbance, may be prevented. As part of this training program, PCWA field staff will be provided with an identification table with photos and descriptions to assist in identifying special status species known or expected to occur near work areas. PCWA is already implementing this type of BMP.

Evaluate Sites with Sensitive Species and Mark/Protect Sensitive Species Habitat

If special status species and/or associated habitats are identified, temporary fencing, signs, or colored ribbon may be used to mark the known location of the species or habitat, such as rare plants or trees with active raptor nests, to help prevent disturbance to the habitat or species during operations activities. PCWA is already implementing this type of BMP.

5.3.2 Implementation Best Management Practices

Implementation BMPs are management measures applied while the activity is being implemented. The following sections provide potential implementation BMPS to reduce potential effects of PCWA operations activities on natural resources.

5.3.2.1 Avoid Sensitive Species Areas

During operations activities, PCWA personnel can do several things to prevent potential effects on terrestrial species and disturbance to terrestrial species habitat. Examples of BMP options follow.

Avoid Disturbance to Sensitive Species

To avoid potentially disturbing sensitive species in the vicinity of operations activities, PCWA staff may stay on roads, paths, or other previously disturbed areas whenever possible. This BMP option also involves helping equipment and vehicles confined to roads, paths, or other previously disturbed areas to avoid disturbing sensitive species in the vicinity. PCWA is already implementing this type of BMP, where possible.

5.3.2.2 Prevent Degraded Water from Entering Streams

BMPs may be implemented to prevent or reduce the amount of degraded water from PCWA's canal system from entering streams. Based on results from water quality monitoring, water

quality conditions downstream from O&M activities that involve canal dewatering can exhibit high turbidity, TSS, and concentrations of constituents associated with sediment or other material.

Modify Canal Operations to Gradually Restore Reservoir Releases to Canals at Slower Rate

Modifying PCWA reservoir management practices during PG&E yearly outages can be effective for reducing sediment loading into receiving waters. When possible, water releases from Mammoth and Clover Valley reservoirs to canals following outages during the PG&E yearly outages may be restored at a slow and graduated rate. These graduated reservoir releases may decrease the potential mobilization and transport of settled materials and constituent loading to receiving waters after canal flows are restored.

5.3.3 Ongoing or Post-Implementation Best Management Practices

Ongoing or post-implementation BMPs are typically management and preventative measures. One potential ongoing or post-implementation BMP was identified to minimize potential effects of PCWA operations activities, and is described below.

5.3.3.1 Implement PCWA Best Management Practice Program

An ongoing PCWA BMP program would serve to update and maintain BMPs, as well as track BMP effectiveness. The program would also provide staff training for BMP implementation during PCWA O&M activity implementation.

BMP alternatives are continually being developed and information on BMP effectiveness is continually changing. It is important to stay updated on BMP news so as to provide for the most effective BMP implementation.

BMP maintenance increases the durability and effectiveness of structural BMPs. In fact, unmaintained BMPs can increase potential effects. For example, if an erosion-control blanket is not well-maintained it could become dislodged and be swept down a canal as debris.

Staff BMP implementation training would consist of a BMP training manual and periodic training sessions on effective BMP implementation in the field. Several of the pre-implementation BMPs, such as species identification training, would be part of this program.

5.4 SUGGESTIONS FOR FURTHER STUDIES

Based on results of NRMP studies, PCWA operations may affect natural resources conditions within the study area. Higher concentrations of trace metals, particularly aluminum and copper, were observed at sites monitored within the PCWA canal system compared to stream sites for sampling events associated with PCWA's operations during the PG&E yearly outages. These data may inconclusively suggest that the PCWA canal system is a source for loading of some constituents to study area streams.

Additional routine and event-based water quality monitoring should be conducted at sites within the PCWA canal system, and stream sites upstream and downstream from canal system contributions, to characterize potential effects of PCWA operations activities on water quality conditions. One of the focal points for additional studies should be to evaluate aluminum and copper inputs to study area streams from the PCWA canal system. Potential sites for routine and operations event-based water quality monitoring include:

- Boardman Canal below Mammoth Reservoir
- End of Boardman Canal outlet
- End of Yankee Hill Canal outlet
- Secret Ravine at Loomis Basin Park
- Secret Ravine at Rocklin Road
- Clover Valley Reservoir release to Clover Valley Creek and Antelope Canal

Additionally, sediment quality monitoring at numerous sites exhibiting variable soil conditions along the canal system and study area streams may be help to determine potential sources of trace metals in PCWA canals and study area streams. Soil sampling for representative soil types should be coordinated with routine and operations event-based water quality monitoring. Soil samples should be collected from undisturbed sites of representative soil types, as characterized by PCWA (2005), near and upstream from canal and stream water quality monitoring sites, and within watersheds of Clover Valley Creek, Antelope Creek, Secret Ravine, and Miners Ravine.

CHAPTER 6.0 POTENTIAL EFFECTS, REGULATORY FRAMEWORK, AND BEST MANAGEMENT PRACTICES FOR MAINTENANCE ACTIVITIES

This chapter provides an overview of the potential effects of PCWA raw water distribution system maintenance activities on natural resource conditions in the study area, the regulatory framework for effects, and potential BMPs to reduce effects of the maintenance activities on natural resources.

6.1 POTENTIAL EFFECTS OF MAINTENANCE ACTIVITIES ON NATURAL RESOURCES

Potential effects of scheduled and as-needed, site-specific PCWA raw water distribution system maintenance activities are described below.

6.1.1 Scheduled Maintenance Activities

The following sections address scheduled maintenance activities conducted by PCWA within their raw water distribution system.

6.1.1.1 Canal Cleaning and Flushing

PCWA's canal cleaning and flushing activities have the potential to affect natural resource conditions in the study area. The following sections describe potential effects of canal cleaning and flushing activities on natural resources.

Physical Resources

Potential effects of PCWA canal cleaning and flushing activities on hydrology, water quality, and soils and sediment quality conditions in the study area are described in the following sections.

Hydrology

PCWA operations during canal cleaning and flushing activities do not affect hydrologic conditions in Canyon Creek or Auburn Ravine. During the canal cleaning and flushing, PCWA canal system contributions to streamflow in Canyon Creek and Auburn Ravine, and/or diversions from Canyon Creek and Auburn Ravine, do not change as a result of PCWA operations.

Continuous-flow data collected from canal and stream sites within PCWA's lower Zone 1 service area during WDY 2006 (October 16, 2005, to October 15, 2006) were evaluated to determine effects of canal cleaning and flushing activities on hydrologic conditions in Clover Valley Creek, Antelope Creek, Secret Ravine, and Miners Ravine. Continuous-flow monitoring locations used for maintenance evaluations, and their respective watersheds, are listed in **Table 6-1**.

TABLE 6-1
CONTINUOUS-FLOW MONITORING STATIONS IN ZONE 1 FOR MAINTENANCE

Secret Ravine Watershed	Miners Ravine Watershed
Secret Ravine at Horseshoe Bar Road	Miners Ravine at Lomida Lane
Yankee Hill Canal Outlet	Ferguson Canal Outlet
Turner Canal Outlet	Stallman Canal Outlet
Boardman Canal Outlet	Baughman Canal Outlet
Secret Ravine at Rocklin Road	Miners Ravine near North Sunrise Avenue

Table 6-2 provides PCWA's schedule of canal outages for cleaning and flushing during March 2006. During these outages for canal cleaning and flushing, canal flows were typically interrupted during business hours to dewater canal segments and allow removal of sediment and debris from canals by PCWA staff.

TABLE 6-2
CANALS OUTAGES FOR CLEANING AND FLUSHING DURING 2006

Canal	Time	Dates
Mammoth Reservoir to Boardman Canal Outlet	7:00 a.m. to 11:00 p.m.	March 13, 14, 15, 16, 17, 20, 21, 22, 23, 24
Baughman Canal		
Ferguson Canal		
Stallman Canal		
Yankee Hill Canal		
Turner Canal		
Turner Pump Canal		
Laird Pump Canal		

Average daily flows for canal and stream sites evaluated during WDY 2006 canal cleaning and flushing activities are shown in **Figure 6-1** for sites within the Secret Ravine watershed, and in **Figure 6-2** for sites within the Miners Ravine watershed. As illustrated in **Figures 6-1** and **6-2**, canal system contributions to flow within study area streams through unregulated releases from canal outlets is variable during periods associated with canal cleaning activities.

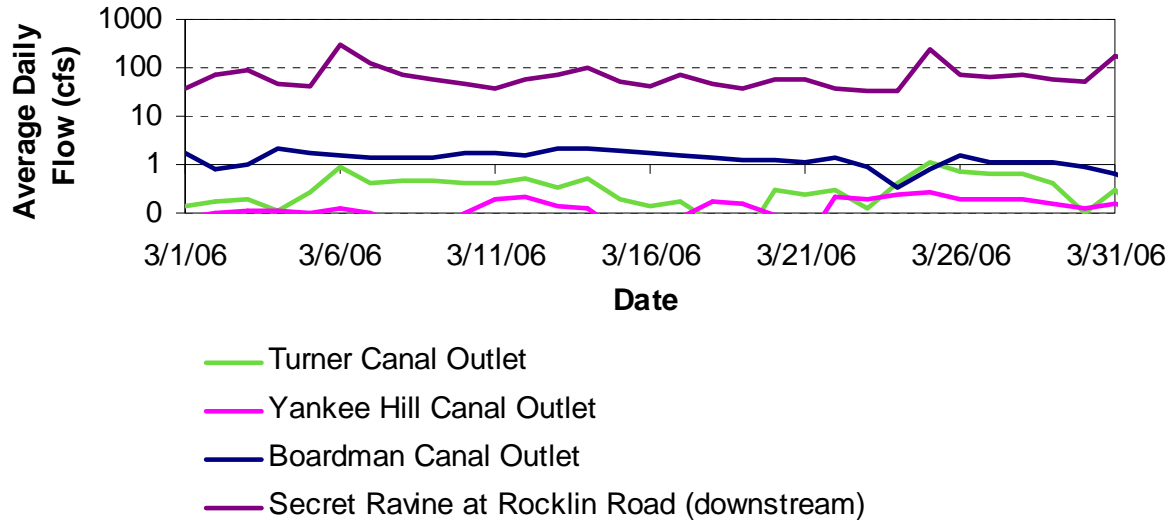


FIGURE 6-1
CANAL OUTLET AND SECRET RAVINE RESPONSES TO CANAL CLEANING AND FLUSHING ACTIVITIES

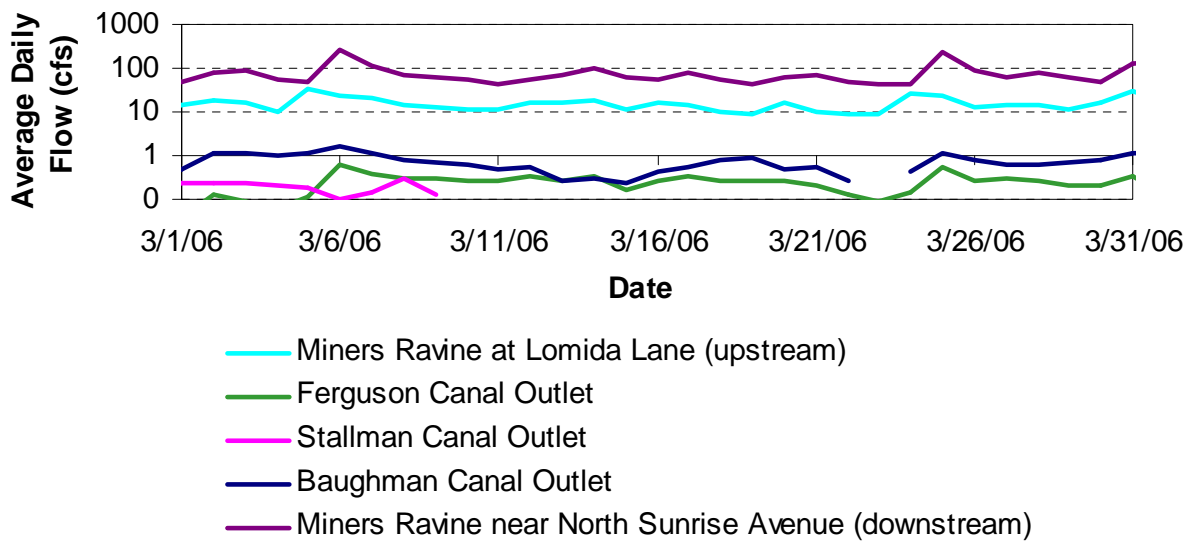


FIGURE 6-2
CANAL OUTLET AND MINERS RAVINE RESPONSES TO CANAL CLEANING AND FLUSHING ACTIVITIES

Based on the average daily flows for sites provided in **Figures 6-1** and **6-2**, the short-duration reduction in flows within the PCWA canal system during canal cleaning and flushing activities is not expected to affect flow conditions in Secret and Miners ravines. Effects on flow conditions in Antelope Creek and Clover Valley Creek are likely similar to conditions shown for Secret and Miners ravines. Precipitation runoff within the watersheds of study area streams is likely to have a much greater influence on stream flow conditions during the time periods that PCWA conducts canal cleaning and flushing activities. Precipitation during March 2006 is shown in **Figure 6-3**.

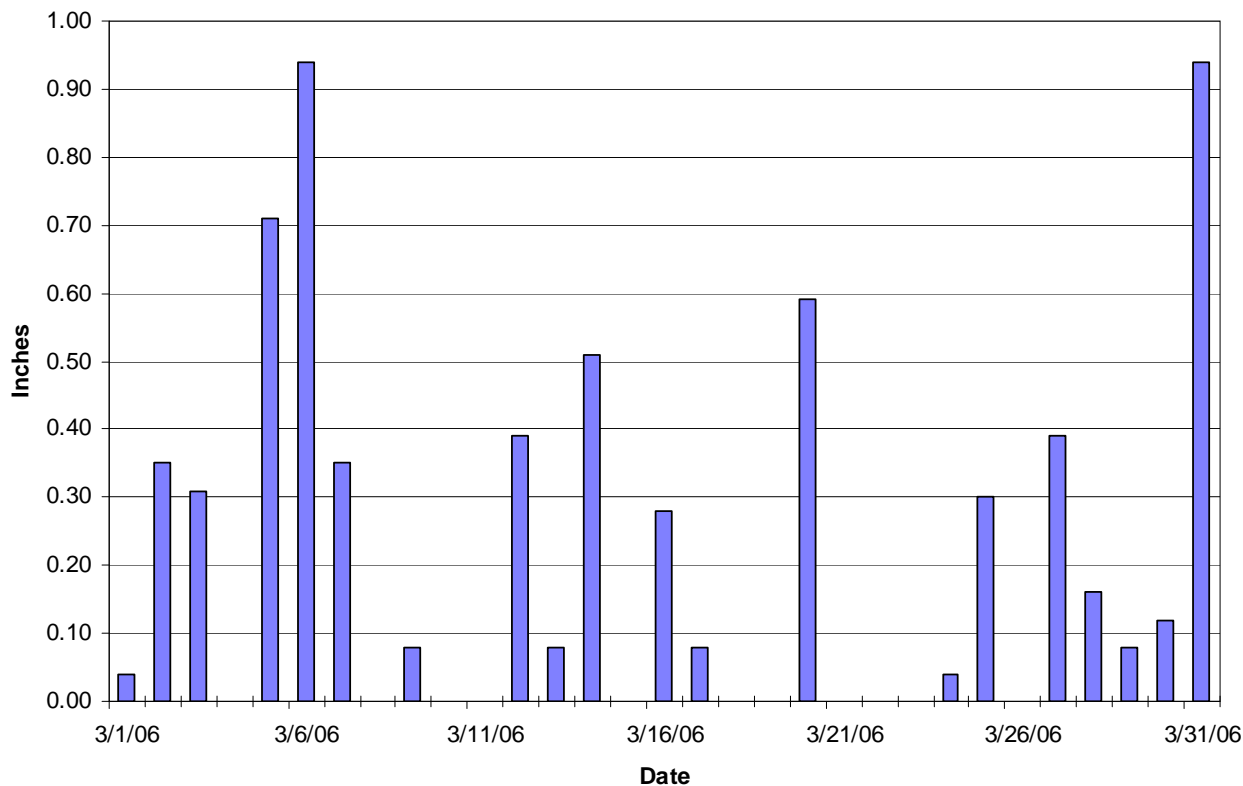


FIGURE 6-3
PRECIPITATION AT CHINA GARDEN ROAD GAGE DURING MARCH 2006

Water Quality

Water quality conditions were monitored at 15 locations within the PCWA canal system and study area streams during PCWA canal cleaning activities. All water quality monitoring locations are located within Zone 1 of the PCWA service area. These locations, shown in **Figures 5-1 and 5-2**, were selected according to canal cleaning locations. **Table 6-3** lists the monitoring site names, site type, associated watershed(s), and information for the canal cleaning activities for which sampling occurred at those locations.

Monitoring for canal cleaning and flushing events along the Boardman, Yankee Hill, Baughman, and Ferguson canals was conducted on March 15, 2007, March 22, 2007, March 26, 2007, and March 27, 2007, respectively. Monitoring sites were located along the canals and stream sites in the Secret Ravine and Miners Ravine watersheds. Results from water quality monitoring and potential effects of canal cleaning activities are discussed below. Water quality conditions were not evaluated in the Auburn Ravine, Clover Valley Creek, and Antelope Creek watersheds, but are likely to be similar to conditions described for Secret Ravine and Miners Ravine. Figures providing a comparison of water quality conditions within the PCWA raw water distribution system and study area streams monitored during canal cleaning activities are included in **Appendix C**.

**TABLE 6-3
WATER QUALITY MONITORING LOCATIONS IN THE PCWA SERVICE AREA FOR CANAL CLEANING ACTIVITIES**

Site Name	Site Identification	Type	Watershed(s)	Canal Cleaning Start/End Time	Weather
Boardman Canal Cleaning, Graveyard Outlet to Hansen Outlet					
Boardman Canal below Mammoth Reservoir	YB81	Canal	Miners Ravine /Secret Ravine	Start: 3/15/2007, 7:15am	Warm and dry
Boardman Canal at Hansen Outlet Release	HANSEN	Canal	Miners Ravine	End: 3/15/2007, 3:50pm	
Miners Ravine at Lomida Lane	MINERSRV7	Stream	Miners Ravine		
Miners Ravine at Moss Lane	MINERSRV5	Stream	Miners Ravine		
Yankee Hill Canal Cleaning					
Boardman Canal at Head of Turner Canal	YB154	Canal	Miners Ravine/ Secret Ravine	Start: 3/22/2007, 6:15pm	Cool and dry
Yankee Hill Canal Outlet Release	YANKEECR	Canal	Secret Ravine	End: 3/22/2007, 3:25pm	
Tributary to Secret Ravine from Yankee Hill Canal	YHTRIB2	Stream	Secret Ravine		
Secret Ravine at Rocklin Road	SECRETRV3	Stream	Secret Ravine		
Baughman Canal Cleaning, Head of Ferguson Canal to Baughman Canal Outlet					
Baughman Canal at Head of Ferguson Canal	YB145	Canal	Miners Ravine	Start: 3/26/2007, 6:10am	Cool with rain at around 2:00 p.m.
Baughman Canal Outlet Release	BAUGHMANCR	Canal	Miners Ravine	End: 3/26/2007, 1:00pm	
Tributary to Miners Ravine from Baughman Canal	BCTRIB1	Drainage	Miners Ravine		
Miners Ravine near N. Sunrise Avenue	MINERSRV3	Stream	Miners Ravine		
Ferguson Canal Cleaning					
Baughman Canal at Head of Ferguson Canal	YB145	Canal	Miners Ravine	Start: 3/27/2007, 6:10am	Cool and dry
Ferguson Canal Outlet Release	FRGCR	Canal	Miners Ravine	End: 3/27/2007, 11:55am	
Tributary to Miners Ravine from Ferguson Canal	FRGTRIB1	Drainage	Miners Ravine		
Miners Ravine at Auburn-Folsom Road	MINERSRV4	Stream	Miners Ravine		

Secret Ravine Watershed

As shown in **Table 6-3**, water quality monitoring in the Secret Ravine watershed was conducted during one canal cleaning event on March 22, 2007, that occurred along a section of the Yankee Hill Canal. Water quality was monitored at two canal sites, upstream and downstream from the canal section that was cleaned (YB154 and YANKEEER, respectively), and two stream sites downstream from the Yankee Hill Canal Outlet release (YHTRIB2 and SECRETRV3). These monitoring sites are listed below from the most upstream to the most downstream locations:

- **Boardman Canal at the Head of Turner Canal (YB154):** Located along the Boardman Canal at the head of the Turner Canal.
- **Yankee Hill Canal Outlet Release (YANKEEER)**
- **Yankee Hill Canal Tributary (YHBTRIB2)**
- **Secret Ravine at Rocklin Road (SECRETRV3)**

As shown in **Figure 6-1**, potential flow contributions from the Yankee Hill Canal comprise a small proportion of streamflow at SECRETRV3. Precipitation runoff within the Secret Ravine watershed is likely to have a much greater influence on water quality conditions in Secret Ravine during the time periods that PCWA conducts canal cleaning and flushing activities.

Water Temperature and Dissolved Oxygen

Minimal to no effects on water temperatures and DO levels were observed at the two stream sites (YHTRIB2 and SECRETRV3) downstream from the canal cleaning activity during this event. Water temperatures at the canal outlet release downstream from the canal cleaning activity, YANKEEER, increased from about 62°F to up to 67°F for about 15 minutes, then stabilized to reflect water temperature conditions similar to values measured upstream from canal cleaning. The temporary increase in water temperature is likely attributed to the displacement and flushing of water that collected in shallow pools and exposed to direct sunlight in the canal after the canal was dewatered. Measured DO levels across canal and stream sites exhibited similar, but inverse trends.

pH, Alkalinity, and Hardness

Based on measurements at sites during monitoring, canal cleaning activities do not appear to affect pH conditions in Secret Ravine. Measured pH levels at YANKEEER increased for a short duration after canal cleaning, and then stabilized to reflect pH levels similar to values measured upstream from canal cleaning. Measured pH levels at YANKEEER increased by more than 1 unit up to 9.2 during canal flushing after cleaning activities, subsequently decreased by more than 2 units to 6.9, then stabilized at 7.7. The pH measured at YHTRIB2 also increased slightly after canal cleaning, but did not fluctuate at SECRETRV3. Alkalinity and total hardness measured at sites during the canal cleaning monitoring event fluctuated slightly at YANKEEER, but remained consistent at both stream sites downstream from the canal cleaning activity. Stream sites monitored demonstrated higher buffering capacity (alkalinity) and lower total hardness compared to canal sites.

Total Suspended Solids and Turbidity

Despite a temporary increase in TSS and turbidity levels observed at YANKEEER after canal cleaning activities, no effects were observed at stream monitoring sites during this canal cleaning monitoring event.

Specific Conductivity and Ions

No effects on SC, calcium, iron, magnesium, potassium, or sodium levels were observed at stream sites in the Secret Ravine watershed during monitoring for canal cleaning activities. Minimal increases in iron concentrations were observed at YANKEEER after flows were restored to Yankee Hill Canal, but were not reflected in samples collected at stream sites downstream. SC, calcium, magnesium, potassium, and sodium values measured at stream sites were higher than canal sites. Water quality results also suggest that chloride, nitrate, and sulfate concentrations at stream sites are not affected by canal cleaning activities.

Trace Elements

Aluminum, barium, copper, and zinc concentrations at YANKEEER increased after flows were restored to Yankee Hill Canal, but do not appear to affect concentrations in samples collected at stream sites downstream. Cadmium concentrations measured at all sites during the canal cleaning monitoring event were below the detection limit (0.5 µg/L).

Miners Ravine Watershed

Water quality conditions in the Miners Ravine watershed were evaluated during canal cleaning and flushing activities along sections of the Boardman, Baughman, and Ferguson canals, on March 15, 2007, March 26, 2007, and March 27, 2007, respectively. On March 15, 2007, water quality was monitored at two canal sites upstream and downstream from canal cleaning activities, and two stream sites in Miners Ravine also upstream and downstream from canal cleaning activities:

- **Boardman Canal below Mammoth Reservoir (YB81)**
- **Hansen Outlet Release (HANSENR):** located at the Hansen outlet from the Boardman Canal. Regulated releases from this canal flow into an unnamed tributary that contributes flows into Miners Ravine.
- **Miners Ravine at Lomida Lane (MINERSRV7):** located at Lomida Lane upstream from the confluence with the unnamed tributary to Miners Ravine receiving regulated releases from HANSENR.
- **Miners Ravine at Moss Lane (MINERSRV5):** located at Moss Lane, downstream from the confluence with the unnamed tributary to Miners Ravine receiving regulated releases from HANSENR.

On March 26, 2007, water quality parameters were monitored at two canal sites upstream and downstream from canal cleaning activities, and two stream sites downstream from canal cleaning activities:

- **Baughman Canal at the Head of Ferguson Canal (YB145):** located upstream from the cleaning event at the head of the Ferguson Canal.
- **Baughman Canal Outlet Release (BAUGHMANCR)**
- **Tributary to Miners Ravine from Baughman Canal (BCTRIB1)**
- **Miners Ravine near N. Sunrise Avenue (MINERSRV3)**

Due to the extensive length of the unnamed tributary to Miners Ravine from Baughman Canal and long travel time from BAUGHMANCR to BCTRIB1, samples obtained during canal cleaning activities at BCTRIB1 and MINERSRV3 were intended to provide a relative comparison of water quality conditions in receiving waters downstream from BAUGHMANCR.

On March 27, 2007, water quality was monitored at two canal sites upstream and downstream from canal cleaning activities, and two stream sites downstream from canal cleaning activities:

- **Baughman Canal at the Head of Ferguson Canal (YB145)**
- **Ferguson Canal Outlet Release (FRGCR):** located at the Ferguson Canal Outlet. Unregulated releases from this canal flow into an unnamed tributary that contributes flows into Miners Ravine.
- **Tributary to Miners Ravine from Ferguson Canal (FRGTRIB1):** located at Rock Crest Place along the unnamed tributary receiving unregulated releases from the FRGCR.
- **Miners Ravine at Auburn-Folsom Road (MINERSRV4):** located on the west side of Auburn-Folsom Road downstream from the confluence with the unnamed tributary to Miners Ravine receiving regulated releases from FRGCR.

As shown in **Figure 6-2**, potential direct flow contributions from the Ferguson and Baughman canals comprise a small proportion of streamflow at MINERSRV3. Precipitation runoff within the Miners Ravine watershed is likely to have a much greater influence on water quality conditions in Miners Ravine during the time periods that PCWA conducts canal cleaning and flushing activities.

Water Temperature and Dissolved Oxygen

Based on water quality monitoring results, water temperature conditions in Miners Ravine were not affected by the March 15, 2007, and March 26, 2007, canal cleaning activities. Water temperatures observed at HANSENCR on March 15, 2007, increased for a short duration, then stabilized to reflect water temperature conditions similar to values measured upstream from canal cleaning. During the March 27, 2007, canal cleaning monitoring event, water temperatures increased for a short duration at FRGCR, and water temperatures observed at FRGTRIB1 and MINERSRV4 also slightly increased, potentially as an effect of canal cleaning activities. DO

levels measured across stream sites in the Miners Ravine watershed were not affected by canal cleaning activities.

pH, Alkalinity, and Hardness

Although measured pH levels temporarily increased at the canal outlets after flows were restored to the canals following canal cleaning, minimal effects were observed at stream sites during the canal cleaning monitoring events. Sharp decreases and subsequent increases in pH observed at canal release outlets were likely responses to the displacement and flushing of water that collected in shallow pools and exposed to direct sunlight in the canal after the canal was dewatered. Alkalinity of water samples collected was higher across stream sites in the Miners Ravine watershed compared to the canal sites. The higher buffering capacity (alkalinity) at stream sites likely attributed to the minimal effects observed on pH at Miners Ravine sites. The canal cleaning activities also did not appear to affect total hardness values observed at stream sites within the Miners Ravine watershed. Although minimal effects were observed in tributaries receiving unregulated releases from canal outlets on March 26 and 27, 2007, no effects were observed in Miners Ravine. **Figure 6-4** shows pH values measured in the Miners Ravine watershed during the March 27, 2007, canal cleaning event.

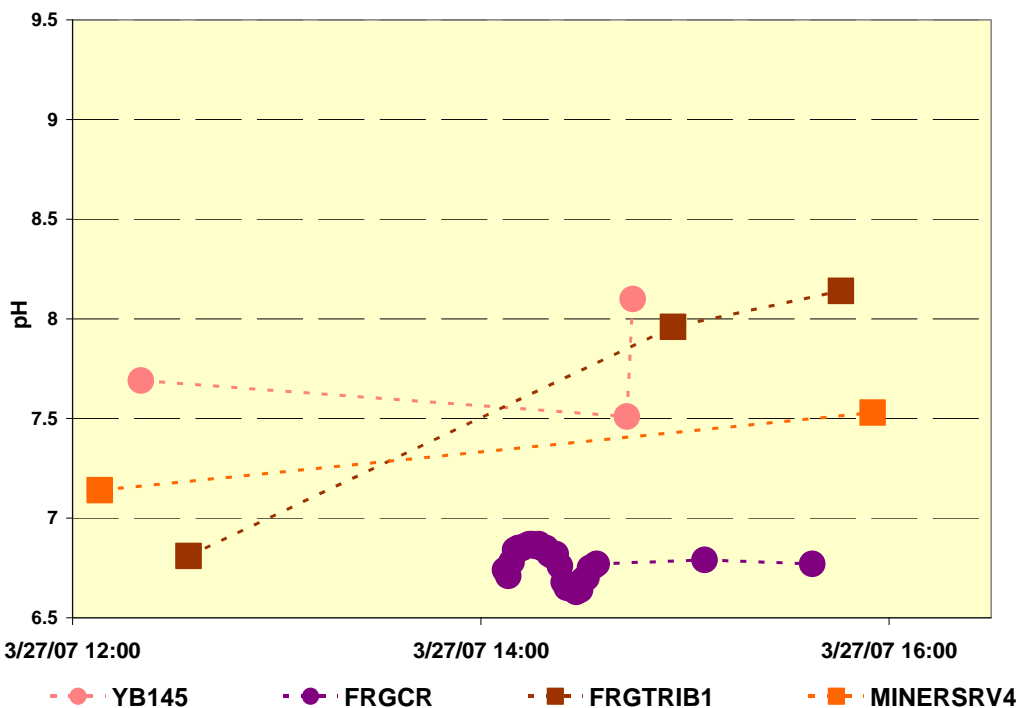


FIGURE 6-4
MEASURED PH LEVELS AT MINERS RAVINE WATERSHED SITES DURING
MARCH 27, 2007, CANAL CLEANING EVENT

Total Suspended Solids and Turbidity

Despite a temporary increase in TSS and turbidity levels observed at canal outlet releases after flows were restored to canals following canal cleaning activities, no related effects were observed at stream monitoring sites in the Miners Ravine watershed during sampling events.

Specific Conductivity and Ions

Based on water quality results, canal cleaning activities did not affect SC and ion concentrations in Miners Ravine. Although calcium, iron, magnesium, potassium, sodium, chloride, and sulfate concentrations increased at canal outlet releases after flows were restored to canals following canal cleaning activities, no changes in SC and ion concentrations were observed at stream monitoring sites. In general, SC and ion concentrations were higher at Miners Ravine watershed stream sites compared to canal sites.

Trace Elements

Following canal cleaning activities, concentrations of aluminum, barium, copper, and zinc increased to very high levels at canal outlet releases for a short duration. During the March 15, 2007, canal cleaning event, aluminum concentrations measured in samples collected in Miners Ravine increased from 120 to 710 $\mu\text{g/L}$, potentially as a result of canal cleaning activities and aluminum loading to the unnamed tributary to Miners Ravine below the Hansen Outlet (**Figure 6-5**). Aluminum levels also increased at BCTRI1 and FRGCR on March 26, 2007, and March 27, 2007, respectively, but did not increase at Miners Ravine sites monitored downstream.

Figures 6-5, 6-6 and 6-7 show aluminum concentrations for canal and stream sites monitored during canal cleaning activities.

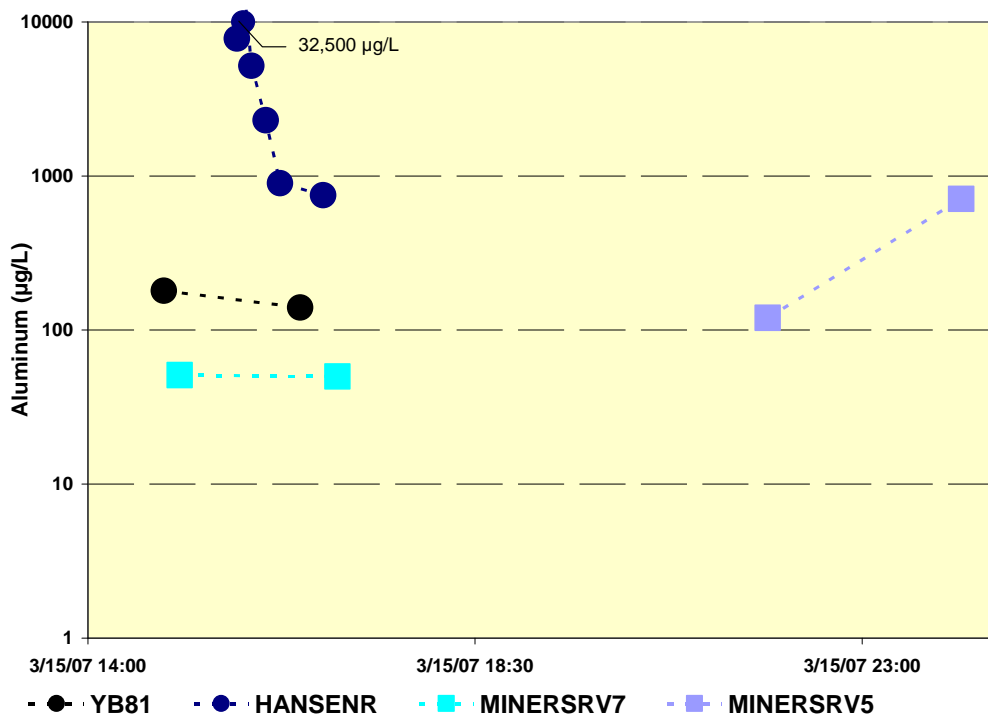


FIGURE 6-5
MEASURED ALUMINUM LEVELS AT MINERS RAVINE WATERSHED SITES
DURING MARCH 15, 2007, CANAL CLEANING EVENT

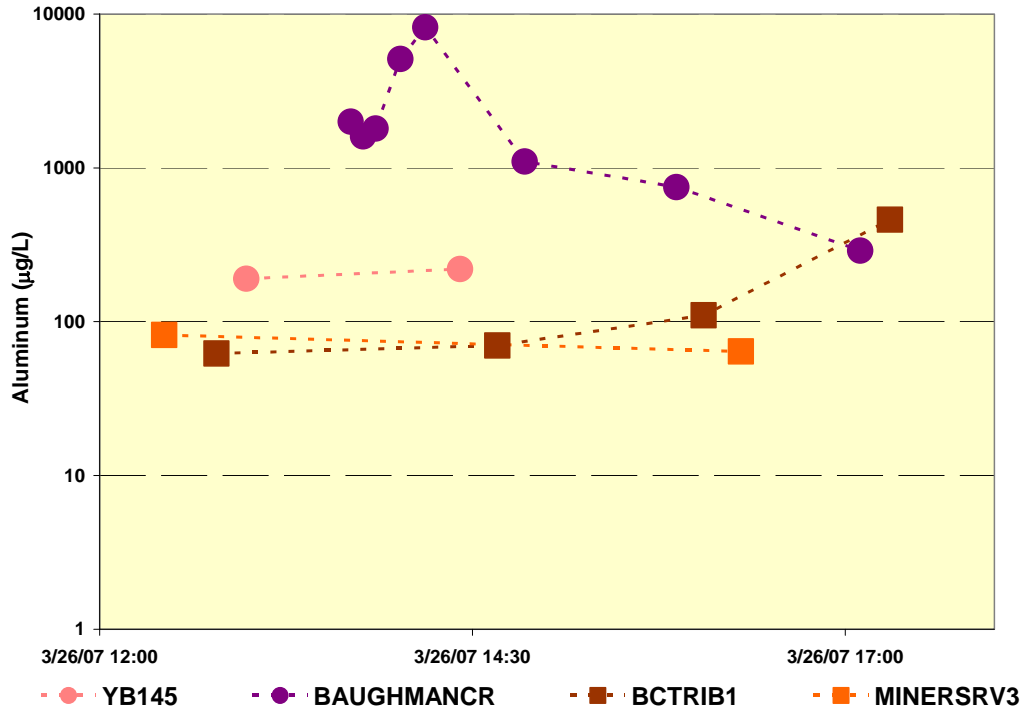


FIGURE 6-6
MEASURED ALUMINUM LEVELS AT MINERS RAVINE WATERSHED SITES
DURING MARCH 26, 2007, CANAL CLEANING EVENT

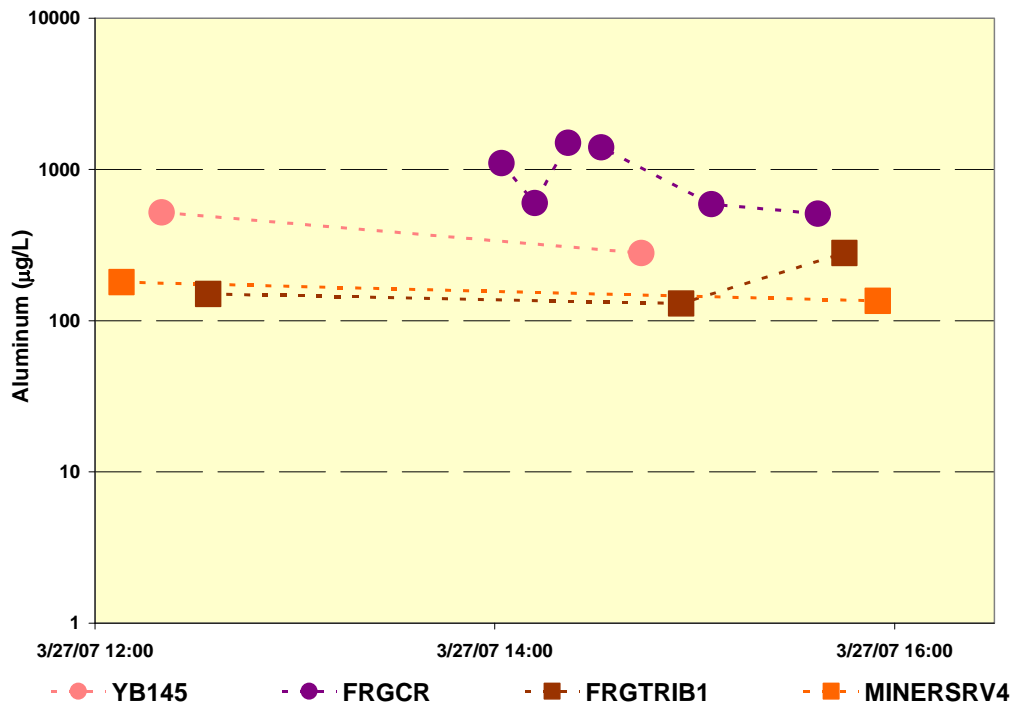


FIGURE 6-7
MEASURED ALUMINUM LEVELS AT MINERS RAVINE WATERSHED SITES
DURING MARCH 27, 2007, CANAL CLEANING EVENT

Barium, copper, and zinc concentrations increased at canal outlet releases for a short duration (about 1 hour) following canal cleaning activities. Water quality data collected during monitoring suggest that these increased concentrations at canal outlets generally did not result in increased concentrations at stream sites downstream from the canal outlet releases. However, the concentration of copper and zinc at MINERSRV5 did increase from 3.2 to 8.8 $\mu\text{g/L}$, and from 5.1 to 7.6 $\mu\text{g/L}$, respectively, during the March 15, 2007, monitoring event. These increases may be attributed to canal cleaning activities. **Figures 6-8 and 6-9** show barium results for sites monitored during the March 26, 2007, and March 27, 2007, canal cleaning events. Copper and zinc results for Miner Ravine watershed sites monitored during the March 15, 2007, canal cleaning event are shown in **Figures 6-10 and 6-11**. Cadmium concentrations measured at all sites during the canal cleaning monitoring event were below the detection limit (0.5 $\mu\text{g/L}$).

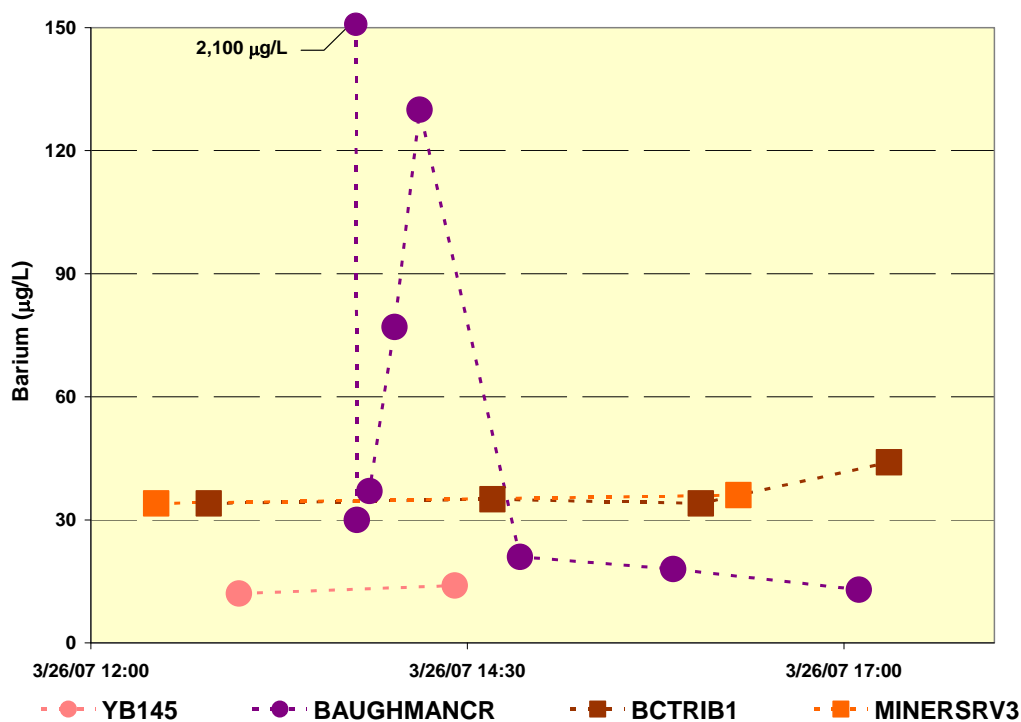


FIGURE 6-8
MEASURED BARIUM LEVELS AT MINERS RAVINE WATERSHED SITES DURING
MARCH 26, 2007, CANAL CLEANING EVENT

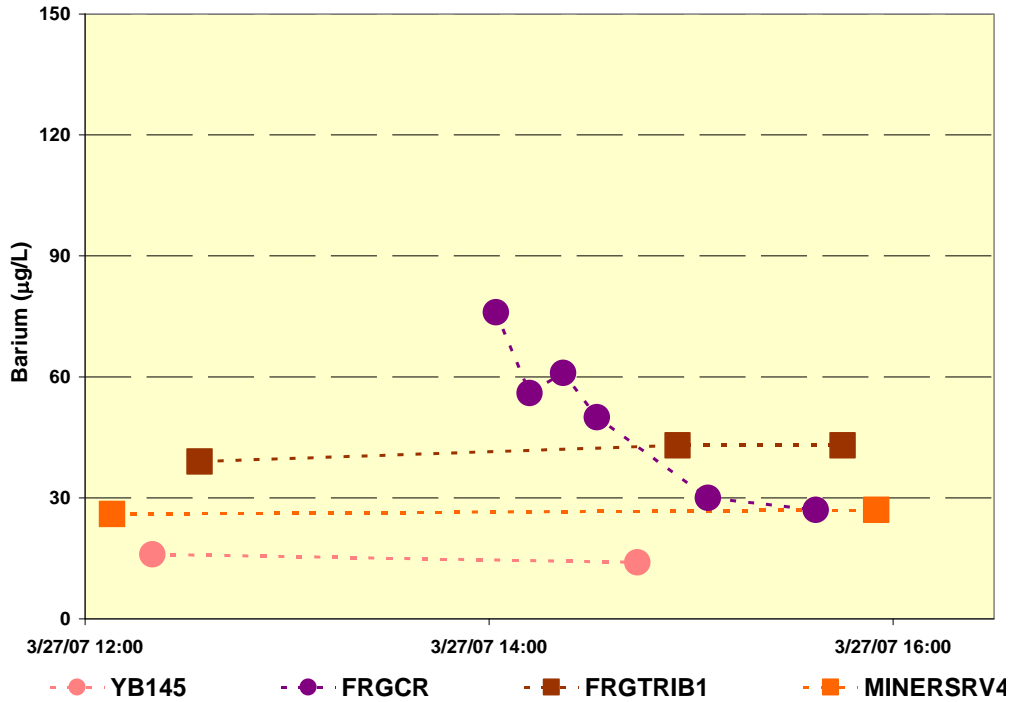


FIGURE 6-9
MEASURED BARIUM LEVELS AT MINERS RAVINE WATERSHED SITES DURING
MARCH 27, 2007, CANAL CLEANING EVENT

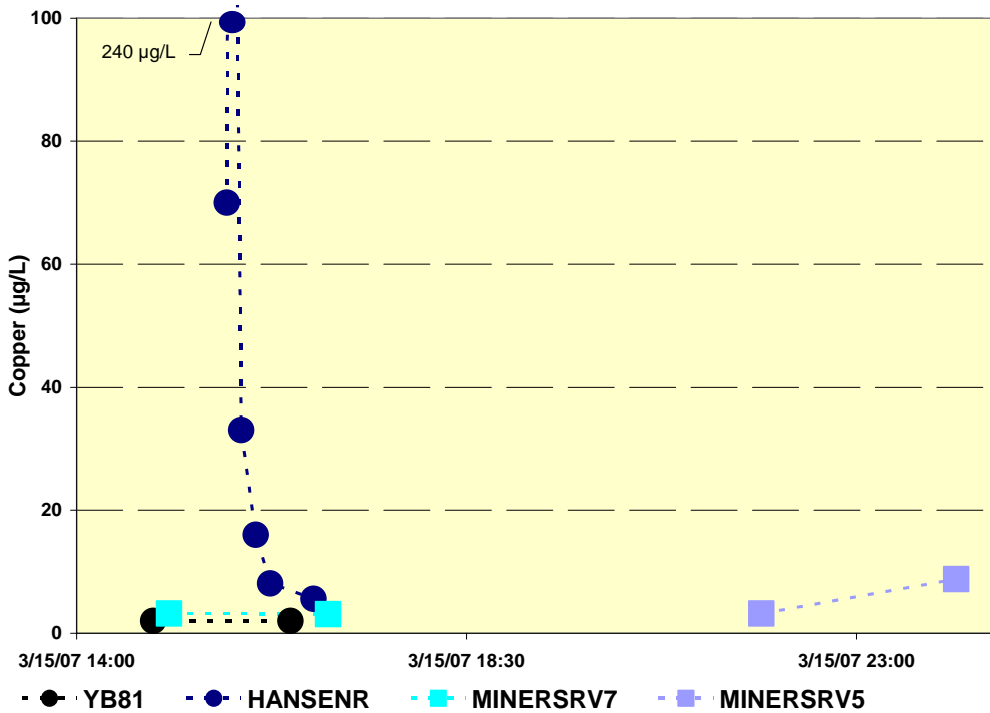


FIGURE 6-10
MEASURED COPPER LEVELS AT MINERS RAVINE WATERSHED SITES DURING
MARCH 15, 2007, CANAL CLEANING EVENT

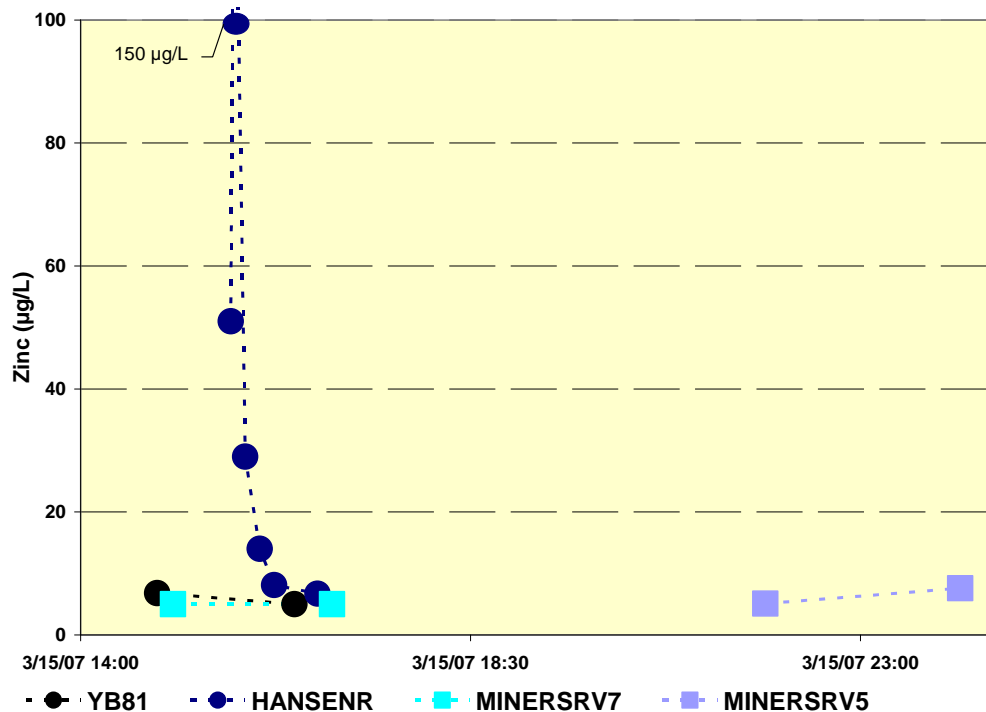


FIGURE 6-11
MEASURED ZINC LEVELS AT MINERS RAVINE WATERSHED SITES DURING
MARCH 15, 2007, CANAL CLEANING EVENT

Soils and Sediment Quality

As described in **Chapter 2**, debris and sediment removed from the canals are typically deposited along canal banks. To quantify the effects of canal cleaning on soil and sediment quality, soils were collected along canal banks where debris had been deposited. Soils were collected in two high-density polyethylene 500-ml canisters from the banks of five canals, the Antelope, Boardman, Yankee Hill, Baughman, and Ferguson canals. These canals were cleaned on February 14, 2007, and March 15, 22, 26, and 27, 2007, respectively. All soil samples were collected on March 30, 2007. These canals were selected and their soils sampled on March 30, 2007, to provide an understanding of the effects of cleaning on soil quality over time. As shown in **Table 6-4**, the selected canals locations for sampling provide data for evaluating soil quality effects after 44, 15, 8, 4, and 3 days, respectively. High air temperatures during the period when the first canal cleaning activity evaluated for soil quality effects to the date of sample collection ranged from 40°F to 80°F, with lows ranging from 27°F to 56°F (**Figure 6-12**). As shown in **Figure 6-3**, rain fell intermittently during the days before the first canal cleaning event and to the sampling date. Air temperature and precipitation may affect the persistence of constituents in soils directly, through chemical and physical interactions, and indirectly, by influencing microbiological communities in soils. At the time of sampling, the weather was sunny, dry, with a high air temperature of 74°F.

**TABLE 6-4
QUALITY OF SEDIMENTS REMOVED FROM CANALS DURING CLEANING AND FLUSHING ACTIVITIES**

Constituent (mg/kg)	Ferguson Canal		Baughman Canal		Yankee Hill Canal		Boardman Canal		Antelope Canal	
	Average	Standard Deviation	Average	Standard Deviation	Average	Standard Deviation	Average	Standard Deviation	Average	Standard Deviation
Aluminum	9,750	+/-1,768	10,000	+/-0	10,800	+/-1,697	4,200	+/-141	12,500	+/-2,121
Barium	89	+/-9.2	62	+/-0.7	62	+/-9.9	41	+/-4.2	125	+/-7.1
Calcium	1,850	+/-354	915	+/-92	4,950	+/-71	1,400	+/-141	2,300	+/-566
Cadmium	Below Detection	Below Detection	Below Detection	Below Detection	0.45	NA	Below Detection	Below Detection	Below Detection	Below Detection
Copper	90	+/-28.3	52	+/-7.8	75	+/-36	22	+/-0.7	55	+/-43
Iron	12,500	+/-2,121	9,500	+/-141	8,450	+/-9,264	6,000	+/-141	20,500	+/-707
Potassium	1,750	+/-354	1,450	+/-71	545	+/-573	860	+/-198	3,000	+/-1,131
Magnesium	3,400	+/-566	2,600	+/-0	2,070	+/-1,739	2,350	+/-212	4,500	+/-283
Sodium	69	+/-11	58	+/-2.8	375	+/-446	54	+/-0	130	+/-14
Zinc	71	+/-1.4	61	+/-3.5	99	+/-73	16	+/-4.2	54	+/-2.8
Days after Cleaning	3		4		8		15		44	

Ten chemical parameters were measured in soil samples collected: aluminum, barium, cadmium, calcium, copper, iron, magnesium, potassium, sodium, and zinc. Results of chemical analyses are shown in **Table 6-4**.

Samples collected had very high concentrations of aluminum, calcium, iron, magnesium, and potassium across all sites. High concentrations of these constituents are not likely attributed to PCWA raw water distribution system O&M activities, because PCWA O&M activities do not introduce these constituents to the study area. High background concentrations of these constituents in study area soils are most likely due to the chemical composition of minerals in parent material comprising soils.

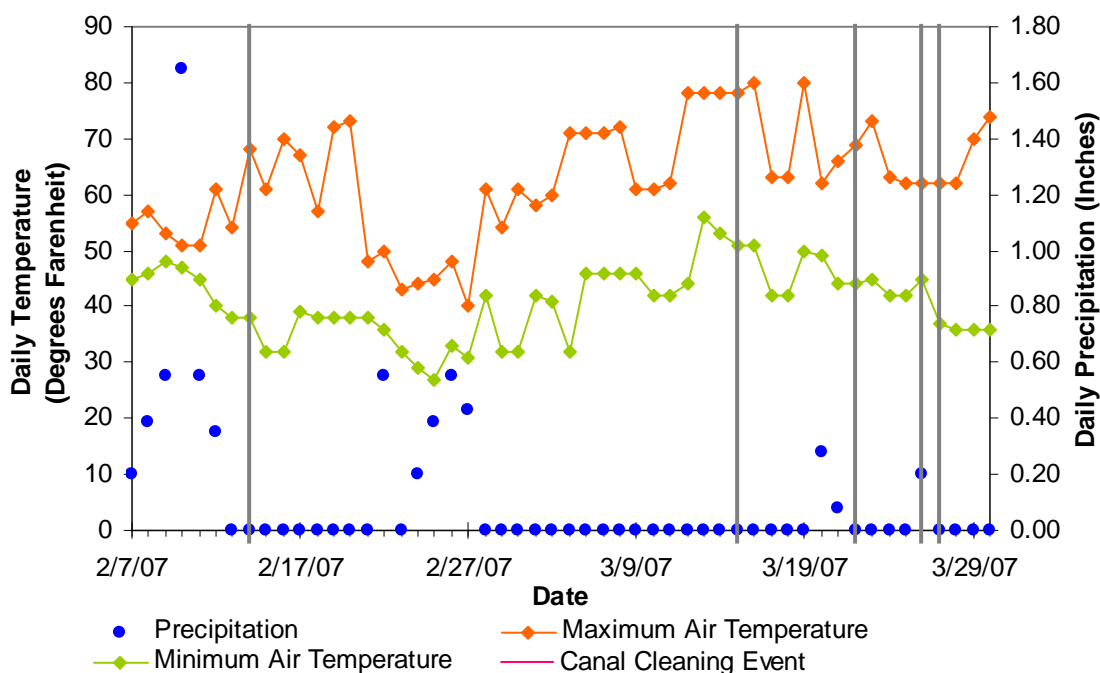


FIGURE 6-12
DAILY AIR TEMPERATURES AND PRECIPITATION BEFORE SOIL SAMPLING
FOR CANAL CLEANING EVENTS

Copper concentrations in soil samples collected across some sites were higher than the mean concentration of copper in soils in the region, while cadmium and zinc concentrations across all sites were consistent with regional mean concentrations for soils shown in **Table 6-5** (Holmgren et al. 1993). These higher copper concentrations may be associated with the removal of sediments from the canal with higher copper concentrations attributed to PCWA's algaecide applications, and deposition of the soils along the canal banks. Barium and sodium concentrations in soil samples collected after PCWA canal cleaning activities varied across sites, but are not expected to be affected by PCWA canal cleaning activities.

Soil compaction and erosion may occur as a result of equipment access and use along canal banks during canal cleaning activities. Mechanical equipment may also introduce chemical contaminants (i.e., petroleum products) to soils at access sites.

**TABLE 6-5
GEOMETRIC MEAN CONCENTRATIONS OF CADMIUM, COPPER,
AND ZINC IN SOILS**

Constituent (mg/kg)	State of California Geometric Mean	California Subtropical Land Resource Region Geometric Mean
Cadmium	0.253	0.254
Copper	37.3	43.4
Zinc	82.7	90.4

Source: Holmgren et al. 1993.

Key:

mg/kg = milligrams per kilogram

Biological Resources

The following sections describe potential effects of PCWA canal cleaning and flushing activities on terrestrial and aquatic habitat and species in the study area.

Terrestrial Habitat and Species

Minimal decreases in study area streams due to a short duration reduction of flows in the PCWA canal system could result in temporary, very minimal decreases in the extent of wetland habitats that may be indirectly supported by canal deliveries. This could have minimal effects on species that use these wetland habitats, such as foraging birds and breeding amphibians, by decreasing the amount of available habitat. Reductions in water levels could expose amphibian eggs in the shallow, vegetated margins of drainages or adjacent wetlands. Potential effects from temporary water reductions on species that use these habitats are expected to be minimal. Flushing after canal cleaning could erode banks and wash away amphibian eggs that may be present on stream margins. The typical timing of the cleaning period in the early part of the year occurs within the breeding period for several amphibian species.

Changes in water quality could indirectly affect terrestrial habitats and species. Increased sedimentation from flushing activities could bury amphibian eggs. Increases in trace elements (such as aluminum and copper) could have some negative effects on plants and wildlife on the margins of canals and tributaries. Amphibians in particular are known to be sensitive to such water quality changes, although effects vary dramatically by type and concentration of contaminant, species, and life stage.

Habitats and species could potentially be affected directly or indirectly by impacts to soils and sediments from equipment, including compaction, erosion, and introduction of petroleum products. Effects on habitats and species could include plant mortality or decreased plant growth. These types of impacts are expected to be relatively minimal and small in aerial extent.

If equipment is used for removal of debris, damage could be caused to habitats by movement of equipment or by placement of debris and soil near canals. Some potential negative effects could occur if raptors are nesting near work areas that may be disturbed by noise. Raptors potentially occurring in the study area include Red-shouldered Hawk, American Kestrel, Red-tailed Hawk, and Great Horned Owl. The nesting period for raptors is generally March 1 to August 15.

Aquatic Habitat and Species

Changes in water quality conditions, particularly aluminum and copper concentrations, observed in study area streams following canal cleaning activities may affect aquatic habitat and species. Most aquatic organisms are relatively unaffected by suspended zinc (Eisler 1993). However, high levels of zinc could result in destruction of the gill epithelium and tissue hypoxia. The temporary increases in zinc in Miners Ravine were still below the acute toxicity levels, and would not substantially affect the fish in Miners Ravine.

Aluminum can affect gill function and growth rates. Aluminum bioavailability is closely tied to pH levels. At elevated aluminum concentrations and pH between 5.5 and 7.0, fish and invertebrates may suffer asphyxiation caused by aluminum adsorption on gill surfaces (NMFS 2006). At lower pH levels, aluminum toxicity can result in erosion of gill epithelium and mortality (NMFS 2006). The EPA standard for the 1-hour maximum concentration exposure of fish to aluminum is 750 µg/L, while the 4-day maximum continuous concentration is 87 µg/L (NMFS 2006). The level of effect is dependent upon other environmental conditions, such as pH and water temperature. Higher pH levels in the water increase the buffering capacity for the effects of aluminum on fishes.

The increase in the aluminum concentration observed at MINERSRV5 following canal cleaning during the March 15, 2007, canal cleaning event may result in negative effects to fish. Because the increase in the aluminum concentration (maximum measured at 710 µg/L) were likely short-lived, and because the pH levels were above 6.5, the long-term effects on the fish present was probably minimal. An increase in aluminum concentrations in study area streams as a result of canal cleaning activities that to levels above 750 µg/L for a prolonged period of time may affect fish, but the degree of effects would be dependent on the length of time and pH levels.

Potential effects of copper on fish include reduced olfactory sensors, and possibly temporary decreased feeding activity. The toxicity of copper on fish is dependent on the chemical form, water hardness, and the lifestage and species exposed. Elevated copper concentrations can result in reduced olfactory sensitivity, affecting the ability to detect predators and prey. Elevated copper concentrations could also reduce survival of benthic macroinvertebrates – prey for many fish species. Copper levels in Miners Ravine resulting from canal cleaning operations on March 15 increased from about 5 µg/L to about 10 µg/L. The increase was likely for a short duration (few hours), but could result in impacts that affect fish gills and benthic invertebrates that are prey for many fish species.

Although not observed during water quality monitoring activities, temporary increases in TSS and/or turbidity levels in streams may affect aquatic species and habitat. Increased sedimentation and turbidity resulting from erosion and/or flushing of sediment associated with canal cleaning activities may result in short-term effects on fish. Prolonged exposure to high levels of suspended sediment can create a loss of visual capability, leading to a reduction in feeding and growth rates; a thickening of the gill epithelium, potentially causing the loss of respiratory function; a clogging and abrasion of gill filaments; and increases in stress levels, reducing the tolerance of fish to disease and toxicants (Waters 1995). In addition, high suspended sediment levels will cause the movement and redistribution of fish populations and

can affect physical habitat. Once the suspended sediment is deposited, it can reduce water depths in pools, decreasing the amount of physical habitat for juvenile and adult fish (Waters 1995). Increased sediment loading can also degrade food-producing habitat downstream of the project area. Sediment loading can interfere with photosynthesis of aquatic flora and result in the displacement of aquatic fauna.

Many fish, including juvenile salmonids, are sight feeders. Turbid waters reduce the fish's efficiency in locating and feeding on prey. Some fish, particularly juveniles, can get disoriented and leave areas where their main food sources are located, which can result in reduced growth rates.

Avoidance is the most common result of increases in turbidity and sedimentation. Fish will not occupy areas that are not suitable for survival, unless they have no other option. Therefore, habitat can become limiting in systems where high turbidity precludes a species from occupying habitat required for specific life stages.

Special Status Species

Minimal streamflow decreases in study area streams due to a short duration reduction of flows in the PCWA canal system could result in temporary, very minimal decreases in the extent of wetland habitats that may be indirectly supported by canal deliveries. This could have minimal effects on special status species that use these wetland habitats, such as special status foraging birds and breeding amphibians, by decreasing the amount of available habitat. Reductions in water levels could expose eggs of special status amphibian species that may occur in the shallow, vegetated margins of drainages or adjacent wetlands. Potential effects from temporary water reductions on species that use these habitats are expected to be minimal. As described above, flushing after canal cleaning could erode banks and wash away amphibian eggs, including those of special status species, which may be present on stream margins. The typical timing of the cleaning period in the early part of the year occurs within the breeding period for several special status amphibian species. The California red-legged frog breeding occurs between late November and March, though most frogs lay eggs in March (USFWS 2002, Stebbins 2003). The foothill yellow-legged frog breeds between mid-March through early June, and the western spadefoot toad breeds late January through July (Stebbins 2003).

Special status plant species (see **Tables 3-12** and **3-13**), if present along the PCWA canal system, could potentially be affected directly or indirectly by impacts to soils and sediments from equipment, including compaction, erosion, and introduction of petroleum products. Effects on species could include plant mortality or decreased plant growth. These types of effects are expected to be unlikely to occur.

If equipment is used to remove debris, damage could be caused to special status plant species, if present, by movement of equipment or by placement of debris and soil near canals. Some potential negative effects could occur if raptors are nesting near work areas that may be disturbed by noise. Special status raptors potentially occurring in the study area include Swainson's hawk, Cooper's hawk, Northern Goshawk, White-tailed Kite, and Northern Harrier. As mentioned above, the nesting period for raptors is generally March 1 to August 15.

Potential water quality effects discussed above could indirectly affect terrestrial habitats and species. Increased sedimentation from flushing activities could bury special status amphibian eggs, if present. Increases in trace elements (such as aluminum and copper) could have some negative effects on special status plants and wildlife, if present, on the margins of canals and tributaries. Amphibians in particular are known to be sensitive to such water quality changes, although effects vary dramatically by species, life stage, and parameters.

Increased levels of aluminum and copper in study area streams during and after canal cleaning activities could potentially affect steelhead and Chinook salmon. As described above, aluminum can affect gill function and growth rates. Pacific salmonids are considered susceptible to copper toxicity, with a mean acute toxicity level at 29.11 µg/L (NMFS 2006). Avoidance by Chinook salmon can occur at levels as low as 0.7 µg/L, and at 1.6 µg/L for rainbow trout. Increased copper levels can result in diminished olfactory sensitivity, which affects the fishes' ability to detect predators, prey, and also to affect imprinting of smolts on their natal stream (NMFS 2006). Exposure to levels at 25 µg/L for 1 and 4 hours indicate a substantial decrease in the number of receptors in the olfactory bulb due to cellular necrosis (cell death) in Chinook salmon. Rainbow trout can tolerate higher concentrations at the 1-hour increment, but have similar effects at the 4-hour interval. Social interactions can also be impaired with copper exposure. Increased stress levels of subordinate fish may also lead to increased copper uptake across the gills. Elevated copper concentrations could also reduce survival of benthic macroinvertebrates – prey for juvenile salmonids. Select examples from research studies of adverse effects with copper to Chinook salmon and steelhead are provided in **Table 6-6**.

**TABLE 6-6
EXAMPLES OF ADVERSE EFFECTS WITH COPPER TO SALMONIDS**

Species (lifestage)	Effect	Effect Concentration ($\mu\text{g/L}$) ^a	Effect statistic	Hardness ^b	Exposure duration	Source
Chinook salmon (<i>Oncorhynchus tshawytscha</i>)						
Juvenile	Avoidance in laboratory exposures	0.75	LOEC	25	20 minutes	Hansen et al. 1999
Juvenile	Loss of avoidance ability	2	LOEC	25	21 days	Hansen et al. 1999
Adult	Spawning migrations in wild apparently interrupted	10-25	LOEC	40	Indefinite	Mebane 2000
NA	Reduced growth (as weight)	1.9	EC ₁₀	25	120 days	Chapman 1982
Fry	Death	19	LC ₅₀	24	96 hours	Chapman 1978
Steelhead (<i>Oncorhynchus mykiss</i>)						
Juvenile – Rainbow trout	Avoidance in laboratory exposures	1.6	LOEC	25	20 minutes	Hansen et al. 1999
NA – Rainbow trout	Loss of homing ability	22	LOEC	63	40 weeks	Saucier et al. 1991
NA	Reduced growth (as weight)	45 to >51	NOEC	24-32	60 days	Mudge et al. 1993
Fry	Death	9-17	LC ₅₀	24-25	96 hours	Chapman 1978, Marr et al. 1996
Adult	Death	57	LC ₅₀	42	96 hours	Chapman and Stevens 1978
Juvenile	Death	24-28	NOEC	24-32	60 days	Mudge et al. 1993
Egg-to-fry	Death	11.9	EC ₁₀	25	120 days	Chapman 1982

Source: NMFS 2007. *An Overview of Sensory Effects on Juvenile Salmonids Exposed to Dissolved Copper.*

Notes:

^a Effects of exposure durations stem from laboratory and field experiments; therefore, in some experiments, multiple routes of exposure may be present (i.e., aqueous and dietary) and water chemistry conditions will likely differ.

^b Toxicity of copper may be influenced by hardness.

Key

EC₁₀ = Effective concentration adversely affecting 10 percent of the test population or percent of the measured response

LC₅₀ = The concentration that kills 50 percent of the test population

LOEC = Lowest observed adverse effect concentration (may not be a threshold, but simply the lowest concentration tested)

NA = Not available

NOEC = No observed adverse effect concentration

6.1.1.2 Weed and Brush Control

The following sections describe potential effects of weed and brush control activities conducted by PCWA on natural resource conditions in the study area. Additionally, the regulatory framework for the weed and brush control activities is provided, along with descriptions of potential BMPs that may reduce potential effects.

Physical Removal of Vegetation

Effects of PCWA's physical removal of vegetation during scheduled canal maintenance activities are described below.

Physical Resources

Potential effects of PCWA's physical removal of vegetation along canal banks on hydrology and water quality conditions in study area streams, and soils and sediment quality in the study area are described below.

Hydrology

Flows within canals are generally not disrupted while PCWA undertakes physical removal of vegetation within or along the canal system. Therefore, physical removal of vegetation is not likely to affect hydrologic conditions within study area streams.

Water Quality

Potential water quality effects of physical removal of vegetation are expected to be minimal to none. Minimal effects on TSS and turbidity may occur if the removal of vegetation results in the dislodging or loosening of soil along canal banks causes loose sediment to be deposited into the canals. During this activity, the removed vegetation is either deposited away from canals or hauled away in trucks, which prevents from potential deposition of debris in the canals. No dewatering or flushing activities are associated with the physical removal of vegetation.

Soils and Sediment Quality

Potential effects of PCWA activities during physical removal of vegetation likely depend on the equipment used for removal, and type and location of vegetation. Equipment used along canal banks may increase erosion, and motorized equipment may introduce petrochemicals to soils and affect sediment quality. These potential effects are likely to be minor.

Biological Resources

The following sections describe potential effects of physical removal of vegetation within the PCWA raw water distribution system on terrestrial and aquatic habitat and species in the study area.

Terrestrial Habitat and Species

Physical removal of vegetation would result in direct loss of vegetation and habitat. Native trees may be trimmed or removed. Bird nests or eggs in vegetation to be trimmed or removed may be disturbed or destroyed. Habitats and species could potentially be affected directly or indirectly by impacts to soils and sediments from equipment used for vegetation removal, including compaction, erosion, and introduction of petroleum products. Potential effects on habitats and

species may include plant mortality or decreased plant growth. These types of impacts are expected to be relatively minimal and small in aerial extent.

If equipment is used to remove vegetation, some potential negative effects could occur if raptors nesting near work areas are disturbed by noise. Raptors potentially occurring in the study area include Red-shouldered Hawk, American Kestrel, Red-tailed Hawk, and Great Horned Owl. The nesting period for raptors is generally March 1 to August 15.

Aquatic Habitat and Species

As described above, flows within canals are generally not disrupted while PCWA undertakes physical removal of vegetation within or along the canal system, and potential water quality effects of physical removal of vegetation are expected to be minimal to none. Therefore, physical removal of vegetation is not likely to affect aquatic habitat and species within study area streams.

Special Status Species

Physical removal of vegetation could result in direct loss of or damage to special status plant species or elderberry shrubs that may host the valley elderberry longhorn beetle, if present. Special status bird nests or eggs in vegetation to be trimmed or removed, if present, may be disturbed or destroyed.

Special status plant species (see **Tables 3-12** and **3-13**), if present, could potentially be affected directly or indirectly by impacts to soils and sediments from equipment used for vegetation removal, including compaction, erosion, and introduction of petroleum products. Effects on species could include plant mortality or decreased plant growth. These types of impacts are expected to be unlikely to occur.

If equipment is used for removal of vegetation, some potential negative effects could occur if raptors are nesting near work areas that may be disturbed by noise. Special status raptors potentially occurring in the study area include Swainson's hawk, Cooper's hawk, Northern Goshawk, White-tailed Kite, and Northern Harrier. As mentioned above, the nesting period for raptors is generally March 1 to August 15.

Algaecide Application

PCWA's raw water distribution system algaecide applications have the potential to affect natural resource conditions in the study area. The following sections describe potential effects of algaecide applications on natural resources.

Physical Resources

The following sections describe potential effects of PCWA's algaecide applications on the hydrology and water quality of study area streams, and soils and sediment quality.

Hydrology

Flows within canals are generally not disrupted while PCWA carries out algaecide applications within the canal system. Therefore, algaecide applications conducted by PCWA in the raw water distribution system are not likely to affect hydrologic conditions in study area streams.

Water Quality

As shown in **Figures 2-8 to 2-11** and discussed in **Table 2-1**, PCWA has 21 established points of algaecide application within the system, with “spot” treatments at other locations as conditions warrant. Water quality conditions at canal and stream sites within the Secret Ravine watershed were monitored during two application events at Boardman Canal below Mammoth Reservoir on May 16, 2007, and August 15, 2007. The locations and times of sampling were selected to determine potential effects of algaecide applications on water quality conditions in receiving waters. These locations are shown in **Figures 5-3 and 5-4**. **Table 6-7** provides details of the algaecide application monitoring events. Potential water quality effects described for sites monitored within the Secret Ravine watershed are assumed to be representative of the potential effects in watersheds of other study area streams affected by PCWA maintenance activities. Figures providing a comparison of water quality conditions within the PCWA raw water distribution system and study area streams monitored during algaecide applications are included in **Appendix C**.

TABLE 6-7
WATER QUALITY MONITORING LOCATIONS FOR ALGAECIDE APPLICATIONS
AT BOARDMAN CANAL BELOW MAMMOTH RESERVOIR

Site Description	Site Identification	Site Type	Application Start /End Time	Weather
Boardman Canal below Mammoth Reservoir ¹	YB81	Canal	Start: 5/16/2007, 8:30 a.m. End: 5/16/2007, 12:00 p.m.	Warm and dry
Yankee Hill Canal Outlet Release	YANKEEER	Canal		
Tributary to Secret Ravine from Yankee Hill Canal	YHTRIB2	Stream		
Secret Ravine at Rocklin Road	SECRETREV3	Stream		
Boardman Canal below Mammoth Reservoir ²	YB81	Canal	Start: 8/15/2007, 8:25 a.m. End: 8/15/2008, 12:00 p.m.	Warm and dry
Yankee Hill Canal Outlet Release	YANKEEER	Canal		
Tributary to Secret Ravine from Yankee Hill Canal	YHTRIB2	Stream		
Secret Ravine at Rocklin Road	SECRETREV3	Stream		

Notes

¹ Cutrine application conducted by PCWA with a target dosage of 800 µg/L

² Cutrine-Plus® application conducted by PCWA with a target dosage of 800 µg/L

Water Temperature and Dissolved Oxygen

No effects on water temperatures were observed during the algaecide application events.

Measured changes in water temperatures during the algaecide events are consistent with diurnal fluctuations with the highest temperatures occurring during the afternoon, and lowest temperatures occurring at night and during the early morning. No effects on DO levels were observed during algaecide application activities.

pH, Alkalinity, and Hardness

Minimal effects on pH were observed during the algaecide application monitoring events. Measured pH levels increased slightly at YANKEE CR and subsequently increased at YHTRIB2 and SECRETRV3. These results are shown in **Figure 6-13** below. According to the Material Safety and Data Sheet for Cutrine-Plus®, the pH of the algaecide ranges from 10.3 to 10.5 (Applied Biochemists 2006). The high pH allows the copper to stay in solution even under conditions of high hardness and alkalinity.

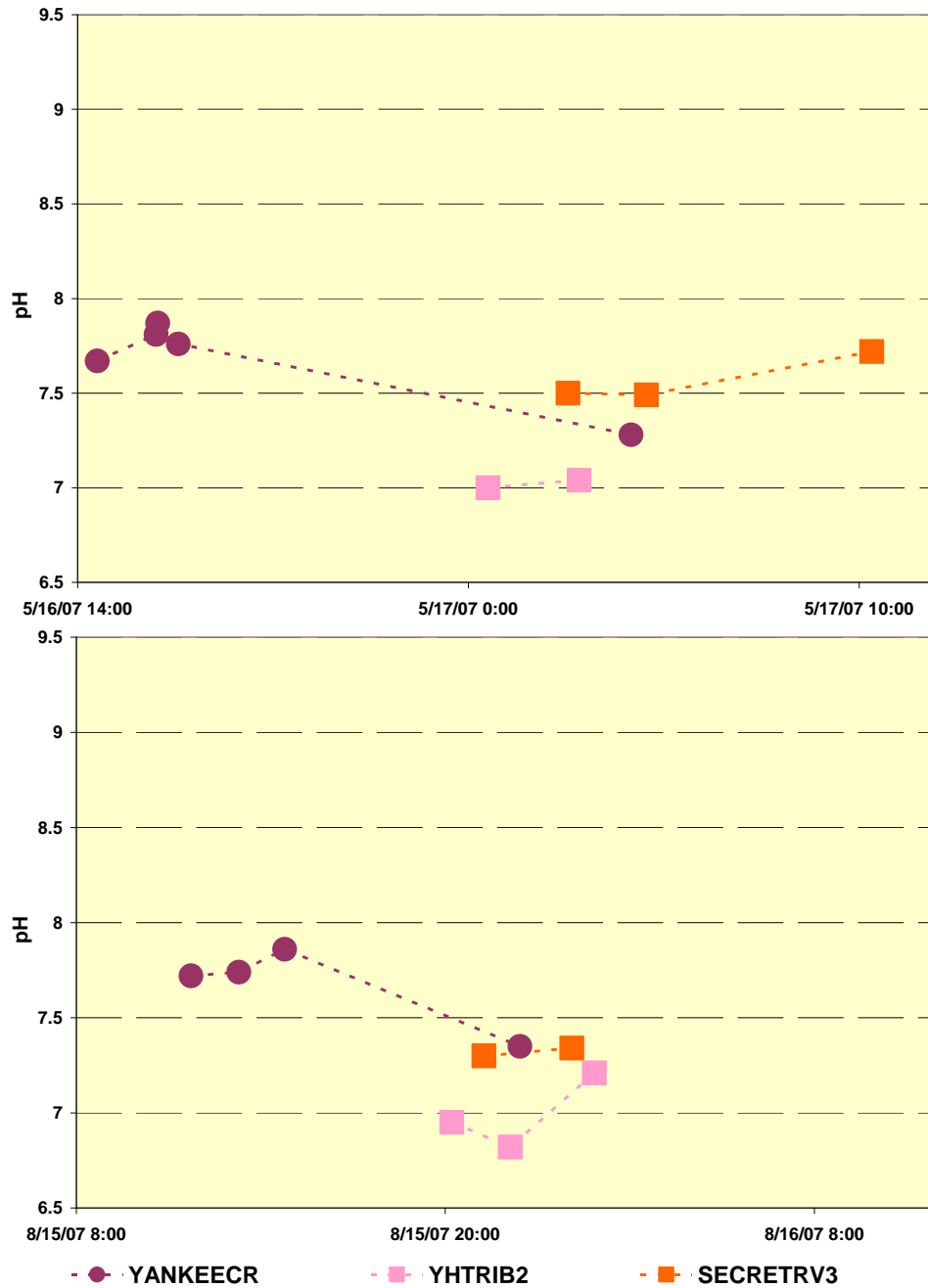


FIGURE 6-13
MEASURED PH LEVELS AT SECRET RAVINE WATERSHED SITES DURING MAY 16, 2007, AND AUGUST 15, 2007, ALGAECIDE APPLICATION EVENTS

No effects on alkalinity and calculated total hardness were observed during algaecide application events. In general, alkalinity and total hardness levels were higher at stream sites compared to canal sites.

Total Suspended Solids and Turbidity

TSS was not sampled during the algaecide application events. No effects on turbidity were observed during the events.

Specific Conductivity and Ions

Measured values in samples collected during monitoring suggest that SC and major ion (calcium, iron, magnesium, potassium, sodium, chloride, nitrate, and sulfate) concentrations at Secret Ravine watershed sites were not affected by algaecide applications.

Trace Elements

Algaecide applications do not appear to affect aluminum, barium, cadmium, and zinc concentrations in study area streams. Copper concentrations at YANKEE CR did increase in response to algaecide applications upstream at Boardman Canal below Mammoth Reservoir. Based on measured values of copper in samples collected during monitoring, minimal to no effects on copper concentrations were observed at YHTRIB2 and SECRETRV3. Copper concentrations at sites monitored during the algaecide application events are shown in **Figures 6-14 and 6-15**. Cadmium and zinc concentrations measured at all sites during algaecide application monitoring events were below the detection limit (0.5, and 20 µg/L, respectively).

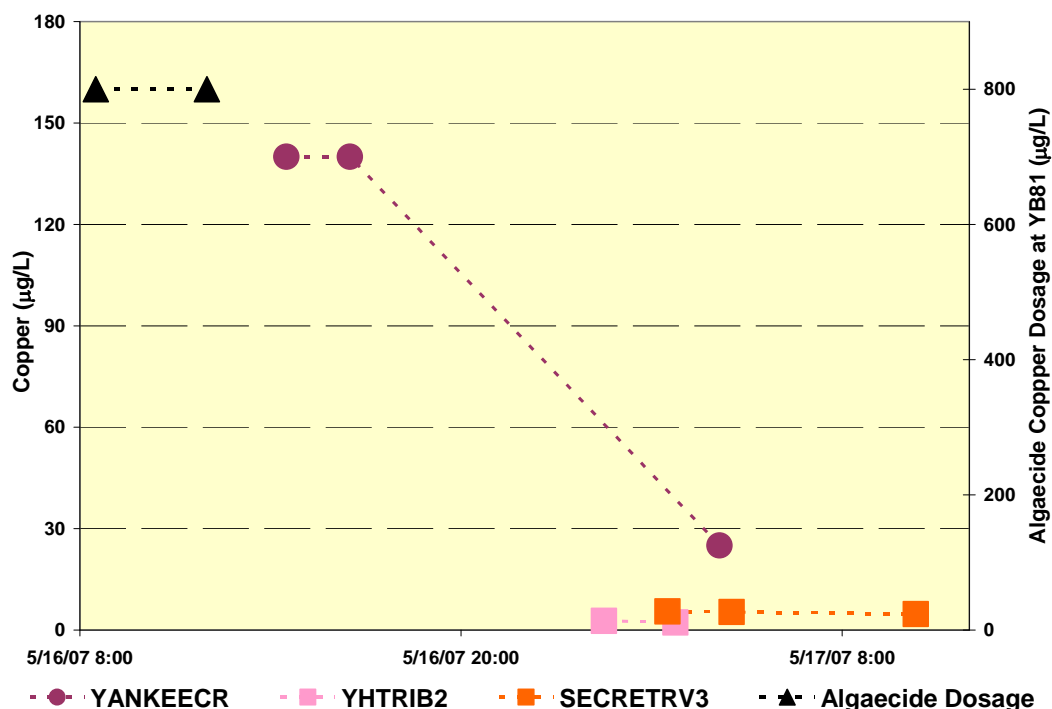


FIGURE 6-14
MEASURED COPPER LEVELS AT SECRET RAVINE WATERSHED SITES DURING
MAY 16, 2007, ALGAECIDE APPLICATION EVENT

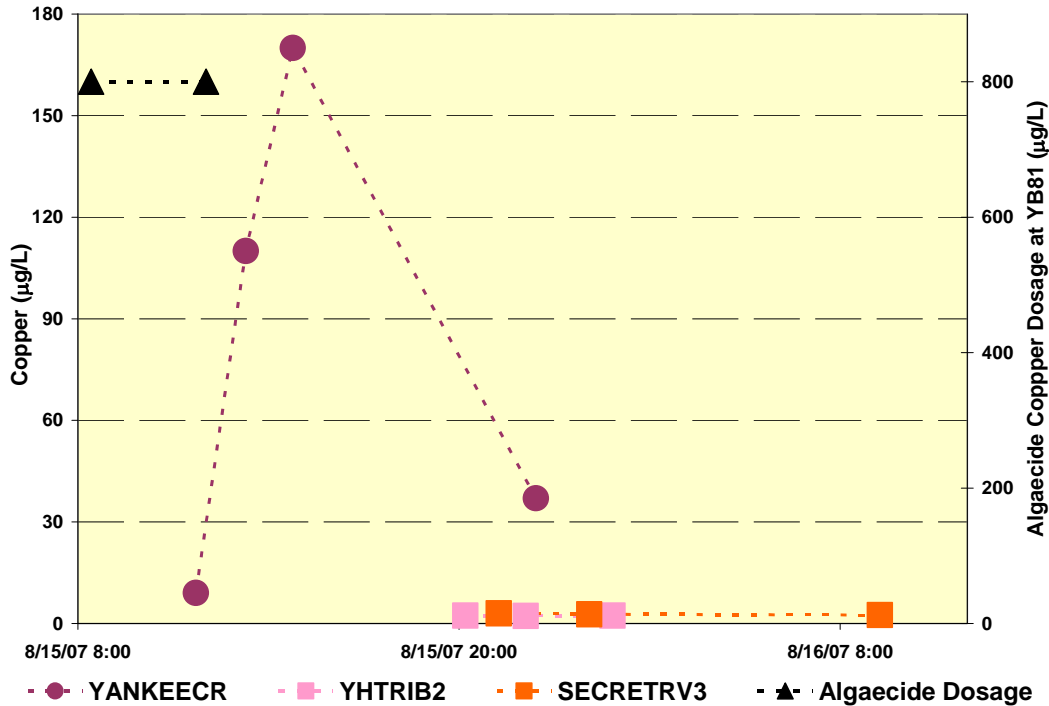


FIGURE 6-15
MEASURED COPPER LEVELS AT SECRET RAVINE WATERSHED SITES DURING
AUGUST 15, 2007, ALGAECIDE APPLICATION EVENT

Soils and Sediment Quality

Algaecides are released directly to water supplies at PCWA canal system locations by staff; therefore, effects of applications on soils and sediment quality in the study area are minimal. Potential effects are likely associated with unintentional discharges to the environment during transport of algaecides to application sites and/or leaks from algaecide storage vessels at application sites. These potential effects are not likely due to training and qualifications requirements for staff involved in algaecide applications.

Biological Resources

The following sections describe potential effects of PCWA’s algaecide applications on biological resources in the study area.

Terrestrial Habitat and Species

Copper in applied algaecides could have some negative effects on plants and wildlife on the margins of canals and tributaries. Exposure routes for copper through dietary consumption of contaminated prey items or direct contact with contaminated sediments are important and may affect a broad range of terrestrial species (NMFS 2007). Heavy metals, especially copper, have been found to be very toxic to amphibians, particularly at the egg and tadpole life stages (U.S. EPA 2008, B.C. Ministry of Water, Land and Air Protection 2004). Algaecides are typically applied starting in April through summer, which coincides with the breeding season and tadpole stages for several amphibian species. Birds and mammals appear to be less sensitive to copper than aquatic organisms; however, toxic effects have been documented, including reduced growth

rates, lowered egg production, and developmental abnormalities in birds, and various physiological effects on mammals, such as liver cirrhosis, damage to kidneys and the brain, and fetal mortality (U.S. EPA 2008, EXTTOXNET 1994a).

Very minimal effects could occur to terrestrial habitats and species associated with trampling of vegetation at application points while algaecides are being applied.

Aquatic Habitat and Species

Based on water quality monitoring results, aquatic habitat and species in study area streams are not likely affected by PCWA activities during algaecide application events. Potential indirect effects are associated with mobilization of constituents associated with fine sediment and organic material that had settled when canals were dewatered during the outage, as described for canal cleaning activities and discussed in **Chapter 7**.

Special Status Species

Copper in applied algaecides could have some negative effects on special status species, if present, on the margins of canals and tributaries. Amphibians in particular are known to be sensitive to such water quality changes, although effects vary dramatically by species, life stage, and contaminant. Algaecides applications typically start during April through summer, which coincides with the breeding season and tadpole stages for several special status amphibians. California red-legged frog breeding occurs between late November and March, though most frogs lay eggs in March (USFWS 2002, Stebbins 2003). The foothill yellow-legged frog breeds between mid-March through early June, and the western spadefoot toad breeds late January through July (Stebbins 2003).

If present, special status plant species could also be affected by trampling while algaecide is being applied.

Based on water quality monitoring results, special status fish species in study area streams are not likely affected by PCWA activities during algaecide application events. Potential indirect effects on special status fish species are associated with mobilization of constituents associated with fine sediment and organic material that had settled when canals were dewatered during the outage, as described for canal cleaning activities and discussed in **Chapter 7**.

Herbicide Application

PCWA's herbicide application activities have the potential to affect natural resource conditions in the study area. The following sections describe potential effects of PCWA's herbicide applications on natural resources.

Physical Resources

The following sections describe potential effects of herbicide applications within the PCWA raw water distribution system on hydrologic and water quality conditions in study area streams, and soils and sediment quality.

Hydrology

Flows within canals are generally not disrupted while PCWA carries out herbicide applications within or near the canal system. Therefore, herbicide applications conducted by PCWA are not likely to affect hydrologic conditions in study area streams.

Water Quality

Potential effects of PCWA herbicide applications for managing pre-emergent vegetation, woody plants, and annual and perennial broadleaf weeds along canal berms were not evaluated through water quality monitoring. Herbicide applications along canal berms are not likely to affect water quality conditions in study area streams due to the rapid degradation of these herbicides, as described in **Chapter 2**.

Water quality was monitored at six locations to evaluate potential effects associated with AquaMaster™ glyphosate aquatic herbicide application events that occurred at Clover Valley and Mammoth reservoirs on August 2, 2007. Two canal monitoring sites and one stream site were sampled downstream from Clover Valley Reservoir in the Antelope Creek watershed, and two canal monitoring sites and one stream site were sampled below Mammoth Reservoir in the Secret Ravine watershed (**Figure 5-4**). Water quality conditions were not monitored at Auburn Ravine, Clover Valley Creek, or Miners Ravine sites, but are likely to be similar to conditions described below for Antelope Creek and Secret Ravine. **Table 6-8** below lists the aquatic herbicide application information and sites monitored for each sampling event. Water quality parameters evaluated through monitoring during the aquatic herbicide application events include water temperature, DO, pH, SC, turbidity, alkalinity, and glyphosate. The results from water quality monitoring during herbicide application events are discussed in this section by watershed. Figures providing a comparison of water quality conditions within the PCWA raw water distribution system and study area streams monitored during herbicide application monitoring events are included in **Appendix C**.

**TABLE 6-8
WATER QUALITY MONITORING LOCATIONS IN THE PCWA SERVICE AREA FOR
HERBICIDE APPLICATION**

Site Description	Site Identification	Site Type	Watershed(s)	Application Start /End Time	Weather
Herbicide Application at Mammoth Reservoir (Glyphosate)					
Boardman Canal below Mammoth Reservoir	YB81	Canal	Miners Ravine/Secret Ravine	Start: 8/2/2007, 8:00 a.m. End: 8/2/2007, 11:30am	Warm and dry, light rain at night
Boardman Canal Outlet Release	BOARDMANCR	Canal	Secret Ravine		
Secret Ravine at Rocklin Road	SECRETRV3	Stream	Secret Ravine		
Herbicide Application at Clover Valley Reservoir (Glyphosate and Reward)					
Clover Valley Reservoir release to Clover Valley Creek and Antelope Canal	CLVRESR	Canal	Antelope Creek/Clover Valley Creek	Start: 8/15/2007, 8:25 a.m. End: 8/15/2008, 12:00 p.m.	Warm and dry
Antelope Stub Canal near Antelope Canal	ANTSTUBCR	Canal	Antelope Creek		
Antelope Creek at Midas Avenue	ANTC3B	Stream	Antelope Creek		

Antelope Creek Watershed

AquaMaster™ was applied to emergent aquatic vegetation along the perimeter of Clover Valley Reservoir on August 2, 2007. Water quality was monitored at:

- **Clover Valley Reservoir release to Clover Valley Creek and Antelope Canal (CLVRESR)**
- **Antelope Stub Canal near Antelope Canal (ANTSTUBCR)**
- **Antelope Creek near Midas Avenue (ANTC3B)**

Based on water quality results, Antelope Creek water temperatures, DO, pH, alkalinity, SC, and turbidity conditions were not affected by the aquatic herbicide application event at Clover Valley Reservoir. Minimal changes in water temperature and DO observed during monitoring are likely due to diurnal fluctuations. The aquatic herbicide application event also did not appear to affect glyphosate concentrations in Antelope Creek; all water quality samples collected at Antelope Creek watershed sites during the monitoring event had glyphosate concentrations below the measurable detection limit (6 µg/L).

Secret Ravine Watershed

AquaMaster™ was applied to emergent aquatic vegetation along the perimeter of Mammoth Reservoir on August 2, 2007. Water quality was monitored at:

- **Boardman Canal below Mammoth Reservoir (YB81)**
- **Boardman Canal Outlet Release (BOARDMANCR)**
- **Secret Ravine at Rocklin Road (SECRETRV3)**

Similar to the conditions described above within the Antelope Creek watershed, the aquatic herbicide application event did not appear to affect water temperature, DO, pH, alkalinity, SC, turbidity, or glyphosate conditions at Secret Ravine watershed sites. All water quality samples collected during the monitoring event had glyphosate concentrations below the measurable detection limit (6 µg/L).

Soils and Sediment Quality

PCWA's application of herbicides along canal berms likely result in temporary effects on soil chemistry. Chemical constituents of herbicides applied by PCWA may include triclopyr, glyphosate, dithiopyr, diquat dibromide, and non-ionic alkylphenol ethoxylate surfactants. As described in **Chapter 2**, these constituents, with the exception of diquat dibromide, degrade rapidly to inert compounds or products with low toxicity. Diquat dibromide is tightly adsorbed to soil particles, persistent, toxic to fish and wildlife, and is unavailable to soil microbes' microbial degradation and for plant uptake.

Biological Resources

The following sections describe potential effects of PCWA's herbicide applications on biological resources in the study area.

Terrestrial Habitat and Species

Application of herbicide may result in indirect mortality or damage to non-target vegetation. Herbicides may also affect wildlife species, particularly amphibians. Glyphosate herbicides, which are used near water, are generally less toxic to wildlife than other types of herbicide; however, effects vary dramatically by concentration of contaminant, species, and life stage. Some studies of glyphosates on amphibians have found negative effects at various life stages, including mortality, developmental defects, and behavioral abnormalities (B.C. Ministry of Water, Land and Air Protection 2004). Other components, such as surfactants, commonly contained in glyphosate formulations, including Roundup®, have also been found to cause severe negative effects to amphibians (USFWS 2002). Herbicides are typically applied in early spring through summer, which coincides with the breeding season for several amphibian species. Glyphosates have been found to be only slightly toxic to birds and mammals (EXTOXNET 1994b, Tu et al. 2001). Triclopyr was also found to be only slightly toxic to birds and mammals (EXTOXNET 1994b, Tu et al. 2001). According to these sources, triclopyr is not expected to bioaccumulate in wildlife. A study in Canada, however, found triclopyr to be harmful to amphibians under normal field use (Thompson et al. 2007).

Aquatic Habitat and Species

Based on results from water quality monitoring during herbicide applications, aquatic habitat and species in study area streams are not likely affected by the application of AquaMaster™ glyphosate aquatic herbicide at PCWA reservoirs. Glyphosate herbicides designed for aquatic use, such as AquaMaster™, have minimal surfactants, and thus have a low toxicity level to fish. Glyphosate dissipates in water by binding to soil particles and organic material or through microbial degradation. Any fish present in Mammoth and Clover Valley reservoirs are likely to suffer minimal effects resulting from the use of AquaMaster™ as an herbicide.

Special Status Species

Application of herbicide may result in indirect mortality or damage to untargeted special status plants or elderberry shrubs hosting the valley elderberry longhorn beetle, if present near the application area. Herbicides may also affect special status wildlife species, particularly amphibians, if present. Herbicides are typically applied in early spring through summer, which coincides with the breeding season for several special status amphibians. California red-legged frog breeding occurs between late November and March, though most frogs lay eggs in March (USFWS 2002, Stebbins 2003). The foothill yellow-legged frog breeds between mid-March through early June, and the western spadefoot toad breeds late January through July (Stebbins 2003).

Special status fishes are not likely affected by the application of the herbicides within the canal system. Herbicides applied by PCWA have a relatively short half life, and AquaMaster™ is relatively nontoxic to fishes.

Other special status species, particularly amphibians, may be negatively affected by applications of herbicides if in close proximity to the application. Water quality monitoring results during the herbicide application event do not show effects to stream habitat.

6.1.2 As-Needed Site-Specific Maintenance Activities

The following sections address potential effects of PCWA's as-needed site-specific maintenance activities on natural resource conditions in the study area. These activities include canal lining/guniting, canal repair, and pipe repair.

6.1.2.1 Canal Lining/Guniting

This section provides an overview of the potential effects of PCWA's canal lining/guniting activities.

Physical Resources

The following sections describe potential effects of PCWA canal repair activities on hydrologic and water quality conditions in study area streams, and soils and sediment quality.

Hydrology

PCWA operations during canal lining/guniting activities do not affect hydrologic conditions in Canyon Creek or Auburn Ravine. During the canal cleaning and flushing, PCWA canal system contributions to streamflow in Canyon Creek and Auburn Ravine, and/or diversions from

Canyon Creek and Auburn Ravine, do not change as a result of PCWA operations. As described above for canal cleaning and flushing activities, continuous-flow data collected from canal and stream sites within PCWA’s lower Zone 1 service area during WDY 2006 were evaluated to determine effects of canal lining/guniting activities on hydrologic conditions in Clover Valley Creek, Antelope Creek, Secret Ravine, and Miners Ravine. Continuous-flow monitoring locations, and their respective watersheds, are listed in **Table 6-1**.

Table 6-9 provides PCWA’s schedule of canal lining/guniting within a portion of PCWA’s raw water distribution system during 2006. During these outages for canal lining/guniting, canal flows were typically interrupted during business hours to dewater canal segments, apply gunite to dewatered segments, and allow sufficient time for the new canal lining to dry.

**TABLE 6-9
CANAL OUTAGES FOR CANAL LINING/GUNITE DURING 2006**

Canal	Date
East Perry near Horseshoe Bar Road	March 6, 7, 8
Boardman near Valley Quail Drive	March 13, 14, 15
Baughman near headgate	March 15, 16
Baughman downstream from Mutoza spill	March 17, 20
Ferguson at Morgan Place/Wells Lane	March 17, 20
End of Stallman Canal	July 18
Boardman at Rocklin road	September 14, 21

Average daily flows for canal and stream sites evaluated during March 2006 canal lining/guniting are shown in **Figure 6-1** for sites within the Secret Ravine watershed, and in **Figure 6-2** for sites within the Miners Ravine watershed. Based on the average daily flows for sites provided in **Figures 6-1** and **6-2**, the short duration reduction in flows within the PCWA canal system during March 2006 canal lining/guniting activities are not likely to affect flow conditions in study area streams. Precipitation runoff within the watersheds of study area streams is likely to have a much greater influence on stream flow conditions during spring season canal lining/guniting activities. Precipitation during March 2006 is shown in **Figure 6-3**. Effects on flow conditions in Antelope Creek and Clover Valley Creek are likely similar to conditions shown for Secret and Miners ravines.

Canal lining/guniting activities during September 2006 are likely to have some effect on flow conditions in study area streams, although canal system contributions to flow within study area streams through unregulated releases from canal outlets are variable. Average hourly flows for the end of Boardman Canal outlet, downstream from canal lining/guniting activities, are shown in **Figure 6-16**. Average daily flows for Secret Ravine at Rocklin Road, which is located just upstream from the Boardman Canal outlet, are also shown in **Figure 6-16**. Based on flow data observed during September 2006, canal lining/guniting during the dry season does have the potential to affect hydrologic conditions in study area streams. **Figure 6-16** shows releases from the end of Boardman Canal potentially comprise approximately one-third of flow in Secret Ravine during September 2006.

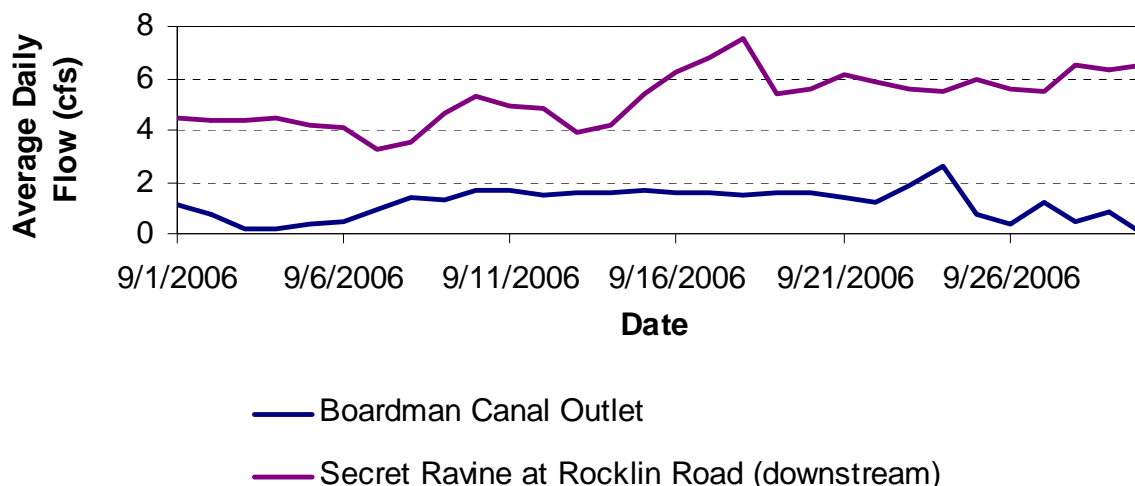


FIGURE 6-16
CANAL OUTLET AND SECRET RAVINE FLOW RESPONSES TO
CANAL LINING/GUNITING ACTIVITIES

Water Quality

Water quality conditions were monitored for PCWA canal lining/guniting activities on February 16, 2007, March 16, 2007, and March 20, 2007, at sites within the Clover Valley Creek, Secret Ravine, and Miners Ravine watersheds, respectively. These locations, shown in **Figures 5-3 and 5-4**, were selected according to canal lining activity locations. **Table 6-10** lists the monitoring site names, site type, associated watershed, and information related to the canal lining/guniting activity. Water quality conditions were not evaluated in the Auburn Ravine, Antelope Creek, or Miners Ravine watersheds, but are likely to be similar to conditions described below for Clover Valley Creek, Secret Ravine, and Miners Ravine. Figures providing a comparison of water quality conditions within the PCWA raw water distribution system and study area streams monitored during monitoring events for canal lining/guniting are included in **Appendix C**.

Clover Valley Creek Watershed

Water quality conditions in the Clover Valley Creek watershed were evaluated at the following sites during canal lining/guniting activities along sections of the Antelope Canal on February 16, 2007:

- **Antelope Canal (ANTCA):** located on the Antelope Canal upstream from the Antelope Canal Outlet. This site was upstream from the canal lining activity, but was located within a dewatered section of the canal.
- **Antelope Canal Outlet Release (ANTCR):** Unregulated releases from this canal flow into an unnamed tributary that contributes flows to Clover Valley Creek.
- **Clover Valley Creek at Rawhide Road (CLVRC6):** located on Clover Valley Creek at Rawhide Road upstream from Antelope Canal Outlet.
- **Clover Valley Creek near Argonaut Avenue (CLVRC3B)**

**TABLE 6-10
WATER QUALITY MONITORING LOCATIONS IN THE PCWA SERVICE AREA FOR CANAL LINING/GUNTING
ACTIVITIES**

Site Description ¹	Site Identification	Type	Watershed(s)	Canal Lining Start/End Time	Weather
Antelope Canal near Antelope Canal Outlet					
Antelope Canal above Outlet Release	ANTCA	Canal	Clover Valley Creek	Start: 2/16/2007, 5:00am End: 2/16/2007, 8:00pm	Warm and dry
Antelope Canal Outlet Release	ANTCR	Canal	Clover Valley Creek		
Clover Valley Creek near Rawhide Road	CLVRC6	Stream	Clover Valley Creek		
Clover Valley Creek near Argonaut Avenue (near Golf Course)	CLVRC3B	Stream	Clover Valley Creek		
Boardman Canal downstream from Baughman Canal					
Boardman Canal below Head of Baughman Canal	YB155	Canal	Secret Ravine	Start: 3/15/2007, 5:00am End: 3/15/2007, 8:10pm	Warm and dry
Boardman Canal below Head of Baughman Canal – downstream	YB155DS	Canal	Secret Ravine		
Boardman Canal Outlet Release	BOARDMANCR	Canal	Secret Ravine		
Secret Ravine at Rocklin Road	SECRETRV3	Stream	Secret Ravine		
Secret Ravine at Roseville Parkway	SECRETRV2	Stream	Secret Ravine		
Boardman Canal near Laird Pump					
Boardman Canal near Laird Pump	315BDU	Canal	Miners Ravine/ Secret Ravine	Start: 3/20/07, 5:00am End: 3/20/07 at 6:30pm	Light Rain
Boardman Canal near Laird Pump	315BDD	Canal	Miners Ravine/ Secret Ravine		
Baughman Canal Outlet Release	BAUGHMANCR	Canal	Miners Ravine		
Tributary to Miners Ravine from Baughman Canal	BCTRIB1	Drainage	Miners Ravine		
Miners Ravine at Moss Lane	MINERSRV5	Stream	Miners Ravine		

Water Temperature and Dissolved Oxygen

Water temperature or DO levels observed at Clover Valley Creek downstream from canal lining activities were not affected by of canal lining along the Antelope Canal.

pH, Alkalinity, and Hardness

Measured pH values at ANTCR increased to up to 11.66 after flows were restored to Antelope Canal following canal lining. Alkalinity and hardness at the Antelope Canal Outlet release also increased for a short duration. Based on water quality measurements upstream (CLVRC6) and downstream (CLVRC3B) from the canal lining, pH, alkalinity, and hardness conditions in Clover Valley Creek did not appear to be affected by canal lining activities. These results are shown below in **Figures 6-17 to 6-19**.

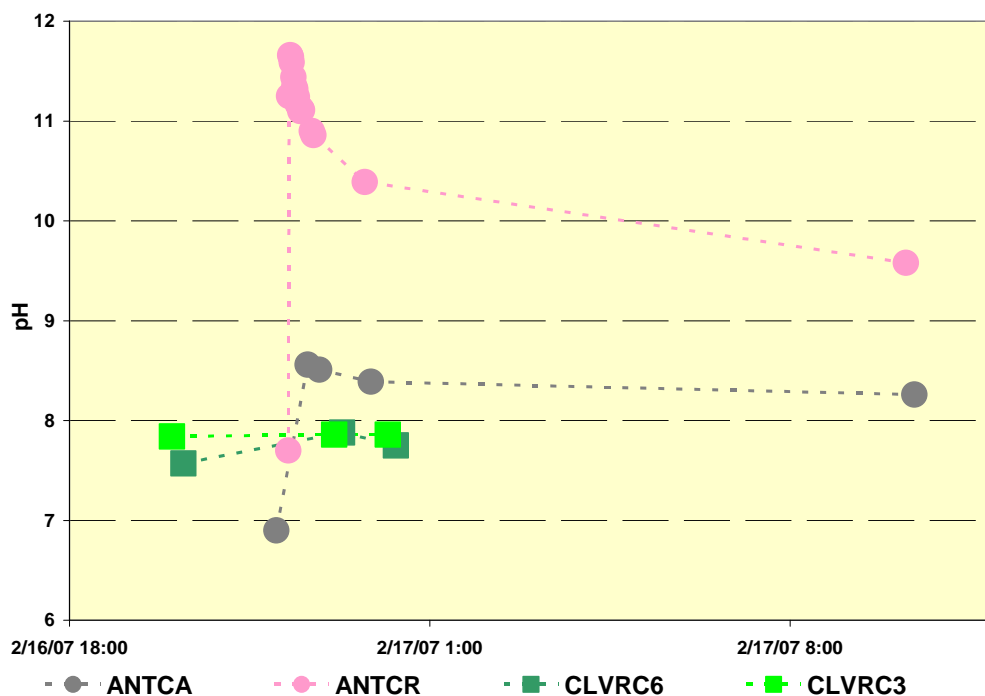


FIGURE 6-17
MEASURED PH LEVELS AT CLOVER VALLEY CREEK WATERSHED SITES
DURING FEBRUARY 16, 2007, CANAL LINING EVENT

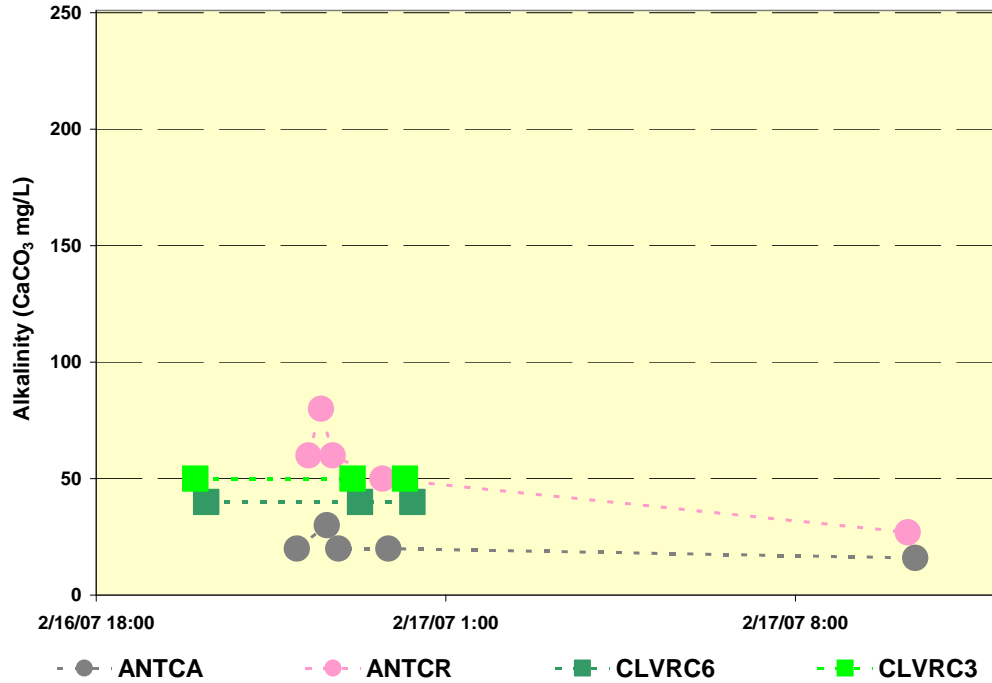


FIGURE 6-18
MEASURED ALKALINITY LEVELS AT CLOVER VALLEY CREEK WATERSHED
SITES DURING FEBRUARY 16, 2007, CANAL LINING EVENT

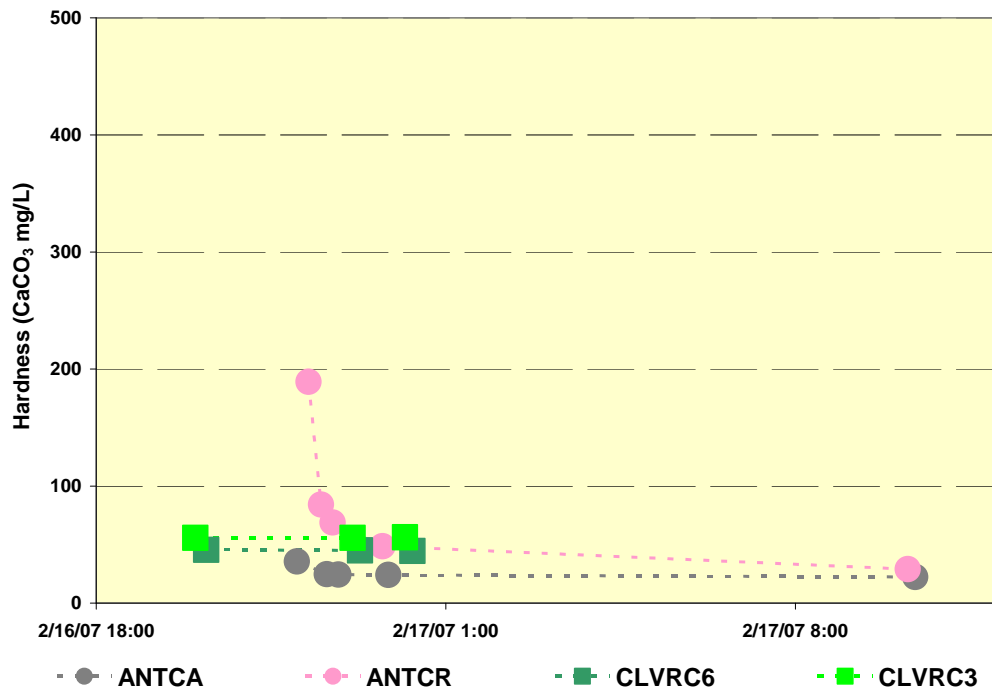


FIGURE 6-19
MEASURED HARDNESS LEVELS AT CLOVER VALLEY CREEK WATERSHED
SITES DURING FEBRUARY 16, 2007, CANAL LINING EVENT

Total Suspended Solids and Turbidity

TSS and turbidity levels measured at ANTCR were very high for a short duration (about 1 hour) after flows were restored to Antelope Canal following lining, but were also comparably high upstream from the canal lining, at ANTCA. Samples collected at Clover Valley Creek sites suggest that Clover Valley Creek TSS and turbidity conditions, however, were not affected by canal lining. TSS and turbidity levels at Clover Valley Creek watershed sites from the canal lining monitoring event are shown in **Figures 6-20** and **6-21**.

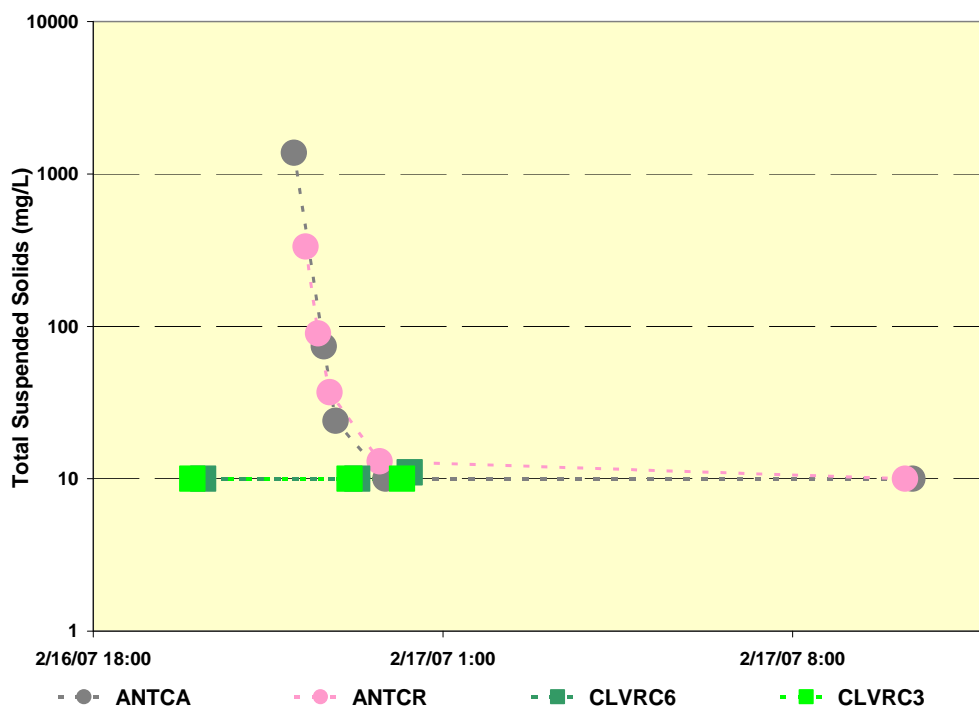


FIGURE 6-20
MEASURED TOTAL SUSPENDED SOLIDS LEVELS AT CLOVER VALLEY CREEK
WATERSHED SITES DURING FEBRUARY 16, 2007, CANAL LINING EVENT

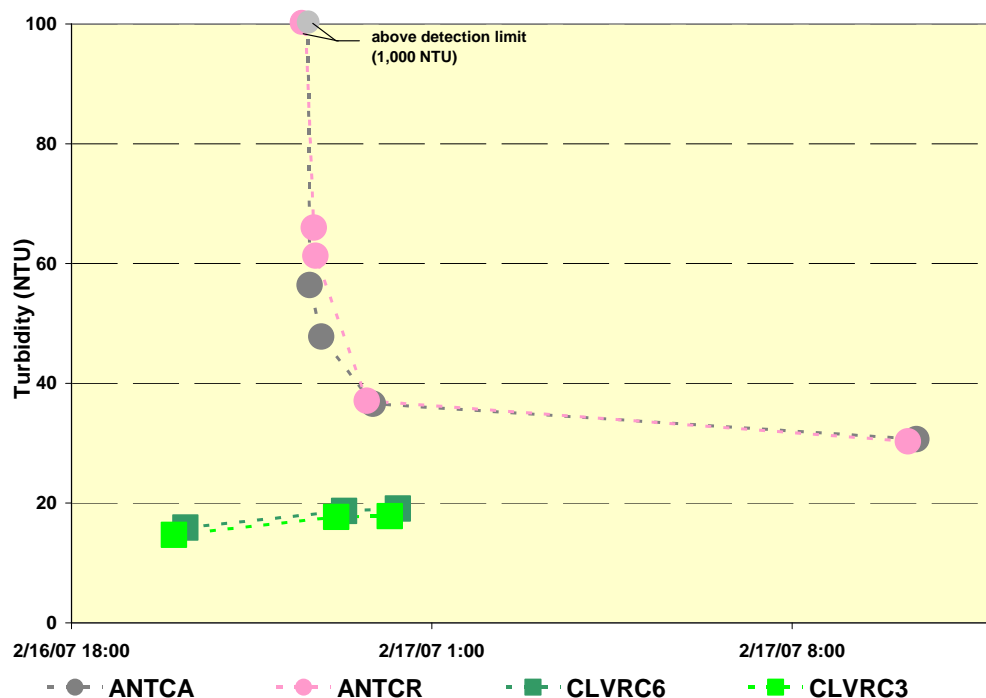


FIGURE 6-21
MEASURED TURBIDITY LEVELS AT CLOVER VALLEY CREEK WATERSHED
SITES DURING FEBRUARY 16, 2007, CANAL LINING EVENT

Specific Conductivity and Ions

SC and ion concentrations (calcium, iron, magnesium, potassium, sodium, chloride, nitrate, sulfate) measured at ANTCR were high for a short duration after flows were restored to Antelope Canal following canal lining, then decreased rapidly. Based on water quality data collected during the sampling event, these elevated levels at ANTCR did not appear to affect SC or major ion concentrations downstream from canal lining at Clover Valley Creek.

Trace Elements

Measured concentrations of aluminum, barium, copper, and zinc at ANTCR were high immediately following the canal lining activity upstream. These high concentrations were likely associated with flushing of sediment and other material that settled after the canal was dewatered for canal cleaning. Aluminum levels measured at CLVRC3 increased following the canal lining activity, but also increased at Clover Valley Creek upstream from the canal lining activity (CLVRC6), suggesting that the increase is not likely associated with the canal lining event. Water quality data collected during the sampling event did not show any effects associated with the canal lining activity on barium, copper, and zinc concentrations at Clover Valley Creek. Aluminum, barium, copper, and zinc results from the canal lining monitoring event are shown in **Figures 6-22 to 6-25**. Cadmium concentrations measured at all sites during the canal cleaning monitoring event were below the detection limit (0.5 µg/L).

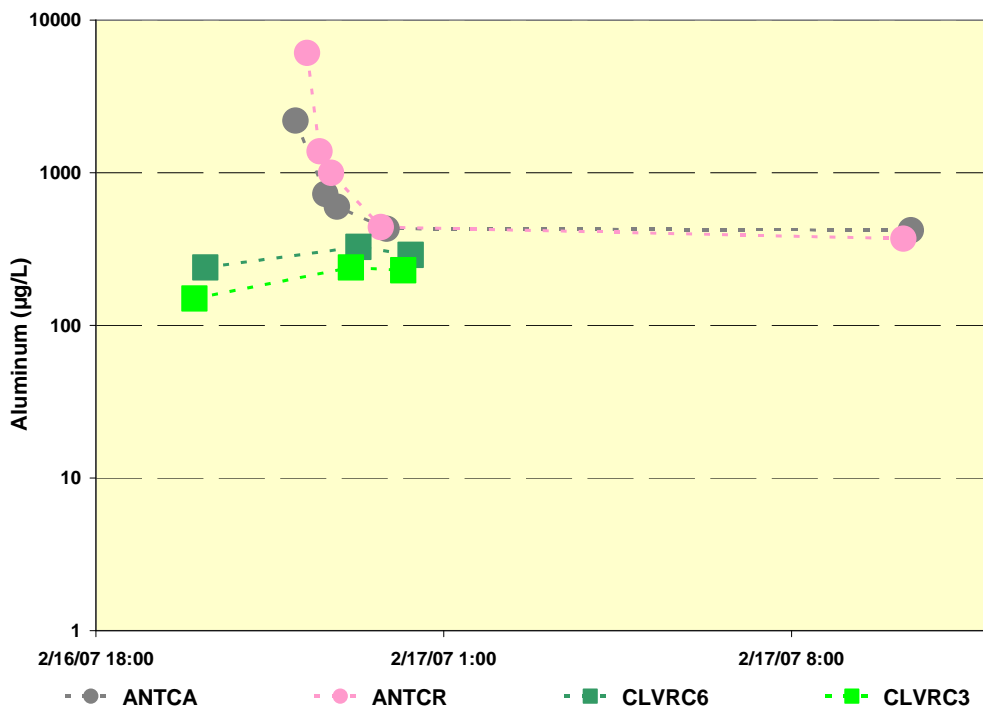


FIGURE 6-22
MEASURED ALUMINUM LEVELS AT CLOVER VALLEY CREEK WATERSHED
SITES DURING FEBRUARY 16, 2007, CANAL LINING EVENT

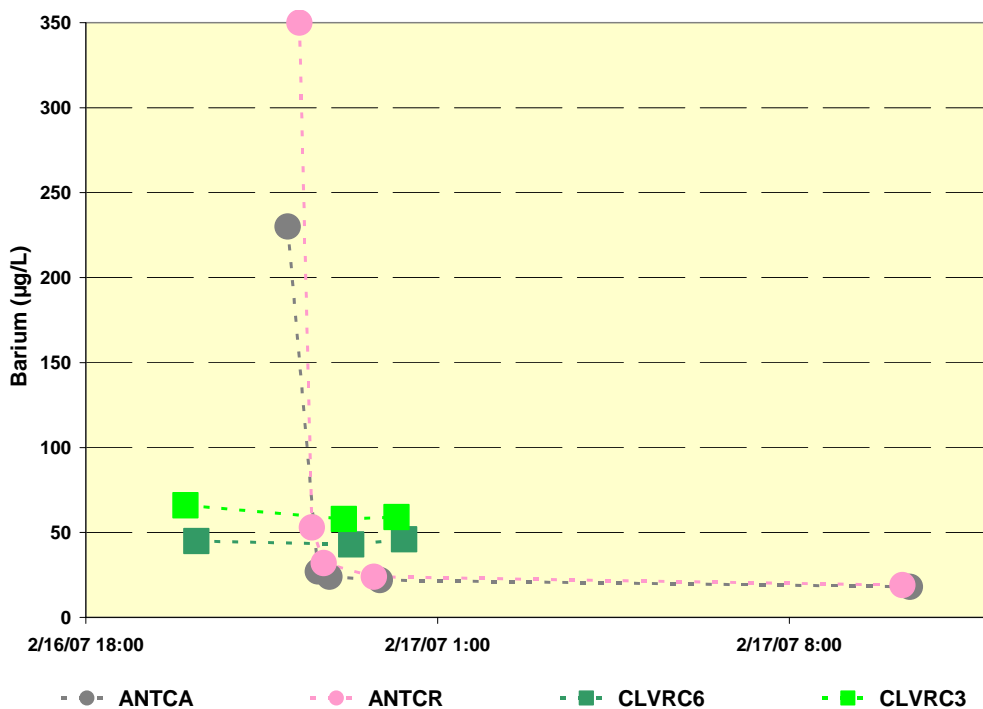


FIGURE 6-23
MEASURED BARIUM LEVELS AT CLOVER VALLEY CREEK WATERSHED
SITES DURING FEBRUARY 16, 2007, CANAL LINING EVENT

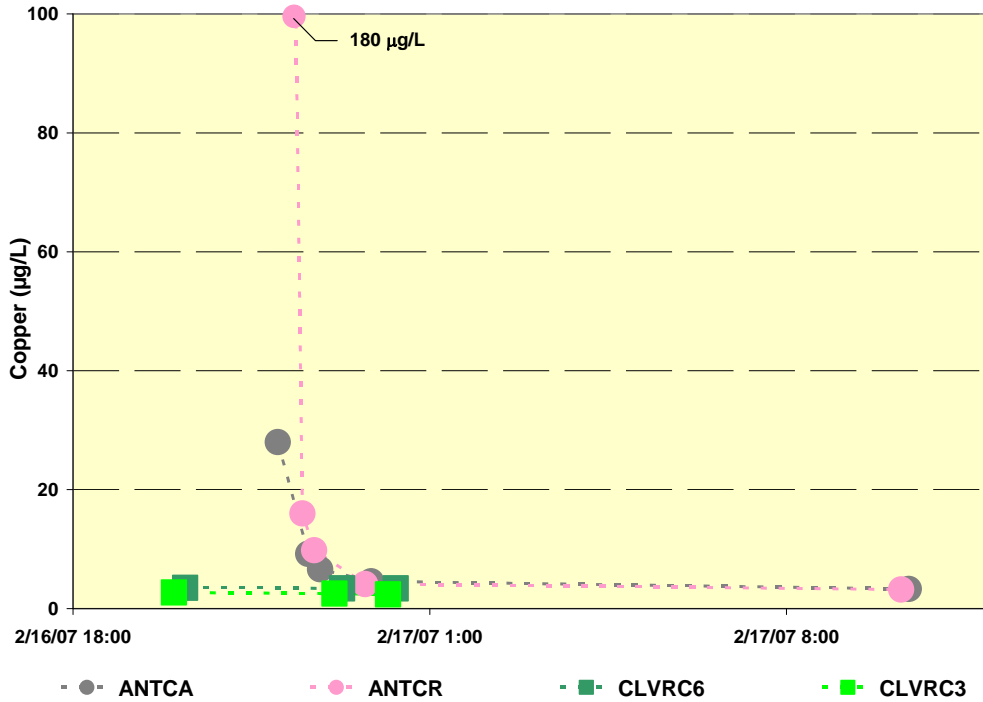


FIGURE 6-24
MEASURED COPPER LEVELS AT CLOVER VALLEY CREEK WATERSHED SITES
DURING FEBRUARY 16, 2007, CANAL LINING EVENT

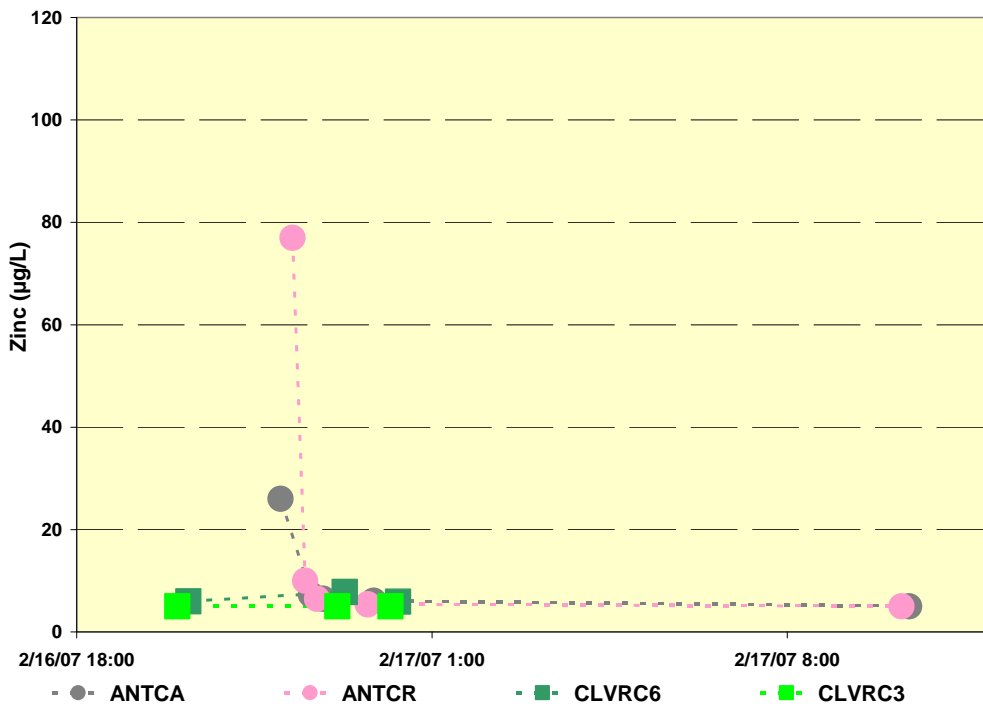


FIGURE 6-25
MEASURED ZINC LEVELS AT CLOVER VALLEY CREEK WATERSHED SITES
DURING FEBRUARY 16, 2007, CANAL LINING EVENT

Secret Ravine Watershed

Water quality conditions in the Secret Ravine watershed were evaluated at the following sites after canal lining/guniting activities along a section of the Boardman Canal downstream from the head of the Baughman Canal on March 20, 2007:

- **Boardman below the head of Baughman Canal (YB155):** located along the Boardman Canal just below the head of the Baughman Canal.
- **Boardman downstream from YB155 (YB155DS):** located downstream from the lined section along the Boardman Canal.
- **Boardman Canal Outlet Release (BOARDMANCR)**
- **Secret Ravine at Rocklin Road (SECRETRV3)**
- **Secret Ravine at Roseville Parkway (SECRETRV2)**

Water Temperature and Dissolved Oxygen

Water quality results suggest that the canal lining/guniting activity monitored did not affect water temperature or DO conditions in Secret Ravine. Minimal to no effects on water temperature and DO were observed in Secret Ravine following canal lining/guniting along the Boardman Canal. DO levels increased slightly at YB155DS and BOARDMANCR for a short duration after flows were restored to the canal following the canal lining.

pH, Alkalinity, and Hardness

Measured values for pH, alkalinity, and hardness at Secret Ravine did not appear to be affected by canal lining activities. The pH levels observed at YB155DS increased to very high levels (up to 11.62) following the canal lining activity, and also increased slightly at BOARDMANCR, but did not affect pH at SECRETRV2. These results of pH measurements are shown in **Figure 6-26**. Alkalinity and hardness values at YB155DS increased after canal lining, but these increases did not result in an increase to alkalinity or hardness for samples collected at BOARDMANCR or SECRETRV2.

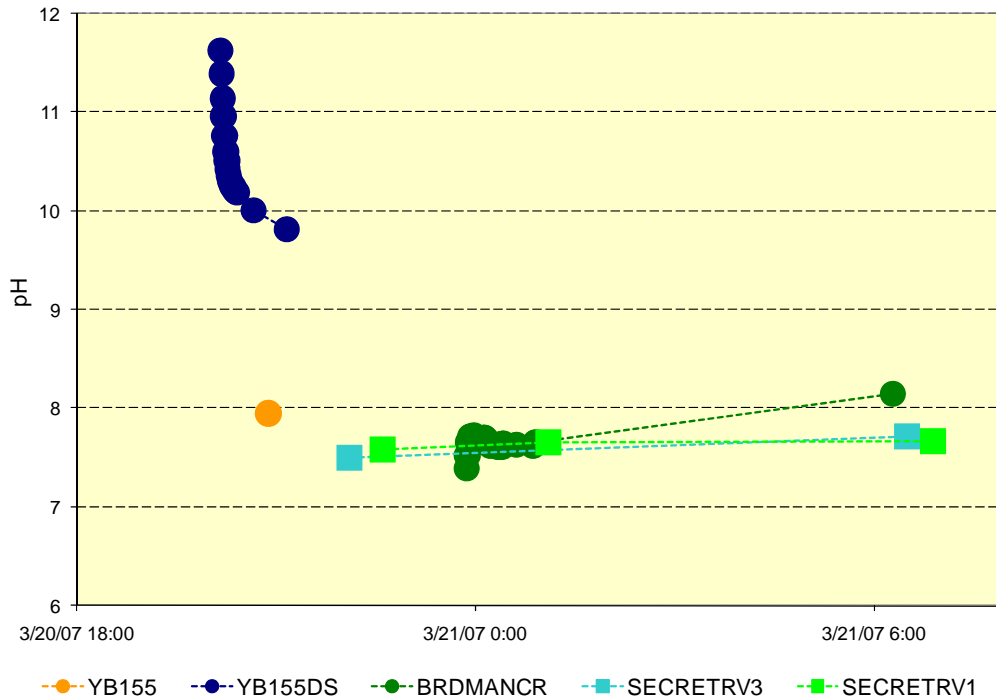


FIGURE 6-26
MEASURED PH LEVELS AT SECRET RAVINE WATERSHED SITES DURING
MARCH 20, 2007, CANAL LINING EVENT

Total Suspended Solids and Turbidity

Despite increases in TSS and turbidity values at YB155DS and BOARDMANCR, TSS and turbidity values measured at SECRETRV2 do not appear to be affected by canal cleaning activities. The high TSS and turbidity values measured at canal sites downstream from the canal lining activity are likely associated with flushing of sediment and other material that settled after the canal was dewatered for canal cleaning.

Specific Conductivity and Ions

SC, calcium, iron, magnesium, potassium, sodium, chloride, nitrate, and sulfate concentrations all increased at YB155DS following canal cleaning, similar to TSS and turbidity. These increases upstream, however, did not appear to affect SC and ion concentrations at the Boardman Canal Outlet release to Secret Ravine or at SECRETRV2.

Trace Elements

Measured concentrations of aluminum were high across all sites evaluated during the canal lining monitoring event, with highest values at YB155DS immediately after flows were restored to the canal below the canal lining activity. Because aluminum concentrations were high in all samples collected during the event, aluminum levels in Secret Ravine are not likely affected by canal lining activities. Barium, copper, and zinc concentrations also increased at YB155DS after flows were restored to Boardman Canal below the canal lining activity. Based on water quality

results, concentrations of these constituents in Secret Ravine do not appear to be affected by canal lining activities upstream.

Miners Ravine Watershed

Water quality conditions in the Miners Ravine watershed were evaluated after a section of the Boardman Canal near Laird Pump was lined on March 15, 2007. The sites monitored during the event include:

- **Boardman Canal near Laird Pump, upstream (315BDU):** located along the Boardman Canal near Laird Pump, upstream from the lining/guniting event.
- **Boardman Canal near Laird Pump, downstream (315BDD):** located along the Boardman Canal near Laird Pump, downstream from the lining/guniting event.
- **Baughman Canal Outlet Release (BAUGHMANCR)**
- **Tributary to Miners Ravine from Baughman Canal (BCTTRIB1)**
- **Miners Ravine at Moss Lane (MINERSRV5)**

Due to the extensive length of the unnamed tributary to Miners Ravine from Baughman Canal and long travel time from BAUGHMANCR to BCTTRIB1, samples obtained during canal lining activities at BCTTRIB1 and MINERSRV5 were intended to provide a relative comparison of water quality conditions in receiving waters downstream from BAUGHMANCR.

Water Temperature and Dissolved Oxygen

Water temperature and DO conditions at stream sites in the Miners Ravine watershed did not appear to be affected by canal lining/guniting activities along the Boardman Canal. DO levels temporarily decreased then increased at 315DD and BAUGHMANCR, but these fluctuations are not likely to affect conditions at stream sites in the Miners Ravine watershed.

pH, Alkalinity, and Hardness

Measured values of pH, alkalinity, and hardness increased to very high levels at 315DD following canal lining activities, but are not likely to affect conditions at Miners Ravine. Values for pH measured at BAUGHMANCR also increased for a short duration, then gradually decreased and stabilized to baseline levels. Results from pH measurements at Miners Ravine watershed sites during the canal lining monitoring event are shown in **Figure 6-27**.

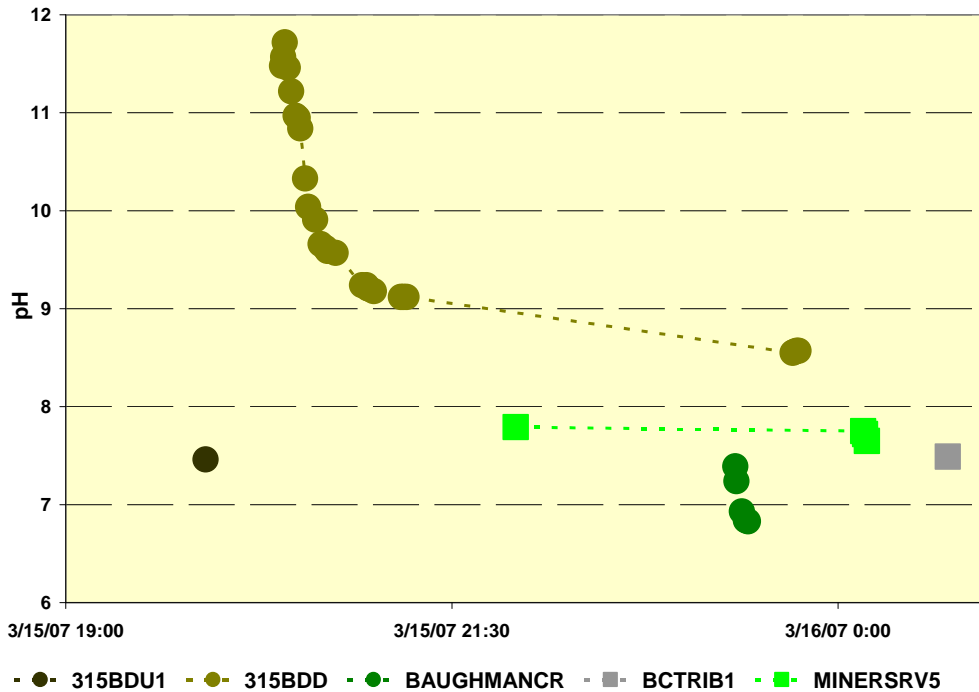


FIGURE 6-27
MEASURED PH LEVELS AT MINERS RAVINE WATERSHED SITES DURING
MARCH 15, 2007, CANAL LINING EVENT

Total Suspended Solids and Turbidity

TSS and turbidity values measured at 315BDD and BAUGHMANCR increased after flows were restored to the canals following canal lining. Turbidity measured at BAUGHMANCR the exceeded detection limit (1,000 NTUs) for some samples. These increases were not likely to affect TSS and turbidity conditions in Miners Ravine. Similar to other canal dewatering activities, these high TSS and turbidity values are likely associated with flushing of sediment and other material that settled after the canal was dewatered for canal lining.

Specific Conductivity and Ions

SC and ion concentrations at Miners Ravine watershed sites exhibited a similar response to canal lining activities as those described for Clover Valley Creek and Secret Ravine watershed sites. SC increased for a short duration at 315BDD, but these increases were not likely to affect conditions downstream in Miners Ravine. Similar trends were observed with calcium, iron, magnesium, potassium, sodium, chloride, nitrate, and sulfate concentrations.

Trace Elements

Aluminum concentrations measured at all Miners Ravine watershed sites during the canal lining event were high, with the highest values at 315BDD immediately after flows were restored to the canal below the canal cleaning activity. Measured barium, copper, and zinc values at 315BDD were also high immediately following the canal lining activity. Sample concentrations of aluminum, copper, and zinc also increased at MINERSRV5 during the event. These increases at MINERSRV5 are not likely to be specifically associated with the canal lining activity, because

MINERSRV5 is upstream from direct canal system inputs to Miners Ravine streamflow, but may be related to canal cleaning activities that occurred within the canal system on March 15, 2007.

Measured concentrations of aluminum were high across all sites in the Miners Ravine watershed evaluated during the canal cleaning monitoring event, with highest values at BAUGHMANCR immediately after flows were restored to the canal below the canal lining activity. Because aluminum concentrations were high in all samples collected during the event, aluminum levels in Miners Ravine are not likely affected by canal lining activities. Barium, copper, and zinc concentrations also increased at YB155DS after flows were restored to Boardman Canal below the canal cleaning activity. Based on water quality results, concentrations of these constituents in Miners Ravine do not appear to be affected by canal lining activities upstream. **Figures 6-28 to 6-31** show aluminum, barium, copper, and zinc results for Miners Ravine watershed sites during the monitoring event for canal lining.

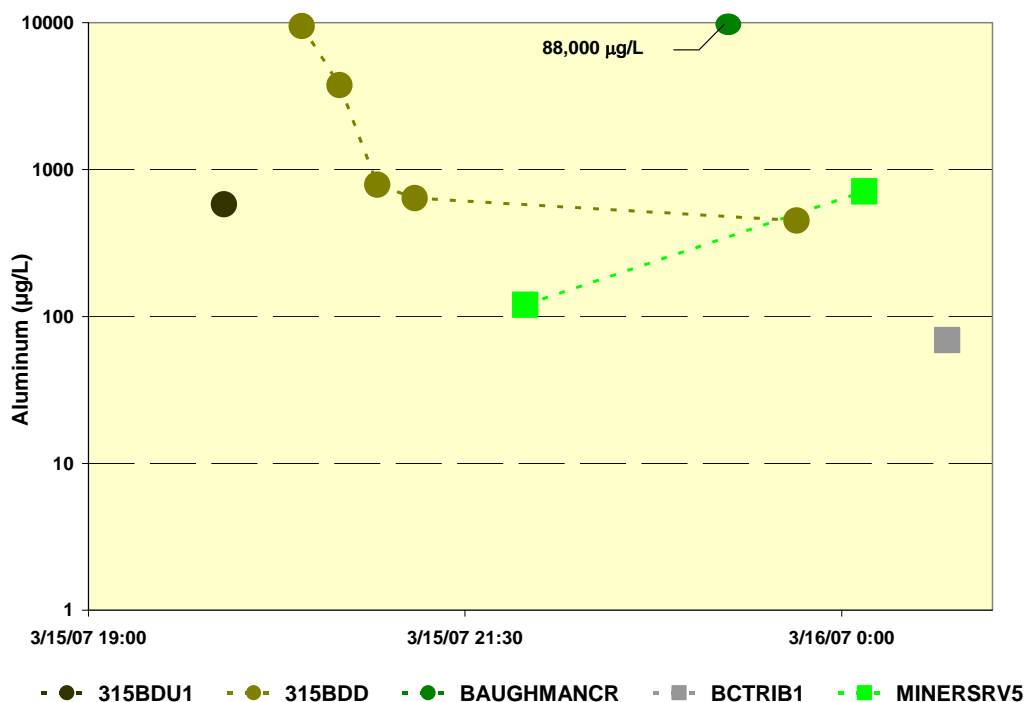


FIGURE 6-28
MEASURED ALUMINUM LEVELS AT MINERS RAVINE WATERSHED SITES
DURING MARCH 15, 2007, CANAL LINING EVENT

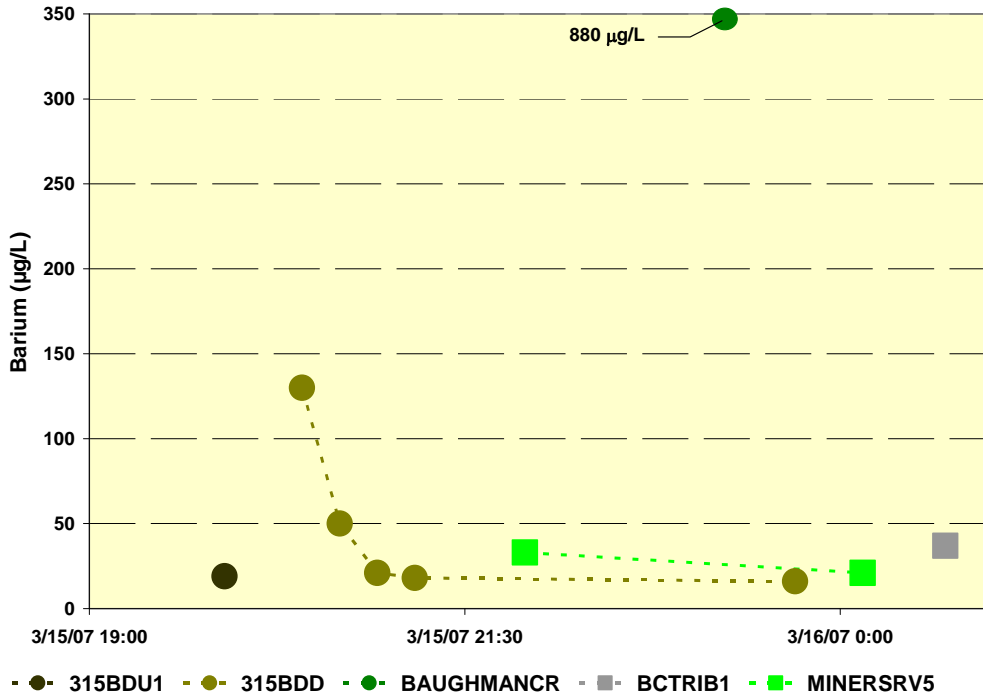


FIGURE 6-29
MEASURED BARIUM LEVELS AT MINERS RAVINE WATERSHED SITES DURING
MARCH 15, 2007, CANAL LINING EVENT

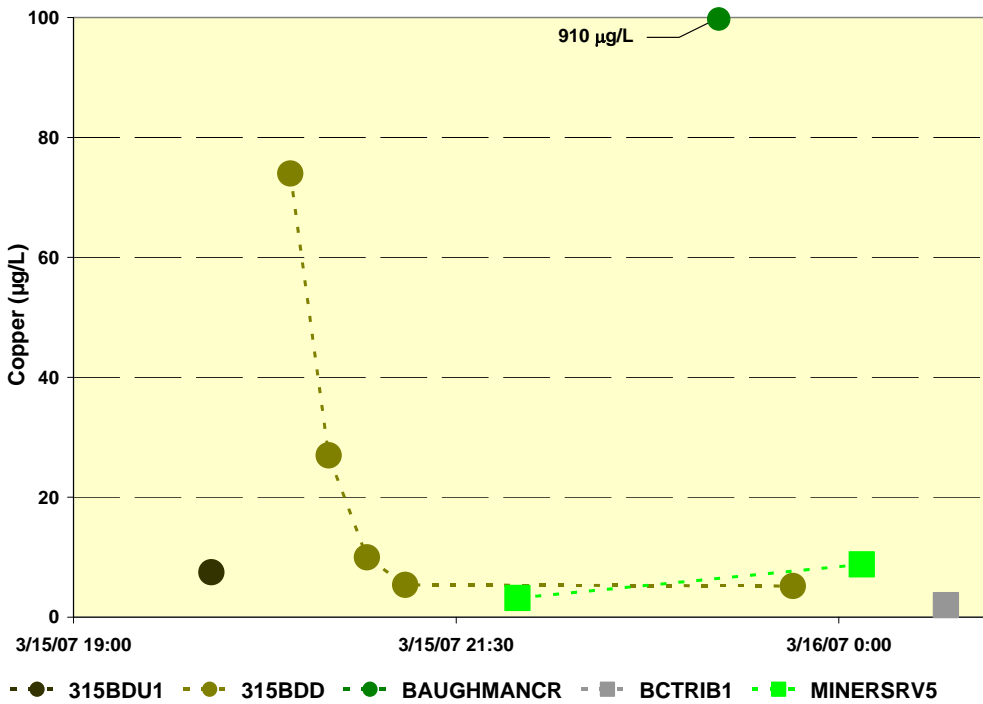


FIGURE 6-30
MEASURED COPPER LEVELS AT MINERS RAVINE WATERSHED SITES DURING
MARCH 15, 2007, CANAL LINING EVENT

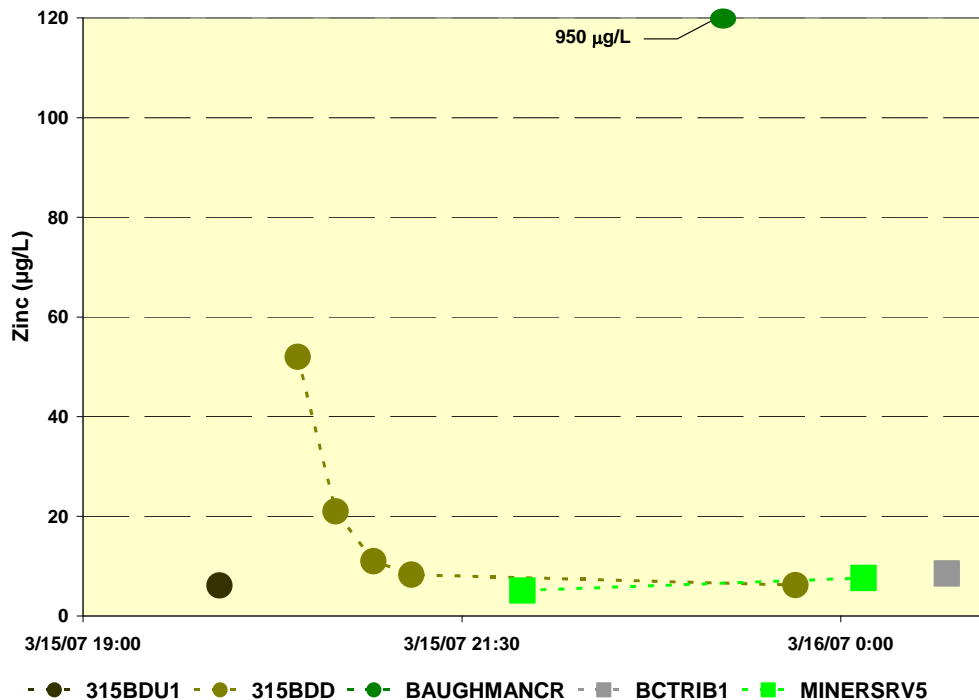


FIGURE 6-31
MEASURED ZINC LEVELS AT MINERS RAVINE WATERSHED SITES DURING
MARCH 15, 2007, CANAL LINING EVENT

Soils and Sediment Quality

The potential effects of canal lining/guniting activities are similar to those described above for canal cleaning activities. Canal lining activities may introduce additional copper to study area soils through the removal of sediments from the canal with higher copper concentrations attributed to PCWA's algacide applications, and deposition of the soils along the canal banks. Additionally, the concrete applied during canal lining activities may increase concentrations of the concrete chemical constituents at the locations of the canal lining activities. Soil compaction and erosion may occur as a result of equipment access and use along canal banks during canal cleaning and lining. Mechanical equipment may also introduce chemical contaminants (i.e., petroleum products) to soils at access sites.

Biological Resources

Terrestrial Habitat and Species

Minimal streamflow decreases in study area streams due to a short duration reduction of flows in the PCWA canal system during canal lining could result in temporary and very minimal decreases in the extent of wetland habitats that may be directly or indirectly supported by canal system operations. This could have minimal effects on species that use these wetland habitats, such as foraging birds and breeding amphibians, by decreasing the amount of available habitat. Reductions in water levels could expose amphibian eggs in the shallow, vegetated margins of drainages or adjacent wetlands. Any potential effects from temporary water reductions on species that use these habitats are expected to be minimal because canal system contributions to

flow within study area streams through unregulated releases from canal outlets are variable. The typical timing of canal lining is during winter, generally outside of the breeding period for most amphibian species; however, canal lining activities can occur throughout the year.

Lining sections of unlined canals may indirectly affect adjacent habitat and species historically supported by canal seepage. Through lining sections of previously unlined canals, oak trees and wetlands may be negatively affected by the decreased seepage along the sections and the resultant change in soil moisture and geochemical conditions.

Potential effects on water quality discussed above could indirectly affect terrestrial habitats and species. Increased loading of sediments and sedimentation from flushing activities could bury amphibian eggs. Increased concentrations of trace elements (such as aluminum and copper) could have some negative effects on plants and wildlife on the margins of canals and tributaries. Amphibians in particular are known to be sensitive to such water quality changes, although effects vary dramatically by type and concentration of contaminant, species, and water quality parameters. Elevated pH values are toxic to amphibians, and may be particularly harmful in combination with other contaminants, such as heavy metals or herbicides, particularly glyphosates (Pesticide Action Network U.K. 1996, Edginton et al. 2004, Horn and Dunson 1995). However, glyphosates and triclopyr have been found to break down faster under higher pH conditions (Tu et al. 2001).

Habitats and species could potentially be affected directly or indirectly by impacts to soils and sediments from equipment used during canal lining, including compaction, erosion, and introduction of petroleum products. Effects on habitats and species could include plant mortality or decreased plant growth. These types of impacts are expected to be relatively minimal and small in aerial extent.

Some potential negative effects could occur if raptors are nesting near canal lining work areas that may be disturbed by noise. Raptors potentially occurring in the study area include Red-shouldered Hawk, American Kestrel, Red-tailed Hawk, and Great Horned Owl. The nesting period for raptors is generally March 1 to August 15.

Aquatic Habitat and Species

Potential effects to of canal lining activities on aquatic habitat and species are likely similar to those discussed described above for canal cleaning activities.

Special Status Species

As described above, minimal streamflow decreases in study area streams due to a short duration reduction of flows in the PCWA canal system during canal lining could result in temporary and very minimal decreases in the extent of wetland habitats that may be indirectly supported by canal deliveries. This could have minimal effects on special status species that use these wetland habitats, such as special status foraging birds and breeding amphibians, by decreasing the amount of available habitat. Reductions in water levels could expose special status amphibian eggs in the shallow, vegetated margins of drainages or adjacent wetlands. Any potential effects from temporary water reductions on species that use these habitats are expected to be minimal because canal system contributions to flow within study area streams through unregulated

releases from canal outlets are variable. Potential effects may be greater during the breeding season for special status amphibian species. The California red-legged frog breeding occurs between late November and March, though most frogs lay eggs in March (USFWS 2002, Stebbins 2003). The foothill yellow-legged frog breeds between mid-March through early June, and the western spadefoot toad breeds late January through July (Stebbins 2003).

Sediment loading to streams after flows are restored to canals following canal lining activities and sedimentation may bury special status amphibian eggs, if present. Increases in concentrations of trace elements, such as aluminum and copper, could have some negative effects on special status plants and wildlife, if present, on the margins of canals and tributaries. Amphibians in particular are known to be sensitive to changes in water quality conditions, although effects vary dramatically by species, life stage, and water quality parameters. Also, increases in pH levels, which were observed at sites after canal lining activities during water quality monitoring events, have been found to be toxic to amphibians, and may be particularly harmful in combination with other contaminants, such as heavy metals or herbicides (Pesticide Action Network U.K. 1996, Edginton et al. 2004, Horn and Dunson 1995).

Special status plant species (**Tables 3-12** and **3-13**), if present, could potentially be affected directly or indirectly by impacts to soils and sediments from equipment used during canal lining, including compaction, erosion, and introduction of petroleum products. Effects on special status plant species could include mortality or decreased growth. These types of impacts are expected to be unlikely to occur.

Some potential negative effects could occur if special status raptor species are nesting near work areas that may be disturbed by noise. Special status raptors potentially occurring in the study area include Swainson's hawk, Cooper's hawk, Northern Goshawk, White-tailed Kite, and Northern Harrier. As mentioned above, the nesting period for raptors is generally March 1 to August 15.

Potential effects of canal lining activities on Chinook salmon and steelhead are the same as described for aquatic habitat and species, and likely similar to those discussed for canal cleaning activities.

6.1.2.2 Canal Repair

PCWA performs repair and/or replacement of canals, flumes, outlet structures, flow-control structures, and customer delivery points throughout the PCWA canal system on a scheduled and as-needed basis. These activities may involve minor repairs with minimal disturbance to customer deliveries and minor effects on environmental resources, while others requiring onsite construction may become more involved. The potential effects of canal repair activities on natural resource conditions are dependent of the nature and extent of the canal repair, as well as the specific environmental setting for the activity. These activities should require project-specific environmental resources analyses to assess the potential effects of the activity on natural resources, and an evaluation to determine measures to minimize potential negative effects. The following sections provide an overview of the types of effects on natural resources that may occur during PCWA's canal repair activities.

Physical Resources

The following sections describe potential effects of PCWA canal repair activities on physical resources in the study area.

Hydrology

Most canal repair activities would result in short-duration interruptions to water flow within segments of the raw water distribution system. These short-duration interruptions to flow are not are likely to affect hydrologic conditions in study area streams.

Canal repair activities requiring onsite construction and canal dewatering for more than a day should warrant a project-specific evaluation to determine potential effects on hydrologic conditions in study area streams.

Water Quality

Although no water quality data was collected during canal repair events, potential effects for canal repair activities are expected to be similar to other canal dewatering and flushing activities. In some cases, equipment may be staged inside the canal during repair. The settling, then mobilization of sediments, organic material, and constituents associated with particulates during flushing activities may result in temporary fluctuations in constituent concentrations. For example, a temporary increase in water temperatures and associated decrease in DO levels may occur. In the case of canal repair, temporary increases in TSS and turbidity are likely because sediment may be disturbed along the canals during repair work. However, these temporary changes are not likely to have substantial effects, if any, along drainage or stream sites downstream from canal repair activities.

Canal repair projects may involve the use of mechanical equipment that require hazardous materials, such as gasoline and diesel fuels, engine oil, and hydraulic fluids. Accidental spills of these substances may contaminate the canal water and receiving water tributaries and streams, adjacent soils, and other riparian habitat.

Soils and Sediment Quality

Soils and sediment quality in the study area may be affected by canal repair activities. Soil compaction and erosion may occur as a result of construction equipment access and use along canal banks. Construction equipment may also introduce chemical contaminants (i.e., petroleum products) to soils at project sites.

Biological Resources

Terrestrial Habitat and Species

Effects on terrestrial habitat and species from canal repair would vary based on the type of repair required, but would be similar to those from canal lining, though generally less severe and smaller in scale.

As with canal lining, minimal streamflow decreases in study area streams due to a short duration reduction of flows in the PCWA canal system during canal repair could result in temporary and very minimal decreases in the extent of wetland habitats that may be directly or indirectly supported by canal system operations. This could have minimal effects on species that use these wetland habitats, such as foraging birds and breeding amphibians, by decreasing the amount of

available habitat. Reductions in water levels could expose amphibian eggs in the shallow, vegetated margins of drainages or adjacent wetlands. Any potential effects from temporary water reductions on species that use these habitats are expected to be minimal.

As with canal lining, potential effects on water quality discussed above could indirectly affect terrestrial habitats and species. Increased loading of sediments and sedimentation from flushing activities could bury amphibian eggs. Increased concentrations of trace elements (such as aluminum and copper) could have some negative effects on plants and wildlife on the margins of canals and tributaries. Amphibians in particular are known to be sensitive to such water quality changes, although effects vary dramatically by type and concentration of contaminant, species, and water quality parameters.

Habitats and species could potentially be affected directly or indirectly by impacts to soils and sediments from equipment used during canal repair, including compaction, erosion, and introduction of petroleum products. Effects on habitats and species could include plant mortality or decreased plant growth. These types of impacts are expected to be relatively minimal and small in aerial extent.

Minimal loss of habitat could occur due to limited trimming or removal of vegetation necessary to access repair areas.

Some potential negative effects could occur if raptors are nesting near canal repair work areas that may be disturbed by noise. Raptors potentially occurring in the study area include Red-shouldered Hawk, American Kestrel, Red-tailed Hawk, and Great Horned Owl. The nesting period for raptors is generally March 1 to August 15.

Aquatic Habitat and Species

Potential effects to of canal repair activities on aquatic habitat and species are likely similar to those discussed described above for canal cleaning activities. In addition, construction-related contaminants could result in a reduction in the growth, survival, and reproductive success of aquatic species. The potential exists for fuel and concrete to spill into the waterway during construction. Various contaminants introduced into the water system, either directly or through surface runoff, may be toxic to fish or cause altered oxygen diffusion rates and acute and chronic toxicity to aquatic organisms, thereby reducing growth and survival.

Special Status Species

Effects on special status species from canal repair would vary based on the type of repair required, but would be similar to those from canal lining, though generally less severe and smaller in scale.

As described above, minimal streamflow decreases in study area streams due to a short duration reduction of flows in the PCWA canal system during canal repair could result in temporary and very minimal decreases in the extent of wetland habitats that may be indirectly supported by canal deliveries. This could have minimal effects on special status species that use these wetland habitats, such as special status foraging birds and breeding amphibians, by decreasing the amount of available habitat. Reductions in water levels could expose special status amphibian eggs in the shallow, vegetated margins of drainages or adjacent wetlands. Any potential effects

from temporary water reductions on species that use these habitats are expected to be minimal because canal system contributions to flow within study area streams are variable. Potential effects may be greater during the breeding season for special status amphibian species. California red-legged frog breeding occurs between late November and March, though most frogs lay eggs in March (USFWS 2002, Stebbins 2003). The foothill yellow-legged frog breeds between mid-March through early June, and the western spadefoot toad breeds late January through July (Stebbins 2003).

Sediment loading to streams after flows are restored to canals following canal repair activities and sedimentation may bury special status amphibian eggs, if present. Increases in concentrations of trace elements, such as aluminum and copper, could have some negative effects on special status plants and wildlife, if present, on the margins of canals and tributaries. Amphibians in particular are known to be sensitive to changes in water quality conditions, although effects vary dramatically by species, life stage, and water quality parameters.

Special status plant species (**Tables 3-12 and 3-13**), if present, could potentially be affected directly or indirectly by impacts to soils and sediments from equipment used during canal repair, including compaction, erosion, and introduction of petroleum products. Special status plant species, if present, could also be damaged or killed during limited trimming or removal of vegetation necessary to access repair areas. Effects on special status plant species could include mortality or decreased growth. These types of impacts are expected to be unlikely to occur.

Some potential negative effects could occur if special status raptor species are nesting near work areas that may be disturbed by equipment noise during canal repair activities. Special status raptors potentially occurring in the study area include Swainson's hawk, Cooper's hawk, Northern Goshawk, White-tailed Kite, and Northern Harrier. As mentioned above, the nesting period for raptors is generally March 1 to August 15.

Potential effects of canal repair activities on Chinook salmon and steelhead are the same as for the aquatic habitat and species described above.

6.1.2.3 Pipe Repair

PCWA performs repair and/or replacement of pipes, culverts, and siphons throughout the PCWA canal system on a scheduled and as-needed basis. These activities may involve minor repairs with minimal disturbance to customer deliveries and minor effects on environmental resources, while others requiring onsite construction may become more involved. As described above for canal repair activities, the potential effects of pipe repair activities on natural resource conditions are dependent of the nature and extent of the pipe repair, as well as the specific environmental setting for the activity. These activities should require project-specific environmental resources analyses to assess the potential effects of the activity on natural resources, and an evaluation to determine measures to minimize potential negative effects. The following sections provide an overview of the types of effects on natural resources that may occur during PCWA's pipe repair activities.

Physical Resources

Hydrology

Most pipe repair activities would result in short-duration interruptions to water flow within segments of the raw water distribution system. These short-duration interruptions to flow are not likely to affect hydrologic conditions in study area streams.

Pipe repair activities requiring onsite construction and canal dewatering for more than a day should warrant a project-specific evaluation to determine potential effects on hydrologic conditions in study area streams.

Water Quality

Although no water quality data was collected during pipe repair events, potential effects for pipe repair activities are also expected to be similar to other canal dewatering and flushing activities. During pipe repair, sediment is often excavated and heavy machinery may be used. The equipment may be staged inside the canal and/or along canal banks during repair. The settling, then mobilization of sediments, organic material, and constituents associated with particulates during flushing activities may result in temporary fluctuations in constituent concentrations. The largest effects, if any, are likely to be temporary increases in TSS and turbidity downstream from pipe repair work.

Soils and Sediment Quality

Soils and sediment quality in the study area may be affected by pipe repair activities. Soil compaction and erosion may occur as a result of construction equipment access and use along canal banks. Construction equipment may also introduce chemical contaminants (i.e., petroleum products) to soils at project sites.

Biological Resources

Terrestrial Habitat and Species

Effects on terrestrial habitat and species from pipe repair would vary based on the type and magnitude of repair required, but would be similar to those from canal repair.

As with canal lining and repair, minimal streamflow decreases in study area streams due to a short duration reduction of flows in the PCWA canal system during pipe repair could result in temporary and very minimal decreases in the extent of wetland habitats that may be directly or indirectly supported by canal system operations. This could have minimal effects on species that use these wetland habitats, such as foraging birds and breeding amphibians, by decreasing the amount of available habitat. Reductions in water levels could expose amphibian eggs in the shallow, vegetated margins of drainages or adjacent wetlands. Any potential effects from temporary water reductions on species that use these habitats are expected to be minimal.

As with canal repair, potential effects on water quality discussed above could indirectly affect terrestrial habitats and species. Increased loading of sediments and sedimentation from flushing activities could bury amphibian eggs. Increased concentrations of trace elements (such as aluminum and copper) could have some negative effects on plants and wildlife on the margins of canals and tributaries. Amphibians in particular are known to be sensitive to such water quality

changes, although effects vary dramatically by type and concentration of contaminant, species, and water quality parameters.

Habitats and species could potentially be affected directly or indirectly by impacts to soils and sediments from equipment used during pipe repair, including compaction, erosion, and introduction of petroleum products. Effects on habitats and species could include plant mortality or decreased plant growth. These types of impacts are expected to be relatively minimal and small in aerial extent.

Minimal loss of habitat could occur due to limited trimming or removal of vegetation necessary to access repair areas.

Some potential negative effects could occur if raptors are nesting near pipe repair work areas that may be disturbed by noise. Raptors potentially occurring in the study area include Red-shouldered Hawk, American Kestrel, Red-tailed Hawk, and Great Horned Owl. The nesting period for raptors is generally March 1 to August 15.

Aquatic Habitat and Species

Potential effects of pipe repair activities on aquatic habitat and species are likely similar to those discussed for canal repair activities.

Special Status Species

Effects on special status species from pipe repair would vary based on the type and magnitude of repair required, but would be similar to those from canal repair.

As described above, minimal streamflow decreases in study area streams due to a short duration reduction of flows in the PCWA canal system during pipe repair could result in temporary and very minimal decreases in the extent of wetland habitats that may be indirectly supported by canal deliveries. This could have minimal effects on special status species that use these wetland habitats, such as special status foraging birds and breeding amphibians, by decreasing the amount of available habitat. Reductions in water levels could expose special status amphibian eggs in the shallow, vegetated margins of drainages or adjacent wetlands. Any potential effects from temporary water reductions on species that use these habitats are expected to be minimal. Potential effects may be greater during the breeding season for special status amphibian species. The California red-legged frog breeding occurs between late November and March, though most frogs lay eggs in March (USFWS 2002, Stebbins 2003). The foothill yellow-legged frog breeds between mid-March through early June, and the western spadefoot toad breeds late January through July (Stebbins 2003).

Sediment loading to streams after flows are restored to canals following canal repair activities and sedimentation may bury special status amphibian eggs, if present. Increases in concentrations of trace elements, such as aluminum and copper, could have some negative effects on special status plants and wildlife, if present, on the margins of canals and tributaries. Amphibians in particular are known to be sensitive to changes in water quality conditions, although effects vary dramatically by species, life stage, and water quality parameters.

Special status plant species (**Tables 3-12 and 3-13**), if present, could potentially be affected directly or indirectly by impacts to soils and sediments from equipment used during pipe repair, including compaction, erosion, and introduction of petroleum products. Special status plant species, if present, could also be damaged or killed during limited trimming or removal of vegetation necessary to access repair areas. Effects on special status plant species could include mortality or decreased growth. These types of impacts are expected to be unlikely to occur.

Some potential negative effects could occur if special status raptor species are nesting near work areas that may be disturbed by equipment noise during pipe repair activities. Special status raptors potentially occurring in the study area include Swainson's hawk, Cooper's hawk, Northern Goshawk, White-tailed Kite, and Northern Harrier. As mentioned above, the nesting period for raptors is generally March 1 to August 15.

Potential effects of pipe repair activities on Chinook salmon and steelhead are the same as for the aquatic habitat and species described above and likely similar to those discussed for canal repair activities.

6.2 REGULATORY FRAMEWORK FOR POTENTIAL EFFECTS OF MAINTENANCE ACTIVITIES

The following sections provide the regulatory framework for the potential effects of PCWA maintenance activities described above. The regulatory framework discussion is organized by Federal, State, and local regulations, and is summarized in **Table 6-11**.

6.2.1 Federal Regulations

Federal laws and regulations associated with the potential effects of PCWA maintenance activities are described below.

6.2.1.1 Clean Water Act

PCWA activities during canal cleaning activities were found to have minimal effects on water quality conditions in study area streams. Effects of canal cleaning (i.e., increases in temperature, TSS, turbidity, calcium, magnesium, nitrates, aluminum, barium, zinc, and decrease in DO level) were observed at canal release points (e.g., YANKEECR, HANSENR), but not at stream sites. Aluminum, barium, and copper levels increased slightly at stream sites (MINERSRV5 and BCTRB1). These effects may indicate the transport of fine sediments and potential mobilization of constituents bound to sediments into receiving waters of the United States. As with yearly PG&E outages, PCWA activities during canal cleaning activities are subject to the provisions under the CWA, but they are not required to be permitted.

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**TABLE 6-11
SUMMARY OF REGULATORY FRAMEWORK AND POTENTIAL BEST MANAGEMENT PRACTICES APPLICABLE TO PCWA MAINTENANCE ACTIVITIES (CONTINUED)**

PCWA Maintenance Activity							Effect	Natural Resource Areas Potentially Affected										Relevant Regulations										Best Management Practices (BMP)			Type of BMP					
								Physical					Biological					Federal					State								Local					Pre-Implementation
Canal Cleaning	Scheduled			As-Needed Site Specific				Hydrology	Water Quality	Soils and Sediment Quality	Wetlands	Nesting birds	Other	Aquatic Habitat and Species	Salmonids	Amphibians	Raptors	Plants	Clean Water Act	Endangered Species Act	Magnuson-Stevens and Sustainable Fisheries Act	Migratory Bird Treaty Act	California Environmental Quality Act	Porter-Cologne	California Endangered Species Act	Fully Protected Species	Fish & Game Code §1602	Native Plant Protection Act	Placer County Conservation Plan	Placer County Stormwater Management Plan	Tree Preservation Ordinance	Oak Woodland Management				
	Physical Removal	Algaecide Application	Herbicide Application	Canal Lining	Canal Repair	Pipe Repair																														
✓				✓	✓	✓		✓	✓				✓	✓	✓			✓	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	Prevent Degraded Water from Entering Streams after Maintenance Activities			
				✓				✓	✓				✓	✓	✓			✓	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	Modify reservoir operations to gradually restore reservoir releases to canals at slower rate			✓		
								✓	✓				✓	✓	✓			✓	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓	Apply sediment trap at storm drains for dewatering before lining activities						
	✓	✓	✓																												Implement an Aquatic Weed Management Program			✓		
✓		✓	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓	Implement PCWA BMP Program			✓			
																															Regulatory Compliance Management for O&M Activities	✓				
✓	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓	Good Housekeeping Practices						
																															Ensure proper handling of materials and wastes					
																														Use proper cleanup procedures after material use			✓			
																														Implement onsite debris and trash management practices						
																														Store materials under a roof or covering with secure tarp						

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PCWA weed and brush control practices may have minimal to no water quality effects on receiving water tributaries and streams during implementation. Physical removal of vegetation may have minimal effects on TSS and turbidity if the removal of vegetation results in the dislodging or loosening of soil along canal banks and causes loose sediment to be deposited into the canals. Algaecide applications were observed to have minimal effects on pH, which increased slightly at both canal and stream sites (YANKEECR and YHTRIB2). Copper concentrations were observed to increase at YANKEECR, and minimal effects on copper concentrations were observed at YHTRIB2 and SECRETRV3. Minimal to no effects were observed with PCWA's herbicide applications. Temporary decreases in DO levels at ANTSTUBCR and ANTC3B are likely not directly related to herbicide applications. PCWA maintains active status with their General NPDES Permit for Discharges of Aquatic Pesticides, and has an active Aquatic Weed Management Program. As part of this program, PCWA completes an evaluation for each algaecide and herbicide application which includes water quality monitoring and treatment efficacy (PCWA 2003b). PCWA also routinely monitors algaecide and herbicide product releases in an effort to identify suitable algaecides and/or herbicides for applications that may have lesser potential effects on natural resources.

PCWA canal lining/guniting practices were observed to result in temporary moderate effects on the water quality of receiving water tributaries and streams. Increases in temperature, pH, TSS, turbidity, aluminum, zinc, and copper were observed at canal outlets (ANTCR, BOARDMANCR, and BAUGHMANCR) and stream sites (CLVRC6, CLVRC3, and MINERSRV5). Although no water quality permits are required for PCWA canal lining practices, compliance with water quality standards is required. Overall, these effects are temporary and can be prevented or minimized with effective BMPs.

Canal and pipe repair activities may have minimal water quality effects on receiving water tributaries and streams. Potential minimal effects are associated with temporary increases in TSS and turbidity from sediment and/or debris entering the canals as a result of soil disturbance from heavy machinery used for canal or pipe repair. With effective BMP implementation, these temporary effects are not likely to have large or long-term impacts, if any, along drainage or stream sites downstream from repair activities. If a canal or pipe repair activity involves any discharge of dredged or fill material into waters of the United States, a Section 404 permit is required with the USACE. Obtaining a Section 404 permit also requires a Section 401 water quality certification with the RWQCB ensuring that any discharge will not violate State water quality standards. Under Section 402 of the CWA, a canal or pipe repair project may also require a general permit for construction activities and compliance under the Placer County Municipal Stormwater Management Program. Associated regulations are further described under the Porter-Cologne Water Quality Control Act.

6.2.1.2 Endangered Species Act

PCWA canal cleaning activities potentially have minimal effects on special status species. Flushing activities after canal cleaning may cause increased TSS and other constituents, and result in minimal effects on special status species, including slight decreases in the extent of

wetland habitats for special status species. Special status species habitat could be damaged by heavy equipment use or by placement of debris and soil near canals and nesting raptors in the vicinity could be disturbed by equipment noise. Under the Federal ESA, regulated by USFWS and NMFS, habitat modification or degradation could be considered a “take” of federally listed species. In which case, an incidental take permit, under Section 10 of the Federal ESA, or a federal interagency consultation, under Section 7 of the Federal ESA, is required.

Potential effects of weed and brush removal activities may require an incidental “take” permit under the Federal ESA if there is a potential for federally listed as endangered or threatened species to be affected. Physical removal of vegetation would result in direct loss of vegetation and habitat. Physical removal of vegetation often require mechanical harvesters, weed rollers, rotovators, and dredging equipment that dislodge contaminated sediments and may affect special status species, such as fish and amphibians (PCWA 2003b). However, this equipment is only used if necessary, and with precautions. Effective BMPs can be implemented to minimize the effects of physical removal of vegetation that would prevent or minimize effects on special status species. Algaecide applications may have minimal effects on special status species, particularly fish and amphibians, from potential toxicity of copper associated with the algaecide. Only slight increases in copper concentrations were observed in receiving streams during monitoring for algaecide application events. Copper concentrations likely associated with algaecide applications were observed to increase during other canal maintenance activities, and are discussed in **Chapter 7**. Herbicide applications may have minimal effects on special status terrestrial species and vegetation along PCWA reservoirs or canal banks from direct exposure to the herbicide.

PCWA canal lining/guniting practices potentially have minimal effects on special status species. Measured pH values in portions of the canal downstream from canal lining activities were high for a short time after flows were restored to the canal system. High pH values can be toxic to federally listed as endangered or threatened fish and other aquatic species.

PCWA canal and pipe repair activities may have variable effects on special status species. Heavy equipment may disturb vegetation along canal banks from access routes and increased noise levels. Construction work along canal banks could cause increased TSS and other constituents in receiving water tributaries and streams, which could affect special status species, particularly fish and amphibians, and the extent of wetland habitats for special status species. Project-specific environmental resources analyses should be performed to assess the potential effects of canal and pipe repair activities on special status species and to determine measures to minimize potential negative effects.

6.2.1.3 Magnuson-Stevens Fishery Conservation and Management Act and the 1996 Sustainable Fisheries Act

PCWA canal cleaning activities may have minimal effects on suitable fishery habitat. As described previously, measures recommended to protect EFH by NMFS are advisory, not prescriptive.

PCWA weed and brush control practices, particularly algaecide application practices, may have minimal effects on fishery resources with respect to potential copper contributions in waters of the United States. Although copper concentrations did not exceed water quality objectives in receiving water tributaries, it was observed to temporarily increase at canal outlets. The toxicity of copper to fish varies with the species and the physical and chemical characteristics of the water. Its toxicity to fish generally decreases as water hardness increases. Fish eggs are more resistant than young fish fry to the toxic effects of copper (Gangstad 1986). Because PCWA applies algaecides and herbicides consistent with NPDES permit requirements, and implements BMPs and other actions specified in a detailed PCWA Algaecide Application Program, these effects are likely reduced.

PCWA canal lining/guniting practices may have minimal effects on suitable fishery habitat. Several constituents, such as pH, turbidity, TSS, SC, and other ions temporarily increased at canal outlets, but minimal to no effects were observed in receiving water tributaries and streams. However, these effects are easily avoidable with effective BMP implementation.

PCWA canal and pipe repair activities may have minimal effects on fishery habitat. Potential sediment loading from construction activities can increase turbidity and limit the ability for fish to hide from predators. Hazardous waste runoff from construction sites can have toxic effects on fish. However, these effects are easily avoidable with effective BMP implementation. Project-specific environmental resources analyses should be performed to assess the potential effects of canal and pipe repair activities on EFH and to determine measures to minimize potential negative effects.

6.2.1.4 Migratory Bird Treaty Act

PCWA canal cleaning activities, weed and brush control practices, and canal lining/guniting practices potentially have minimal effects on migratory bird species from the use of equipment and machinery. However, it is unlikely that these effects would constitute a “take” of a migratory bird species or habitat (as defined by the MBTA) and therefore would not be subject to the MBTA.

PCWA canal and pipe repair activities may have minimal effects on migratory bird species. Noise disturbance and improper equipment staging can cause birds to abandon their nests or resting sites, and the removal of trees that provide habitat for migratory birds can reduce their populations in the vicinity of the construction site. However, with effective BMP implementation, these effects can be dramatically reduced or eliminated.

6.2.2 State Regulations

Laws and regulations governed by the State of California and associated with the potential effects of PCWA maintenance activities are described below.

6.2.2.1 California Environmental Quality Act

PCWA maintenance activities may be considered projects requiring CEQA review if there is potential for resulting in direct change in the environment, or a reasonably foreseeable indirect change in the environment. Some PCWA maintenance activities may be exempt from CEQA. Relevant exemptions include emergency projects (Section 15269), statutory exemptions described in State of California CEQA Guidelines Section 15282, and Class 1 and Class 2 categorical exemptions described in Sections 15301 and 15302. Each PCWA maintenance activity or project should be given a preliminary review to determine whether CEQA applies and whether the project may be eligible for an exemption from CEQA. If an exemption is not applicable, an initial study must be prepared to determine if the project may have a significant effect on the environment. The purposes of an initial study are to:

- (1) Provide the lead agency with information to use as a basis of deciding whether to prepare an EIR or negative declaration.
- (2) Enable an applicant or lead agency to modify a project, mitigating adverse impacts before an EIR is prepared, thereby enabling the project to qualify for a negative declaration.
- (3) Assist the preparation of the EIR on the effects determined to be significant.
 - A. Focusing the EIR on the effects determined to be significant.
 - B. Identifying the effects determined not to be significant.
 - C. Explaining the reasons for determining that potentially significant effects would not be significant.
 - D. Identifying whether a program EIR, tiering, or another appropriate process can be used for analysis of the project's environmental effects (Section 15063.c).

An initial study prepared by PCWA for maintenance activities or projects should include, in brief form, the following:

- (1) A description of the project including the location of the project.
- (2) An identification of the environmental setting.
- (3) An identification of environmental effects by use of a checklist, matrix, or other method, provided that entries on a checklist or other form are briefly explained to indicate that there is some evidence to support the entries. The brief explanation may be either through a narrative or a reference to another information source such as an attached map, photographs, or an earlier EIR or negative declaration. A reference to

another document should include, where appropriate, a citation to the page or pages where the information is found.

- (4) A discussion of the ways to mitigate the significant effects identified, if any.
- (5) An examination of whether the project would be consistent with existing zoning, plans, and other applicable land-use controls.
- (6) The name of the person or persons who prepared or participated in the Initial Study (Section 15063.d).

A Negative Declaration or Mitigated Negative Declaration must be prepared by PCWA for maintenance activities or projects subject to CEQA when (1) the initial study shows that there is no substantial evidence that the project may have a significant effect on the environment; or, (2) the initial study identifies potentially significant effects, but:

- (1) Revisions in the project plans or proposals (i.e., BMPs) made by, or agreed to by the applicant before a proposed mitigated negative declaration and initial study are released for public review would avoid the effects or mitigate the effects to a point where clearly no significant effects would occur.
- (2) There is no substantial evidence, in light of the whole record before the agency, that the project as revised may have a significant effect on the environment (Section 15070).

A Negative Declaration prepared by PCWA and circulated for public review should include:

- (a) A brief description of the project, including a commonly used name for the project, if any.
- (b) The location of the project, preferably shown on a map, and the name of the project proponent.
- (c) A proposed finding that the project will not have a significant effect on the environment.
- (d) An attached copy of the Initial Study documenting reasons to support the finding.
- (e) Mitigation measures, if any, included in the project to avoid potentially significant effects (Section 15071).

As described in **Chapter 4**, if an Initial Study concludes that a PCWA activity or project is determined to have significant effects on the environment, and EIR must be prepared. The EIR for the activity or project should evaluate the potential significant effects on environmental resources, identify a range of feasible alternatives to the project that would avoid or reduce its impacts, and identify mitigation measures that would minimize or avoid those impacts.

6.2.2.2 Porter-Cologne Water Quality Control Act

As described previously in **Chapter 4**, the CWA defines Water Quality Standards as provisions of State or Federal law, which consist of U.S. EPA and California water quality criteria and water quality objectives for designated beneficial uses for the waters of the United States.

The regulatory framework and effects for PCWA canal cleaning activities are similar to those described previously under the CWA. PCWA canal cleaning activities were found to be in compliance with State water quality standards and objectives regulated by the Central Valley RWQCB. Of the Criteria for Priority Toxic Pollutants in the State of California, cadmium, copper, and zinc were three criteria parameters monitored for during PCWA canal cleaning activities. Cadmium levels were not exceeded. The freshwater CMCs for zinc (120 µg/L) and copper (9 µg/L) were exceeded at some canal release sites monitored during the canal cleaning activities, but no exceedances were observed within receiving water tributaries or streams within the Secret Ravine and Miners Ravine watersheds. Therefore, PCWA canal cleaning activities were observed to be in compliance with state water quality standards. However, if an exceedance did occur within receiving waters of the United States, they are temporary and can be prevented and/or minimized through effective BMP implementation. Of the water quality objectives associated with beneficial uses of the Sacramento River in the Sacramento-San Joaquin Basin Plan, barium, copper, iron, zinc, DO, pH, and turbidity were monitored during PCWA canal cleaning activities. The basin plan water quality objectives for trace elements barium, copper, and zinc were exceeded at canal release points during cleaning events, but no exceedances were recorded in receiving water tributaries and streams within the Secret Ravine and Miners Ravine watersheds. Therefore, PCWA canal cleaning activities were observed to be in compliance with basin plan trace element water quality objectives for the Sacramento River. Basin plan water quality objectives for basic parameters were observed to be slightly exceeded in receiving water tributaries and streams. The DO level in the FRGTRIB1 (6.1 mg/L) was observed to be slightly below the minimum DO level for waters with designated coldwater fishery beneficial uses (7.0 mg/L) during the March 27, 2007, cleaning event. Some pH and turbidity levels at canal release points were observed to exceed the water quality objectives, but none was observed within receiving water tributaries or streams during canal cleaning events. Due to the DO decrease being so slight and temporary, it is not a large concern that PCWA can meet water quality objectives for basic parameters during canal cleaning events.

The regulatory framework for PCWA weed and brush control practices is similar to the framework described previously under the CWA. Of all water quality standards and objectives, the basin plan water quality objective for turbidity has the most potential for exceeding the limit during the physical removal of vegetation. However, increases in turbidity and suspended sediments can easily be avoided or minimized through effective BMP implementation. As described in **Chapter 4**, an NPDES permit is now required under the CWA for aquatic pesticide applications. NPDES permits for discharges to surface waters must meet the most protective (lowest) and appropriate limits in order to protect all designated beneficial uses of the receiving water, which constitute state water quality criteria and Central Valley RWQCB basin plan water quality objectives. PCWA's algacide applications currently comply with NPDES permit requirements. Although copper levels temporarily increased at canal outlets, they remained well below water quality standards and objectives for copper during monitoring for algacide application events. Herbicide applications were also found to be in compliance with state water quality standards and objectives regulated by the Central Valley RWQCB.

The regulatory framework and effects for PCWA canal lining/guniting practices are similar to those described previously under the CWA. No water quality standards were observed to be exceeded in waters of the United States during canal lining activities. DO concentrations were lower than the minimum level water quality objective at canal outlets, but not at tributary or stream sites. Recorded pH levels reached 11.7 at canal sites downstream from lining activities and canal outlets, but the basin plan water quality objective range for pH (6.5 to 8.5) was not exceeded at tributary or stream sites. Turbidity levels exceeded the basin plan water quality objective (increase by greater than 20 percent) in Miners and Secret ravines, but remained below 100 NTUs. Barium, iron, zinc, and copper levels were increased at canal sites downstream from the lining activity and at canal outlets, but they did not exceed water quality objectives in receiving water tributaries and streams. Turbidity was the only parameter observed to exceed water quality objective levels during canal lining activities, and may be controlled by effective BMP implementation.

The regulatory framework and effects for PCWA canal and pipe repair activities are similar to those described for the CWA. If a Section 401 certification is required, an application should be prepared and submitted for approval before project implementation. Increases in turbidity in receiving water tributaries and streams are of primary concern during these activities, and increases in turbidity and suspended sediments can easily be avoided or minimized through effective BMP implementation. The Placer County Stormwater Management Program (required under the RWQCB Phase II MS4 permit) provides guidance on the implementation of BMPs that minimize the potential effects of construction activities. A pipe repair project that results in the disturbance of greater than 1 acre of land requires a General Construction General Permit with the RWQCB. Under Construction General Permit requirements, a SWPPP is required to be prepared, be on site at all times, and be followed by a designated construction contractor to ensure that contaminants are not discharged into the river. Water quality monitoring and observation reports at construction sites is required during at least two precipitation events, the first one being the first-flush rain event. Monitoring results and other information are to be submitted in annual reports each June to the RWQCB for compliance review. Monitoring results are compared to nonenforceable EPA Parameter Benchmark Levels (see **Chapter 3**) that, if exceeded, a warning letter is sent to the permittee advising implementation of more effective BMPs to minimize waste discharges.

6.2.2.3 California Endangered Species Act

Under the California ESA, the effects on special status species from PCWA maintenance activities during PCWA canal cleaning activities, PCWA weed and brush control practices, canal lining/guniting practices, and canal and pipe repair activities are similar to those described previously under the Federal ESA. However, the California ESA addresses the incidental take of State-listed species as threatened or endangered.

6.2.2.4 California Fish and Game Code-Fully Protected Species

Under the Fish and Game Code-Fully Protected Species, the effects on special status species from PCWA canal cleaning activities, PCWA weed and brush control practices, canal

lining/guniting practices, and canal and pipe repair activities, are similar to those described previously under the Federal ESA. However, this code addresses the incidental take of fully protected species. DFG is unable to authorize incidental take of fully protected species, such as White-tailed Kite and the California Black Rail, when activities are proposed in areas inhabited by those species. Therefore, the take of any fully protected species for project implementation is prohibited.

6.2.2.5 California Fish and Game Code Section 1602 – Lake and Streambed Alteration Program

In accordance with the Lake and Streambed Alteration Program, PCWA is required to notify DFG of any proposed activity that may substantially modify study area streams or lakes. Potential PCWA maintenance activities that may require notification include actions that will substantially divert or obstruct the natural flow of any river, stream, or lake; substantially change or use any material from the bed, channel, or bank of, any river, stream, or lake; or deposit or dispose of debris, waste, or other material containing crumbled, flaked, or ground pavement where it may pass into any river, stream, or lake. If PCWA canal repair or pipe repair activities have the potential to modify streams or lakes as described above, PCWA should provide notification to DFG under the Lake and Streambed Alteration Program.

6.2.2.6 California Native Plant Protection Act

This act applies to endangered and “rare” plant species, subspecies, and varieties of wild native plants in California. PCWA canal cleaning, weed and brush control, canal lining/guniting, and canal and pipe repair activities may affect endangered and “rare” plant species during the use of equipment and machinery in canals and along canal banks. PCWA weed and brush control practices may also have moderate effects on endangered and “rare” plant species. Physical removal of vegetation could result in direct loss of vegetation and habitat. Herbicide applications near special endangered and “rare” plant species may expose it to the toxic effects of herbicides. However, with proper application and effective BMP implementation, these effects can be prevented or minimized.

6.2.3 Local Requirements and Considerations

The following sections describe the framework for local requirements during PCWA maintenance activities.

6.2.3.1 Placer County Conservation Plan

As described in **Chapter 4**, the PCCP includes plans with goals to protect fish and wildlife and their habitat and protect streams, wetlands and other water resources, as well as coverage under several environmental permits to be issued to Participating Entities. With PCCP long-term environmental permits described in **Chapter 4**, PCWA will be covered for activities projects that require it.

The regulatory framework for PCWA maintenance activities related to the PCCP are the same as the those described for CWA, ESA, Porter-Cologne Water Quality Control Act, California ESA, California Fish and Game Code-Fully Protected Species, and Lake and Streambed Alteration Program.

6.2.3.2 Placer County Stormwater Management Plan

PCWA construction activities during canal and pipe repair projects may be subject to Construction Site Stormwater Runoff Control guidelines the Placer County SWMP. Projects within Placer County will be designed using BMPs for stormwater discharges. The SWMP provides guidance in establishing BMPs before, during, and after construction activities, as well as long-term maintenance BMPs.

Placer County has established procedures specified in the county Grading and Erosion Prevention Ordinance for applying and enforcing construction site pollution control measures, including site plan reviews, requiring erosion and sediment control BMPs, inspections, and enforcement of violations.

6.2.3.3 Placer County Code, Tree Preservation Ordinance

Lining of previously unlined section of PCWA's canal system may indirectly affect adjacent trees historically supported by canal seepage. Also, PCWA canal and pipe repair activities may require the removal of trees. Placer County's tree ordinance sets county-wide requirements for projects within riparian zones, permit requirements for removal of landmark trees, removal of more than 50 percent of trees, and commercial firewood cutting, and establishes tree preservation zones. For example, the removal of more than 50 percent of existing native trees (equal to or greater than 6 inches in diameter at breast height), and of any landmark tree, is subject to the issuance of a tree permit. A "landmark tree" means a tree or grove of trees designated by resolution of the board of supervisors to be of historical or cultural value, an outstanding specimen, an unusual species and/or of significant community benefit (i.e., palms, along English Colony Road, oak canopy tree areas, Deodar cedars on Highway 49, major heritage oak trees). Tree preservation zone provisions are applicable to the Dry Creek-West Placer Community Plan, Granite Bay Community Plan, portions of the Loomis Basin General Plan, and the Auburn-Bowman Community Plan. A tree preservation zone map is available in the Placer County Planning Office for more details on zoning areas

6.2.3.4 Placer County Oak Woodland Management Plan

As described above, PCWA's canal lining, canal repair, and pipe repair activities may affect trees, including oaks, adjacent to canals. The regulatory framework related to the Placer County Oak Woodland Management Plan for canal lining, and canal and pipe repair activities are similar to those described in the Placer County Tree Preservation Ordinance. As part of this plan, projects are subject CEQA assessments for oak woodland habitats.

6.3 BEST MANAGEMENT PRACTICE OPTIONS TO ADDRESS POTENTIAL EFFECTS OF MAINTENANCE ACTIVITIES

Potential BMPs to reduce potential effects of PCWA maintenance activities on natural resources are summarized in Table 6-11, and described below. The list of BMP options is not comprehensive; instead, it provides examples of BMPs that may be implemented to minimize particular potential effects of PCWA canal maintenance activities. Several BMP options for maintenance activities are similar to those for operations activities described in Section 5.3; therefore, are not described as thoroughly in this section.

6.3.1 Pre-Implementation Best Management Practices

Below are potential pre-implementation BMPs for reducing potential effects of PCWA maintenance activities on natural resources in the study area.

6.3.1.1 Improve Canal Bank Stability and Install Sediment Control Measures at Canal Outlets

Canal bank erosion along unlined canals may occur after canal flows are restored following dewatering activities associated with canal cleaning and lining activities. The following measures to improve canal bank stability are described in **Chapter 5**:

- Install velocity dissipaters at canal outlets
- Line banks below canal outlets

Additional BMP options to address potential effects of bank erosion below canal outlets and sediment loading in receiving waters from dewatering during maintenance activities are described below.

Install Erosion-Control Blankets in Areas of Soil Disturbance

Erosion-control blankets and turf reinforcement mats combine vegetative growth with synthetic materials to form a high-strength mat that prevents soil erosion in drainage areas and on steep slopes. Where applicable, PCWA may apply a geotextile blanket or biodegradable mat on graded slopes to minimize actively bared and easily eroded soils. These blankets also enhance vegetative growth and provide removal of particulates through sedimentation and soil infiltration (EPA 2005b). PCWA is already implementing this type of BMP, where possible.

Install Temporary Fiber Rolls in Areas of Soil Disturbance

Fiber rolls (also called fiber logs or straw wattles) are tube-shaped erosion-control devices filled with straw, flax, rice, coconut fiber material, or composted material (EPA 2008a). Temporary fiber rolls are typically made of rice straw, are contained in tubular black netting, and can be staked down along a sloped area. Rice straw is weed free and naturally biodegradable, which can enhance the soil and help vegetation become established. Each roll is wrapped with ultraviolet (UV)-degradable polypropylene netting for longevity or with 100 percent

biodegradable materials like burlap, jute, or coir. Fiber rolls are used on slopes to reduce runoff velocity and control or capture eroded sediment to prevent sediment loading in receiving water streams. On steep slopes, fiber rolls used in conjunction with a properly designed and installed erosion-control blanket may be very effective in reducing erosion and sedimentation.

Apply Spray-On Soil Binders in Areas of Soil Disturbance

Spray-on emulsion is often used as a temporary tackifier for hydroseeding or mulch, or a stand-alone, heavy-duty soil binder for erosion control. Plant-based, polymer, and cementitious-based emulsions penetrate the topsoil and bind soil particles together. These agents form a protective, flexible film to strengthen the soil surface and provide bank stabilization and erosion control. Polymer emulsions may be applied with hydroseeders, water trucks, or other spraying devices. Spraying devices with a mechanical agitator or mixing apparatus or hydraulic recirculation are known to be most effective. These emulsions are best applied to low or moderate slopes, and best avoided in areas where the binder would likely be removed in the near future or in areas with high-volume sheet flow because it has a tendency to be washed away. Reapplication of soil binders may be necessary to effectively stabilize the soil throughout the season.

6.3.1.2 Avoid Potential Wet Weather Effects

Avoidance of potential adverse effects of PCWA maintenance activities during wet weather, when and where feasible, can be very effective. BMP options to avoid potential wet weather effects for PCWA maintenance activities are described below.

Plan and Design Projects to Minimize Land Disturbance

Scheduled maintenance activities, particularly canal and pipe repair, can be planned and designed with consideration in minimizing excavation and land disturbance. This BMP involves avoiding land disturbance during periods of high precipitation, and land disturbance in areas vulnerable to erosion. PCWA is already implementing this type of BMP, when possible.

Identify Areas Susceptible to Erosion for Future Canal Lining Activities

During maintenance activities, PCWA staff may identify segments of unlined canals or lined areas along the canal that are visibly disturbed and/or susceptible to bank erosion for future canal lining activities. Future lining of these segments typically reduces erosion and sloughing of canal banks. PCWA already implements this type of BMP.

Choose Canal Crossing Sites Where Erosion Potential is Low

Maintenance activities, such as canal lining and canal cleaning, may require hoses and/or other equipment to rest across the canal. Areas along canals with visible erosion or loose sediment should be avoided and equipment should be located along stable canal sections. PCWA is already implementing this type of BMP.

6.3.1.3 Protect Sensitive Species and Sensitive Species Habitat

Before conducting maintenance activities, special status species and sensitive species habitat can be protected by the following BMPs described in **Chapter 5**:

- Provide staff with species identification training.
- Evaluate sites with sensitive species and mark/protect sensitive species habitat.

In addition to options described in **Chapter 5** for the “Evaluate sites with Sensitive Species and Mark/Protect Sensitive Species Habitat” BMP option, a protective curtain can be placed around sensitive plant species and/or habitat near herbicide application areas to minimize the exposure of special status species and/or habitat to the potential toxic effects of herbicides. Types of protective curtains include tarps or a pesticide containment pad made of impermeable materials, such as synthetic liners.

6.3.1.4 Strategic Scheduling of Maintenance Activities

Maintenance activities can be scheduled, or BMPs implemented, at specific times of the year to avoid or minimize potential effects on terrestrial and aquatic biological resources. Activities can be planned to avoid species sensitive periods and to avoid wet weather erosion effects. For example, a project or activity can be scheduled to avoid periods during bird nesting and/or amphibian breeding seasons. Projects requiring equipment and machinery can be scheduled during a time of low erosion potential, such as the dry season. PCWA is already implementing this type of BMP, when possible.

6.3.1.5 Regulatory Compliance Management for Operations and Maintenance Activities

Before maintenance activity or project implementation, permits may need to be obtained and BMPs implemented to comply with rules and regulations. BMP checklists are available from many governmental resources as planning guides for environmental compliance. An example is EPA’s “Managing Your Environmental Responsibilities: A Planning Guide for Construction and Development” that describes BMPs that should be implemented before, during, and after canal and pipe repair activities. In addition, there are several guidance documents online providing information on delegating specific tasks to employees for a construction project with an associated General NPDES Construction Stormwater Permit, such as a manager who would be responsible for knowing the location and ensuring implementation of a project SWPPP.

Regulatory compliance activities include periodically updating documents, such as PCWA’s Aquatic Weed Management Program, which is reviewed annually and updated, as needed.

6.3.2 Implementation Best Management Practices

The following sections identify potential BMPs to reduce potential effects associated with PCWA maintenance activities on natural resources within the PCWA raw water distribution area that should be considered during implementation of PCWA maintenance activities.

6.3.2.1 Protect Sensitive Species and Sensitive Species Habitat

Special status species and sensitive species habitat can be protected during implementation of some maintenance activities by applying the following BMP:

Stockpile Materials Away from Sensitive Species Habitat Areas

Before conducting canal cleaning or canal lining activities, PCWA may designate areas that should be avoided based on observed sensitive species or known sensitive species habitat areas. During canal cleaning or canal lining activities, PCWA personnel would stockpile any debris (i.e., vegetation, sediment, and/or gunite removed from canals) away from these known occurrences or areas of sensitive species habitat, or only in previously disturbed areas, to minimize potential effects of these materials on natural resources through physical damage to vegetation/species by deposition of material or constituent loading to receiving streams. PCWA is already implementing this type of BMP.

6.3.2.2 Avoid Sensitive Species Areas

During operations activities, PCWA personnel can do several things to prevent potential effects on terrestrial species and disturbance to terrestrial species habitat. Examples of BMP options follow. During maintenance activities, PCWA personnel can do several things to avoid potential effects on terrestrial species and disturbance to terrestrial species habitat. Several BMP options for PCWA maintenance activities are similar to those described in **Chapter 5** for operations activities, including:

- Avoid disturbance to sensitive species

An additional BMP option to avoid sensitive species during maintenance activity implementation is described below.

Avoid Active Raptor Nesting Areas

PCWA staff can avoid potential impacts to raptors through avoiding active raptor nesting areas during maintenance activities. PCWA may conduct raptor survey at locations of scheduled maintenance activities during the breeding season (generally March through August) to scan for active nests. If active nests are observed, the area should be avoided to the maximum extent possible. If activities do occur in the area, noise and other disturbance should be kept to a minimum. PCWA is already implementing this type of BMP for canal lining activities, when possible.

6.3.2.3 Prevent Degraded Water from Entering Streams After Operations and Maintenance Activities

Water flows restored to the canal system immediately following maintenance activities that involve canal dewatering may flush accumulate debris and sediment, along with associated constituents, to receiving streams. BMPs may be implemented to prevent or reduce the amount of degraded water from PCWA's canal system from entering streams. BMP options for maintenance activities previously described in **Chapter 5** include:

- Modify reservoir operations to gradually restore reservoir releases to canals at a slower rate

Additional BMPs that may prevent degraded water from entering streams after maintenance activities are described below.

Apply Sediment Trap at Storm Drains for Dewatering Before Canal Lining

For some types of maintenance activities that require complete dewatering of ponded water, such as canal lining, water remaining in canals is pumped out of a canal segment before preparing segments for canal lining. These waters may exhibit elevated concentrations of constituents and should not be discarded to receiving waters or storm drains. Temporary sediment traps can be installed at nearby storm drains to filter sediment and associated constituents from small volumes of water removed from canals.

Treat First Flush Flows to Reduce Downstream Water Quality Effects

Results from water quality monitoring associated with canal lining activities at locations below newly lined canal segments demonstrated pH values that were higher in comparison to sites upstream from newly lined segments. Water with elevated pH values may be treated to buffer potential changes to pH that may occur through geochemical interactions of ions in canal waters with newly lined gunite sections. Nontoxic solutions that may lower pH and neutralize potential effects of canal lining on pH would reduce potential water quality effects on receiving streams.

6.3.3 Ongoing or Post-Implementation Best Management Practices

Potential ongoing or post-implementation BMPs for maintenance include the following option described in **Chapter 5**:

- Implement PCWA BMP Program

Additional ongoing or post-implementation BMP options for maintenance activities are described below.

6.3.3.1 Avoid Potential Wet Weather Effects

Install Erosion- and Sedimentation-Control Measures After Land-disturbing Activities

If PCWA maintenance activities may disturb land during the wet season, loose sediment and/or material in the vicinity of the canal system should be contained using sediment-control measures, such as a tarp surrounded with fiber rolls, to protect the materials from being transported into downstream waterways. PCWA already implements this type of BMP, when possible.

6.3.3.2 Prevent Degraded Water from Entering Streams After Operations and Maintenance Activities

Implement an Aquatic Weed Management Program

PCWA currently implements an Aquatic Weed Management Program. As part of this program, PCWA completes an evaluation for each algaecide and herbicide application which includes water quality monitoring and treatment efficacy (PCWA 2003b). PCWA also routinely monitors

algaecide and herbicide product releases in an effort to identify suitable algaecides and/or herbicides for applications that may have lesser potential effects on natural resources.

6.3.3.3 Good Housekeeping Practices

Good housekeeping is practiced to maintain clean and orderly work sites and to prevent materials originating in the work site area from affecting natural resources. Good housekeeping practices include plans, procedures, and activities designed to prevent or minimize potential pollutant runoff into waterways. PCWA's Hazardous Materials Plan describes these practices in detail. Examples of good housekeeping BMPs are as follows:

Ensure Proper Handling of Materials and Wastes

Spill kits should be kept nearby and used to prevent further contamination if wastes are accidentally spilled. If a spill is large, the spill should be reported to the Office of Environmental Health Hazard Assessment (OEHHA). PCWA is already implementing this type of BMP.

Use Proper Cleanup Procedures After Material Use

PCWA staff should not wash excess gunite into canals following completion of canal lining activities. Once canal lining activities are completed, excess gunite should be contained and properly disposed. If equipment used for canal lining activities needs to be rinsed, wastewater should be captured, contained in a storage vessel, and exported to a disposal facility. PCWA is already implementing this type of BMP.

Implement Onsite Debris and Trash Management Practices

During PCWA maintenance activities, PCWA should (1) keep debris and trash under cover either in an enclosed trash container, (2) prevent waste materials to accumulate on the ground, and (3) inspect maintenance sites daily for litter and debris. If feasible, construction and demolition debris such as wood, metal, and concrete, should be recycled. PCWA is already implementing this type of BMP.

Store Materials Under a Roof or Covering with a Secure Tarp

Proper storage of pollutant materials, such as fuel, oil, concrete, and other hazardous liquids, should be considered for materials used for maintenance activities. When pollutant materials must be stored on site, they should be stored in a secure, covered location with secondary containment provisions. Additional options include designating specific areas on site for material delivery and storage, location of material storage areas away from waterways and storm drain outlets, installation of containment berms between stored materials and site drainage system, proper labeling of materials and containers, and keeping material containers tightly sealed after use. Maintenance site supervisors should check for leaching or spreading of contaminants from areas where potentially hazardous materials are stored. PCWA already implements this type of BMP.

6.4 SUGGESTIONS FOR FURTHER STUDIES

Based on results of NRMP studies, PCWA maintenance may affect natural resources conditions within the study area. Higher concentrations of trace metals, particularly aluminum and copper, were observed at sites monitored within the PCWA canal system compared to stream sites for sampling events associated with PCWA's maintenance activities that involved dewatering of canal segments. These data may inconclusively suggest that the PCWA canal system is a source for loading of some constituents to study area streams.

Additional water quality monitoring should be conducted at sites to characterize potential effects of PCWA maintenance activities on water quality conditions. Water quality monitoring sites for maintenance event-based monitoring should include:

- Canal sites immediately upstream and downstream from the maintenance activities within the PCWA canal system
- End of canal outlets downstream from maintenance activities
- Stream sites upstream and downstream from canal system contributions

Nearby routine water quality monitoring sites within the same watersheds as the maintenance sites should also be included during maintenance event-based water quality monitoring to characterize effects of maintenance activities. One of the focal points for additional studies should be to evaluate aluminum and copper inputs to study area streams from the PCWA canal system. During algaecide application events, additional and more frequent water quality monitoring at select canal outlets downstream from Clover Valley and Mammoth reservoirs during and after algaecide applications. Water quality results for these events, coupled with flow data at algaecide application points and canal outlets, would provide PCWA with the data to calculate the mass balance for copper and estimate mass loading of copper to study area streams during algaecide applications. Water quality monitoring should also be conducted upstream and downstream from BMPs implemented by PCWA to reduce potential impacts to water quality to evaluate BMP effectiveness. Sample timing for all maintenance event-based water quality monitoring should be determined based on hydrologic conditions at each site to characterize potential constituent loading to study area streams following maintenance activities.

As described in **Chapter 5**, additional sediment quality monitoring at numerous sites exhibiting variable soil conditions along the canal system and study area streams may help to determine potential sources of trace metals in PCWA canals and study area streams. Soil sampling for representative soil types should be coordinated with maintenance event-based water quality monitoring. Soil samples should be collected from sediments removed from canals during canal cleaning and canal lining activities, and from undisturbed sites of representative soil types, as characterized by PCWA (2005), near and upstream from canal and stream water quality monitoring sites within watersheds of Clover Valley Creek, Antelope Creek, Secret Ravine, and Miners Ravine.

Additionally, effects of canal lining activities on wetlands and/or trees, including oak trees, located adjacent to canals are not clearly understood. Further studies should be conducted to evaluate potential effects of canal lining on wetlands and/or trees adjacent to canals. Studies may include evaluating potential changes to moisture and geochemical conditions of soils near potentially affected wetlands and/or trees before and after canal lining activities.

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CHAPTER 7.0 POTENTIAL EFFECTS, REGULATORY FRAMEWORK, AND BEST MANAGEMENT PRACTICES FOR INTERRELATED PCWA OPERATIONS AND MAINTENANCE ACTIVITIES

This chapter provides an overview of the potential effects of interrelated PCWA O&M activities on natural resource conditions in the study area, the regulatory framework for effects, and potential BMPs to reduce effects of interrelated PCWA O&M activities on natural resources.

7.1 POTENTIAL EFFECTS OF INTERRELATED PCWA OPERATIONS AND MAINTENANCE ACTIVITIES ON NATURAL RESOURCES

This section describes potential effects of PCWA O&M activities that, when combined, may increase adverse effects to natural resources. Interpretations of the potential effects of interrelated PCWA activities are based on the potential effects of operations activities discussed in **Chapter 5** and potential effects of PCWA maintenance activities discussed in **Chapter 6**. Potential interrelated effects associated with canal or pipe repair, however, are not addressed in this chapter. As described in **Chapter 6**, canal repair and pipe repair activities should require project-specific environmental resources analyses to assess the potential effects of the activity on natural resources, and an evaluation to determine measures to minimize potential negative effects.

7.1.1 Yearly Outages

PCWA operations during the PG&E yearly outages in combination with other PCWA O&M activities may increase adverse effects to natural resources. No interrelated effects are anticipated on natural resources during PCWA operations related to yearly outages and:

- Seasonal delivery schedule changes
- Seasonal flood management practices
- Maintenance related to physical removal of vegetation along PCWA's raw water distribution system
- Maintenance related to herbicide applications along PCWA's raw water distribution system

The following summarizes potential effects of PCWA operations during yearly outages that may be interrelated to potential effects observed during other PCWA O&M activities:

- Routine Operations – During routine PCWA operations, the PCWA canal system provides direct contributions to flows within study area streams through regulated releases to streams used for conveyance to customers, unregulated releases from canal

outlets, and indirect contributions through customer return flows (USACE and PCWA 2008). These canal system contributions to streamflow have a positive effect on hydrologic conditions in study area streams, creating and sustaining suitable habitat conditions for many aquatic species during the dry season. These positive effects on natural resources, when combined with potential negative effects on hydrological conditions associated with PCWA's operations during the outages, likely result in interrelated effects to natural resources. Potential interrelated effects to biological resources, including wetlands supported by canal contributions, Central Valley steelhead, and Chinook salmon, are representative of historic conditions within the study area.

- Canal Cleaning – Removal of debris and sediment from the canals during canal cleaning activities potentially reduces adverse interrelated effects of PCWA operations during yearly outages on water quality conditions in study area streams. PCWA's canal cleaning activities remove much of the unconsolidated sediment, organic material, and associated copper from algaecide applications that may settle in canals when canals are dewatered during the outage.
- Weed and Brush Control – Algaecide Application: Interrelated effects of PCWA operations during yearly outages and PCWA's algaecide applications were observed during water quality monitoring events for yearly outages, particularly within the Secret Ravine watershed. Measured copper values at canal and stream sites in the Secret Ravine watershed during the October 2007 sampling event increased after flows were restored to the canal system. The higher copper values observed during the yearly outages were likely attributed to mobilization of copper associated with fine sediment and organic material remaining within the canals after canal cleaning activities, or that had accumulated and settled when canals were dewatered during the outage. The effects on water quality from these interrelated activities likely result in adverse effects on terrestrial and aquatic biological resources.
- Canal lining – Removal of debris and sediment from the canals during canal preparation for lining activities, along with improved canal bank stability when canals are lined, likely decreases potential adverse effects of PCWA operations during PG&E yearly outages on water quality conditions in study area streams.

7.1.2 Seasonal Delivery Schedule Changes

No interrelated effects are anticipated on natural resources during PCWA operations related to seasonal delivery schedule changes in combination with other PCWA O&M activities.

7.1.3 Seasonal Flood Management Practices

PCWA operations during seasonal flood management practices in combination with other PCWA O&M activities may increase adverse effects to natural resources. No interrelated effects

are anticipated on natural resources during PCWA operations related to seasonal flood management practices and:

- Yearly outages
- Seasonal delivery schedule changes
- Routine operations
- Maintenance from physical removal of vegetation along PCWA's raw water distribution system
- Maintenance from herbicide applications along PCWA's raw water distribution system

The following summarizes potential effects of PCWA operations during seasonal flood management practices that may be interrelated to potential effects observed during other PCWA O&M activities:

- Canal Cleaning – Removal of debris and sediment from the canals during canal cleaning activities potentially reduces adverse interrelated effects of PCWA operations during seasonal flood management practices on water quality conditions in study area streams. PCWA's canal cleaning activities remove much of the unconsolidated sediment and organic material that accumulates in canals and may be flushed from canals during seasonal flood management practices. These effects are likely similar to conditions generally exhibited across study area streams during periods of high precipitation runoff.
- Weed and Brush Control – Algaecide Application – Flood management practices have the potential to cause adverse effects to natural resources when combined with algaecide applications along PCWA's raw water distribution system. Potential adverse effects may occur through loading of copper remaining within the canals after canal cleaning activities to wetlands and streams, and accumulation of copper in wetland and stream sediments may affect biological resources.
- Canal Lining – Within sections of the canal system that are lined or recently lined before PCWA seasonal flood management practices, canal lining activities potentially result in reduced adverse interrelated effects from PCWA operations during seasonal flood management practices. Removal of debris and sediment from the canals during canal preparation for lining activities, along with improved canal bank stability when canals are lined, potentially decreases adverse effects of PCWA operations during seasonal flood management practices on water quality conditions in study area streams, similar to conditions generally exhibited across study area streams during periods of high precipitation runoff.

7.1.4 Routine Operations

Routine PCWA operations in combination with other PCWA O&M activities may increase adverse effects to natural resources. No interrelated effects are anticipated on natural resources during PCWA operations related to routine operations and:

- Seasonal delivery schedule changes
- Seasonal flood management practices
- Routine operations
- Canal cleaning along PCWA's raw water distribution system
- Physical removal of vegetation along PCWA's raw water distribution system
- Herbicide applications along PCWA's raw water distribution system

The following summarizes potential effects of PCWA operations during routine operations that may be interrelated to potential effects observed during other PCWA O&M activities:

- Yearly Outages – When combined with operations during PG&E yearly outages, negative effects on hydrological conditions associated with PCWA's routine operations during the yearly outages may increase adverse effects to natural resources. These potential interrelated effects are summarized above in the section describing interrelated effects associated with PCWA operations during PG&E yearly outages. As described in **Chapter 5**, flow contributions associated with PCWA routine operations have an overall positive effect on hydrologic conditions in study area streams.
- Canal Lining – Removal of debris and sediment from the canals during canal preparation for lining activities, along with improved canal bank stability when canals are lined, likely decreases potential adverse effects of routine operations on water quality conditions in study area streams.

7.1.5 Canal Cleaning and Flushing

PCWA operations during canal cleaning in combination with other PCWA O&M activities may increase adverse effects to natural resources. No interrelated effects are anticipated on natural resources during PCWA operations related to canal cleaning and:

- Seasonal delivery schedule changes
- Routine operations
- Physical removal of vegetation along PCWA's raw water distribution system

- Herbicide applications along PCWA's raw water distribution system
- Canal lining along PCWA's raw water distribution system

The following summarizes potential effects of PCWA operations during canal cleaning that may be interrelated to potential effects observed during other PCWA O&M activities:

- Yearly Outages – As described above, removal of debris and sediment from the canals during canal cleaning activities likely decreases potential adverse effects of PCWA operations during yearly outages on water quality conditions in study area streams.
- Seasonal flood management practices – As described above, removal of debris and sediment from the canals during canal cleaning activities likely decreases potential adverse effects of PCWA operations during seasonal flood management practices on water quality conditions in study area streams.
- Weed and Brush Control – Algaecide Application – PCWA's canal cleaning activities, when combined with algaecide applications along PCWA's raw water distribution system, likely have adverse interrelated effects to natural resources. Water quality data collected during canal cleaning activities, summarized in **Chapter 6**, show increased concentrations of copper at study area stream sites immediately following canal cleaning. Increased concentrations of copper are likely the result of the mobilization of copper associated with fine sediment and organic material remaining within the canals after canal cleaning activities or that had settled within upstream and/or downstream canal sections that were dewatered for canal cleaning. Copper loading to wetlands and streams, and accumulation of copper in wetland and stream sediments may affect biological resources.

7.1.6 Weed and Brush Control – Physical Removal of Vegetation

No interrelated effects are anticipated on natural resources during physical removal of vegetation in combination with other PCWA O&M activities.

7.1.7 Weed and Brush Control – Algaecide Application

Algaecide applications along PCWA's raw water distribution system in combination with other PCWA O&M activities may increase adverse effects to natural resources. No interrelated effects are anticipated on natural resources during algaecide applications and:

- Seasonal delivery schedule changes
- Routine operations
- Physical removal of vegetation along the PCWA canal system

- Herbicide applications along PCWA's raw water distribution system

The following summarizes potential interrelated effects of PCWA algaecide applications when combined with other PCWA O&M activities:

- Yearly Outages – PCWA's algaecide applications, when combined with operations during yearly outages, will likely result in adverse interrelated effects to natural resources. As described above, higher copper concentrations observed at sites during yearly outage water quality monitoring events were likely attributed to mobilization of copper associated with fine sediment and organic material that had settled when canals were dewatered during the outage. Copper loading to wetlands and streams, and accumulation of copper in wetland and stream sediments may affect biological resources.
- Seasonal Flood Management Practices – Algaecide applications along PCWA's raw water distribution system have the potential to cause adverse effects to natural resources when combined with seasonal flood management practices. Potential adverse effects may occur through copper loading to wetlands and streams, and accumulation of copper in wetland and stream sediments may affect biological resources.
- Canal Cleaning – As described above, PCWA algaecide applications, when combined with canal cleaning activities, likely result in adverse interrelated effects to natural resources. Increased concentrations of copper in study area streams following canal cleaning activities are likely the result of the mobilization of copper from algaecide applications associated with fine sediment and organic material that had settled when canals were dewatered for canal cleaning. Accumulation of copper in wetland and stream sediments may affect biological resources.
- Canal Lining – Similar to potential interrelated effects associated with algaecide applications and canal cleaning activities, PCWA algaecide applications, when combined with canal lining activities, likely cause adverse interrelated affects to natural resources. Measured copper values in study area streams following canal lining activities were marginally higher compared to routine operations. The higher values result from the mobilization of copper from algaecide applications associated with fine sediment and organic material that had settled when canals were dewatered for canal lining.

7.1.8 Weed and Brush Control – Herbicide Application

No interrelated effects are anticipated on natural resources during PCWA herbicide applications in combination with other PCWA O&M activities.

7.1.9 Canal Lining

PCWA canal lining activities in combination with other PCWA O&M activities may increase adverse effects to natural resources. No interrelated effects are anticipated on natural resources during PCWA operations related to canal lining and:

- Yearly outages
- Seasonal schedule delivery changes
- Seasonal flood management practices
- Canal cleaning along PCWA's raw water distribution system
- The physical removal of vegetation along PCWA's raw water distribution system
- Herbicide applications along PCWA's raw water distribution system

The following summarizes potential effects of PCWA operations during canal lining that may be interrelated to potential effects observed during other PCWA O&M activities:

- Routine Operations – Similar to conditions for seasonal flood management practices and described above, removal of debris and sediment from the canals during canal preparation for lining activities, along with improved canal bank stability when canals are lined, likely decreases potential adverse effects of routine operations on water quality conditions in study area streams.
- Weed and Brush Control – Algaecide Application – As described above, canal lining activities, when combined algaecide applications, likely have adverse interrelated effects to natural resources. Higher concentrations of copper observed in study area streams following canal lining activities were likely due to the mobilization of copper from algaecide applications associated with fine sediment and organic material that had settled when canals were dewatered for canal lining. Accumulation of copper in wetland and stream sediments may affect biological resources.

7.2 REGULATORY FRAMEWORK FOR POTENTIAL EFFECTS OF INTERRELATED PCWA OPERATIONS AND MAINTENANCE ACTIVITIES

The regulatory framework for potential effects of PCWA operations activities described in **Chapter 5**, along with the regulatory framework for potential effects of PCWA maintenance activities described in **Chapter 6**, apply to the potential interrelated effects described in this chapter. The regulatory framework for each of the potential interrelated PCWA O&M activities described that may have adverse effects on natural resources when combined with other O&M activities is summarized in **Tables 5-3** and **6-11**. The following sections provide an overview of

the Federal and State regulations, and local requirements and considerations applicable to the potential effects of interrelated O&M activities described above.

7.2.1 Federal Regulations

Federal laws and regulations associated with the potential effects of interrelated PCWA O&M activities are described in **Chapters 5** and **6**, and listed below:

- CWA
- ESA
- Magnuson-Stevens Fishery Conservation and Management Act and the 1996 Sustainable Fisheries Act
- MBTA

7.2.2 State Regulations

Laws and regulations governed by the State of California and associated with the potential effects of interrelated PCWA O&M activities are described in **Chapters 5** and **6**, and listed below:

- CEQA
- Porter-Cologne Water Quality Control Act
- California ESA
- California Fish and Game Code-Fully Protected Species
- California Fish and Game Code Section 1602 – Lake and Streambed Alteration Program
- California Native Plant Protection Act

7.2.3 Local Requirements and Considerations

The following local requirements and considerations are associated with the potential effects of interrelated PCWA O&M activities are described in **Chapters 5** and **6**:

- PCCP
- Placer County SWMP
- Placer County Code, Tree Preservation Ordinance

- Placer County Oak Woodland Management Plan

7.3 BEST MANAGEMENT PRACTICE OPTIONS TO ADDRESS POTENTIAL EFFECTS OF INTERRELATED PCWA OPERATIONS AND MAINTENANCE ACTIVITIES

The BMPs to address potential effects of PCWA operations activities described in **Chapter 5**, along with the regulatory framework for potential effects of PCWA maintenance activities described in **Chapter 6**, also apply for the potential interrelated effects described in this chapter. Potential BMPs to reduce potential effects of interrelated PCWA O&M activities on natural resources are summarized in **Tables 5-3** and **6-11**, and listed below. The list of BMP options is not comprehensive; instead, it provides examples of BMPs that may be implemented to minimize particular potential effects of interrelated PCWA O&M activities.

7.3.1 Pre-Implementation Best Management Practices

Below are potential pre-implementation BMPs for reducing potential effects of interrelated PCWA O&M activities on natural resources in the study area.

- Improve canal bank stability and install sediment traps at canal outlets
 - Install velocity dissipaters at canal outlets
 - Line banks at canal outlets
 - Install erosion-control blankets in areas of soil disturbance
 - Install temporary fiber rolls in areas of soil disturbance
 - Apply spray-on soil binders in areas of soil disturbance
- Avoid potential wet weather effects
 - Patrol canals and remove potential obstructions to prevent erosion and property damage
 - Minimize amount of water purchased from PG&E during periods of high precipitation
 - Distribute flood releases from canal system by releasing flows at numerous intermediate outlets
 - Plan and design projects to minimize land disturbance
 - Install erosion and sedimentation control measures after land-disturbing activities
 - Identify areas susceptible to erosion for future canal lining activities
 - Choose canal crossing sites where erosion potential is low
- Protect sensitive species and sensitive species habitat

- Provide staff with species identification training
- Evaluate sites with sensitive species and mark/protect sensitive species habitat
- Stockpile materials away from sensitive species habitat areas
- Strategic scheduling of maintenance activities

7.3.2 Implementation Best Management Practices

The following sections are implementation BMPS to reduce potential effects of PCWA maintenance activities on natural resources:

- Avoid sensitive species areas
 - Avoid disturbance to sensitive species
 - Avoid active raptor nesting areas
- Prevent degraded water from entering streams after O&M activities
 - Modify canal operations to gradually restore reservoir releases to canals at slower rate
 - Apply sediment trap at storm drains for dewatering before canal lining
 - Treat first flush flows to reduce downstream water quality effects

7.3.3 Ongoing or Post-Implementation Best Management Practices

The following are ongoing post-implementation BMPs to reduce the potential interrelated effects of PCWA O&M activities on natural resources:

- Regulatory compliance management for O&M activities
- PCWA Best Management Practice Program
- Good housekeeping
 - Ensure proper handling of materials and wastes
 - Use proper cleanup procedures after material use
 - Implement onsite debris and trash management practices
 - Store materials under a roof or covering with a secure tarp

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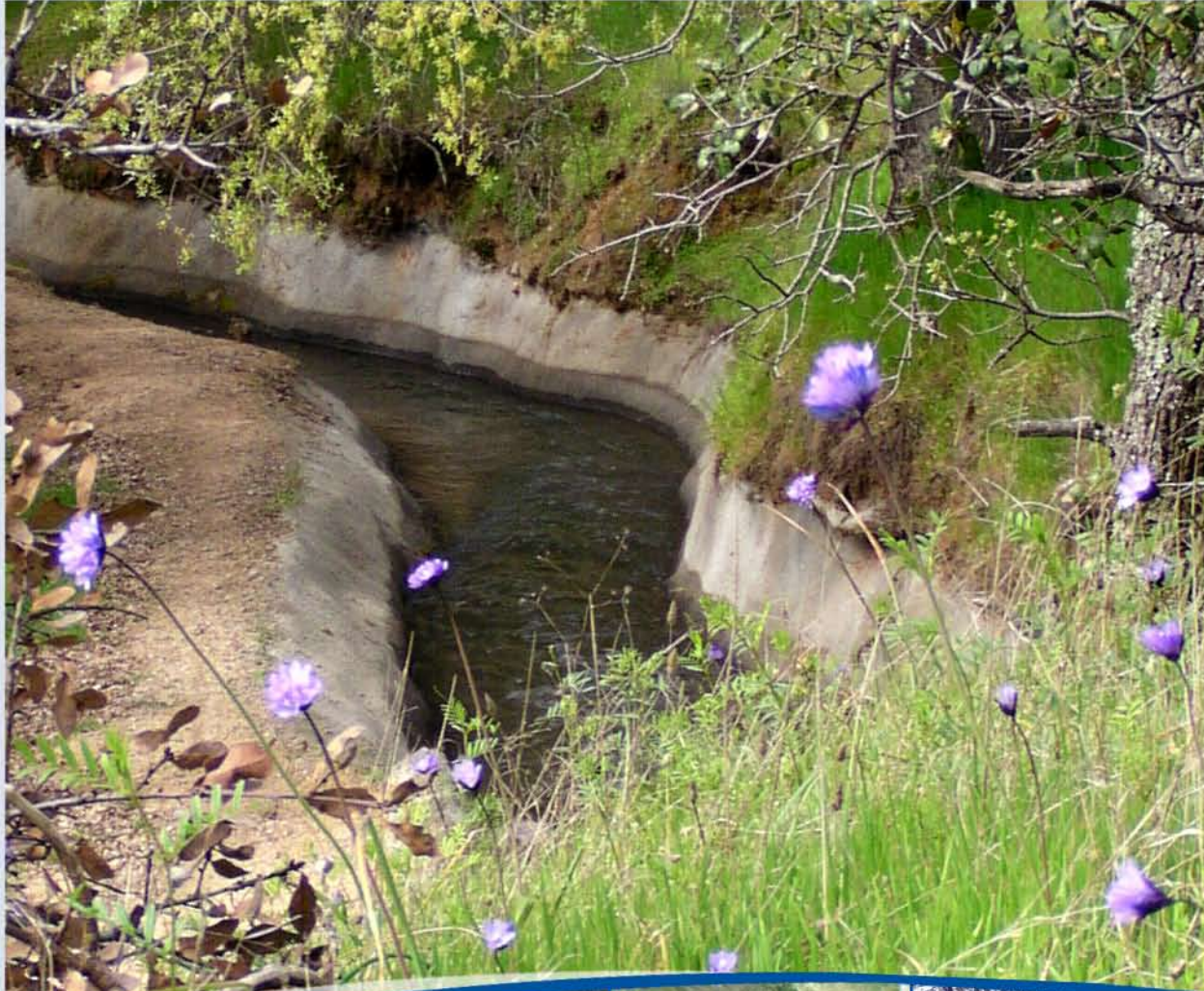
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Appendix A



APPENDIX A
BENTHIC MACROINVERTEBRATE DATA REPORT

APPENDIX A. BENTHIC MACROINVERTEBRATE DATA REPORT

CONTENTS:

Report Summary

Report on Benthic Macroinvertebrate Data

ATTACHMENTS

Attachment 1 - BMI data

- Fields 500 organism protocol
- Data standardized to CAMLnet taxa list

Attachment 2 - IBI data

Including tolerance value, functional feeding groups, metrics, and IBI scores

Summary

This Project was developed by MWH to characterize the stream health of areas related to canal inputs from the Placer County Water Agency operations.

Bioassessment is a widely accepted method of evaluating water quality and watershed health. Dry Creek Conservancy gathers data in accordance with the California Stream Bioassessment Procedure. Samples were identified by Wayne Fields of Hydrozoology. Tom King of BioAssessment Services analyzed the data and calculated an index of biotic integrity (IBI) for each sample site based on the Southern California IBI method. This IBI is considered appropriate for local watersheds in the absence of a foothill or valley IBI.

Three sites chosen for the study were:

- A site on Auburn Ravine immediately downstream of the outlet of the American River tunnel.
- A Secret Ravine site in Loomis Basin Park near King Road.
- A Miners Ravine Site immediately downstream of the off-stream detention basin recently constructed by Placer County Flood Control and Water Conservation District.

Results of the analysis were:

- The Secret Ravine site IBI value was higher than any previously sampled sites in Dry Creek Watershed.
- The Auburn Ravine site IBI value was higher than most Dry Creek Watershed sites but lower than might be expected by its apparently excellent habitat.
- The Miners Ravine site IBI value fell within the range expected.

The project results suggest that upstream areas of Secret Ravine may provide the best habitat in Dry Creek Watershed. The surprisingly low IBI score for the Auburn Ravine site may be related to tunnel operations. Further sampling is necessary to confirm that these results are a true representation of the sites and not normal variation. Sampling should be designed to discover the reason for the high IBI score at the Secret Ravine site, to discover the reason for the lower than expected IBI score at the Auburn Ravine site, and to track the evolution of the Miners Ravine stream channel as it adjusts to the newly constructed detention basin.

Report on Benthic Macroinvertebrate Data

Introduction

Biological monitoring (bioassessment) is becoming a widely used and accepted method for evaluating water quality throughout the United States (SWRCB, 2003). Periphyton, aquatic vertebrate and benthic macroinvertebrates (BMI) are commonly monitored aquatic assemblages in bioassessment monitoring (U.S. EPA, 1999). In order to conduct a cost-effective, scientifically valid rapid biological assessment, monitoring may be reduced to one aquatic assemblage (U.S. EPA, 1999). BMI are the common aquatic assemblages measured in rapid monitoring protocols. They are useful in evaluating the overall health of flowing water systems, and are affected by changes in a stream's chemical and or physical structure (Karr and Kerans, 1991). Their sensitivity to stresses (temperature, dissolved oxygen, chemical and organic pollution) makes them effective indicators of specific anthropogenic disturbances (House et al., 1993). Streams within the California central valley have been greatly altered to accommodate urban and agricultural development. Physical habitat (vegetation and substrate) is often reduced or removed completely, greatly impacting aquatic organisms within the stream. (The paragraph above is from Department of Pesticide Regulation Environmental Monitoring Branch Study Proposal #233)

Purpose

This Project was developed by MWH to characterize the stream health of areas related to canal inputs from the Placer County Water Agency operations.

Methods

DCC collects and processes samples following the targeted riffle method of *Standard Operating Procedures for Collecting Benthic Macroinvertebrate Samples and Associated Physical and Chemical Data for Ambient Bioassessments in California*, February 2007, Aquatic Bioassessment Laboratory, California Department of Fish and Game. (<http://www.dfg.ca.gov/abl/Field/datacollection.asp>) The protocol describes methods to sample eight square feet of riffle area in a 150 meter reach. Previous to fall 2005 DCC sampled with the California Stream Bioassessment procedure protocol. DCC recently engaged BioAssessment Services to standardize the pre 2005 data so metrics from the two protocols could be compared. Since 2000 DCC has sent samples to the professional taxonomy laboratory of Wayne Fields for identification. Wayne sub samples 500 organisms and identifies them to the lowest taxa possible; his identification is attached as Attachment 1.

Tom King of BioAssessment Services analyzed the data by calculating an index of biotic integrity (IBI) for each sample site. After standardizing the data to be used in the IBI calculation (shown in Attachment 1) Tom used the Index of Biotic Integrity for coastal southern California (SoCal B-IBI) described in *Ode, P.R., A.C. Rehn and J.T. May. 2005. A quantitative tool for assessing the integrity of southern coastal California streams. Environmental Management Vol. 35, No. 4, pp. 493-504. Springer Science+Business Media, Inc.* as being the most appropriate for our area. The following description of the SoCal ecoregion from Ode et al shows similarities to our local watersheds.

The SoCal B-IBI is the most comprehensive assessment to date of freshwater biological integrity in California. As in other Mediterranean climate regions, the combination of aridity, geology, and high-amplitude cycles of seasonal flooding and drying in southern coastal California makes its streams and rivers particularly sensitive to disturbance (Gasith and Resh 1999). This sensitivity, coupled with the burgeoning human population and vast conversion of natural landscapes to agriculture and urban areas, has made it the focus of both state and federal attempts to maintain the ecological integrity of these strained aquatic resources.

The SoCal B-IBI assigns scores to data based on the relative quality of BMI assemblages as defined by seven metrics described in Ode et al. The seven metrics are:

- Coleoptera Richness – the total number of Coleoptera taxa present in the sub samples.
- EPT Richness – the total number of taxa from the Ephemeroptera, Plecoptera and Trichoptera insect orders.
- Predator Richness – total number of taxa categorized as predators.
- Collectors (%) – the percent of individuals present in the sub sample categorized as collectors.
- Intolerant Organisms (%) (0-3) - the percent of individuals present in the sub sample categorized as having a tolerance value of 0 to 3.
- Non-insect Taxa (%) – The percent of the sub sample taxa that are non-insect.
- Tolerant Taxa (%) – The percent of taxa from the sub sample that are considered tolerant of stream degradation.

The IBI is based on scores assigned to empirically determined ranges of metric values from very large regional data sets. The IBI scores are calculated by applying the scoring ranges as described in Ode et al. to each mean metric value. A factor of 1.43 is multiplied to the summed metric scores yielding the IBI. The IBI can range from 0 to 100. Because an IBI hasn't been developed for the local ecoregion, Tom warns that the metrics and IBI should be used with caution.

Sampling Sites

Because of limited funds only three sites were chosen for sampling.

- The site on Auburn Ravine (ARTM) is immediately downstream of the outlet of the American River tunnel and incorporated flows from that source as well as flows from Auburn Ravine.
- The Secret Ravine site (SRLB) is in Loomis Basin Park near King Road which is considerably upstream of the most upstream regular DCC sampling site at Rocklin Road (DCC5). It reflects a different set of PCWA outputs than the regular DCC sampling sites since it is upstream of the Boardman Canal output.
- The Miners Ravine Site (MRSC) is immediately downstream of the off-stream detention basin recently constructed by Placer County Flood Control and Water Conservation District. This sample can be a baseline for assessing changes after construction of the detention basin. It also reflects input from the Placer County Wastewater Treatment Plant near Dick Road and all PCWA canal tributaries to Miners Ravine.



Auburn Ravine - top of reach. Tunnel is to left.



Riffle habitat with riparian vegetation.



Secret Ravine - reach with eroded bank.



Gravel habitat at eroded bank



Miners Ravine - bottom of reach looking up.

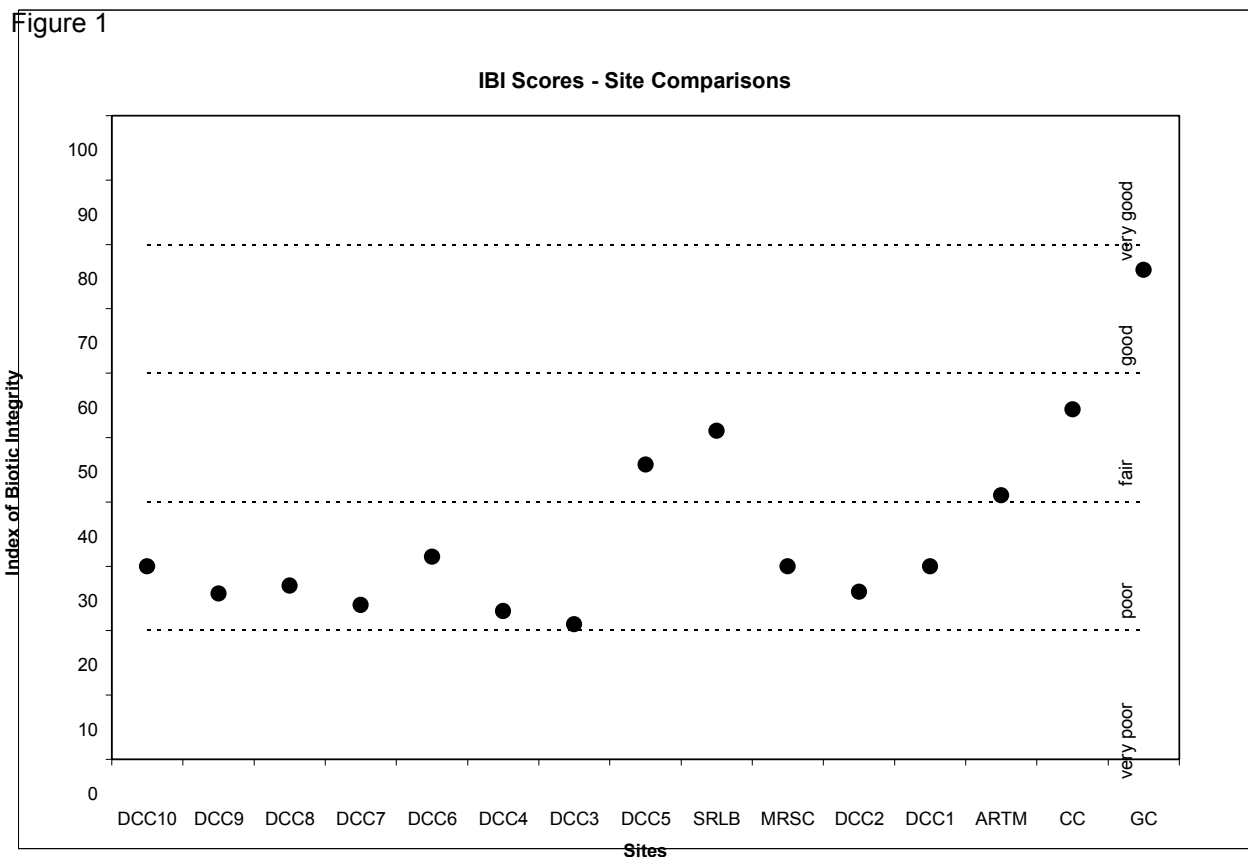


Riffle habitat.

Results

Figure 1 shows a plot of IBI scores for the three project sample sites, as well as comparison data for sample sites in the Dry Creek Watershed from 2000 through 2006, a composite of four sites from Coon Creek in 2005 (CC), and from Greenwood Creek (GC). Observations from the plot are:

- All but one Dry Creek site (DCC5, Secret Ravine at Rocklin Road) previously sampled fell in the poor range.
- The score for the Secret Ravine site sampled for the project is higher than any previous Dry Creek sites. There is no other data from this site for comparison.
- The score for the Auburn Ravine site fell at the break between poor and fair and was higher than all but one previously sampled Dry Creek site (DCC5).
- The score for the Miners Ravine site sampled for the project fell in the poor range along with previous Dry Creek sites but was slightly higher than the Dry Creek sites previously sampled, DCC7 and DCC 2.



Site codes represent the following streams:

DCC: streams draining the Dry Creek watershed including -

- 1) Antelope Creek at King Road
- 2) Miner's Ravine above Cottonwood Dam and at Dick Cook Road
- 3) Linda Creek at Barton
- 4) Clover Valley Creek u/s Golf course

- 5) Secret Ravine at Sierra College
- 6) Secret Ravine at Miner's Ravine
- 7) Miner's Ravine at Secret Ravine
- 8) Antelope at Atlantic
- 9) Linda/Kirby u/s Dry Creek Confluence
- 10) Dry Creek above Rio Linda Blvd Bridge
- CC: Coon Creek

GC: Greenwood Creek at an elevation of approximately 600 feet, which drains into the South Fork American River

MWH Project sites –

- SRLB: Secret Ravine at Loomis Basin Park
- MRSC: Miners Ravine downstream of Sierra College Blvd.
- ARTM: Auburn Ravine at the tunnel mouth

Table 1 shows IBI scores for each of the seven metrics for the three project sites and for additional sites shown for comparison.

Table 1 –Scores for the seven metrics

(IBI scores are calculated by multiplying metric scores by a factor of 1.43.)						
	DCC5	CC	GC	ARTM	SRLB	MRSC
Coleoptera taxa	0	6	5	4	4	0
EPT taxa	6	5	10	5	6	5
Predator Taxa	8	5	8	2	5	4
Collectors (%)	6	4	6	5	5	4
Intolerant (%)	3	4	6	1	2	1
Non-Insect (%)	4	6	8	4	7	2
Tolerant (%)	5	8	10	8	7	5
Total	32	38	53	29	36	21

Along with BMI sampling the California Stream Bioassessment Procedure specifies a set of physical habitat assessments that may be used to explain BMI data. Some data from the physical habitat assessment that might be useful to explain BMI results are shown in Table 2 below.

Table 2 – Selected Physical Habitat	Scores			
	DCC5	ARTM	SRLB	MRSC
	2006			
Flow (cfs)	6.9	9.6	3.0	1.7
Temp (C)	15.9	14.1	13.2	12.9
Habitat types: (% riffle)	10	41	15	11
Slope (average %)	1.45	2.5	0.5	1.4
Instream Habitat (20 possible)	13	14	11	5
Sediment Deposition (20 possible)	10	19	11	5
Channel Alteration (20 possible)	15	15	11	18

Discussion

The data suggest the following questions:

- Why are SRLB scores higher than previously sampled Dry Creek sites?

The Physical habitat data don't seem to offer an explanation since several of the parameters actually indicate higher quality at the DCC5 site. The most notable difference in IBI metric scores shown in Table 1 is for Coleoptera taxa which are 4 at SRLB and 0 at DCC5. The absence of Coleoptera taxa has been noted in *Preliminary Report on Benthic Macroinvertebrate Data Dry Creek Conservancy Bioassessment Program 2000 to 2006, Dry Creek Conservancy, June 2007*. No good explanation has been offered other than the general high level of sediment in Dry Creek Watershed. It may be that the healthier bmi community at SRLB is simply a reflection of fewer urban inputs due to less impervious surface.

- Why aren't ARTM scores higher given its high physical habitat scores?

The habitat quality at the Auburn Ravine site is strikingly good compared to any site in Dry Creek Watershed. There is a high percentage of riffles and very little sediment as shown in Table 2. The major human influence is a gravel road that runs parallel to the bank about 30 feet from the stream channel and about 12 feet above water surface elevation. In spite of the road there is very little sediment in the substrate; the cobble and gravel are very clean.

There are several possible impacts on the bmi community at ARTM. The American River Tunnel operations may flush the channel of bugs and biotic material leaving it clean of sediment but relatively barren of bmi. Less manipulation of instream flows has been suggested as a reason that DCC5 has a much higher score than other Dry Creek sites as discussed in the excerpt below. (Dry Creek Conservancy, June 2007.)

“The Dry Creek Watershed receives imported water in its major tributaries.

- Can water deliveries explain the very low Clover Valley IBI since Clover Valley flows in summer are almost entirely due to imported water?
- Can the higher quality BMI community in Coon Creek be explained by relatively smaller amounts of imported water?
- Can the higher quality BMI community at SR5 be due to it being above the outlet of the Boardman Canal, a major contributor to dry season Secret Ravine flows? In a 1999 report on BMI fauna in Secret Ravine Wayne Fields noted in-stream flow changes as follows:

The almost daily occurrence of an artificial increase in flow which was observed during habitat mapping and was estimated to sometimes double or even triple the flow in the stream...since the fauna in streams at this elevation is adapted to a regime in which fluctuations in flow are limited to the rainy period, the addition of this much extra water on an irregular basis can only serve to disrupt the usual pattern of life.

In fact, much recent work has been done on the impact on BMI of allochthonous material, which in streams is organic material from outside the stream flow that contributes to stream ecology and the vigor of BMI. (Tom King, personal communication; Lotic System Ecology, Wikipedia) Manipulated flows have been shown to flush this material from streams resulting in a depressed BMI community.”

Another impact could be inputs from the City of Auburn wastewater treatment plant upstream. But the lack of algae growth suggest that there is not a high level of nutrients in the water as

might be expected downstream of a treatment plant. Other water quality parameters such as dissolved oxygen, pH, and conductivity are similar to other sampling sites and at healthy levels.

The MRSC IBI scores don't raise questions since they are similar to previous Dry Creek Watershed and Miners Ravine results. Low scores can be explained by lack of habitat complexity and high amounts of sediment. It is also worth noting that the channel immediately upstream of the sampling reach which is alongside the detention basin is very lacking in instream habitat. The channel is straight due to constraint by a levee. Previous to the project there was a large beaver pond alongside the levee that probably held back a large amount of sediment. Currently the substrate is a homogenous run of fine sediment with no boulders, cobble, woody debris or other complexity. It will be interesting to see if the channel can improve from natural processes. A large amount of riparian vegetation planted on the project side of the stream has been established successfully and may contribute to improvement in instream habitat depending on how it's managed. It will also be interesting to see if the lack of complexity will have an impact on the downstream reach that was sampled.

In general we should be cautious about giving too much significance to only one sampling event. There is significant variation from season to season and also within a given season at a site. A longer record is needed to establish that the project results are representative of the sites.

Conclusions and Recommendations

The project results add another site in Dry Creek Watershed to the "fair" range of IBI ranking and suggest that upstream areas of Secret Ravine may provide the best habitat in Dry Creek Watershed. The IBI score for the Auburn Ravine site is surprisingly low given the high quality of the habitat. The low score may be related to tunnel operations. The Miners Ravine site results fall within the range of previous sampling results in Dry Creek Watershed. Habitat alongside the detention basin immediately upstream of the sampling site is notably lacking in complexity. Further sampling is necessary to confirm that these results are a true representation of the sites and not normal variation. Sampling should be designed to discover the reason for the high IBI score at the Secret Ravine site and the lower than indicated IBI score at the Auburn Ravine site.

PHYLUM/	FAMILY	GENUS and SPECIES	Level I Final ID	AUBURN RAVINE (11/01/2007)	SECRET RAVINE (11/02/2007)	MINERS RAVINE (11/05/2007)
	NON-INSECTS					
PHYLUM/CLASS/ORDER						
Platyhelminthes	Planariidae	<i>Dugesia tigrina</i>	Turbellaria	66	8	66
Nemertea	Tetrastemmatidae	<i>Prostoma graecense</i>	<i>Prostoma</i>	8	27	9
Annelida/Oligochaeta			Oligochaeta	36	87	152
Hirudinea	Erpobdellidae	<i>Mooreobella microstoma</i>	<i>Mooreobella</i>			1
Arthropoda/Amphipoda						
Amphipoda	Crangonyctidae	<i>Crangonyx floridanus</i>	<i>Crangonyx</i>	7	15	6
		<i>Stygobromus sp.</i>	<i>Stygobromus</i>	2		
	Hyalellidae	<i>Hyalella azteca</i>	<i>Hyalella</i>			17
Arachnida/						
Hydracarina	Sperchontidae	<i>Sperchon sp. A</i>	<i>Sperchon</i>		6	4
Mollusca/						
Gastropoda	Ancylidae	<i>Ferrissia californica</i>	<i>Ferrissia</i>			3
	Planorbidae	<i>Gyraulus deflectus</i>	<i>Gyraulus</i>	8		
		<i>Micromenetus dilatatus</i>	<i>Micromenetus</i>	3		1
		<i>Planorbella tenuis</i>	<i>Planorbella</i>			1
Bivalvia	Corbiculidae	<i>Corbicula fluminea</i>	<i>Corbicula</i>		6	15
	Sphaeriidae	<i>Pisidium casertanum</i>	<i>Pisidium</i>	4		
	INSECTS					
ORDER	FAMILY	GENUS and SPECIES				
Ephemeroptera	Baetidae	<i>Baetis tricaudatus</i>	<i>Baetis</i>	310	52	41
		<i>Fallceon quilleri</i>	<i>Fallceon quilleri</i>		4	8
	Caenidae	<i>Caenis latipennis</i>	<i>Caenis</i>			1
	Ephemerellidae	<i>Eurylophella lodi</i>	<i>Eurylophella lodi</i>	1		
	Leptohyphidae	<i>Tricorythodes minutus</i>	<i>Tricorythodes</i>	1	24	14
Odonata	Gomphidae	<i>Ophiogomphus occidentis</i>	<i>Ophiogomphus</i>		1	
	Libellulidae	<i>Brechmorhoga mendax</i>	<i>Brechmorhoga mendax</i>		12	5
	Calopterygidae	<i>Hetaerina americana</i>	<i>Hetaerina americana</i>		1	1
	Coenagrionidae	<i>Argia vivida</i>	<i>Argia</i>		15	9
Plecoptera	Perlodidae	<i>Isoperla sp.</i>	<i>Isoperla</i>		2	
Trichoptera	Brachycentridae	<i>Brachycentrus occidentalis</i>	<i>Brachycentrus</i>	5		
		<i>Micrasema sp.</i>	<i>Micrasema</i>		11	
	Glossosomatidae	<i>Glossosoma sp.</i>	<i>Glossosoma</i>	1	2	
		<i>Protoptila sp.</i>	<i>Protoptila</i>	1	3	1
	Helicopsycheidae	<i>Helicopsyche borealis</i>	<i>Helicopsyche</i>			1
	Hydropsychidae	<i>Hydropsyche californica</i>	<i>Hydropsyche</i>	45	33	102
	Hydroptilidae	<i>Hydroptila sp. A</i>	<i>Hydroptila</i>		1	
		<i>Leucotrichia pictipes</i>	<i>Leucotrichia pictipes</i>		1	
		<i>Oxyethira sp.</i>	<i>Oxyethira</i>			3
	Leptoceridae	<i>Nectopsyche gracilis</i>	<i>Nectopsyche</i>		3	1
	Philopotamidae	<i>Chimarra sp.</i>	<i>Chimarra</i>	2	19	31
	Rhyacophilidae	<i>Rhyacophila coloradensis</i>	<i>Rhyacophila</i>	1		
Lepidoptera	Pyralidae	<i>Parapoynx sp.</i>	<i>Parapoynx</i>		2	
Coleoptera	Elmidae	<i>Cleptelmis sp.</i>	<i>Cleptelmis</i>	2	1	
		<i>Dubiraphia giulianii</i>	<i>Dubiraphia</i>		1	
		<i>Ordobrevia nubifera</i>	<i>Ordobrevia nubifera</i>	7		
Diptera	Chironomidae	<i>Pentaneura sp.</i>	Tanypodinae	1		
			Orthoclaadiinae	4	40	44
		<i>Rheotanytarsus sp.</i>	Tanytarsini		16	6
	Simuliidae		<i>Simulium</i>	0	84	23
	Tipulidae	<i>Antocha monticola</i>	<i>Antocha</i>	1		
		<i>Tipula sp.</i>	<i>Tipula</i>		1	
	Empididae	<i>Neoplasta sp.</i>	<i>Neoplasta</i>	1		
	Stratiomyidae	<i>Caloparyphus sp.</i>	<i>Caloparyphus</i>			1
				517	478	567
			NUMBER OF SPECIES	29	48	41
			TOTAL NUMBER OF ORGANISMS	517	494	570
			TOTAL NUMBER OF SQUARES PICKED (OF 24)	3	5	4
			EXTRAPOLATED NUMBER OF ORGANISMS	4136	2371	3420

Level I Final ID ¹	AUBURN SECRET MINER'S RAVINE RAVINE RAVINE				
	CTV ²	FFG ³	110107	110207	110507
<i>Cleptelmis</i>	4	cg	2	1	
<i>Dubiraphia</i>	6	cg		1	
<i>Ordobrevia nubifera</i>	4	sc	7		
Tanypodinae	7	p	1		
Orthocladiinae	5	cg	4	40	44
Tanytarsini	6	cg		16	6
<i>Simulium</i>	6	cf		84	23
<i>Antocha</i>	3	cg	1		
<i>Tipula</i>	4	ot		1	
<i>Neoplasta</i>	6	p	1		
<i>Caloparyphus</i>	7	cg			1
<i>Baetis</i>	5	cg	310	52	41
<i>Fallceon quilleri</i>	4	cg		4	8
<i>Caenis</i>	7	cg			1
<i>Eurylophella lodi</i>	1	cg	1		
<i>Tricorythodes</i>	4	cg	1	24	14
<i>Isoperla</i>	2	p		2	
<i>Brachycentrus</i>	1	ot	5		
<i>Micrasema</i>	1	ot		11	
<i>Glossosoma</i>	1	sc	1	2	
<i>Protophila</i>	1	sc	1	3	1
<i>Helicopsyche</i>	3	sc			1
<i>Hydropsyche</i>	4	cf	45	33	102
<i>Hydroptila</i>	6	ot		1	
<i>Leucotrichia pictipes</i>	6	sc		1	
<i>Oxyethira</i>	3	ot			3
<i>Nectopsyche</i>	3	ot		3	1
<i>Chimarra</i>	4	cf	2	19	31
<i>Rhyacophila</i>	0	p	1		
<i>Parapoynx</i>	5	sh		2	
<i>Ophiogomphus</i>	4	p		1	
<i>Brechmorhoga mendax</i>	9	p		12	5
<i>Hetaerina americana</i>	6	p		1	1
<i>Argia</i>	7	p		15	9
<i>Turbellaria</i>	4	p	66	8	66
<i>Prostoma</i>	8	p	8	27	9
<i>Oligochaeta</i>	5	cg	36	87	152
<i>Mooreobella</i>	8	p			1
<i>Crangonyx</i>	4	cg	7	15	6
<i>Stygobromus</i>	4	cg	2		
<i>Hyalella</i>	8	cg			17
<i>Sperchon</i>	8	p		6	4
<i>Ferrissia</i>	6	sc			3
<i>Gyraulus</i>	8	sc	8		
<i>Micromenetus</i>	6	sc	3		1
<i>Planorbella</i>	6	sc			1
<i>Corbicula</i>	10	cf		6	15
<i>Pisidium</i>	8	cf	4		
Total			517	478	567

Appendix A
Attachment 2

Taxa Richness (mod level 1)	23	29	28
CG	70	50	51
CF	9.9	30	30

SoCal IBI Metrics ⁴

Coleoptera Taxa	2	2	0
EPT Taxa	9	12	10
Predator Taxa	5	8	7
CG Taxa + CF Individuals (%)	80	80	81
Intolerant Organisms (%) (0-3)	1.9	4.4	1.1
Non-insect Taxa (%)	35	21	39
Tolerant Taxa (%)	13	14	21

SoCal IBI Scores ⁴

Coleoptera Taxa	4	4	0
EPT Taxa	5	6	5
Predator Taxa	2	5	4
CG Taxa + CF Individuals (%)	5	5	4
Intolerant Organisms (%) (0-3)	1	2	1
Non-insect Taxa (%)	4	7	2
Tolerant Taxa (%)	8	7	5
Score Sum	29	36	21

SoCal IBI (possible range: 0-100)

1.429 41 51 30

¹ Southwest Association of Freshwater Invertebrate Taxonomists (SAFIT) level 1 with modification including chironomids to subfamily/ tribe
Nematodes removed from list

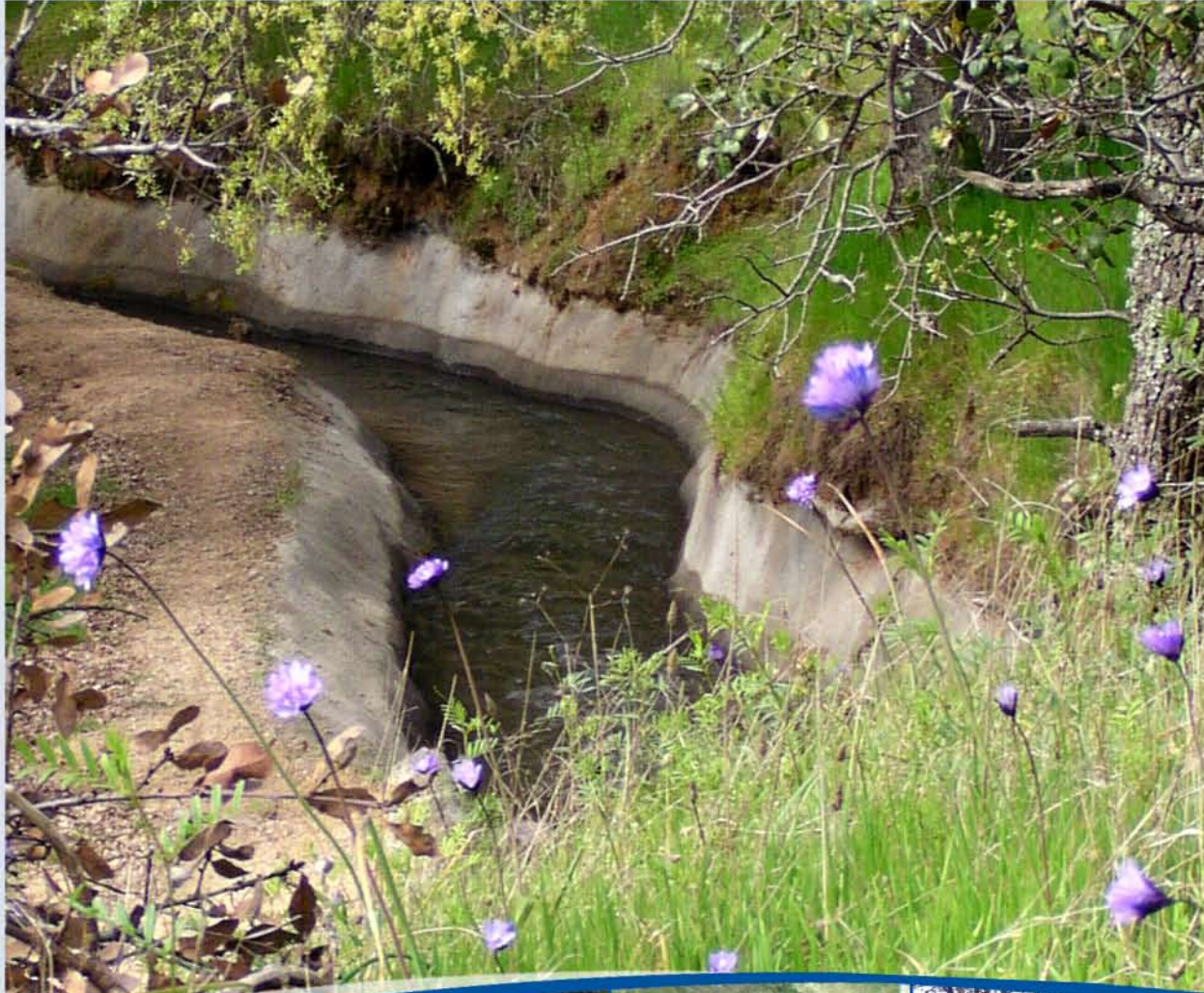
² California Tolerance Value from California Aquatic Macroinvertebrate Laboratory Network (CAMLnet), 27 January 2003 revision

³ Functional Feeding Groups from CAMLnet, 27 January 2003 revision

⁴ Ode, P.R., A.C. Rehn and J.T. May. 2005. A quantitative tool for assessing the integrity of southern coastal California streams.
Environmental Management Vol. 35, No. 4, pp. 493–504. Springer Science+Business Media, Inc.

Note: Use SoCal IBI for this data set with caution. While relative biological signals are insightful, the metrics and scoring criteria were not optimized for the Dry Creek watershed.

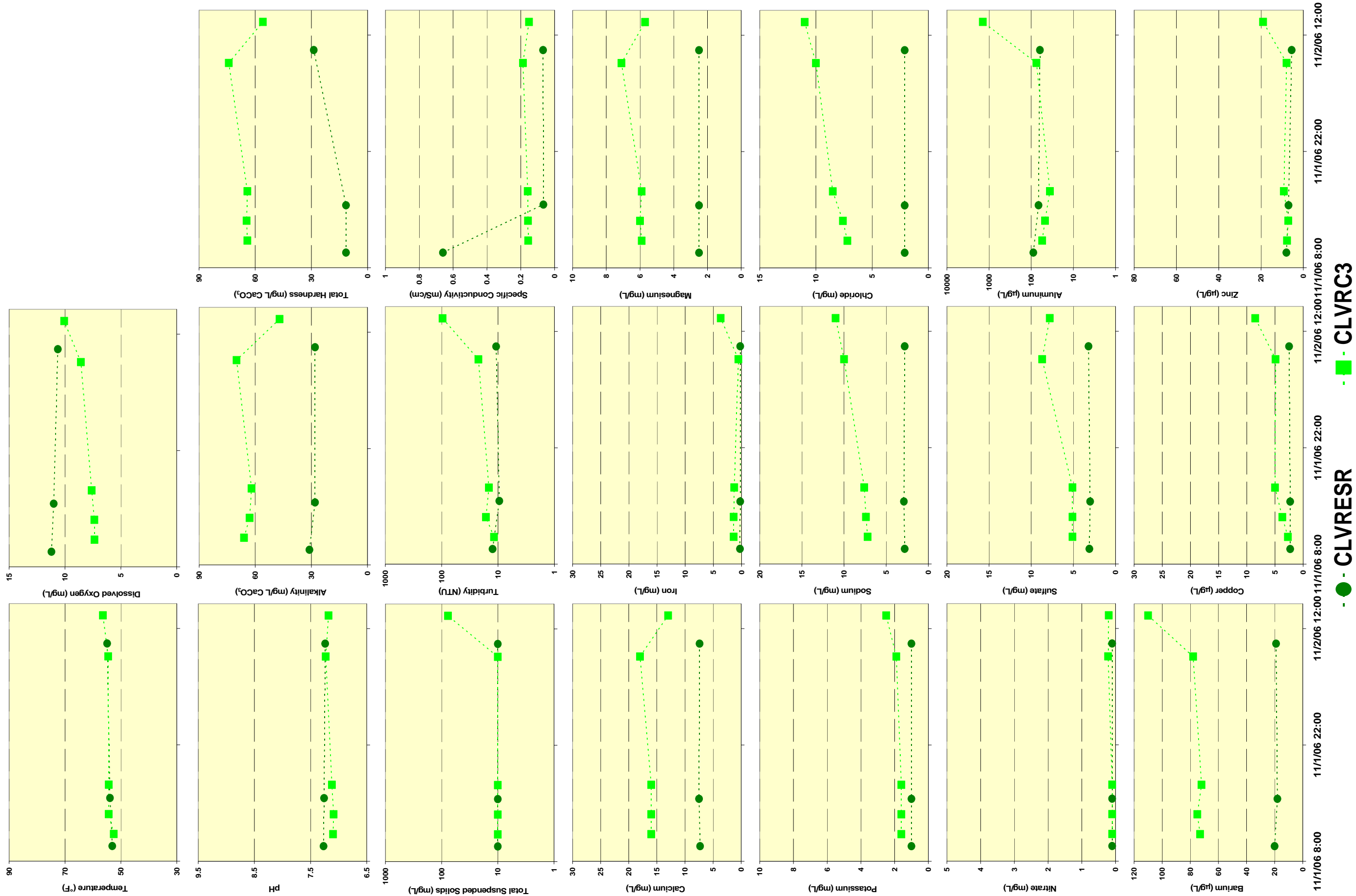
Appendix B



APPENDIX B
WATER QUALITY CONDITIONS FOR SYSTEMWIDE OPERATIONS

B.1 WATER QUALITY CONDITIONS AT CANAL AND STREAM SITES DURING YEARLY OUTAGES

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CLVRESR **CLVRC3**
FIGURE B-1A
WATER QUALITY CONDITIONS AT CLOVER VALLEY CREEK WATERSHED SITES
DURING YEARLY OUTAGES

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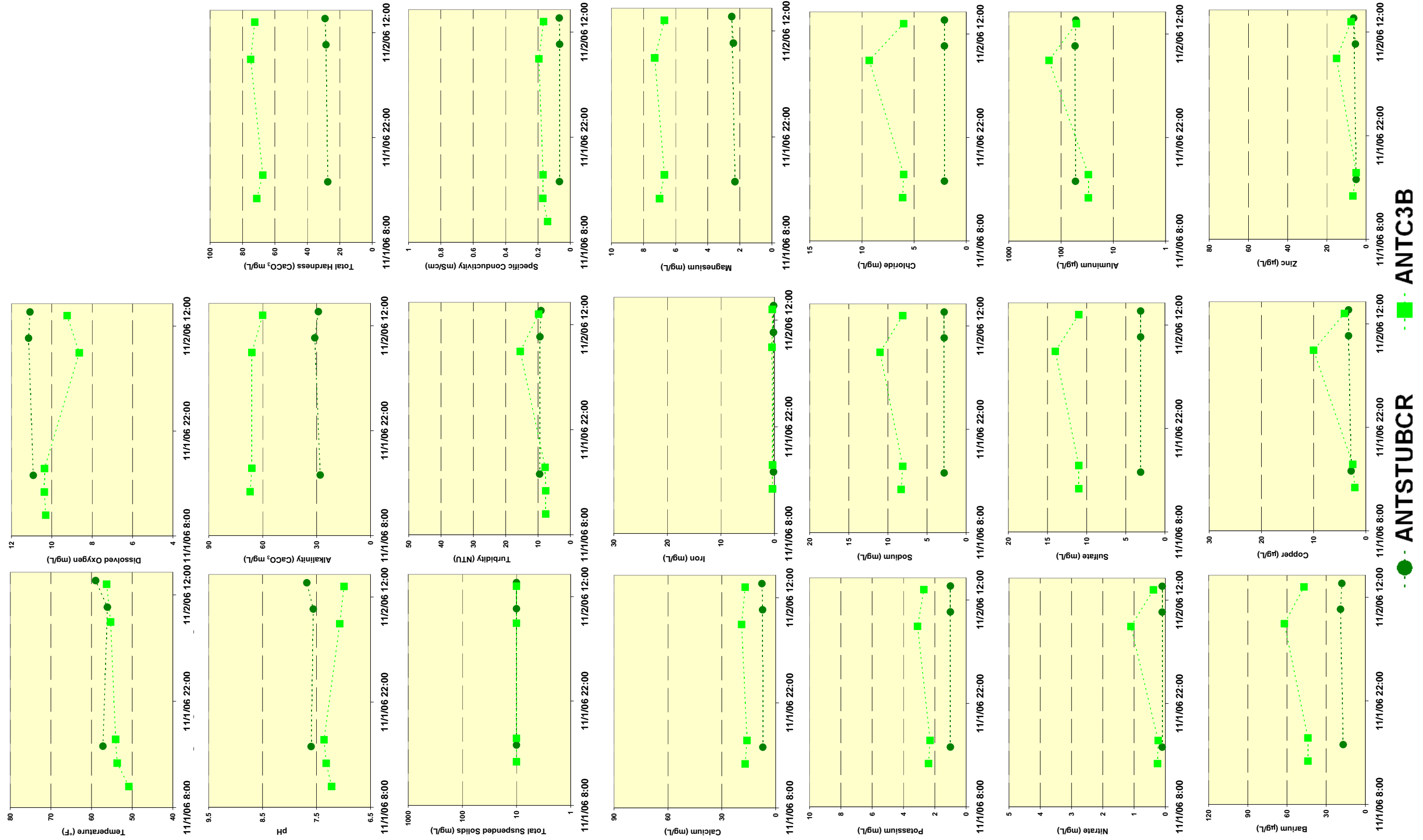


FIGURE B-2B
 WATER QUALITY CONDITIONS AT ANTELOPE CREEK WATERSHED SITES
 DURING YEARLY OUTAGES

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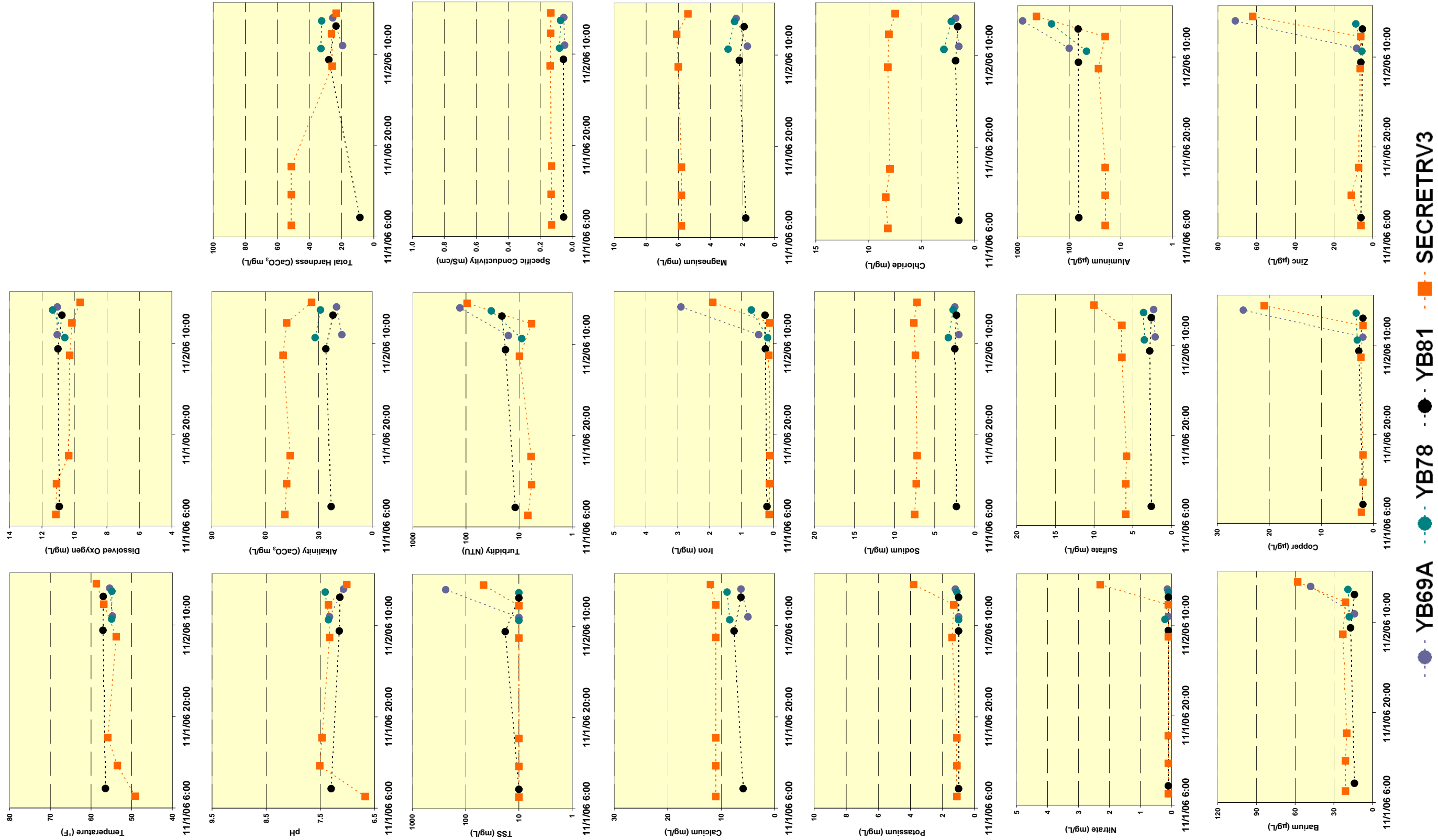


FIGURE B-1C
 WATER QUALITY CONDITIONS AT SECRET RAVINE WATERSHED SITES
 DURING YEARLY OUTAGES

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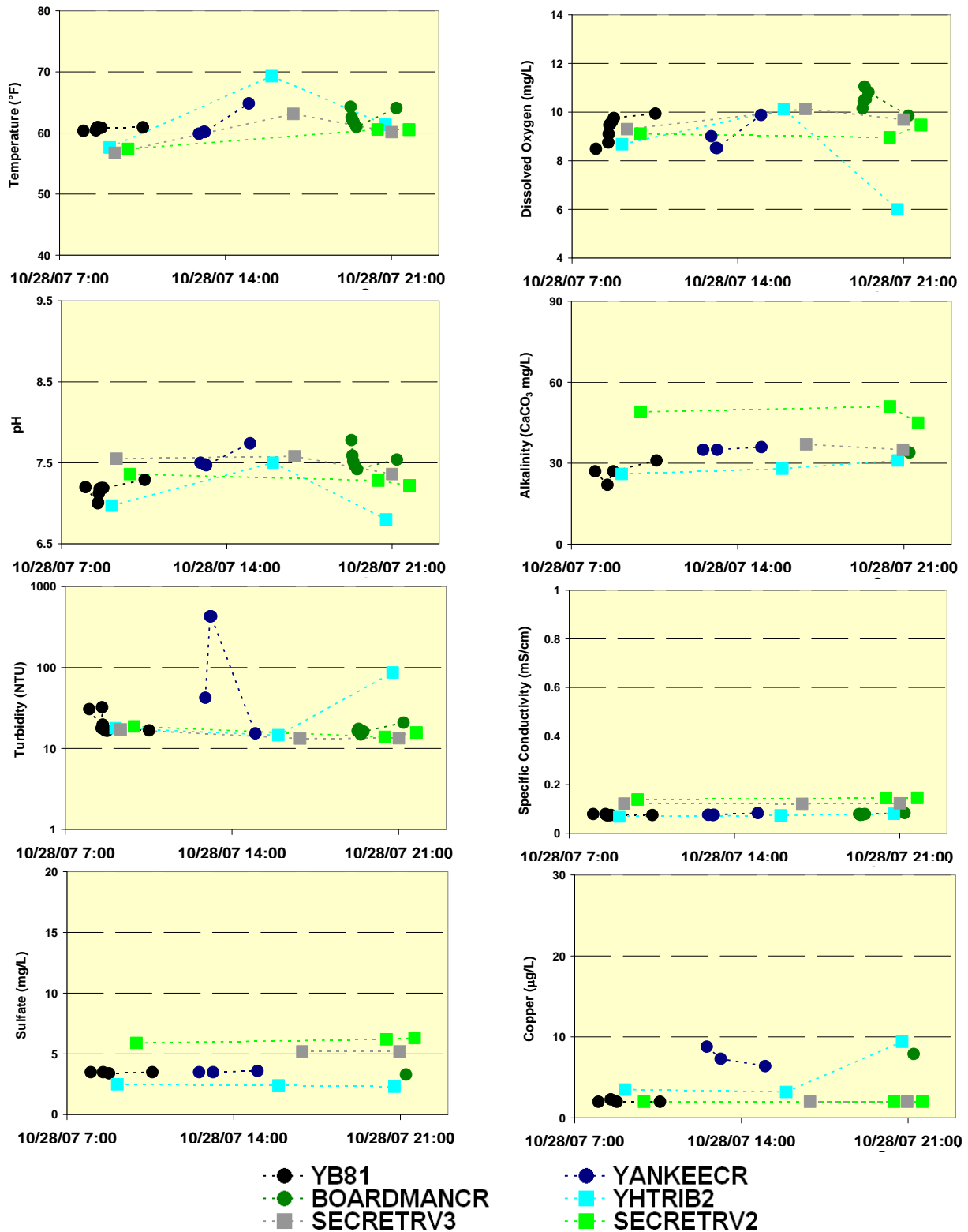
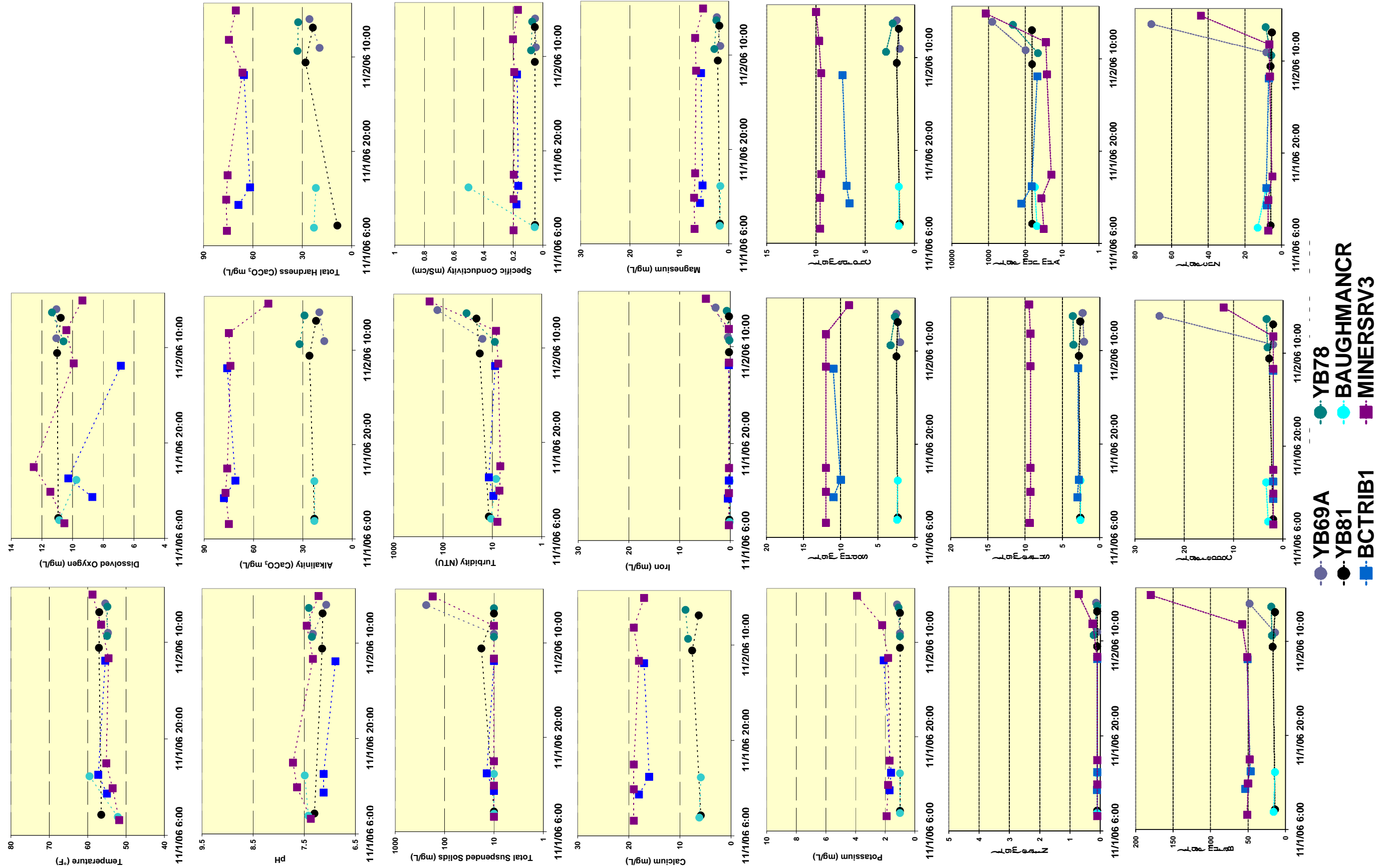


FIGURE B-1D
WATER QUALITY CONDITIONS AT SECRET RAVINE WATERSHED SITES
DURING YEARLY OUTAGES

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● YB69A ● YB78
● YB81 ● BAUGHMANCR
■ BCTRI1 ■ MINERSRV3

FIGURE B-1E
 WATER QUALITY CONDITIONS AT MINERS RAVINE WATERSHED SITES
 DURING YEARLY OUTAGES

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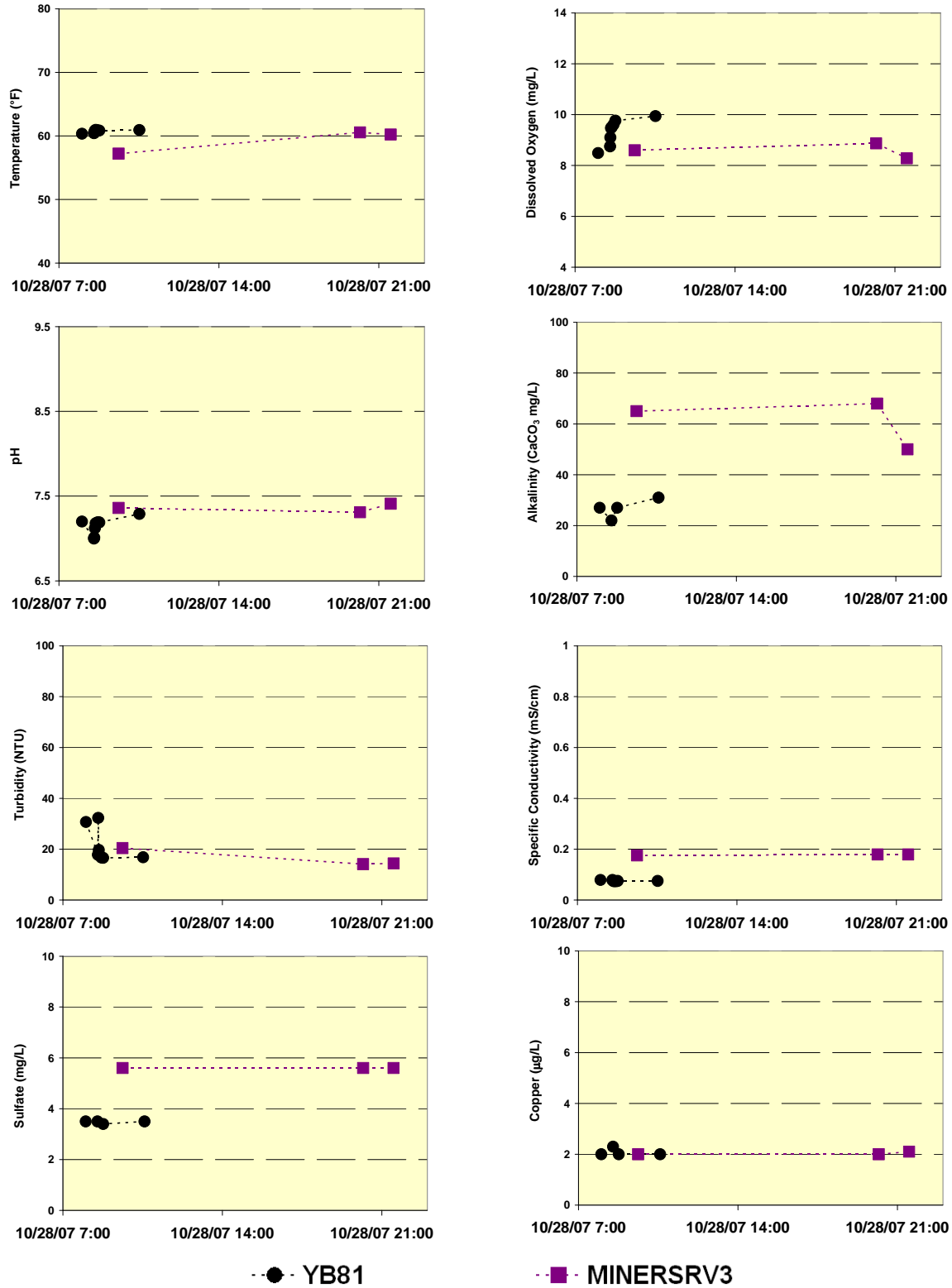


FIGURE B-1F
WATER QUALITY CONDITIONS AT MINERS RAVINE WATERSHED SITES DURING
YEARLY OUTAGES

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**B.2 WATER QUALITY CONDITIONS AT CANAL AND STREAM SITES DURING
ROUTINE PCWA OPERATIONS**

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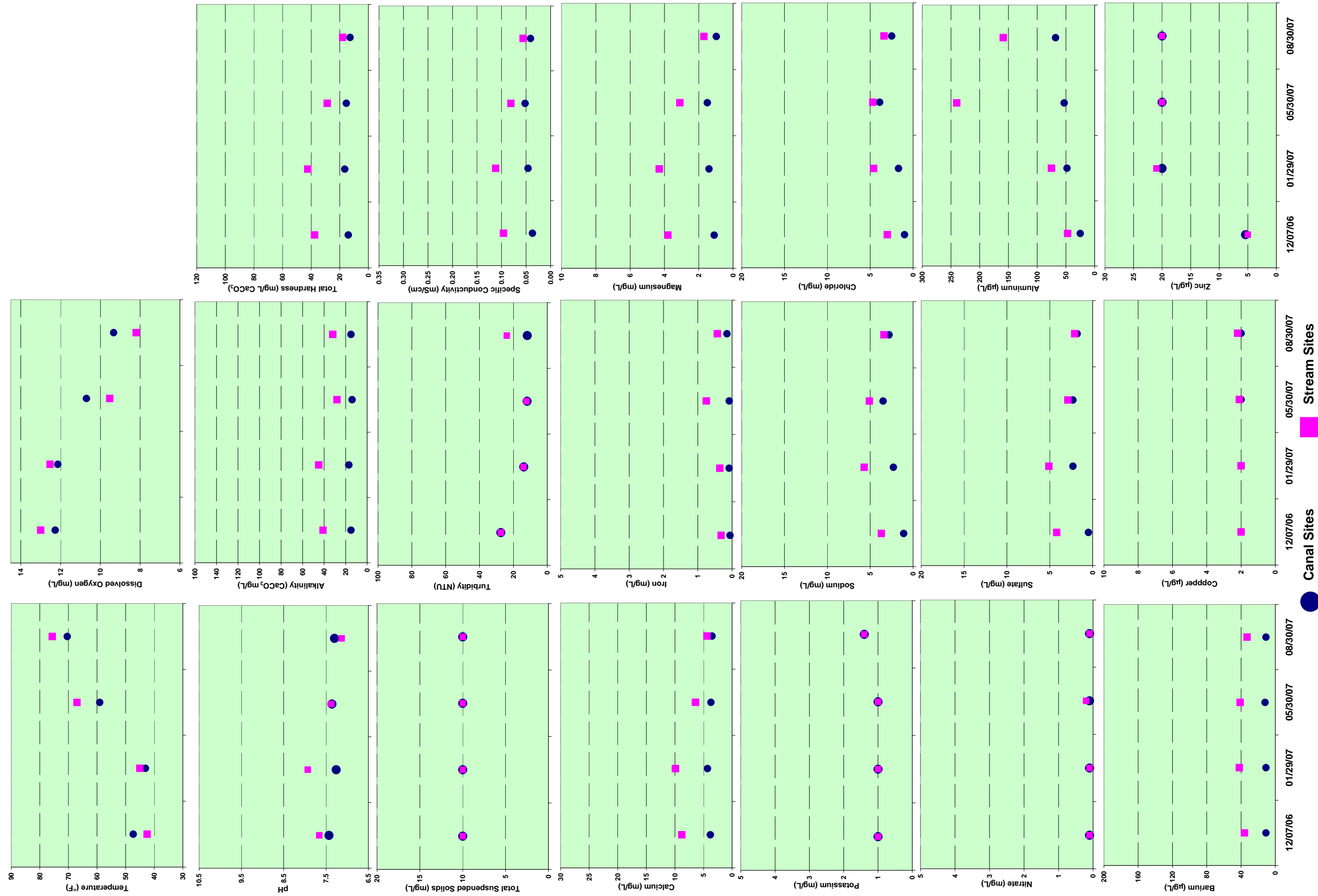


FIGURE B-2A
WATER QUALITY CONDITIONS AT CLOVER VALLEY CREEK WATERSHED SITES
DURING PCWA ROUTINE OPERATIONS

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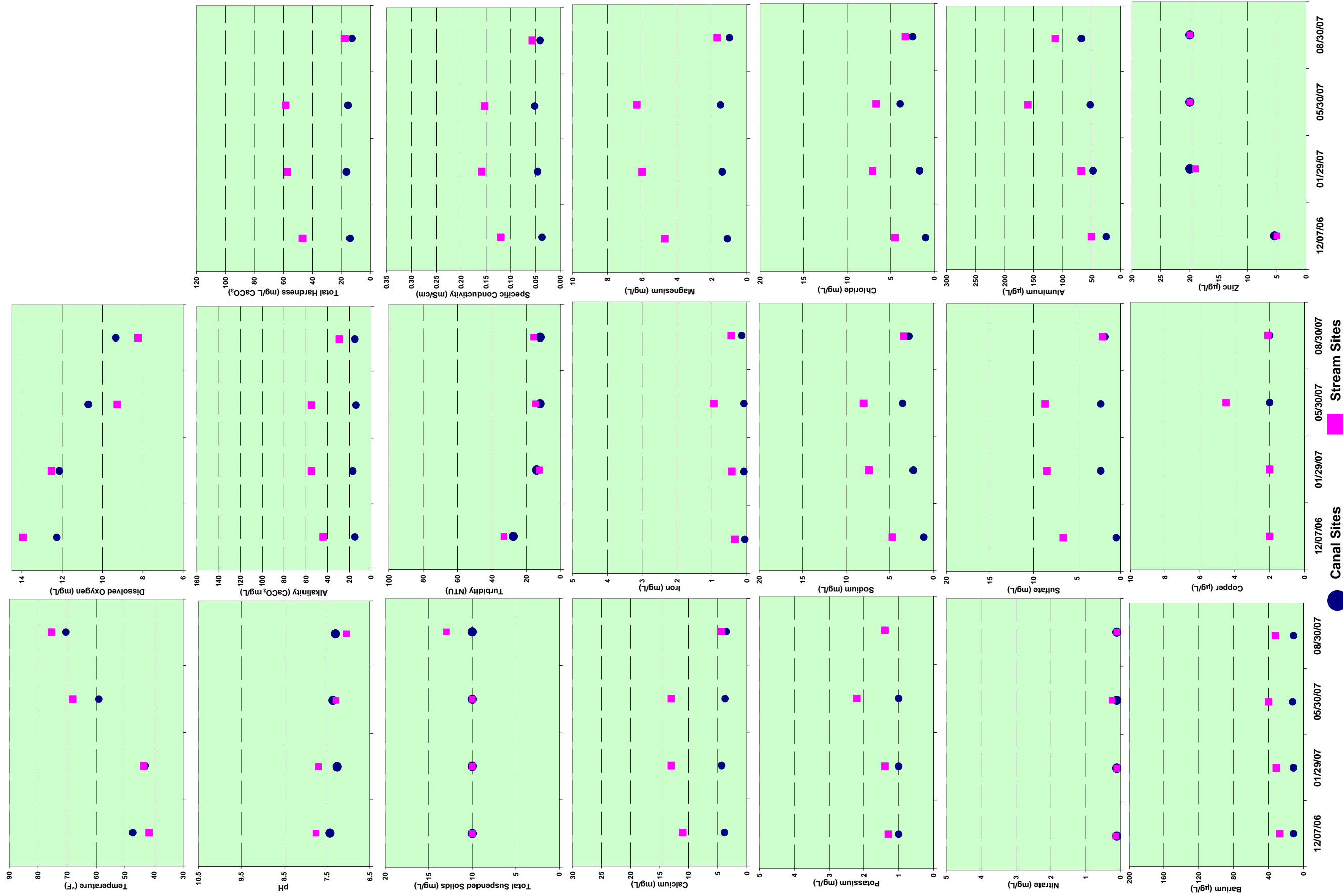


FIGURE B-2B
WATER QUALITY CONDITIONS AT ANTELOPE CREEK WATERSHED SITES
DURING PCWA ROUTINE OPERATIONS

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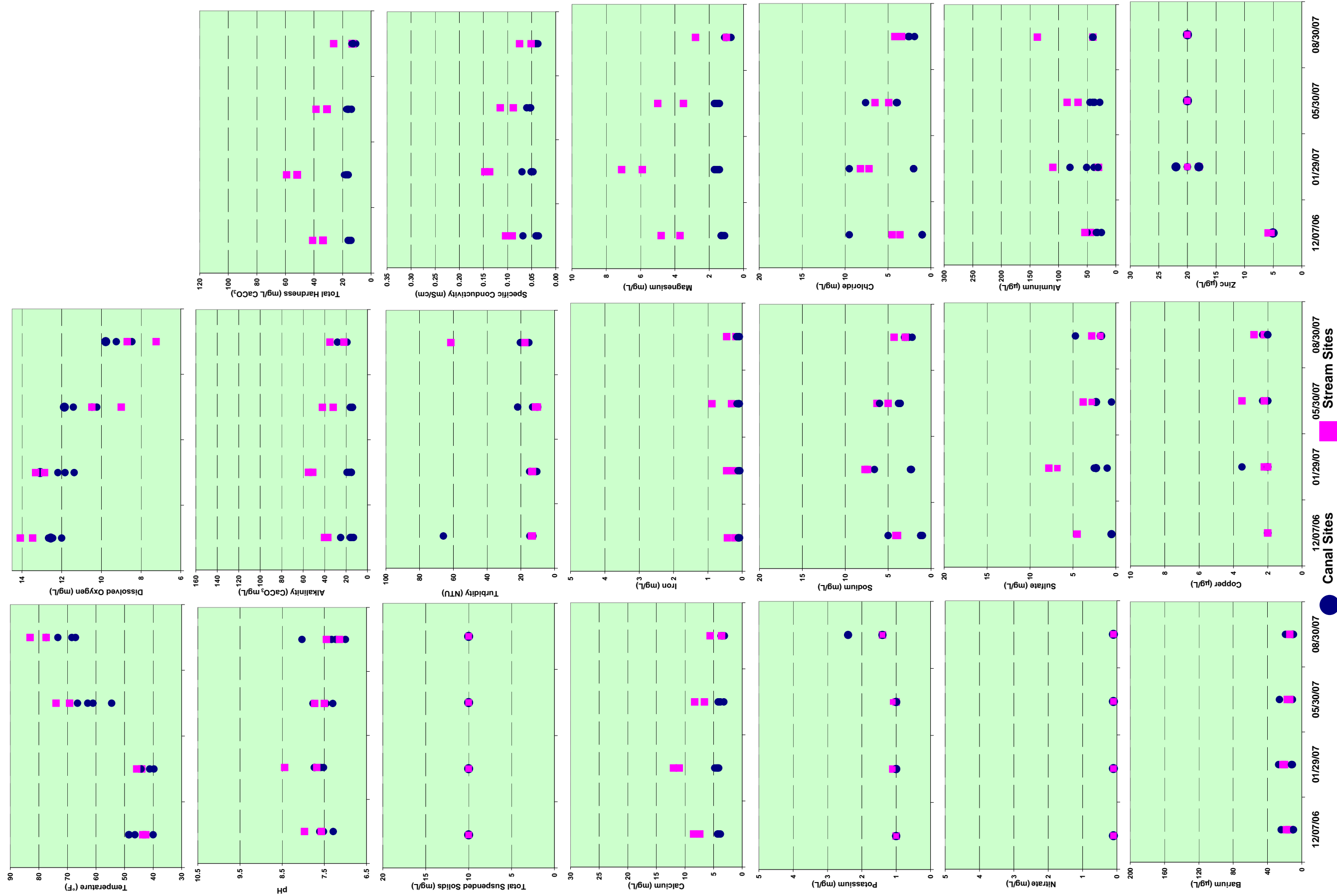
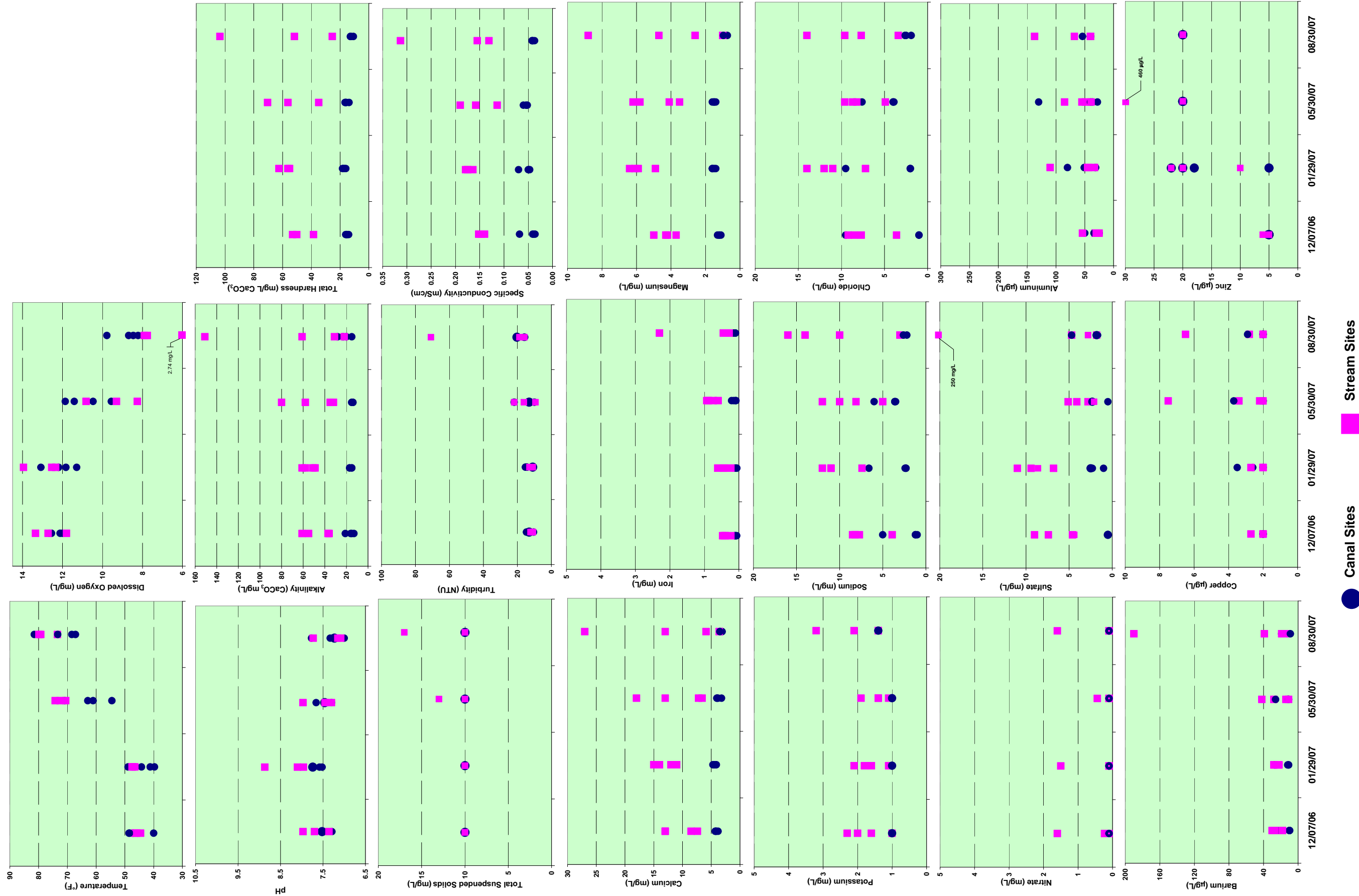


FIGURE B-2C
WATER QUALITY CONDITIONS AT SECRET RAVINE WATERSHED SITES
DURING PCWA ROUTINE OPERATIONS

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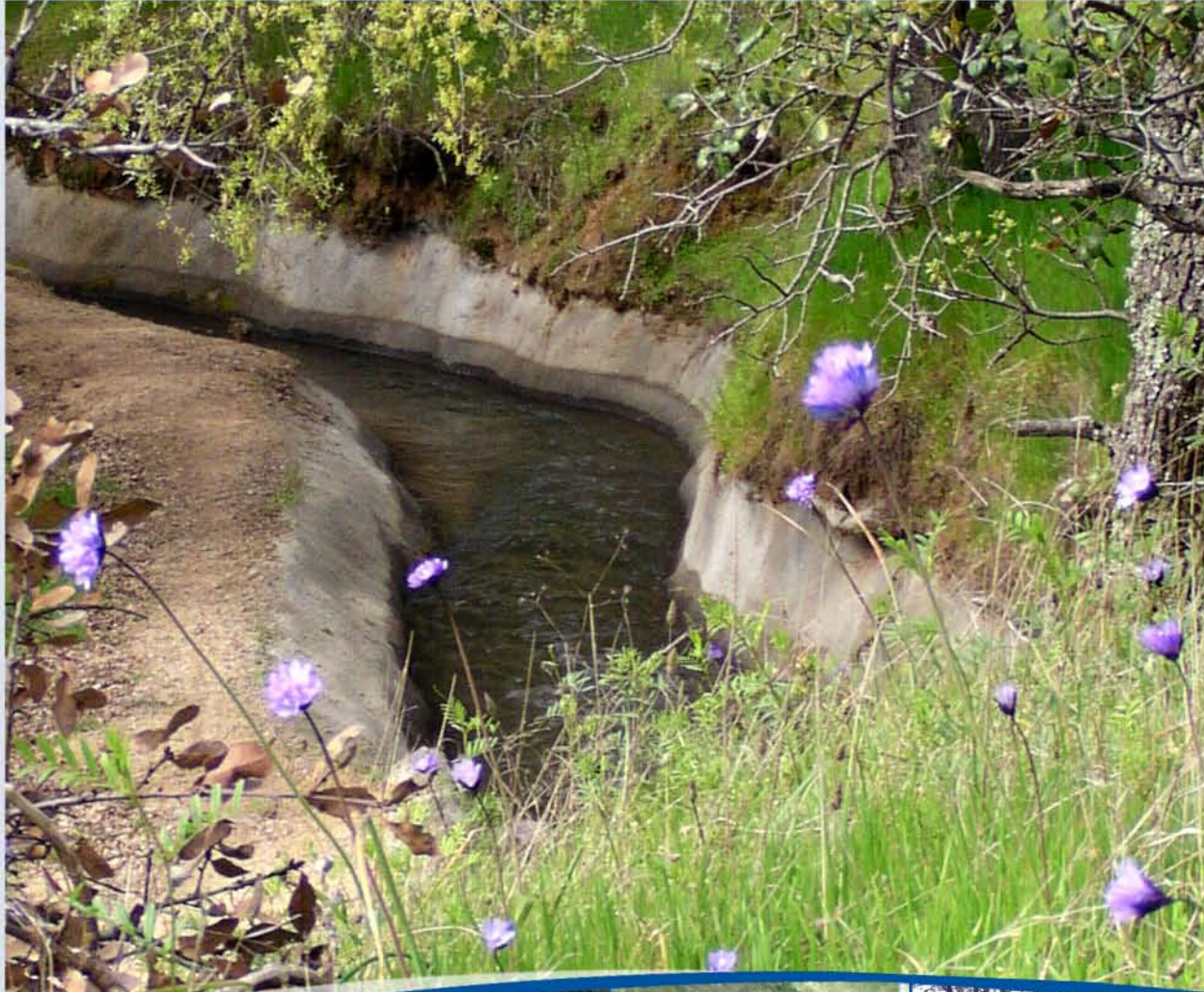


● Canal Sites ■ Stream Sites

FIGURE B-2D
WATER QUALITY CONDITIONS AT MINERS RAVINE WATERSHED SITES
DURING PCWA ROUTINE OPERATIONS

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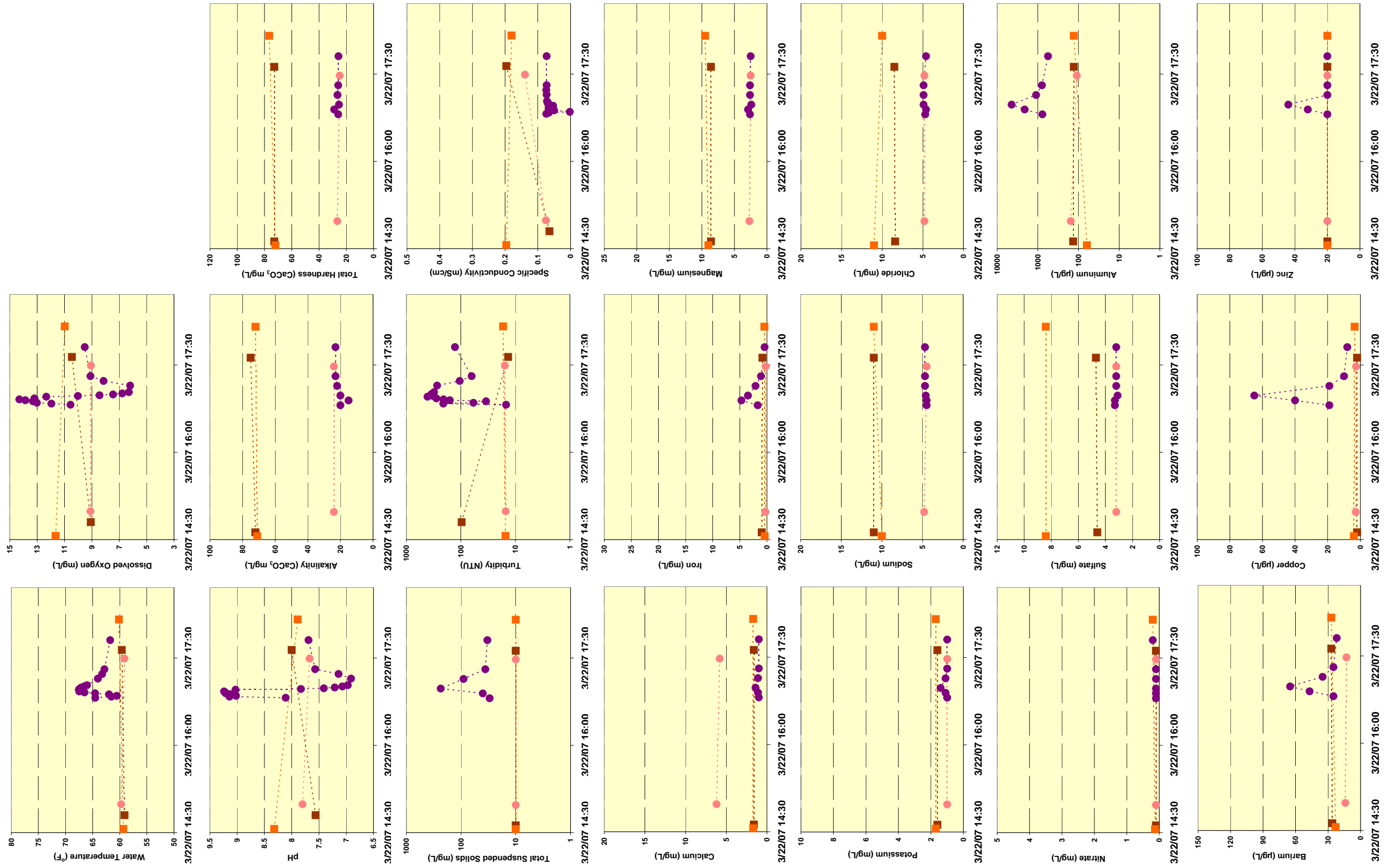
Appendix C



APPENDIX C
WATER QUALITY CONDITIONS DURING MAINTENANCE ACTIVITIES

**C.1 WATER QUALITY CONDITIONS AT CANAL AND STREAM SITES DURING
CANAL CLEANING ACTIVITIES**

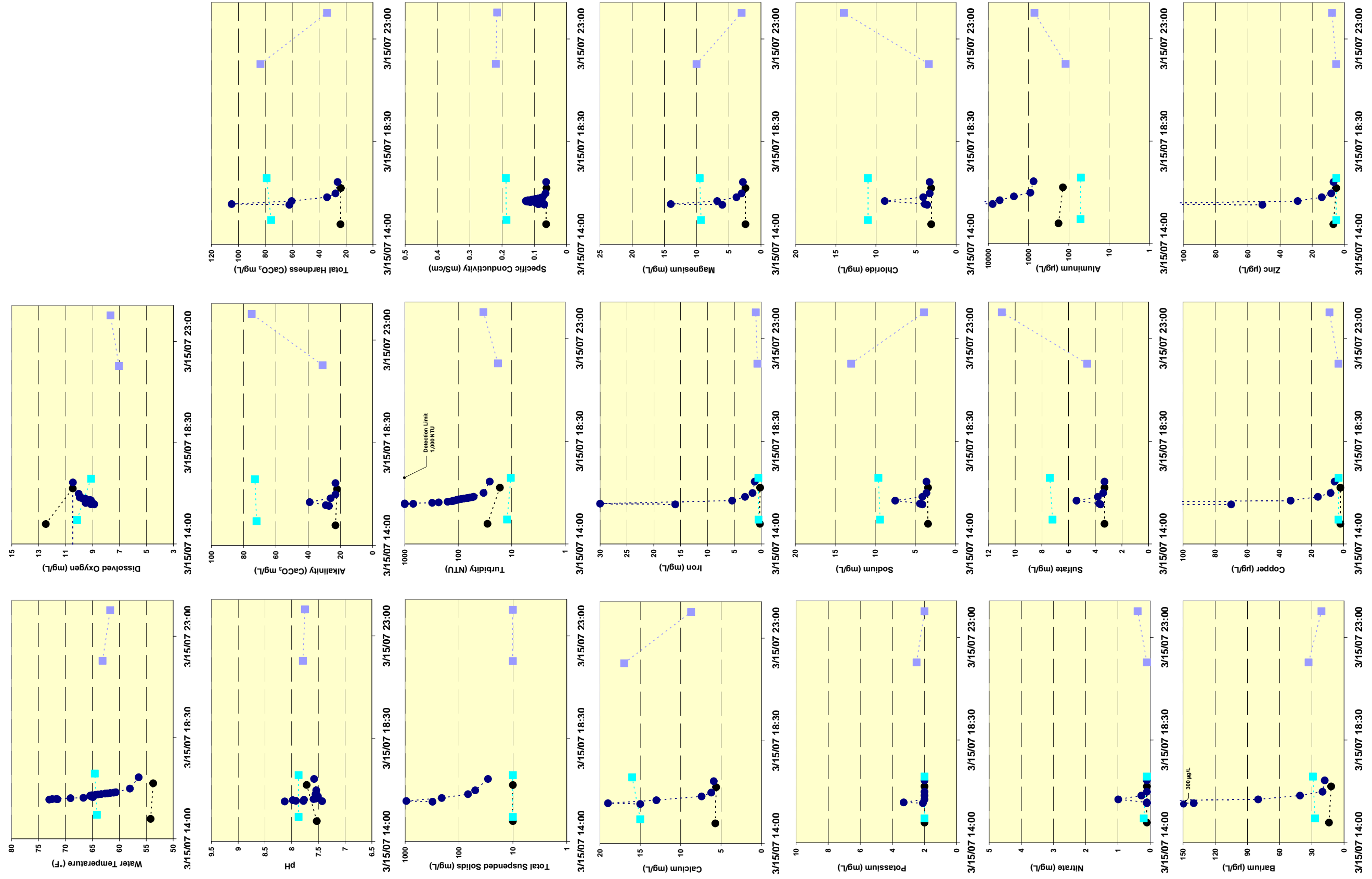
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● YB154 ■ YHTRIB2 ● YANKEECR ■ SECRETRV3
- - - - - - - - - - - -

FIGURE C-1A
WATER QUALITY CONDITIONS AT SECRET RAVINE WATERSHED SITES
DURING CANAL CLEANING ACTIVITIES

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YB81
 MINERSRV7
 HANSEN R
 MINERSRV5

FIGURE C-1B
WATER QUALITY CONDITIONS AT MINERS RAVINE WATERSHED SITES
DURING CANAL CLEANING ACTIVITIES

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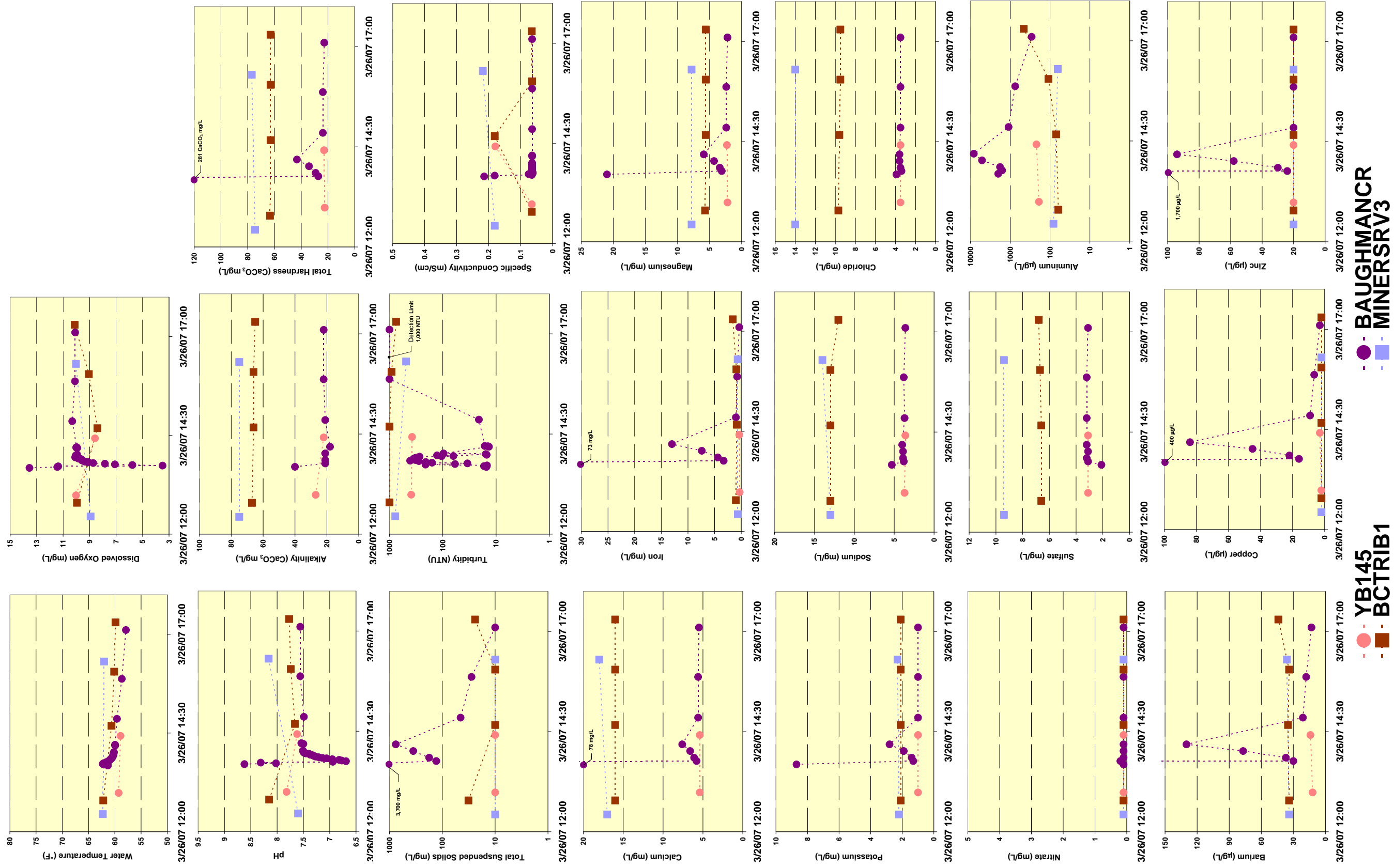
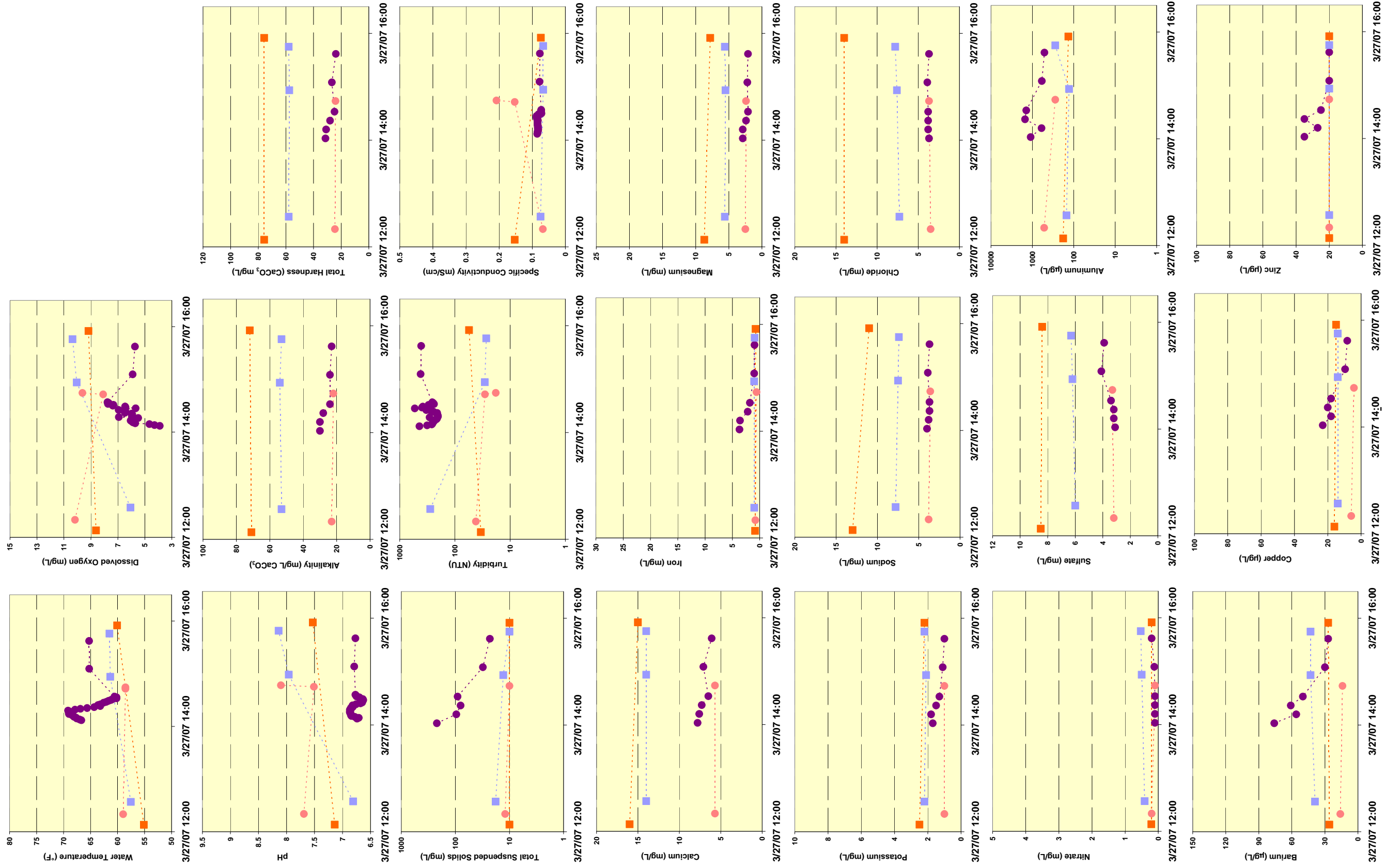


FIGURE C-1C
WATER QUALITY CONDITIONS AT MINERS RAVINE WATERSHED SITES
DURING CANAL CLEANING ACTIVITIES

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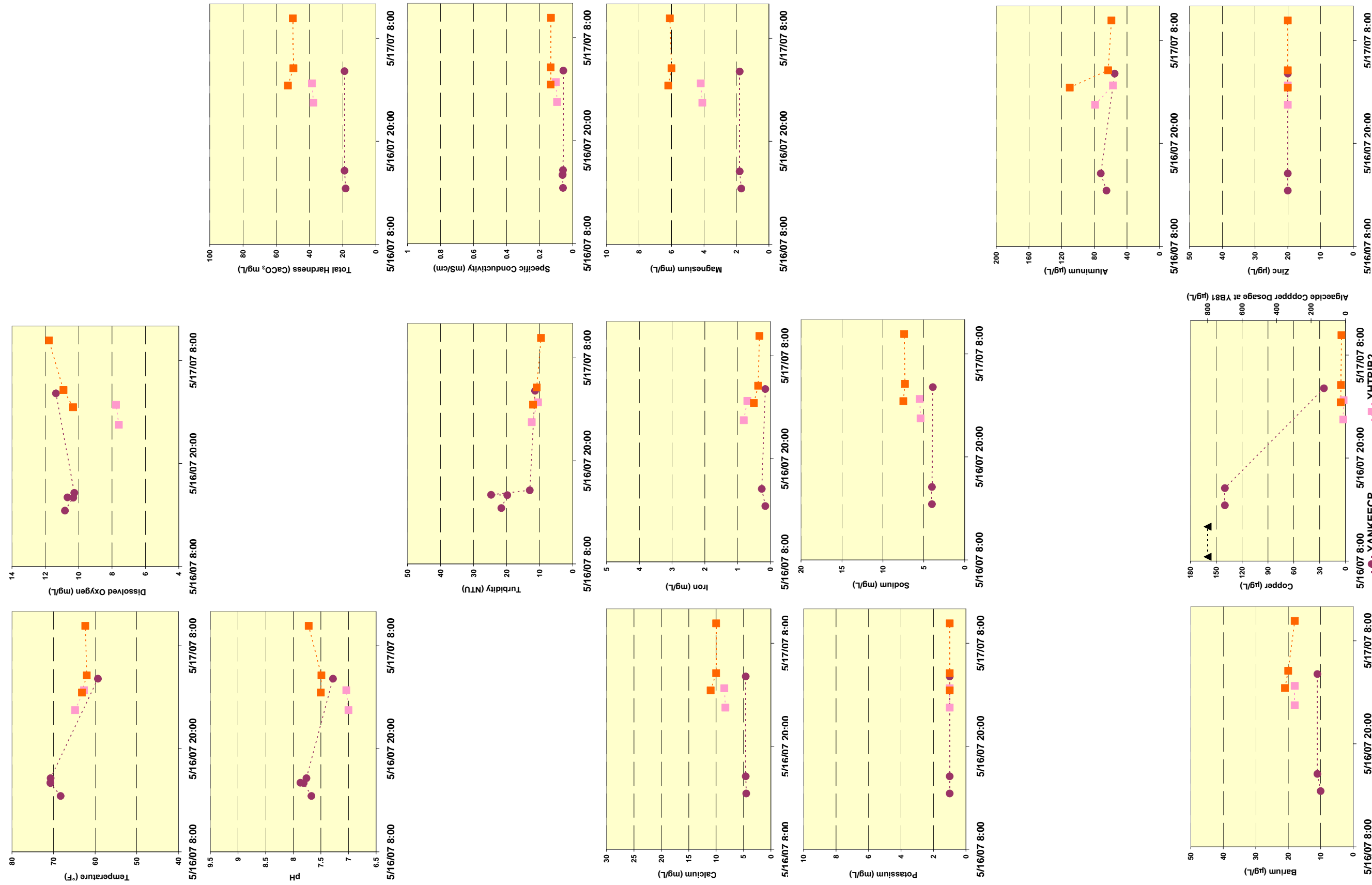


WATER QUALITY CONDITIONS AT MINERS RAVINE WATERSHED SITES
DURING CANAL CLEANING ACTIVITIES
FIGURE C-1D

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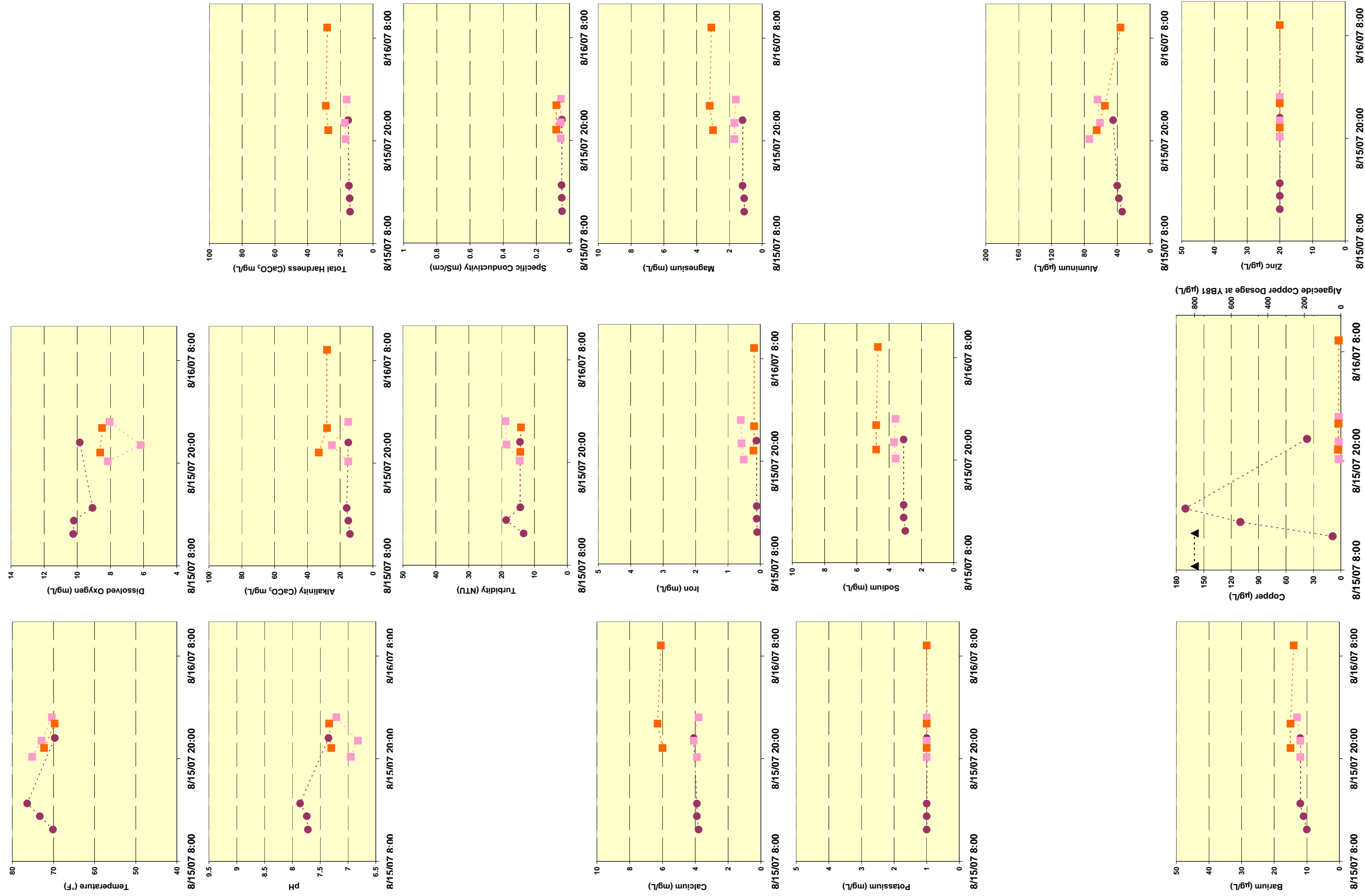
C.2 WATER QUALITY CONDITIONS AT CANAL AND STREAM SITES DURING ALGAECIDE APPLICATIONS

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YANKEECR **YHTRIB2** **SECRETRV3**
FIGURE C-2A
WATER QUALITY CONDITIONS AT SECRET RAVINE WATERSHED SITES
DURING ALGAECIDE APPLICATIONS

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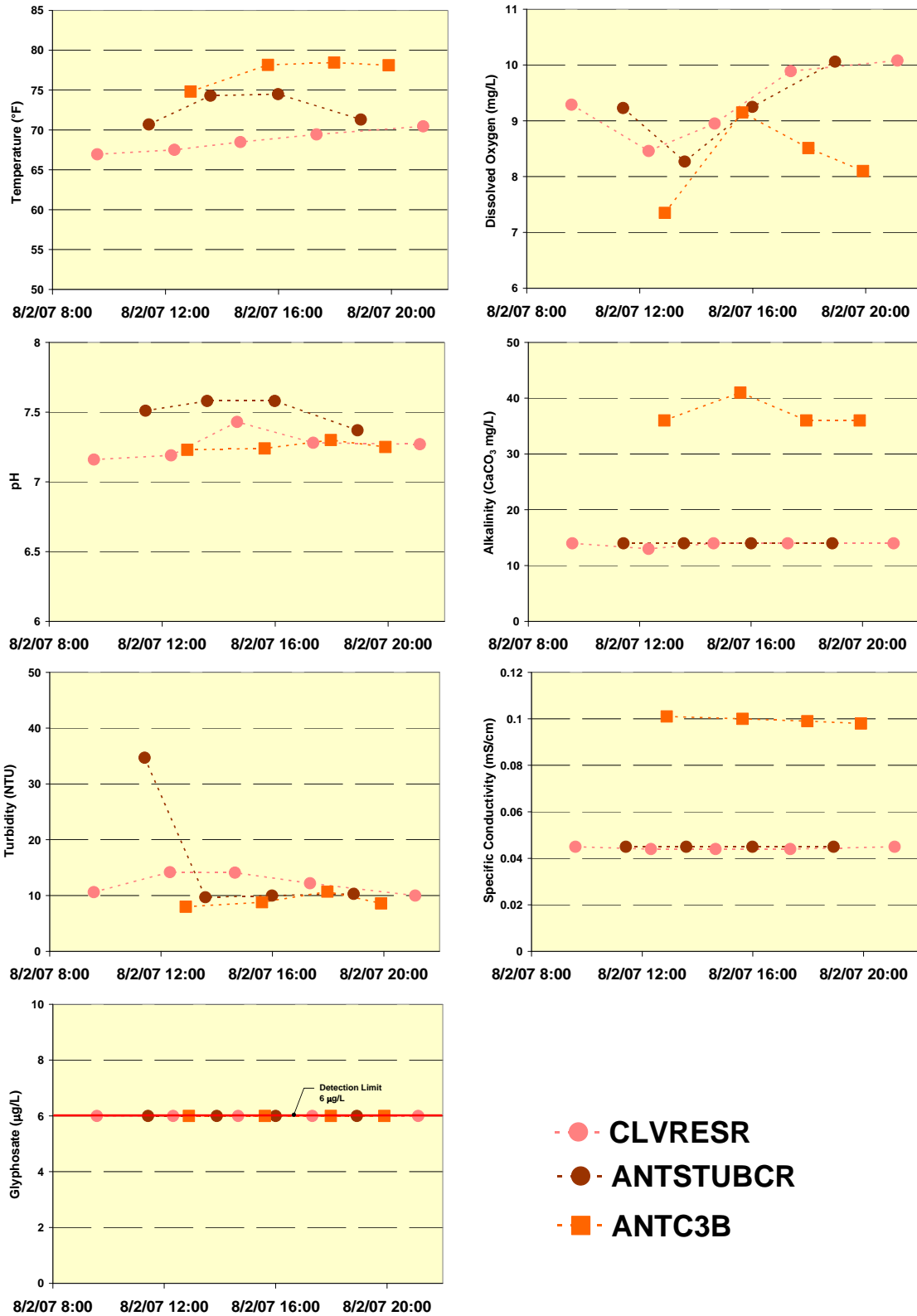
● YANKEECR ■ YHTRIB2 ■ SECRETRV3

FIGURE C-2B
WATER QUALITY CONDITIONS AT SECRET RAVINE WATERSHED SITES
DURING ALGAECIDE APPLICATIONS

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C.3 WATER QUALITY CONDITIONS AT CANAL AND STREAM SITES DURING HERBICIDE APPLICATIONS

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**FIGURE C-3A
WATER QUALITY CONDITIONS AT ANTELOPE CREEK WATERSHED SITES
DURING HERBICIDE APPLICATIONS**

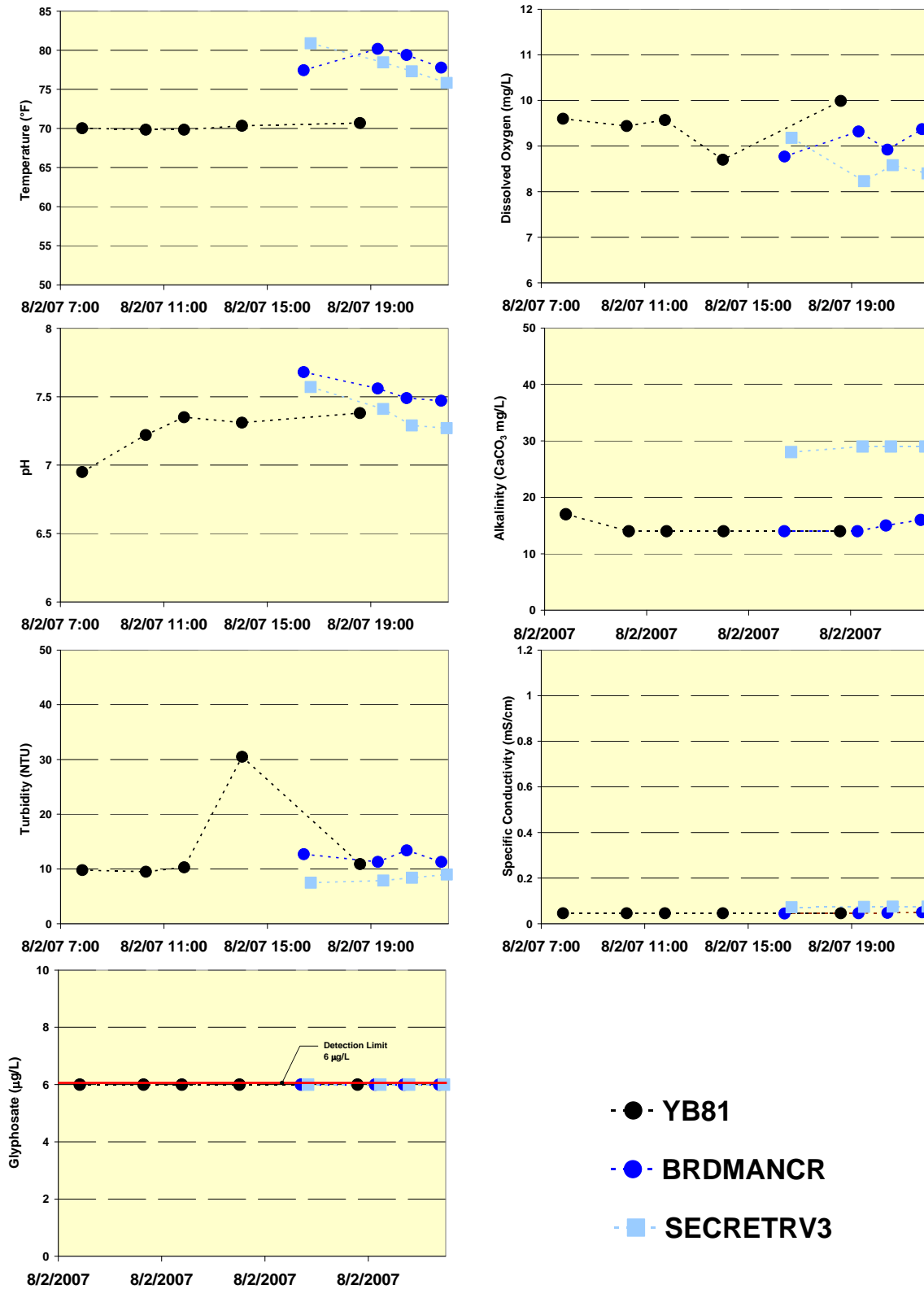


FIGURE C-3B
WATER QUALITY CONDITIONS AT SECRET RAVINE WATERSHED SITES
DURING HERBICIDE APPLICATIONS

C.4 WATER QUALITY CONDITIONS AT CANAL AND STREAM SITES DURING CANAL LINING ACTIVITIES

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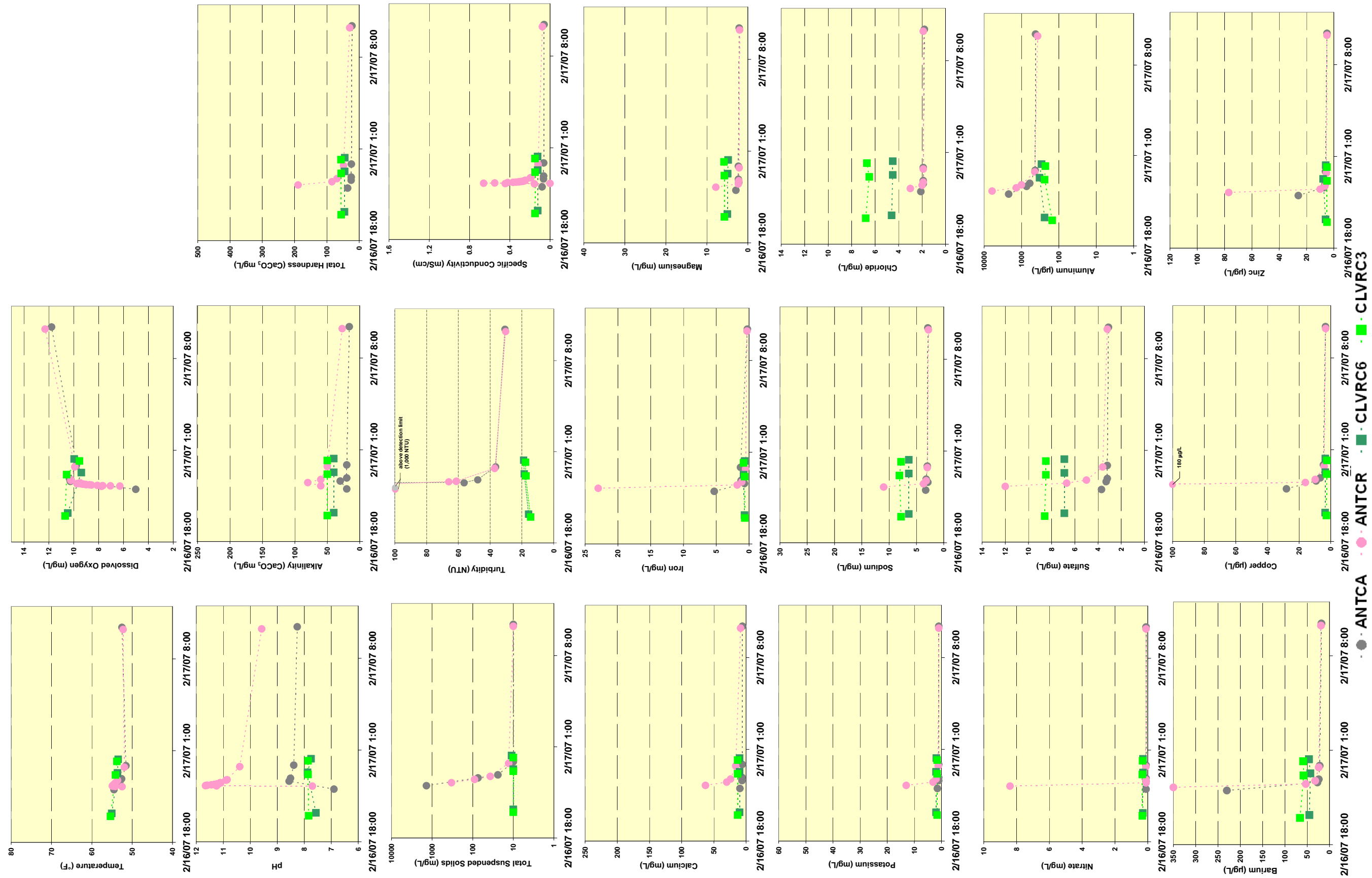
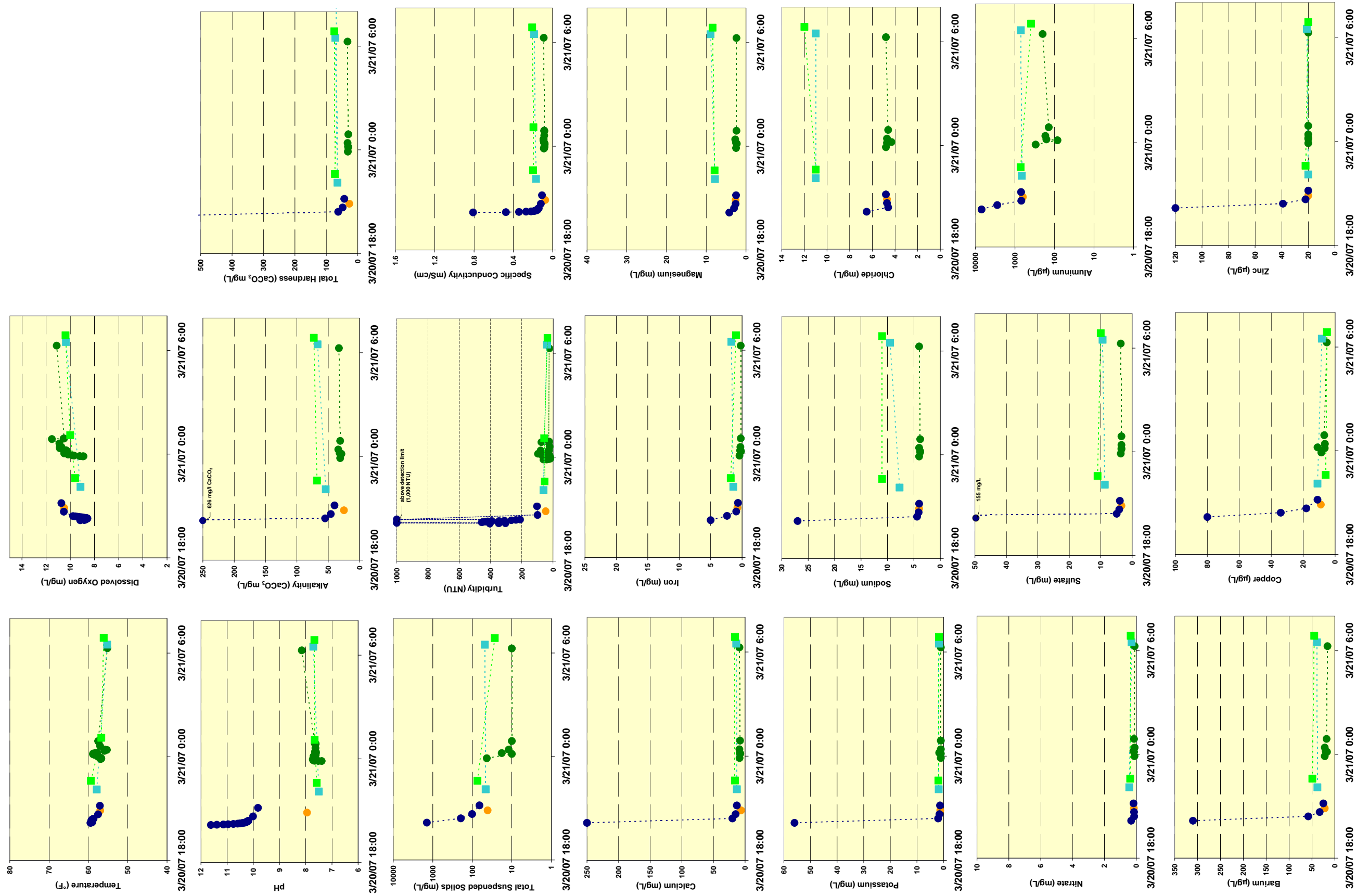


FIGURE C-4A
WATER QUALITY CONDITIONS AT CLOVER VALLEY CREEK WATERSHED SITES
DURING CANAL LINING ACTIVITIES

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YB155 SECRETRV3 YB155DS BRDMANCR

FIGURE C-4B
WATER QUALITY CONDITIONS AT SECRET RAVINE WATERSHED SITES
DURING CANAL LINING ACTIVITIES

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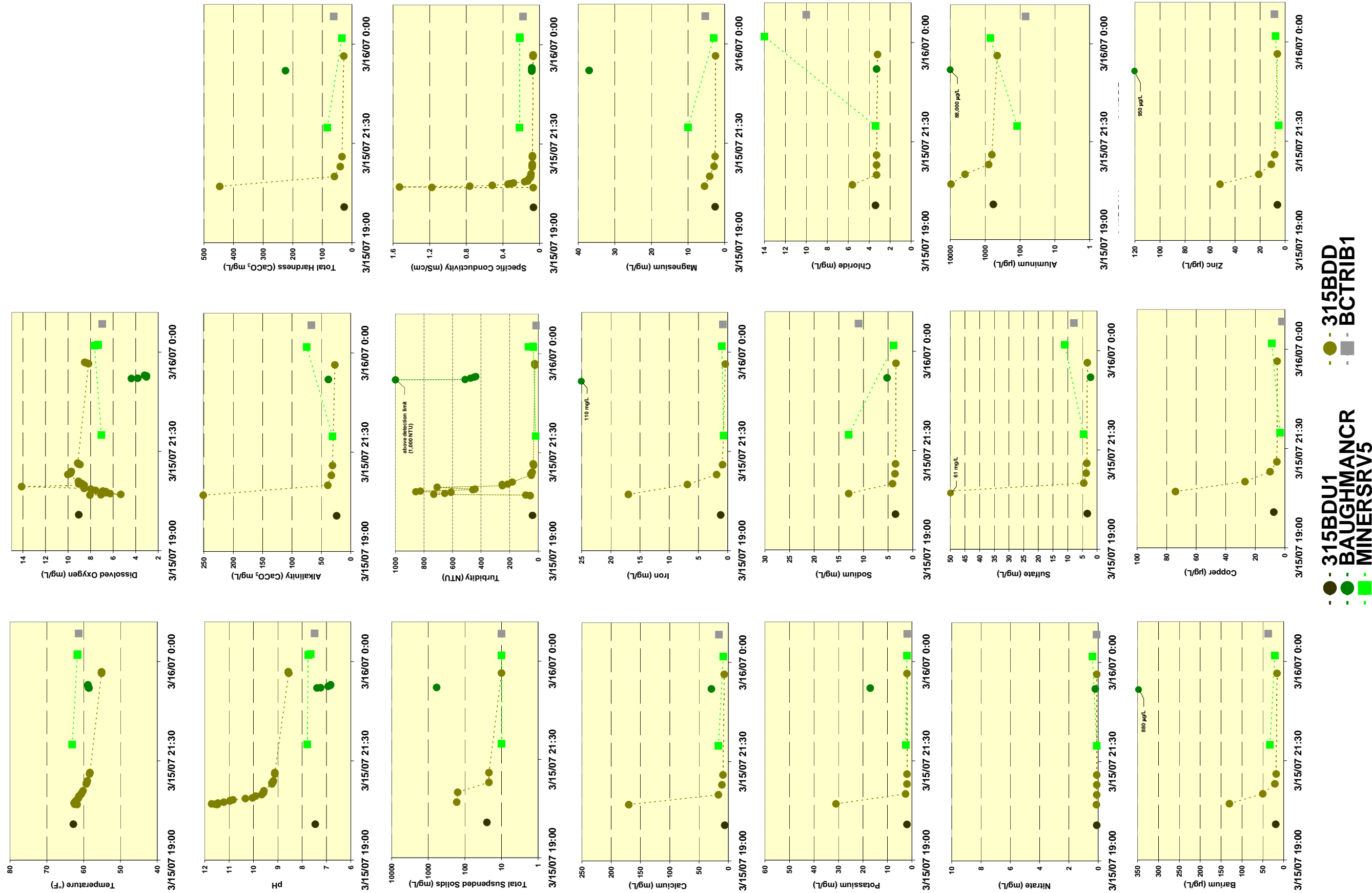


FIGURE C-4C
WATER QUALITY CONDITIONS AT MINERS RAVINE WATERSHED SITES
DURING CANAL LINING ACTIVITIES

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prepared by

