RECEIVED
FEB 03 2015
DIVISION OF WATER QUALITY

Attachment E – Notice of Intent

WATER QUALITY ORDER NO. 2013-0002-DWQ
GENERAL PERMIT NO. CAG990005

STATEWIDE GENERAL NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM (NPDES) PERMIT FOR RESIDUAL AQUATIC PESTICIDE DISCHARGES TO WATERS OF THE UNITED STATES FROM ALGAE AND AQUATIC WEED CONTROL APPLICATIONS

I. NOTICE OF INTENT STATUS (see Instructions)

Mark only one item A. New Applicator B. ☒ Change of Information: WDID# 5B01AP00001

C. ☐ Change of ownership or responsibility: WDID#

II. DISCHARGER INFORMATION

A. Name Department of Water Resources			
B. Mailing Address 1416 - 9th Street			
C. City Sacramento	D. County Sacramento	E. State CA	F. Zip 95814
G. Contact Person Jeffrey Janik	H. E-mail address Jeff.Janik@water.ca.gov	I. Title Program Manager	J. Phone 916-653-5688

III. BILLING ADDRESS (Enter Information *only* if different from Section II above)

A. Name			
B. Mailing Address			
C. City	D. County	E. State	F. Zip
G. E-mail address	H. Title	I. Phone	

IV. RECEIVING WATER INFORMATION

A. Algaecide and aquatic herbicides are used to treat (check all that apply):

1. ☒ Canals, ditches, or other constructed conveyance facilities owned and controlled by Discharger.
   Name of the conveyance system: State Water Project Aqueducts, Reservoirs and Forebays*
2. ☐ Canals, ditches, or other constructed conveyance facilities owned and controlled by an entity other than the Discharger.
   Owner's name: _____
   Name of the conveyance system: _____
3. Directly to river, lake, creek, stream, bay, ocean, etc.
   Name of water body: _____

B. Regional Water Quality Control Board(s) where treatment areas are located (REGION 1, 2, 3, 4, 5, 6, 7, 8, or 9): Region 2, 4, 5, 6, and 8
(List all regions where algaecide and aquatic herbicide application is proposed.)

V. ALGAECIDE AND AQUATIC HERBICIDE APPLICATION INFORMATION

A. Target Organisms: _____

Surface and submerged aquatic weeds, algae (Cladophora sp., diatoms, and cyanobacteria)

B. Algaecide and Aquatic Herbicide Used: List Name and Active ingredients

Copper: Komeen®, Nautique®, EarthTec®, and Copper Sulfate Pentahydrate
Diquat
Endothall (e.g., Aquathol® K (liquid formulation) and Aquathol® Super K Granular)
Fluridone (e.g., Sonar®)
Imazamox (e.g., Clearcast®)
Sodium Carbonate Peroxyhydrate (e.g., PAK 27®)
Triclopyr

C. Period of Application: Start Date** _____ End Date** _____
**Applications will be made on an as-needed basis during the year, after other options have been exhausted.

D. Types of Adjuvants Used: N/A

VI. AQUATIC PESTICIDE APPLICATION PLAN

Has an Aquatic Pesticide Application Plan been prepared and is the applicator familiar with its contents?
☒ Yes ☐ No

If not, when will it be prepared? _____

VII. NOTIFICATION

Have potentially affected public and governmental agencies been notified? ☒ Yes ☐ No

VIII. FEE

Have you included payment of the filing fee (for first-time enrollees only) with this submittal?
☐ YES ☐ NO ☒ NA

*Aqueducts: South Bay, Coastal Branch, East Branch, and California; Reservoirs and Forebays: Patterson Rsvr., Dyer Rsvr., Pyramid Lake, Castaic Lake, Silverwood Lake, Lake Perris, Quail Lake, Clifton Court FB, O'Neill FB, and Coastal Branch FBs.

IX. CERTIFICATION

"I certify under penalty of law that this document and all attachments were prepared under my direction and supervision in accordance with a system designed to ensure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine or imprisonment. Additionally, I certify that the provisions of the General Permit, including developing and implementing a monitoring program, will be complied with."

A. Printed Name: Jeffrey Janik

B. Signature: Duane S[illegible] for Jeffrey Janik **Date:** 1/30/2015

C. Title: Program Manager

XI. FOR STATE WATER BOARD STAFF USE ONLY

WDID:	**Date NOI Received:**	**Date NOI Processed:**
Case Handler's Initial:	**Fee Amount Received:** **$**	**Check #:**
☐ **Lyris List Notification of Posting of APAP**	**Date** _____	**Confirmation Sent** _____

The Department of Water Resources

Aquatic Pesticides Application Plan

WATER QUALITY ORDER NO. 2013-0002-DWQ

Statewide General National Discharge Pollutant Discharge Elimination System Permit for the Discharge of Aquatic Pesticides for Aquatic Weed Control in Waters of the United States

January 29, 2015

The Department of Water Resources
Environmental Assessment Branch
1416 Ninth Street
Sacramento, California 95814

Table of Contents

INTRODUCTION AND LOCATION 1

TABLE 1. Aquatic Weed and Algal Bloom Control Programs in the State Water Project 1

PROJECT BACKGROUND 3

1. SOUTH BAY AQUEDUCT 4

2. CLIFTON COURT FOREBAY 10

3. PATTERSON RESERVOIR 17

4. DYER RESERVOIR 22

5. O'NEILL FOREBAY 27

6. COASTAL BRANCH AQUEDUCT 33

7. EAST BRANCH AQUEDUCT 38

8. PYRAMID LAKE 43

9. CASTAIC LAKE 51

10. SILVERWOOD LAKE 57

11. LAKE PERRIS 64

12. QUAIL LAKE 71

13. CALIFORNIA AQUEDUCT 78

FIGURES 84

APPENDIX A 104

INTRODUCTION AND LOCATION

The Department of Water Resources (DWR) applied for a statewide general National Pollutant Discharge Elimination System (NPDES) Permit from the State Water Resources Control Board (SWRCB) to continue application of aquatic herbicides, when necessary, to State Water Project (SWP) aqueducts, forebays, and reservoirs (Table 1). Figures 1 to 14 show the locations of SWP facilities. A Mitigated Negative Declaration (MND) was prepared by DWR to comply with California Environmental Quality Act (CEQA) requirements associated with regulatory requirements established by the SWRCB. DWR, a public entity, was granted a section 5.3 exception by the SWRCB (Water Quality Order 2004-0009-DWQ). In 2014, DWR applied for a section 5.3 exception for the use of copper at four additional water bodies: O'Neill Forebay, Pyramid Lake, Silverwood Lake, and Quail Lake.

DWR applies copper compounds (copper sulfate pentahydrate, Komeen®, Nautique®, Captain XTR®, EarthTec®) and sodium carbonate peroxyhydrate (PAK®27) on an as-needed basis to control aquatic weeds and algal blooms so that such blooms do not degrade drinking water quality through elevated tastes and odors, production of algal toxins, clogging of filters, and reduction in water flows. DWR is adding diquat, endothall, fluridone, imazamox, and triclopyr to the list of aquatic herbicide treatment options for the SWP. DWR does not use adjuvants or surfactants when treating SWP water bodies.

The proposed Project would involve the continued application of aquatic herbicides to control aquatic weeds and algal blooms at SWP reservoirs and aqueducts operated by DWR (Table 1). Figures 1 - 14 provide area maps for each of the reservoirs and aqueducts. The facilities are located within the boundaries of five Regional Water Quality Control Boards (RWQCB). DWR will request a prohibition exemption from the Lahontan Regional Water Quality Control Board as soon as practicable in order to comply with the Lahontan Regional Board's discharge requirements.

TABLE 1. Aquatic Weed and Algal Bloom Control Programs in the State Water Project

	Region (RWQCB)	Counties	Problem Biota	Associated Problems	Aquatic Herbicide
RESERVOIRS					
Clifton Court Forebay	5	Contra Costa	aquatic weeds and cyanobacteria	reduced water flows*, taste and odor, and filter clogging	copper-based
Patterson Reservoir	2	Alameda	filamentous algae (*Cladophora*)	filter clogging	copper-based and imazamox
Dyer Reservoir	2	Alameda	cyanobacteria	taste and odor and filter clogging	copper-based, imazamox, and sodium carbonate peroxyhydrate

	Region (RWQCB)	Counties	Problem Biota	Associated Problems	Aquatic Herbicide
O'Neill Forebay	5	Merced	aquatic weeds	reduced water flows*	copper-based, diquat, endothall, fluridone, imazamox, and triclopyr
Coastal Branch Forebays	5	Kings and San Luis Obispo	aquatic weeds	filter clogging	sodium carbonate peroxyhydrate
Pyramid Lake	4	Los Angeles	aquatic weeds and cyanobacteria	taste and odor and toxins	copper-based, diquat, endothall, fluridone, imazamox, sodium carbonate peroxyhydrate, and triclopyr
Castaic Lake	4	Los Angeles	aquatic weeds and cyanobacteria	taste and odor, filter clogging, and toxins	copper–based, fluridone, imazamox, and triclopyr
Silverwood Lake	6	San Bernardino	aquatic weeds and cyanobacteria	taste and odor and toxins	copper-based, diquat, endothall, fluridone, imazamox, sodium carbonate peroxyhydrate, and triclopyr
Lake Perris	8	Riverside	aquatic weeds and cyanobacteria	taste and odor, filter clogging, and toxins	copper–based, fluridone, imazamox, and triclopyr
Quail Lake	4	Los Angeles	aquatic weeds and cyanobacteria	taste and odor and toxins	copper–based, diquat, endothall, fluridone, imazamox, sodium carbonate peroxyhydrate, and triclopyr
AQUEDUCTS					
South Bay Aqueduct	2	Alameda and Contra Costa	*Cladophora* and diatoms	reduced water flows*	copper-based
Coastal Branch Aqueduct	5	Kings and San Luis Obispo	aquatic weeds and cyanobacteria	taste and odor and filter clogging	copper-based

	Region (RWQCB)	Counties	Problem Biota	Associated Problems	Aquatic Herbicide
East Branch Aqueduct	6	Los Angeles, San Bernardino, and Riverside	cyanobacteria	taste and odor, filter clogging, and toxins	copper-based
California Aqueduct (Intake Channel at MP 0.93 to Banks Pumping Plant, MP 249.65-250.99, MP 277.31-278.13, MP 279.05-280.45, and MP 285.69-292.16)	5	Contra Costa and Kern	*Cladophora* and aquatic weeds	reduced water flows; filter clogging	copper-based and endothall

*Creates operational problems by clogging trash racks and filters.

RWQCB – Regional Water Quality Control Boards

Region 2 San Francisco Bay
Region 4 Los Angeles
Region 5 Central Valley
Region 6 Lahontan
Region 8 Santa Ana

PROJECT BACKGROUND

DWR operates and manages the SWP, the largest state-built, multipurpose water project in the United States. The SWP depends on a complex system of dams, reservoirs, power plants, pumping plants, and aqueducts to deliver water. The Project provides drinking water to more than 25 million Californians and SWP water is used to irrigate about 750,000 acres of farmland, mainly in the south San Joaquin Valley. Also, the SWP was designed and built to control floods, generate power, and provide recreational facilities as well as enhance habitats for fish and wildlife.

The mission of DWR is to manage the water resources of California in cooperation with other agencies, to benefit the State's people, and to protect, restore, and enhance the natural and human environments. To carry out this mission, DWR routinely monitors and tests water samples from its reservoirs, aqueducts, and other water supply facilities to assure compliance with state and federal requirements for safe drinking water quality.

Water quality monitoring provides detailed information on concentrations and distribution of chemical, physical, and biological properties at more than 40 stations throughout the Project. Objectives of this monitoring are to:

- Assess the influence of hydrological conditions and project operations on water quality.
- Document long-term changes in SWP water quality.

- Provide water quality data to assess water treatment plant operational needs.
- Identify, monitor, and respond to water quality emergencies and determine impacts to the Project.
- Provide data needed to determine if State Water Contracts Article 19 and California Department of Public Health (CDPH) Drinking Water Standards are being met.
- Assess issues of concern through special studies.

DWR applies aquatic herbicides for two main purposes: 1) to control cyanobacteria (blue-green algae) that can produce taste and odor and toxic compounds and 2) to control aquatic weeds and algae that can negatively impact water conveyance for municipal, irrigation, and industrial purposes and clog filters at water treatment plants.

DWR routinely monitors taste and odor compounds produced by algae. Chemical substances in water that often are associated with earthy, musty smelling or tasting water include geosmin and 2-methylisoborneol (MIB), which are produced in natural and manmade lakes by cyanobacteria. Geosmin and MIB are natural by-products of algal chlorophyll production, although not all algae produce them or produce them in the same amounts, so the presence of algae alone is not a good indicator of taste and odor problems.

DWR's evaluation of a taste and odor event is based upon microscopic examination of samples, and most importantly, the chemical analysis of MIB and geosmin. When sampling results indicate that concentrations of geosmin or MIB in reservoir waters are increasing within the 10 nanograms per liter (ng/l) range (1 ng/l is one nanogram per liter of water, or one part per trillion), DWR water quality staff respond by searching for the location of the source of the geosmin or MIB. To do this, water quality samples are collected and analyzed, and field staff ascertains possible algae sources. If an algae source is identified, DWR staff then develops an application plan to control the specific algae that are associated with the elevated geosmin and/or MIB concentrations.

1. SOUTH BAY AQUEDUCT

a. Site Description

The South Bay Aqueduct (SBA) originates at Bethany Reservoir, an enlarged section of the California Aqueduct about one mile downstream from the Harvey O. Banks Pumping Plant near the town of Byron and within the boundaries of the San Francisco Bay Regional Water Quality Control Board, Region 2. Completed in 1966, the 44.1-mile system serves portions of Alameda and Santa Clara Counties, including the cities of Livermore and Santa Clara (Figure 1). Eleven miles of the system are open aqueduct with the remainder consisting of pipelines and tunnels.

The open aqueduct section begins at the Backsurge Pool (Milepost (MP) 3.31) to Dyer Altamont Check (MP 5.15) and then continues as a pipeline for about 2.5 miles. The open aqueduct section continues from MP 7.61 to Del Valle Check 7 (MP 16.38) at which point the SBA again becomes a pipeline to the terminus at the Santa Clara terminal tank (MP 42.07). Due to the shallowness of about 5 feet, filter clogging diatoms and taste and odor causing cyanobacteria create water quality and delivery problems from about March to October.

b. Treatment Area

Application area: Copper sulfate or EarthTec® is applied at three locations: Backsurge Pool (MP 3.31), Patterson Check (MP 9.44), and Arroyo Seco Check (MP 12.0).

Treatment Area: Copper sulfate or EarthTec® is applied at a maximum of three locations in the open portion of the SBA. The treatment area is defined from the Backsurge Pool at MP 3.31 to the end of the open aqueduct section at Del Valle Check 7 (MP 16.38).

c. Aquatic Weeds and Algae Controlled and Rationale

i. Background

Algae problems began in the SBA soon after the start of aqueduct operations in 1966. DWR applies copper sulfate and EarthTec® for two main purposes: 1) to control cyanobacteria that can produce taste and odor compounds, and 2) to control attached algae such as *Melosira varians* and *Cladophora* sp. that can negatively impact conveyance of water supplies for municipal, irrigation, and industrial purposes and reduce filter run times in water treatment plants.

DWR routinely monitors for taste and odor compounds produced by algae. Chemical substances in water that are often associated with earthy, musty smelling or tasting water include geosmin and 2-methylisoborneol (MIB), which are produced in natural and manmade lakes by certain types of cyanobacteria. Geosmin and MIB are natural by-products of algal chlorophyll production, although not all algae produce them in the same amounts, so the presence of algae alone is not a good indicator of taste and odor problems.

ii. Control Tolerances

(1) Taste and Odor

MIB less than 5 ng/L and geosmin less than 10 ng/L are not detected in drinking water by most customers.

Taste and odor production is monitored on a weekly basis using Solid Phase Microextraction (SPME). The taste and odor causing substances, MIB and geosmin are reported in parts per trillion (ng/L) concentrations.

(2) Filter Clogging

Algal fluorescence less than 200 units and algal biomass less than 5,000 mg/m^3 do not cause operational problems to water conveyance or reduction in filter run times at water treatment plants.

Algal biomass and species composition are analyzed directly using the Utermohl technique (inverted microscope method). Algal fluorescence is measured continuously with a Turner 10AU fluorometer. The data are posted daily to the DWR Water Quality website: http://www.water.ca.gov/swp/waterquality/AutostationData/index.cfm.

d. Algaecides and Aquatic Herbicides Applied and Method of Application

Aquatic herbicide: Copper-based herbicides (copper sulfate pentahydrate crystals, EarthTec®). Copper sulfate pentahydrate crystals or EarthTec® are applied in a manner consistent with product labeling.

Application method: Burlap bags filled with copper sulfate crystals are suspended in the aqueduct in a manner consistent with product labeling. EarthTec® is applied according to label instructions.

e. Decision to Select Herbicides

DWR's decision to apply copper sulfate or EarthTec® is based upon microscopic examination of samples and most importantly, the chemical analysis of MIB and geosmin. When sampling results indicate that concentrations of taste and odor compounds, algal biomass or fluorescence exceed the control tolerances (see section c above), DWR water quality staff respond by searching for the location of the source of the problem. To do this, water quality samples are collected and analyzed, and field staff ascertains possible algae sources.

Prior to application of copper sulfate or EarthTec®, DWR evaluates potential operational strategies. These modifications may include withdrawing water from deeper depths on the intake tower of Lake Del Valle, blending, or utilizing other sources of water. If application of copper sulfate or EarthTec® is deemed necessary, the early warning monitoring for MIB and geosmin and biomass provides detailed information on the location of the source blooms.

f. Herbicide Dose and Determination

Copper sulfate pentahydrate or EarthTec® is applied consistent with product labeling instructions for control of attached and planktonic algae.

The quantity of copper applied is calculated based on the aqueduct flow and the target dose using a spreadsheet program (FlowTimes) developed by DWR. The model calculates the amount (pounds) of copper sulfate required at each of the three application points, and the start and end times of the copper sulfate application required to meet the target concentration.

g. Gates and Control Structures

Turnouts are closed for a minimum of two hours prior to the start of the copper sulfate or EarthTec® treatment and remain closed for a minimum of two hours after the copper sulfate or EarthTec® has passed the following three turnouts:

Arroyo Mocho Check – located at MP 14.6 on the South Bay Aqueduct.

Arroyo Valle 1 (AV1) – located at MP 0.9DV on the Del Valle Branch Pipeline.

Arroyo Valle 2 (AV2) – located at MP 1.53DV on the Del Valle Branch Pipeline.

AV1 and AV2 are operated manually while the Arroyo Mocho gate is controlled remotely at the Delta Field Division in Byron. The gates at AV1 and AV2 are inspected during operation to ensure that the gate is closed and no water is discharged into Arroyo Mocho Creek. The Arroyo Mocho gate is equipped with a flow meter that is monitored in the DWR control room to verify proper operation of the gate.

h. Exception Period

The Department of Water Resources was granted a section 5.3 exception. Application of copper to the South Bay Aqueduct would be carried out only on an as-needed basis during the year, after other options have been exhausted. Application of copper sulfate or EarthTec® to the aqueduct is required at regular intervals throughout the growing season to prevent loss in water delivery capacity.

i. Monitoring Plan

See Appendix A.

j. Procedures to Prevent Sample Contamination from Persons, Equipment, and Vehicles Associated with Algaecide and Aquatic Herbicide Application

Water quality sampling is conducted by trained DWR staff following established procedures designed to prevent contamination of samples. Sampling guidelines are contained in "Water Quality Field Manual for the State Water Project" produced by DWR.

Procedures that prevent sample contamination include:

- Use clean sample bottles that are non-reactive. Glass and polyethylene bottles are used for SWP water samples.
- Wear gloves that are powder-free vinyl to avoid the contamination associated with latex gloves.
- Samples are immediately placed in an ice chest away from contaminants as soon as the samples are taken.

k. Best Management Practices Implemented

Application: Copper sulfate or EarthTec® is applied under the supervision of a certified pesticide applicator. Delta Field Division has one licensed Pest Control Advisor (PCA) who also works in the San Luis Field Division and seven Certified Qualified Applicators (QAC). These individuals are trained to ensure that algaecides and aquatic herbicides are applied at rates consistent with label requirements and in a manner that avoids potential adverse effects including, but not limited to, fish kills. Copper sulfate has been used since the early 1970s to control filter clogging algae (*Cladophora*) and taste and odor producing cyanobacteria in the SBA.

Notification: The Department's South Bay Water Contractors, who also provide treated municipal water to customers, are notified by email at least 48 hours prior to a treatment. The notification includes date, start and end time of the treatment, and travel time of copper sulfate or EarthTec® by milepost. The Contractors are Alameda County Flood Control and Water Management District, Zone 7; Alameda County Water District; and Santa Clara Valley Water District. Additionally, a PCA will submit a written recommendation for the use of aquatic herbicides to the County Agricultural Commissioner.

Treatment: The copper is applied during daylight hours of maximum photosynthetic activity to optimize copper uptake by the algal community.

Spill Prevention and Cleanup: Staff will apply copper sulfate or EarthTec® according to label instructions in order to prevent spills. In the event of a spill, staff will follow the field

division's established emergency response procedures and refer to the applicable material safety data sheet (MSDS) for instructions on containing and cleaning up the spill. Emergency response and MSDS procedures will be reviewed regularly. A copy of the emergency response procedures and material safety data sheets will be available during each treatment. Cleanup equipment will be kept in good working order and will be readily available at each application site.

Water Quality Monitoring: SBA water quality is monitored continuously by automated instrumentation. The station at Del Valle Check (MP 16.38) is equipped with sensors to measure water temperature, turbidity, pH, specific conductance, and algal biomass (flow-through fluorometry). Additional data are obtained at the Vallecitos Check (MP 22.4) water quality station, which is equipped with water quality instruments that measure water temperature, turbidity, pH, and specific conductance. Further, water quality data from grab samples are available for Santa Clara Terminal Tank (MP 42, about 0.5 miles from the end of the treated section) each month in which water is released from Del Valle Reservoir.

Access: There are limited recreational activities on the SBA, and most sections are closed to public access with locked gates. Fishing is not permitted in the SBA.

Post-Treatment: The efficacy of the treatment is evaluated at about one week after the application. Algae are surveyed to determine the effectiveness of the treatment at reducing biomass, and taste and odor compounds are monitored weekly throughout the year.

l. Possible Alternatives to Algaecides and Aquatic Herbicide Use

i. Evaluation of Management Options

(1) No Action

If the SBA was not treated, attached algae would severely impact deliveries to water contractors in the South Bay region. A "no action" option is therefore not acceptable.

(2) Prevention

Nutrient Control. Some preventive measures involve limiting or eliminating nutrients that support aquatic weed and algae growth. Due to the size of the Delta and the numerous inflows, controlling nutrients is not a feasible preventive control option for the SBA.

(3) Mechanical or Physical Methods

Scraping of Aqueduct. Attempts were made in the 1980s to remove algae by scraping the aqueduct lining. A boom truck was used to drag a large link belt. The method was ineffective in removing algae and resulted in damage to the concrete aqueduct lining and mass loading of debris. The procedure was discontinued.

Continuously Operated Travelling Screens. Aquatic weeds and macro-algae (*Cladophora*) are removed at Del Valle Check (MP 16.38). The filter clogging diatoms are too small to be removed and are controlled with copper sulfate or EarthTec®.

(4) Cultural Methods

Aqueduct Dewatering. The aqueduct has been drained about every eight years since 1970. The main purpose of the draining is to remove accumulated silt that is deposited in the aqueduct invert. Attached algae recolonize the upper aqueduct lining soon after the silt is removed.

Reduction of Light. Enclosing the aqueduct (open section) of the SBA would eliminate light which is necessary for plant photosynthesis. This is not a viable BMP due to the high cost (about 10 million dollars) of covering the 11 miles of open aqueduct. Similarly, the use of dyes which work by screening portions of sunlight spectrum necessary for photosynthesis would not be a feasible alternative in a flowing aqueduct.

(5) Biological Control Agents

Introduction of Weed Eating Fish. Grass carp/white amur (*Ctenopharyngodon idella Val.*) have been approved for stocking by the California Department of Fish and Wildlife (CDFW) under controlled conditions where the water body is a closed system. The SBA has releases to streams, and in addition, water can be pumped into Lake Del Valle. Therefore, grass carp would not be a viable alternative to copper sulfate or EarthTec® in managing algae in the SBA.

(6) Algaecides and Aquatic Herbicides

Aquatic Herbicide Treatment. An ongoing program of algae control using copper sulfate and EarthTec® is necessary to minimize the impacts on SBA water quality and quantity. Copper sulfate has proven to be effective at reducing the target algae without adverse effects on non-target organisms. There are no alternatives to using copper sulfate and EarthTec® that are effective at controlling attached algae and registered for use in California. If the SBA was not treated, attached algae would severely impact deliveries to water contractors in the South Bay region.

ii. Decision Matrix to Select the Most Appropriate Formulation

The decision matrix below evaluates the aquatic weed and algae control options identified for the South Bay Aqueduct (section i: “Evaluation of Management Options” above).

Decision Making Criteria	No Action	Prevention	Mechanical or Physical	Cultural Methods	Biological Agents	Algaecides and Aquatic Herbicides
Is the impact to the environment low or easily mitigated?	Yes	Yes	Yes	Yes	Yes	Yes
Is the cost of this option reasonable?	N/A	No	No	No	No	Yes
Has (have) the method(s) been effectively implemented at this site?	No	No	No	No	No	Yes
Option(s) selected for the South Bay Aqueduct.						X

2. CLIFTON COURT FOREBAY

a. Site Description

Clifton Court Forebay is located in the southeast corner of Contra Costa County about ten miles northwest of the city of Tracy and within the borders of the Central Valley Regional Water Quality Control Board, Region 5 (Figure 2). The forebay is a shallow 28,653 acre-foot reservoir at the head of the California Aqueduct. Water enters the forebay via a gated structure connected at West Canal, a channel of Old River that allows waters of Sacramento-San Joaquin Delta to enter the forebay.

The forebay provides storage for off-peak pumping and permits regulation of flows into the Harvey O. Banks Pumping Plant. Inflows to the forebay are generally made during high tides. Construction of the forebay was completed in December 1969. Aquatic weeds were treated with Komeen® or Nautique® to reduce aquatic weeds that clog and obstruct the primary and secondary trash racks at the Skinner Delta Fish Protective Facility and at Banks Pumping Plant.

Clogging of trash racks at the Skinner Fish Facility has caused a number of unscheduled shutdowns in pumping at Banks Pumping Plant. In response to the operational problems caused by the excessive amounts of aquatic weeds, the first chemical treatment was conducted in May 1995. From 1995 to 2006, complex copper (Komeen® or Nautique®) was applied once or twice annually usually during May or June. Copper-based herbicides have not been applied in Clifton Court Forebay since 2006 with the listing of the North American green sturgeon (*Acipenser medirostris*) as a threatened species.

Future applications of herbicides to control aquatic weeds would not be done until those applications were determined to have little to no detrimental effect on resident salmon, steelhead, or sturgeon. Applications would be based on the life history of each species, their absence during the approved pesticide application dates, and modified operational procedures which help avoid pesticide exposure by the species.

b. Treatment Area

i. Aquatic Weeds

Application Area: Copper-based herbicides were applied to approximately 700 - 1,000 of the 2,180 surface acres in the forebay from 1995 to 2006. Historically, areas with the highest growth of weeds were targeted for treatment. Future application of the herbicides will be to the smallest area possible that provides relief to State Water Project operations.

Treatment Area: Aquatic weed problems in Clifton Court Forebay to 2006 were restricted to about 700 - 1,000 of the 2,180 total surface acres. Copper-based herbicides were applied either by helicopter or boats dispensing the herbicide by subsurface hoses to only those portions where aquatic weeds were abundant. For each application, a map was submitted in the annual report to the Regional Board showing the application area, treatment area, immediately adjacent areas, and water bodies receiving treated water (where applicable).

ii. Algae

Application Area: The nearshore zone of the forebay was treated with copper sulfate to control benthic cyanobacteria. The MIB or geosmin producing cyanobacteria were found in a zone extending out approximately 500 feet from the shoreline. Future application of the herbicides will be to the smallest area possible that provides relief to State Water Project operations.

Treatment Area: Algal problems in Clifton Court Forebay to 2006 were caused by attached benthic cyanobacteria that produce taste and odor compounds. Copper was applied to the nearshore areas of the forebay when results of Solid Phase Microextraction (SPME) analysis exceeded the control tolerances (discussed in section c below). The specific treatment area was variable and for each application, a map was submitted in the annual report to the Regional Board showing the application area, treatment area, immediately adjacent areas, and water bodies receiving treated water (where applicable).

c. Aquatic Weeds and Algae Controlled and Rationale

i. Background

Copper applications in Clifton Court Forebay are conducted to control: 1) aquatic weeds that often restrict the conveyance of water in the SWP and 2) algal blooms (cyanobacteria) that produce taste and odor compounds.

(1) Aquatic Weeds

Aquatic weed accumulation may be so severe that pumping at the Banks Pumping Plant is restricted or halted, and water delivery to the California and South Bay Aqueducts ceases. Six species of the submersed aquatic weeds that are prevalent in Clifton Court Forebay are listed as “Prevalent species in California considered among the world’s most troublesome aquatic weeds” (University of California, 2001.).

The aquatic plant community in 2006 was composed of a mixed assemblage of mostly submersed plants including Egeria (*Egeria densa*), sago pondweed (*Potamogeton pectinalus*), Eurasian watermilfoil (*Myriophyllum spicatum*), coontail (*Cerataphyllum demersum*), American pondweed (P*otamogeton nodosus*), curly-leaf pondweed (*Potamogeton crispus*) and several other taxa of lesser abundance.

(2) Algae

DWR routinely monitors for taste and odor compounds produced by algae. Chemical substances in water that are often associated with earthy, musty smelling or tasting water include geosmin and 2-methylisoborneol (MIB), which are produced in natural and manmade lakes by certain types of algae. Geosmin and MIB are natural by-products of algal chlorophyll production, although not all algae produce them in the same amounts, so the presence of algae alone is not a good indicator of taste and odor problems.

ii. Control Tolerances

(1) Aquatic Weeds

The quantity of aquatic weeds removed from the Skinner trash racks is recorded. Operational problems at Banks Pumping Plant and Skinner Fish Facility begin when approximately 20 cubic yards of aquatic weeds per day are removed from the trash racks.

(2) Algae

Taste and odor – MIB less than 5 ng/L and geosmin less than 10 ng/L are not detected in drinking water by consumers.

Taste and odor production is monitored on a weekly basis using SPME. The taste and odor causing substances MIB and geosmin are reported in parts per trillion (ng/L) concentrations.

d. Algaecides and Aquatic Herbicides Applied and Method of Application

Aquatic herbicide: Copper-based herbicides. Chelated copper products (Komeen® or Nautique®) and copper sulfate pentahydrate crystals were applied in a manner consistent with product labeling.

Application method: Two methods used at Clifton Court Forebay were aerial application by helicopter and subsurface application from boats.

e. Decision to Select Herbicides

i. Aquatic Weeds

No future treatments are planned unless the use of herbicides is determined to have little or no detrimental effect on resident salmon, steelhead, or sturgeon.

ii. Algae

No future treatments using copper-based herbicides are planned unless the use of herbicides is determined to have little or no detrimental effect on resident salmon, steelhead, or sturgeon.

f. Herbicide Dose and Determination

i. Aquatic Weeds

Complex copper was applied according to the label instructions and the depth of the forebay. The application rate was 13 gallons per surface acre.

ii. Algae

Copper sulfate pentahydrate was applied according to the label instructions. The target algae were benthic or attached algae, and the application rate was dependent on the water depth.

g. Gates and Control Structures

Prior to treatment, the radial gates at the Clifton Court Inlet structure will be closed for 24 hours to allow fish to move out of the proposed treatment areas and towards the salvage facility. The radial gates will remain closed for 24 hours after the treatment to allow at least 24 hours of contact time between the herbicide and the treated vegetation in the forebay. Gates will be reopened after a minimum of 48 hours.

h. Exception Period

The Department of Water Resources was granted a section 5.3 exception. Application of copper to Clifton Court Forebay would be carried out only as-needed between July 1 and August 31 dependent on the level of vegetation biomass in the forebay. The frequency of herbicide applications is not expected to occur more than twice per year.

i. Monitoring Plan

See Appendix A. Monitoring of the water column concentrations of copper is proposed during and after herbicide application. No monitoring of the copper concentration in the sediment or detritus is proposed.

j. Procedures to Prevent Sample Contamination

Water quality sampling is conducted by trained DWR staff following established procedures designed to prevent contamination of samples. Sampling guidelines are contained in “Water Quality Field Manual for the State Water Project” produced by DWR.

Procedures that prevent sample contamination include:

- Use clean sample bottles that are non-reactive. Glass and polyethylene bottles are used for SWP water samples.
- Wear gloves that are powder-free vinyl to avoid the contamination associated with latex gloves.

- Samples are immediately placed in an ice chest away from contaminants as soon as the samples are taken.

k. Best Management Practices Implemented

Note: No future treatments are planned unless the use of herbicides is determined to have little or no detrimental effects on resident salmon, steelhead, or sturgeon. If aquatic herbicide applications are allowed in Clifton Court Forebay, the BMPs described below will be implemented. In addition, EarthTec® would be considered as a potential chemical to control algae in the forebay.

Application. Delta Field Division has one licensed Pest Control Advisor (PCA) who also works in the San Luis Field Division and seven Certified Qualified Applicators (QAC). These individuals are trained to ensure that algaecides and aquatic herbicides are applied at rates consistent with label requirements and in a manner that avoids potential adverse effects including, but not limited to, fish kills. The aquatic herbicide use will be consistent with the label instructions. Copper compounds (Komeen® or Nautique®) will be applied by a certified contractor under the supervision of a California Certified Pest Control Advisor. The herbicide will be applied by boat, starting at the shore and moving sequentially farther offshore in its application.

Notification. The Byron-Bethany Irrigation District and SBA water contractors are notified prior to the treatment. Additionally, a PCA will submit a written recommendation for use of the aquatic herbicide to the County Agricultural Commissioner.

Preliminary Site Evaluation. The forebay is surveyed by boat and from shore to determine when and if a chemical treatment is necessary. Based on aquatic weed growth patterns since 1995, DWR determined that one or two aquatic herbicide treatments were required each year to control aquatic weed growth in the forebay. In addition, staff is continuously evaluating different chemical treatment options. In 1999 and 2000, a non-copper based herbicide was tested in experimental plots using Sonar™ (active ingredient is fluridone).

Secondary site evaluations and pre-treatment monitoring are routinely done. The location of treatment sites in the forebay were based on results of a plant survey conducted from a boat. The size and location of the treatment sites and herbicide application rates were determined by location, density, and species of aquatic weeds present. The location and number of acres to be treated are conveyed to the helicopter applicator.

Treatment: Prior to treatment, the radial gates that allow water to enter Clifton Court from Old River are closed. The forebay elevation is also lowered (-1.5 feet) to reduce surface area and thus increase exposure of the target aquatic weeds. The forebay is isolated from the Delta and downstream water users for a period of 36 hours. Following the herbicide label instructions, water is held in the forebay for a period of not less than 24 hours after the herbicide application is completed.

Prior to scheduling the helicopter, staff receives a weather forecast from the DWR meteorologist. Additionally, real-time data on wind direction and speed is collected at the DWR weather station located at the forebay. To minimize herbicide drift, the aerial application is cancelled if continuous wind velocity exceeds 10 mph.

Fish Monitoring: The salvage of listed fish at the Skinner Fish Facility will be monitored prior to the application of the herbicides in Clifton Court Forebay.

Spill Prevention and Cleanup: Delta Field Division staff applies aquatic herbicides according to label instructions in order to prevent spills. In the event of a spill, staff will follow the field division's established emergency response procedures and refers to the material safety data sheet (MSDS) for instructions on containing and cleaning up the spill. Emergency response and MSDS procedures will be reviewed regularly. A copy of the emergency response procedures and material safety data sheets will be available during each treatment. Cleanup equipment will be kept in good working order and will be readily available at each application site.

Water Quality Monitoring: Clifton Court Forebay water quality is monitored on a real-time basis with automated equipment. The station at Clifton Court is equipped with sensors to measure water temperature, turbidity, pH, specific conductance, and algal biomass (flow-through fluorometry). Additional data are obtained near Banks Pumping Plant (about 3 miles from the treatment site). The Banks Pumping Plant water quality station measures the same water quality parameters as Clifton Court. Real-time total and dissolved organic carbon are also measured at Banks Pumping Plant.

Access: No recreational boats are permitted on Clifton Court Forebay except during a limited period during duck hunting season when no herbicide applications are done.

Post-Treatment: The efficacy of the treatment is evaluated about one week after the application. The aquatic weeds are surveyed both by boat and from the shore to determine the effectiveness of the treatment. Water quality conditions are also monitored closely at the Banks Pumping Plant water quality station.

Minimize Treatment Area: The smallest area will be treated that provides relief to State Water Project operations.

l. Possible Alternatives to Algaecide and Aquatic Herbicide Use

i. Evaluation of Management Options

(1) No Action

Since 2006, when application of copper-based herbicides was suspended due to the listing of the North American green sturgeon, aquatic weed biomass increased and coverage expanded to more than 1,000 surface acres.

(2) Prevention

Nutrient Control. Preventive measures involve limiting or eliminating nutrients that support aquatic weed and algae growth. Due to the size of the Delta and the numerous inflows, controlling nutrients is not a realistic preventive control option for Clifton Court Forebay.

(3) Mechanical or Physical Methods

Mechanical Harvesting. Since 2006, when aquatic herbicide application was suspended, a mechanical harvester has been used to remove weeds near the outlet from Clifton Court Forebay. The harvester is used for regular removal of pond weeds to help maintain flows to Skinner Fish Facility and Banks Pumping Plant.

Dredging. Clifton Court Forebay is shallow with many areas less than 2 meters deep allowing light to penetrate to the bottom substrate. Dredging would deepen the forebay and reduce the amount of light available for photosynthesis of rooted aquatic weeds. DWR is evaluating options, costs, and potential environmental impacts from dredging the forebay.

(4) Cultural Methods

Drawdown. A potential method of control would be to lower the water level and control aquatic weeds by desiccation. The major drawback is that draining of the forebay would be required since the nuisance aquatic weeds are rooted to the substrate. A drawdown of two to three weeks to allow for desiccation is not feasible due to demands on water conveyance and pumping.

Dredging. See above discussion under (3) Mechanical or Physical Methods.

(5) Biological Control Agents

Weed Eating Fish. CDFW has approved use of triploid grass carp/white amur (*Ctenopharyngodon idella Val.*) in a few closed water systems in California. Clifton Court Forebay is not a closed system, and fish stocked in the forebay could swim back into the Delta under certain conditions. CDFW is opposed to introducing grass carp in the Delta due to the potential impacts to the sensitive fisheries. Therefore, grass carp would not be an alternative to aquatic herbicides in managing aquatic weeds and algae in the Clifton Court Forebay.

(6) Algaecides and Aquatic Herbicides

In 1999, DWR tested a non-copper based aquatic herbicide to control aquatic weeds. A granular formulation of Sonar™ (SRP) was applied in four 10-acre test plots, and after one month, weed density was compared to untreated controls. We found no significant reduction in aquatic weeds within the Sonar™ treated plots. Although Sonar™ has been effective in a number of lakes, the short residence time in Clifton Court and high water movements combined to reduce its efficacy in the forebay. In 2000, we treated one 50-acre test plot again using the granular Sonar™. Due to the high flushing rate in the forebay, Sonar had no effect on the aquatic weed biomass.

An ongoing program of algal control using algaecides is necessary to minimize the impacts on SBA water quality and quantity.

ii. Decision Matrix to Select the Most Appropriate Formulation

The decision matrix below evaluates the aquatic weed and algae control options identified for Clifton Court Forebay (section i: "Evaluation of Management Options" above).

Decision Making Criteria	No Action	Prevention	Mechanical or Physical	Cultural Methods	Biological Agents	Algaecides and Aquatic Herbicides
Is the impact to the environment low or easily mitigated?	Yes	Yes	Yes	Yes	Yes	Yes
Is the cost of this option reasonable?	N/A	No	No	No	No	Yes
Has (have) the method(s) been effectively implemented at this site?	No	No	Yes	No	No	Yes
Option(s) selected for Clifton Court Forebay.			X			X

3. PATTERSON RESERVOIR

a. Site Description

Patterson Reservoir, an extension of the South Bay Aqueduct (SBA), is a small storage facility located in the boundaries of the San Francisco Bay Regional Water Quality Control Board, Region 2 (Figure 3). The reservoir serves the primary purposes of increasing water reliability by providing water to the Patterson Pass Water Treatment Plant during power interruptions, lowering power costs, and improving quality of delivered water. It has an area of 4.2 acres, a storage capacity of 90 acre-feet (AF), and 0.3 miles of shoreline. Water enters the reservoir from the SBA through a weir at Milepost (MP) 9.36.

b. Treatment Area

The reservoir shoreline is treated by broadcasting the algaecide to control filamentous algae (*Cladophora).*

c. Algae Controlled and Rationale

i. Background

Growth of attached filamentous algae (*Cladophora*) in Patterson Reservoir is a recurring problem that negatively impacts operations at Patterson Pass Water Treatment Plant. Algal biomass and species composition are monitored routinely in Patterson Reservoir during the growing season.

ii. Control Tolerances

Algal fluorescence less than 200 units and algal biomass less than 5,000 mg/m^3 do not cause operational problems to water conveyance or reduction in filter run times at water treatment plants.

Algal biomass and species composition are analyzed directly using the Utermohl technique (inverted microscope method). Algal fluorescence is measured continuously with a Turner 10AU fluorometer. The data are posted daily to the DWR Water Quality website: http://www.water.ca.gov/swp/waterquality/AutostationData/index.cfm.

d. Algaecides and Aquatic Herbicides Applied and Method of Application

i. Aquatic herbicide: Copper sulfate pentahydrate crystals.

Application method: Applications are made by broadcasting or spraying the aquatic herbicide by DWR staff or an approved aquatic herbicide applicator following product label instructions.

ii. Aquatic herbicide: Imazamox. Imazamox is a derivative of ammonium salt of imazamox, the active ingredient in the herbicide Clearcast®. Imazamox is a selective herbicide that controls floating, emergent, and shoreline weed species while allowing non-target species to colonize. The chemical is absorbed through the leaves, stems, and roots of aquatic weeds. Once absorbed by a plant, imazamox inhibits an enzyme essential to the plant's synthesis of three-branched chain amino acids.

As indicated in the U.S. EPA Ecotoxicity Database, imazamox has low toxicity to aquatic life. Imazamox has been granted a tolerance exemption by the U.S. EPA, meaning that there are no food residue limits in fish, shellfish, crustaceans, or irrigated crops.

Application method: Imazamox will be applied to the nearshore areas by broadcasting from the shore or by boat following the product label instructions.

e. Decision to Select Herbicides

DWR's decision to apply copper sulfate or EarthTec® in Patterson Reservoir is based on microscope analysis of algal species composition and biomass. When results indicate that algal biomass exceeds the control tolerances (see c above), an aquatic herbicide application is scheduled.

Early detection of increasing levels of algal biomass allows Patterson Reservoir to be treated early before populations of nuisance algae reach maximum growth. The result is that much lower quantities of the algaecide are needed to reduce algal biomass.

f. Herbicide Dose and Determination

Aquatic herbicides are applied according to the label instructions. The target algae are filamentous algae (*Cladophora*) and the total application dose depends on the water depth and reservoir volume.

g. Gates and Control Structures

There are no gates or control structures at the inlet from the SBA, and the reservoir outlet is directly connected to the Patterson Pass Water Treatment Plant.

h. Exception Period

The Department of Water Resources was granted a section 5.3 exception. Application of copper to Patterson Reservoir would be carried out only on an as-needed basis during the year, after other options have been exhausted. Application of copper sulfate or EarthTec® to the reservoir is required periodically during the growing season to prevent loss in water delivery capacity.

An exception period does not apply to the use of imazamox.

i. Monitoring Plan

See Appendix A.

j. Procedures to Prevent Sample Contamination

Water quality sampling is conducted by trained DWR staff following established procedures designed to prevent contamination of samples. Sampling guidelines are contained in "Water Quality Field Manual for the State Water Project" produced by DWR.

Procedures that prevent sample contamination include:

- Use clean sample bottles that are non-reactive. Glass and polyethylene bottles are used for SWP water samples.
- Wear gloves that are powder-free vinyl to avoid the contamination associated with latex gloves.
- Samples are immediately placed in an ice chest away from contaminants as soon as the samples are taken.

k. Best Management Practices Implemented

Application: Copper sulfate and EarthTec® are applied under the supervision of a certified herbicide applicator. Delta Field Division has one licensed Pest Control Advisor (PCA) who also works in the San Luis Field Division and seven Certified Qualified Applicators (QAC). These individuals are trained to ensure that algaecides and aquatic herbicides are applied at rates consistent with label requirements and in a manner that avoids potential adverse effects including, but not limited to, fish kills.

Notification: Zone 7 Water Agency provides treated municipal water to customers and is notified by email at least 48 hours prior to a treatment. The notification includes the treatment date, time and amount of copper sulfate or EarthTec® being applied. Zone 7 Water Agency has the only intake on Patterson Reservoir. Additionally, a PCA will submit a written recommendation for use of the aquatic herbicide to the County Agricultural Commissioner.

Treatment: Aquatic herbicides are dispensed by broadcasting directly on the algal mats to maximize the herbicide's effectiveness and minimize the amount applied.

Spill Prevention and Cleanup: Staff will apply aquatic herbicides according to label instructions in order to prevent spills. In the event of a spill, staff will follow the field division's established emergency response procedures and refer to the material safety data sheet (MSDS) for instructions on containing and cleaning up the spill. Emergency response and MSDS procedures will be reviewed regularly. A copy of the emergency response procedures and material safety data sheets will be available during each treatment. Cleanup equipment will be kept in good working order and will be readily available at each application site.

Water Quality Monitoring: SBA water quality is monitored continuously by automated instrumentation. The station at Del Valle Check (MP 16.38) is equipped with sensors to measure water temperature, turbidity, pH, specific conductance, and algal biomass (flow-through fluorometry). Additional data are obtained at the Vallecitos Check (MP 22.4) water quality station, which is equipped with water quality instruments that measure water temperature, turbidity, pH, and specific conductance. Further, water quality data from grab samples are available for Santa Clara Terminal Tank (MP 42, about 0.5 miles from the end of the treated section) each month in which water is released from Del Valle Reservoir.

Access: Patterson Reservoir has locked gates that allow access to authorized personnel only. Public access is not allowed, and fishing is not permitted in Patterson Reservoir.

Post-Treatment: The efficacy of the treatment is evaluated one week after the application. Algae are surveyed to determine the effectiveness of the treatment at reducing filamentous algae.

l. Possible Alternatives to Algaecides and Aquatic Herbicide Use

i. Evaluation of Management Options

(1) No Action

If Patterson Reservoir was not treated, algae would severely impact deliveries to Zone 7 Water Agency and to customers in the South Bay region. A "no action" option is therefore not acceptable.

(2) Prevention

Nutrient Control. Some preventive measures involve limiting or eliminating nutrients that support aquatic algal growth. Due to the vast size of the Sacramento-San Joaquin Delta and the numerous inflows, controlling nutrient inputs is not a realistic preventive control option for Patterson Reservoir.

(3) Mechanical or Physical Methods

Use of Rakes or Nets. Filamentous algae can sometimes be controlled by physically removing algae with a rake or net. Due to the rapid rate of growth of the algae during the growing season, this method requires ongoing efforts and an inordinate amount of limited staff resources. Therefore, this control method is not a feasible alternative.

(4) Cultural Method

Drawdown. Lowering the water level with drawdown is a potential method to control some species of algae by desiccation. The major drawback is that a long period of several weeks would be necessary. The resulting negative impact on water deliveries to Zone 7 Water Agency makes this control method unacceptable.

(5) Biological Control Agents

Introduction of Weed Eating Fish. Grass carp/white amur (*Ctenopharyngodon idella* Val.) have been approved for stocking by CDFW under controlled conditions where the water body is a closed system. Patterson Reservoir is connected to the SBA by a weir, and fish could swim out of the reservoir. Therefore, grass carp would not be a feasible alternative to algaecides to manage algae in Patterson Reservoir.

(6) Algaecides and Aquatic Herbicides

Aquatic Herbicide Treatment. An ongoing program of algae control using copper sulfate, EarthTec®, and imazamox is necessary to minimize the impacts on SBA water quality and quantity. Aquatic herbicides have proven to be effective at reducing the target algae without adverse effects on non-target organisms. There are no alternatives to using the aquatic herbicides that are effective at controlling attached algae and registered for use in California. If the SBA was not treated, attached algae would severely impact deliveries to water contractors in the South Bay region.

ii. Decision Matrix to Select the Most Appropriate Formulation

The decision matrix below evaluates the aquatic weed and algae control options identified for Patterson Reservoir (section i: "Evaluation of Management Options" above).

Decision Making Criteria	No Action	Prevention	Mechanical or Physical	Cultural Methods	Biological Agents	Algaecides and Aquatic Herbicides
Is the impact to the environment low or easily mitigated?	Yes	Yes	Yes	Yes	Yes	Yes
Is the cost of this option reasonable?	N/A	No	No	No	No	Yes
Has (have) the method(s) been effectively implemented at this site?	No	No	Yes	No	No	Yes
Option(s) selected for Patterson Reservoir.						X

4. DYER RESERVOIR

a. Site Description

Dyer Reservoir is a small storage facility located in the boundaries of the San Francisco Bay Regional Water Quality Control Board, Region 2 (Figure 4). The reservoir was completed by the Department of Water Resources in 2011 as part the enlargement of the South Bay Aqueduct Branch (SBA) of the California State Water Project. The 43 mile SBA supplies water to three water retailers (Zone 7 Water Agency, Alameda County Water District, and Santa Clara Valley Water Agency) in Alameda and Santa Clara counties in the San Francisco Bay area, serving about two million residents. It currently supplies about 170,000 acre-feet of water a year for ground water replenishment and for six municipal water treatment plants.

Dyer Reservoir serves the primary purposes of increasing water reliability by providing water to treatment plants during power interruptions, lowering power costs, and improving quality of delivered water. The reservoir has a maximum storage capacity of 500 acre-feet, surface area of 24 acres, and a depth of about 25 feet. Water is pumped into the reservoir from the California Aqueduct and discharged into the Dyer Canal, the first aqueduct reach of the SBA.

b. Treatment Area

The entire volume of the reservoir is treated by boat to control planktonic cyanobacteria.

c. Algae Controlled and Rationale

i. Background

Blooms of filter clogging and taste and odor causing cyanobacteria (cyanoHabs) appeared shortly after Dyer Reservoir was completed and filled in 2011. Weekly microscopic analysis identified the main nuisance algae as *Aphanizomenon flos-aquae* and *Anabaena* sp. Phytoplankton biomass and species composition as well as taste and odor compounds are monitored weekly. In addition, samples are analyzed twice monthly from May to October for cyanotoxins (microcystins, anatoxin-a).

ii. Control Tolerances

(1) Taste and Odor

MIB less than 5 ng/L and geosmin less than 10 ng/L are not detected in drinking water by most customers.

Taste and odor production is monitored weekly using Solid Phase Microextraction (SPME). The taste and odor causing substances 2-methylisoborneol (MIB) and geosmin are reported in parts per trillion (ng/L) concentrations.

(2) Filter Clogging

We determined that algal biomass of less than 5,000 mg/m^3 does not cause operational problems to water conveyance or reduction in filter run times at water treatment plants.

Algal biomass and species composition are analyzed directly using an inverted microscope.

d. Herbicides and Application Method

i. Aquatic herbicide: Copper-based herbicides. Chelated copper products (Komeen® or Nautique®), copper sulfate pentahydrate crystals, and EarthTec® are applied in a manner consistent with product labeling.

Application method: Subsurface application from boats is the method used at Dyer Reservoir. The applications are conducted by DWR or an approved aquatic herbicide applicator following product label instructions.

ii. Aquatic herbicide: Imazamox. Imazamox is a derivative of ammonium salt of imazamox, the active ingredient in the herbicide Clearcast®. Imazamox is a selective herbicide that controls floating, emergent, and shoreline weed species while allowing non-target species to colonize. The chemical is absorbed through the leaves, stems, and roots of aquatic weeds. Once absorbed by a plant, imazamox inhibits an enzyme essential to the plant's synthesis of three-branched chain amino acids.

As indicated in the U.S. EPA Ecotoxicity Database, imazamox has low toxicity to aquatic life. Imazamox has been granted a tolerance exemption by the U.S. EPA, meaning that there are no food residue limits in fish, shellfish, crustaceans, or irrigated crops.

Application method: Imazamox will be applied to the nearshore areas from a GPS guided application vessel and following the product label instructions.

iii. Aquatic herbicide: Sodium carbonate peroxyhydrate. Sodium carbonate peroxyhydrate (e.g., PAK®27) is approved for use as an algaecide in California and by the U.S. Environmental Protection Agency (EPA). PAK®27 is also approved under NSF/ANSI Standard 60 (drinking water treatment chemicals). All ingredients in PAK®27 have either Generally Recognized as Safe (GRAS) food additive status from the U.S. Food and Drug Administration (FDA) or exemptions from tolerances from the U.S. EPA.

The active ingredient in PAK®27 is sodium carbonate peroxyhydrate which is an addition compound of sodium carbonate and hydrogen peroxide (H_2O_2). The nominal amount of sodium carbonate peroxyhydrate is 85% in PAK®27 which corresponds to 27.6% H_2O_2. The approved application rate is 3 to 100 pounds per acre-foot.

Application of method: Applications are made by boat and are conducted by DWR or an approved aquatic herbicide applicator following product label instructions.

e. Decision to Use Herbicides

DWR's decision to apply aquatic herbicides in Dyer Reservoir is based on microscope analysis of algae species composition and biomass and the chemical analysis of MIB and geosmin. When results indicate that concentrations of taste and odor compounds or algal biomass exceed the control tolerances (see c above), an aquatic herbicide application is scheduled.

Early detection of increasing levels of algal biomass and taste and odor compounds allows Dyer Reservoir to be treated early before populations of nuisance cyanoHabs reach maximum growth. The result is that much lower quantities of the algaecide are needed to reduce algal biomass and control the taste and odor producing algae.

f. Herbicide Dose and Determination

When selecting an aquatic herbicide for application, DWR will consider factors such as the species to be controlled and the beneficial uses of the water body. The target algae in Dyer Reservoir are planktonic cyanobacteria and the total application dose depends on the water depth and reservoir volume. During PAK®27 treatments, the reservoir elevation is lowered and total volume reduced to about 100 acre-feet resulting in a lower quantity of the algaecide required to effectively control the cyanoHabs. All aquatic herbicide applications will follow product label instructions.

g. Gates and Control Structures

The reservoir inlet and outlet valves are closed prior to applying aquatic herbicides and remain closed for a minimum of six hours. When copper is applied, inlet and outlet valves will remain closed for at least 24 hours.

h. Exception Period

The Department of Water Resources was granted a section 5.3 exception. Application of copper to Dyer Reservoir would be carried out only on an as-needed basis during the year, after other options have been exhausted.

An exception period does not apply to the use of imazamox and sodium carbonate peroxyhydrate since these aquatic herbicides do not contain copper.

i. Monitoring Plan

See Appendix A.

j. Procedures to Prevent Sample Contamination

Water quality sampling is conducted by trained DWR staff following established procedures designed to prevent contamination of samples. Sampling guidelines are contained in "Water Quality Field Manual for the State Water Project" produced by DWR.

Procedures that prevent sample contamination include:

- Use clean sample bottles that are non-reactive. Glass and polyethylene bottles are used for SWP water samples.
- Wear gloves that are powder-free vinyl to avoid the contamination associated with latex gloves.
- Samples are immediately placed in an ice chest away from contaminants as soon as the samples are taken.

k. Best Management Practices Implemented

Application: Copper-based herbicides, imazamox, and sodium carbonate peroxyhydrate (e.g., PAK®27) are applied under the supervision of a certified herbicide applicator such as Clean Lakes, Inc. or by DWR staff. Delta Field Division has one licensed Pest Control Advisor (PCA) who also works in the San Luis Field Division and seven Certified Qualified Applicators (QAC). These individuals are trained to ensure that algaecides and aquatic herbicides are applied at rates consistent with label requirements and in a manner that avoids potential adverse effects including, but not limited to, fish kills.

Notification: The Department's South Bay Water Contractors, who also provide treated municipal water to customers, are notified by email at least 48 hours prior to a treatment. The notification includes the treatment date and time and date and time when releases will resume from Dyer reservoir. The Contractors are Alameda County Flood Control and Water Management District, Zone 7; Alameda County Water District; and Santa Clara Valley Water District. Additionally, a PCA will submit a written recommendation for use of the aquatic herbicide to the County Agricultural Commissioner.

Treatment: Copper-based herbicide treatments are by subsurface application from boats. Imazamox is an aqueous formulation that is broadcast sprayed by subsurface hoses to submerged vegetation. Sodium carbonate peroxyhydrate (PAK®27) is dispensed by subsurface hoses from a boat to maximize the effectiveness of the algaecide.

Spill Prevention and Cleanup: Staff will apply aquatic herbicides (copper-based products, imazamox, or sodium carbonate peroxyhydrate) according to label instructions in order to prevent spills. In the event of a spill, staff will follow the field division's established emergency response procedures and refer to the applicable material safety data sheet (MSDS) for instructions on containing and cleaning up the spill. Emergency response and MSDS procedures will be reviewed regularly. A copy of the emergency response procedures and material safety data sheets will be available during each treatment. Cleanup equipment will be kept in good working order and will be readily available at each application site.

Water Quality Monitoring: SBA water quality is monitored continuously by automated instrumentation. The station at Del Valle Check 7 (MP 16.38) is equipped with sensors to measure water temperature, turbidity, pH, specific conductance, and algal biomass (flow-through fluorometry). Additional data are obtained at the Vallecitos Check (MP 22.4) water quality station, which is equipped with water quality instruments that measure water temperature, turbidity, pH, and specific conductance. Further, water quality data from grab sample are available for Santa Clara Terminal Tank (MP 42, about 0.5 miles from the end of the treated section) each month in which water is released from Del Valle Reservoir.

Access: Most sections are closed to public access with locked gates, and fishing is not permitted in the SBA.

Post-Treatment: The efficacy of the treatment is evaluated one week after the application. Algae are surveyed to determine the effectiveness of the treatment at reducing cyanoHabs and taste and odor compounds are monitored weekly throughout the year.

l. Possible Alternatives to Algaecides and Aquatic Herbicide Use

i. Evaluation of Management Options

(1) No Action

If Dyer Reservoir was not treated, planktonic algae would severely impact deliveries to water contractors in the South Bay region. A "no action" option is therefore not acceptable.

(2) Prevention

Nutrient Control. Some preventive measures involve limiting or eliminating nutrients that support aquatic algal growth. Due to the vast size of the Sacramento-San Joaquin Delta and the numerous inflows, controlling nutrient inputs is not a realistic preventive control option for Dyer Reservoir.

(3) Mechanical or Physical Methods

Planktonic cyanoHabs in Dyer Reservoir are too small to be controlled by mechanical or physical methods.

(4) Cultural Method

Drawdown. Lowering the water level with drawdown is a potential method to control some species of algae by desiccation. The major drawback is that a long period of several weeks would be necessary. Cyanobacteria are extremely tolerant to desiccation; therefore, drawdown is not feasible for Dyer Reservoir.

(5) Biological Control Agents

Introduction of Weed Eating Fish. Grass carp/white amur (*Ctenopharyngodon idella* Val.) have been approved for stocking by the California Department of Fish and Wildlife under controlled conditions where the water body is a closed system. Dyer reservoir is connected to the SBA allowing fish to escape from the reservoir. Therefore, grass carp would not be a feasible alternative to algaecides to manage cyanoHabs algae in Dyer Reservoir.

(6) Algaecides and Aquatic Herbicides

Copper-based herbicides, imazamox, and sodium carbonate peroxyhydrate have been proven to be environmentally safe herbicides that are effective at reducing target aquatic weeds and cyanobacteria without adverse effects on non-target species. If Dyer Reservoir was not treated, taste and odor compounds, and filter clogging algae would have severe impacts on the quality of water deliveries to the three SBA water districts. The early warning plan of high frequency monitoring has greatly reduced the quantity of algaecides applied to Dyer Reservoir.

ii. Decision Matrix to Select the Most Appropriate Formulation

The decision matrix below evaluates the aquatic weed and algae control options identified for Dyer Reservoir (section i: "Evaluation of Management Options" above).

Decision Making Criteria	No Action	Prevention	Mechanical or Physical	Cultural Methods	Biological Agents	Algaecides and Aquatic Herbicides
Is the impact to the environment low or easily mitigated?	Yes	Yes	Yes	Yes	Yes	Yes
Is the cost of this option reasonable?	N/A	No	No	No	No	Yes
Has (have) the method(s) been effectively implemented at this site?	No	No	Yes	No	No	Yes
Option(s) selected for Dyer Reservoir.						X

5. O'NEILL FOREBAY

a. Site Description

O'Neill Forebay is located approximately ten miles west of Los Banos in Merced County and is within the borders of the Central Valley Regional Water Quality Control Board, Region 5 (Figure 5). The forebay has a capacity of 56,400 acre-feet, a surface area of 2,700 acres, 12 miles of shoreline, and a maximum depth of 40 feet.

O'Neill Forebay receives Sacramento-San Joaquin Delta water via the California Aqueduct (SWP) and the Delta-Mendota Canal (federal Central Valley Project). Gianelli Pumping-Generating Plant, operated by DWR, pumps water from O'Neill Forebay into San Luis Reservoir for storage beginning in fall or for temporary storage to generate electricity when water is released from the reservoir back into O'Neill Forebay. During irrigation months, water is released into O'Neill Forebay and into the San Luis Canal (California Aqueduct between Mileposts 70.89 and 172.26) and flows by gravity to Dos Amigos Pumping Plant where it is lifted more than 100 feet to allow gravity flow for 165 miles to the Buena Vista Pumping Plant. Water is lifted at several pumping plants and continues down the California Aqueduct to water contractors serving customers in Southern California.

b. Treatment Area

The smallest area possible that provides relief to the SWP will be treated by boat to control aquatic weeds.

c. Aquatic Weeds Controlled and Rationale

i. Background

Aquatic weeds of concern in O'Neill Forebay include narrow-leaf pondweeds (*Potamogeton* sp.), broad pondweed (*Stuckenia striata*), and sago pondweed (Potamogeton pectinatus *L.)*. Aquatic weeds problems associated with the forebay include clogged trash racks and reduction of water flow into San Luis Reservoir.

d. Herbicides and Application Method

i. **Aquatic herbicide: Copper-based herbicides.** Chelated copper products (Komeen® or Nautique®), copper sulfate pentahydrate crystals, and EarthTec® will be applied in a manner consistent with product labeling.

Application method: Copper-based herbicides will be applied in the forebay by helicopter or boat according to label instructions.

ii. **Aquatic herbicide: Diquat.** Diquat is a contact herbicide that is effective at controlling a broad spectrum of aquatic weeds. Diquat applications typically provide weed control within seven to ten days. Water bodies treated with diquat may be reopened for swimming just after application. Depending on the size of the treatment, water from the treatment area cannot be used for irrigation for 24 to 72 hours.

Application method: Diquat will be applied through injection hoses into the treatment area. Applications are made following label instructions.

iii. **Aquatic herbicide: Endothall.** Endothall is a fast-acting contact herbicide that is effective at controlling aquatic weeds. Endothall works by disrupting the plant's biochemical processes at the cellular level. The dipotassium salt of endothall is used for control of aquatic weeds and is the active ingredient in Aquathol® K (liquid formulation) and Aquathol® Super K Granular.

Application method: Granular formulations of endothall, will be applied by boat using a pellet blower. Liquid formulations of endothall will be applied through injection hoses into the treatment area. Applications will be made following label instructions.

iv. **Aquatic herbicide: Fluridone.** Fluridone (e.g., Sonar®) is a slow-acting systemic herbicide used to control broad-leaved submerged aquatic vegetation (SAV), including Eurasian watermilfoil. Fluridone works by inhibiting the weed's ability to produce carotene, resulting in the degradation of chlorophyll and finally the death of the plant. Since this is a slow process, it is necessary to maintain an adequate concentration of the chemical for a sufficient period of time in order to effectively control aquatic weeds.

Fluridone, applied at the approved concentration rate in accordance with label instructions, has not been found to be toxic to waterfowl and wildlife. The label does not restrict the use of fluridone-treated water for swimming, fishing, or drinking water. However, there is a restriction against the use of fluridone within 1/4 mile of any potable water intake.

Application method: Fluridone will be applied when the target SAV begins active growth. Fluridone will be applied to the nearshore area of the reservoir from a GPS guided application vessel using a granular pellet blower following product label instructions.

v. **Aquatic herbicide: Imazamox.** Imazamox is a derivative of ammonium salt of imazamox, the active ingredient in the herbicide Clearcast®. Imazamox is a selective herbicide that controls floating, emergent, and shoreline weed species while allowing non-target species to colonize. The chemical is absorbed through the leaves, stems, and roots of aquatic weeds. Once absorbed by a plant, imazamox inhibits an enzyme essential to the plant's synthesis of three-branched chain amino acids.

As indicated in the U.S. EPA Ecotoxicity Database, imazamox has low toxicity to aquatic life. Imazamox has been granted a tolerance exemption by the U.S. EPA, meaning that there are no food residue limits in fish, shellfish, crustaceans, or irrigated crops.

Application method: Imazamox will be applied to the nearshore areas of the forebay from a GPS guided application vessel following the product label instructions.

vi. **Aquatic herbicide: Triclopyr.** Triclopyr (e.g., Renovate®) is a systemic broadleaf herbicide. This product is effective against Eurasian watermilfoil and is not a restricted use material. Triclopyr is approved by the EPA for use in potable water reservoirs provided setback buffers are created and maintained between the application site and the location of the intake. The set back distance is a function of the application rate selected for use. The buffers allow dilution to occur and ensure that herbicide ingredients that might reach the intake will be below the applicable federal drinking water tolerances. Triclopyr is a desirable tool for controlling Eurasian watermilfoil because of the systemic and selective nature of the herbicide.

Application method: Triclopyr is applied to O'Neill Forebay to control aquatic weeds including sago pondweed (*Stuckenia pectinata*) that grow in the littoral zone. The amount of herbicide applied varies and is a function of the surface area of the treatment site, average water depth of the site, and recommended application rate. Renovate® OTF granular formulation, or other triclopyr product, is applied from a GPS guided application vessel using a combination of granular pellet blower and eductor systems following product label instructions.

e. Decision to Use Herbicides

The decision to apply aquatic herbicides is made when aquatic weeds have the potential to negatively affect the beneficial uses of the forebay. Early treatment of aquatic weeds before the plant populations reach maximum biomass will allow DWR to reduce the quantity of aquatic herbicide needed to control the nuisance species.

f. Herbicide Dose and Determination

When selecting an aquatic herbicide for application, DWR will consider factors such as the species to be controlled and the beneficial uses of the forebay to ensure the most appropriate herbicide is applied. The selected aquatic herbicide (fluridone, imazamox, or triclopyr) will be applied according to the label instructions. The target species in O'Neill Forebay are

aquatic weeds such as sago pondweed. The total application dose depends on the water depth and volume.

g. Gates and Control Structures

Pumping from O'Neill Forebay to San Luis Reservoir will be curtailed during the aquatic weed application.

h. Exception Period

In 2004, DWR was granted a section 5.3 exception to treat several SWP water bodies with copper-based herbicides. In 2014, DWR applied for a section 5.3 exception to apply copper to O'Neill Forebay. Application of copper-based herbicides to the forebay at regular intervals throughout the growing season will help prevent loss in water delivery capacity. Application of copper to O'Neill Forebay would be carried out only on an as-needed basis during the year. An exception period does not apply to the use of diquat, endothall, fluridone, imazamox, and triclopyr since copper is not an active ingredient of these aquatic herbicides.

i. Monitoring Plan

See Appendix A.

j. Procedures to Prevent Sample Contamination

Water quality sampling is conducted by trained DWR staff following established procedures designed to prevent contamination of samples. Sampling guidelines are contained in "Water Quality Field Manual for the State Water Project" produced by DWR.

Procedures that prevent sample contamination include:

- Use clean sample bottles that are non-reactive. Glass and polyethylene bottles are used for SWP water samples.
- Wear gloves that are powder-free vinyl to avoid the contamination associated with latex gloves.
- Samples are immediately placed in an ice chest away from contaminants as soon as the samples are taken.

k. Best Management Practices Implemented

Application: Copper-based herbicides, diquat, endothall, fluridone, imazamox, and triclopyr are applied under the supervision of a certified herbicide applicator by a contractor or DWR staff. San Luis Field Division has four Certified Qualified Applicators (QAC). In addition, this field division shares a Pest Control Adviser (PCA) with the Delta Field Division. These individuals are trained to ensure that algaecides and aquatic herbicides are applied at rates consistent with label requirements and in a manner that avoids potential adverse effects including, but not limited to, fish kills.

Notification: State Water Contractors are notified by email at least 48 hours prior to a treatment. The notification includes the type of aquatic herbicide applied, surface area, and treatment date and time. Additionally, a PCA will submit a written recommendation for use of the aquatic herbicide to the County Agricultural Commissioner.

Treatment: Granular formulations of endothall, fluridone and triclopyr are applied by boat using a pellet blower. Diquat, endothall (Aquathol®K), and imazamox (e.g., Clearcast®) are aqueous formulations that are broadcast sprayed or applied by subsurface hoses to submerged vegetation.

Helicopter. Copper sulfate pentahydrate will be applied aerially by helicopter following product label instructions. DWR will obtain a weather forecast and monitor wind direction and speed prior to treatment. To minimize herbicide drift, the aerial application will be cancelled if continuous wind velocity exceeds 10 mph.

Spill Prevention and Cleanup: Staff will apply aquatic herbicides according to label instructions in order to prevent spills. In the event of a spill, staff will follow the field division's established emergency response procedures and refer to the applicable material safety data sheet (MSDS) for instructions on containing and cleaning up the spill. Emergency response and MSDS procedures will be reviewed regularly. A copy of the emergency response procedures and material safety data sheets will be available during each treatment. Cleanup equipment will be kept in good working order and will be readily available at each application site.

Water Quality Monitoring: O'Neill Forebay water quality is monitored continuously by automated instrumentation. The automated station at California Aqueduct Check 13 (MP 70.89) is equipped with sensors to measure water temperature, turbidity, pH, specific conductance, and UVA-254 absorbance. Additional data are obtained from monthly grab samples collected at this station. The analytical results of these grab samples are available online through DWR's Water Data Library (http://www.water.ca.gov/waterdatalibrary/).

Access: O'Neill Forebay is open to the public for recreational use. The forebay will be closed to the public during aquatic herbicide applications.

Post-Treatment: The efficacy of the treatment is evaluated one week after the application.

l. Possible Alternatives to Aquatic Herbicide Use

i. Evaluation of Management Options

(1) No Action

If O'Neill Forebay was not treated, aquatic weeds would impact pumping into San Luis Reservoir and deliveries to water contractors. A "no action" option is therefore not acceptable.

(2) Prevention

Nutrient Control. Some preventive measures involve limiting or eliminating nutrients that support aquatic algal growth. Due to the vast size of the Sacramento-San Joaquin Delta and the numerous inflows, controlling nutrient inputs is not a realistic preventive control option for O'Neill Forebay.

(3) Mechanical or Physical Methods

Mechanical Harvesting. Aquatic weeds are harvested during the summer and fall months with a mechanical weed harvester. The weed harvester mows aquatic weeds near the intake channel to Gianelli Pumping-Generating Plant during the summer and fall to increase water delivery. Harvesting is labor intensive and the area cleared of aquatic weeds daily is minor compared to the total area of the forebay impacted by weeds.

(4) Cultural Method

Drawdown. Operation of O'Neill Forebay prevents lowering the water elevation sufficiently to expose aquatic weeds to desiccation for the required time period; therefore drawdown is not feasible for O'Neill Forebay.

(5) Biological Control Agents

Introduction of Weed Eating Fish. Grass carp/white amur (*Ctenopharyngodon idella* Val.) have been approved for stocking by the California Department of Fish and Wildlife under controlled conditions where the water body is a closed system. However, feeding by this species is initially selective, and as sources of preferred weeds become scarce, feeding will continue on other plants which can result in reduction of native vegetation needed for game fish habitat. In addition, O'Neill Forebay is connected to both San Luis Reservoir and the California Aqueduct which would allow fish movement out of the Forebay. Therefore, grass carp would not be a feasible alternative to aquatic herbicides to manage aquatic weeds in O'Neill Forebay.

(6) Algaecides and Aquatic Herbicides

Aquatic Herbicide Treatment. Fluridone, imazamox, and triclopyr have been proven to be environmentally safe herbicides that are effective at reducing target aquatic weeds without adverse effects on non-target species. If O'Neill Forebay was not treated, aquatic weeds would negatively impact agricultural, municipal and industrial water deliveries in the SWP.

ii. Decision Matrix to Select the Most Appropriate Formulation

The decision matrix below evaluates the aquatic weed and algae control options identified for O'Neill Forebay (section i: "Evaluation of Management Options" above).

Decision Making Criteria	No Action	Prevention	Mechanical or Physical	Cultural Methods	Biological Agents	Algaecides and Aquatic Herbicides
Is the impact to the environment low or easily mitigated?	Yes	Yes	Yes	Yes	Yes	Yes
Is the cost of this option reasonable?	N/A	No	No	No	No	Yes
Has (have) the method(s) been effectively implemented at this site?	No	No	Yes	No	No	Yes
Option(s) selected for O'Neill Forebay.						X

6. COASTAL BRANCH AQUEDUCT

a. Site Description

The Coastal Branch Aqueduct originates at California Aqueduct at Milepost (MP) 184.63 near Kettleman City and extends 115 miles to near Vandenberg Air Force Base in San Luis Obispo County (Figure 6). Most of the aqueduct system consists of enclosed pipelines and tunnels. Algae and attached weed problems are restricted to the first 14.8-mile open section of the aqueduct beginning at the junction of the California Aqueduct to Devil's Den Pumping Plant. The treated section is within the boundaries of the Central Valley Regional Water Quality Control Board (Region 5).

b. Treatment Areas

Application Area: Copper-based herbicides are applied at one to three locations: MP 0.2 and, when necessary, Badger Hill Pumping Plant (MP 4.3) and Devil's Den Forebay.

Treatment Area: The treatment area is the aqueduct from MP 0.2 to Bluestone Pumping Plant at MP 19.0.

c. Aquatic Weeds and Algae Controlled and Rationale

i. Background

Copper sulfate crystals have been used since 1985 to control clogging problems caused by attached algae (*Cladophora*), aquatic weeds including horned pondweed (*Zannichellia palustris* L.) and sago pondweed (*Potamogeton pectinalus*), and taste and odor producing cyanobacteria at turnouts, forebays, and trash racks at the three pumping plants. Copper-based herbicides are applied during the growth season which typically runs from April to October. Sodium carbonate peroxyhydrate (e.g., PAK®27) may be applied to the forebays to control cyanobacteria.

ii. Control Tolerances

Taste and odor – MIB less than 5 ng/L and geosmin less than 10 ng/L are not detected by consumers in drinking water supplies.

Taste and odor production is monitored using Solid Phase Microextraction (SPME). The taste and odor causing substances, 2-methylisoborneol (MIB) and geosmin are reported in parts per trillion (ng/L) concentrations.

Filter clogging – High accumulation of aquatic weeds and algae on turnouts and trash racks at the pumping plants may result in complete plant shutdown or reduced pumping. Copper-based herbicides are applied when aquatic weeds and algae create operational problems.

d. Aquatic Herbicides Applied and Method of Application

i. Aquatic herbicide: Copper-based herbicides. Chelated copper products (Komeen® or Nautique®), copper sulfate pentahydrate crystals, and EarthTec® are applied in a manner consistent with product labeling.

Application method: Copper-based herbicides are applied according to label instructions at two to four sites in the aqueduct.

ii. Aquatic herbicide: Sodium carbonate peroxyhydrate (e.g., PAK®27).

Application method: PAK®27 is applied to the CBA according to label instructions.

e. Decision to Select Herbicides

The decision to treat the CBA with copper-based algaecides is made when water operations begin to be impacted by algae or aquatic weeds clogging turnouts and trash racks and reducing water flow. The application dose rate is determined by water flow rate in the aqueduct and the target species.

Preliminary site evaluation is done to determine the timing of a copper-based herbicide application. Based on data since 1985, DWR determined that treatments are needed to control algae and aquatic weeds during the growth season which usually runs from April to October. The treatment schedule is based on visual inspection of the Aqueduct, accumulation of plant material on trash racks, and reduced flows at the pumping plants.

Copper-based herbicides have proven to be effective at reducing the target aquatic weeds and algae without adverse effects on non-target organisms. Sodium carbonate peroxyhydrate (e.g., PAK®27) is also an effective algaecide identified for use in the forebays. There are no alternatives to copper-based herbicides and sodium carbonate peroxyhydrate that are effective at controlling aquatic weeds and algae and registered for use in California. If the Coastal Branch Aqueduct was not treated, aquatic weeds and algae could severely impact deliveries to water users in the Central Coast region and the Berrenda Mesa Water District.

f. Herbicide Dose and Determination

Copper–based herbicides are applied consistent with product labeling instructions for the control of algae and aquatic weeds. Sodium carbonate peroxyhydrate (e.g., PAK®27) is applied according to the label instructions and is used to control cyanobacteria in the forebays of the Coastal Branch Aqueduct.

g. Gates and Control Structures

Not applicable.

h. Exception Period

The Department of Water Resources was granted a section 5.3 exception. Application of copper to the Coastal Branch Aqueduct would be carried out only on an as-needed basis during the year. Application of copper-based herbicides to the aqueduct is required at regular intervals throughout the growing season to prevent loss in water delivery capacity. An exception period does not apply to the use of sodium carbonate peroxyhydrate since copper is not an active ingredient of that algaecide.

i. Monitoring Plan

See Appendix A.

j. Procedures to Prevent Sample Contamination

Water quality sampling is conducted by trained DWR staff following established procedures designed to prevent contamination of samples. Sampling guidelines are contained in "Water Quality Field Manual for the State Water Project" produced by DWR.

Procedures that prevent sample contamination include:

- Use clean sample bottles that are non-reactive. Glass and polyethylene bottles are used for SWP water samples.
- Wear gloves that are powder-free vinyl to avoid the contamination associated with latex gloves.
- Samples are immediately placed in an ice chest away from contaminants as soon as the samples are taken.

k. Best Management Practices Implemented

Application: San Joaquin Field Division (SJFD) has two licensed Pest Control Advisors (PCA) and 15 Certified Qualified Applicators (QAC). These individuals are trained to ensure that algaecides and aquatic herbicides are applied at rates consistent with label requirements and in a manner that avoids potential adverse effects. Copper sulfate has been used in the Coastal Branch Aqueduct since about 1985 to control clogging problems at trash racks and pumping plants caused by attached algae (*Cladophora*) and aquatic weeds including horned pondweed (*Zannichellia palustris* L.). The copper sulfate applications are directed under the supervision of a PCA, and the use of copper sulfate is consistent with label instructions in order to avoid adverse effects including, but not limited to, fish kills.

Sodium carbonate peroxyhydrate (e.g., PAK®27) is applied under the supervision of a certified herbicide applicator by a contractor or DWR staff. PAK®27 is used to control cyanobacteria in the forebays of the Coastal Branch Aqueduct.

Spill Prevention and Cleanup: Staff will apply copper-based compounds and sodium carbonate peroxyhydrate (e.g., PAK®27) according to label instructions in order to prevent spills. In the event of a spill, staff will follow the field division's established emergency response procedures and refer to the applicable material safety data sheet (MSDS) for instructions on containing and cleaning up the spill. Emergency response and MSDS procedures will be reviewed regularly. A copy of the emergency response procedures and material safety data sheets will be available during each treatment. Cleanup equipment will be kept in good working order and will be readily available at each application site.

Notification: Downstream water users that could be impacted by a copper-based herbicide or sodium carbonate peroxyhydrate application are notified prior to a treatment. The notified water users are Berrenda Mesa Water District and Central Coast Water Authority. Additionally, a PCA will submit a written recommendation for use of the aquatic herbicide to the County Agricultural Commissioner.

Treatment: Copper-based herbicides are applied during the daylight hours of maximum photosynthetic activity to optimize copper uptake by the aquatic vegetation. Sodium carbonate peroxyhydrate is dispensed by subsurface hoses from a boat to maximize the effectiveness of the algaecide.

Access: There are no recreational activities in the Coastal Aqueduct and most sections are inaccessible to the public with locked gates and fences.

l. Possible Alternatives to Algaecides and Aquatic Herbicide Use

i. Evaluation of Management Options

(1) No Action

If Coastal Branch Aqueduct was not treated, algae and aquatic weeds would severely impact deliveries to water users. A "no action" option is therefore not feasible.

(2) Prevention

Nutrient Control. Some preventive measures involve limiting or eliminating nutrients that support aquatic weed and algal growth. Due to the vast size of the Sacramento-San Joaquin Delta and the numerous inflows, controlling upstream nutrient loading is not a realistic preventive control option for the Coastal Branch Aqueduct.

(3) Mechanical or Physical Methods

Scraping of Aqueduct. DWR routinely removes aquatic weeds and algae by dragging a large chain along the aqueduct lining. The method removes algae and aquatic weeds but is time consuming and requires a large expenditure of

manpower. The procedure provides a short-term solution and must be repeated frequently to reduce the impact of aquatic vegetation on water conveyance.

Self-Cleaning Trash Racks. A travelling screen is installed at the forebay to Devil's Den Pumping Plant at MP 14.8. The travelling screen is effective when aquatic weed biomass is low but when weeds are abundant, removal of the weeds from the screen must be assisted with one to two DWR staff working nearly continuously during the peak weed season.

Floating Weed Boom Deflector. DWR staff is investigating installation of a weed deflection system at the California Aqueduct to deflect floating aquatic weeds past the Coastal Aqueduct intake channel. During the early weed season, the main contribution of aquatic weeds is from weeds grown upstream in the 100 miles aqueduct section below the Dos Amigos Pumping Plant. These weeds break off and are entrained into the Coastal Aqueduct. The floating boom would be installed at an angle or arc to deflect floating weeds but not impede flow in the main aqueduct. Several designs are being evaluated.

(4) Cultural Methods

Drawdown. Drawdown is a potential method that entails lowering the water level to control algae by desiccation. The major drawback is that a long period of two to three weeks would be necessary. A drawdown of that length of time would be difficult due to demands on water conveyance and pumping. Therefore, drawdown is not feasible for the Coastal Branch Aqueduct.

(5) Biological Control Agents

Introduction of Weed Eating Fish. Grass carp/white amur (*Ctenopharyngodon idella* Val.) have been approved for stocking by the California Department of Fish and Wildlife under controlled conditions where the water body is a closed system. Water from the Coastal Branch Aqueduct could not be completely isolated from the main California Aqueduct and the stocked fish could potentially escape from the Coastal Branch Aqueduct. Therefore, grass carp would not be an alternative to copper–based compounds in managing algae and aquatic weeds in the Coastal Branch Aqueduct.

(6) Algaecides and Aquatic Herbicides

Copper-based herbicides have proven to be effective at reducing the target aquatic weeds and algae without adverse effects on non-target organisms. Sodium carbonate peroxyhydrate (e.g., PAK®27) is also an effective algaecide identified for use in the forebays of the Coastal Branch Aqueduct to control cyanobacteria. There are no alternatives to using the copper herbicides and sodium carbonate peroxyhydrate that are effective at controlling attached weeds and cyanobacteria and registered for use in California. If the Coastal Branch Aqueduct was not treated, algae and aquatic weeds would negatively affect water delivery and quality.

ii. Decision Matrix to Select the Most Appropriate Formulation

The decision matrix below evaluates the aquatic weed and algae control options identified for the Coastal Branch Aqueduct (section i: "Evaluation of Management Options" above).

Decision Making Criteria	No Action	Prevention	Mechanical or Physical	Cultural Methods	Biological Agents	Algaecides and Aquatic Herbicides
Is the impact to the environment low or easily mitigated?	Yes	Yes	Yes	Yes	Yes	Yes
Is the cost of this option reasonable?	N/A	No	Yes	No	No	Yes
Has (have) the method(s) been effectively implemented at this site?	No	No	No	No	No	Yes
Option(s) selected for the Coastal Branch Aqueduct.						X

7. EAST BRANCH AQUEDUCT

a. Site Description

The California Aqueduct divides into two branches at Tehachapi Afterbay at Milepost (MP) 304.02. The West Branch extends for 32 miles passing through Pyramid Lake to the terminus at Castaic Lake. The East Branch continues about 140 miles from the bifurcation with the West Branch to its terminus at Lake Perris at MP 443 and is within the boundaries of the Lahontan Regional Water Quality Control Board, Region 6 (Figures 7 - 9).

b. Treatment Areas

Application Area: Dependent on the location of the source of taste and odor production as determined by Solid Phase Microextraction (SPME) analysis.

Treatment Area: The specific area is variable and dependent on the location of the source of taste and odor production as determined by monitoring and SPME analysis. For each application, a map will be submitted in the annual report to the State Water Resources Control Board showing the application area, treatment area, immediately adjacent areas, and water bodies receiving treated water (where applicable).

c. Weeds Controlled and Rationale

i. Background

Off-flavor compounds, MIB and geosmin, produced by attached cyanobacteria in the East Branch of the California Aqueduct have been controlled with copper sulfate since about 1991. The most troublesome portion for taste and odor problems is located between MP 326 and MP 403. Copper sulfate has also been applied to the first and second Devil Canyon Afterbays to control the attached cyanobacterial genera, *Phormidium* and *Oscillatoria*. Treatment with copper sulfate and EarthTec® is limited to the aqueduct pools where taste and odor producing cyanobacteria are present.

ii. Control Tolerances

Taste and odor – MIB less than 5 ng/L and geosmin less than 10 ng/L are not detected by consumers in drinking water supplies.

Taste and odor production is monitored weekly using SPME. The taste and odor causing substances 2-methylisoborneol (MIB) and geosmin are reported in parts per trillion (ng/L) concentrations.

d. Herbicides and Application Method

i. Aquatic herbicide: Copper-based herbicides. Chelated copper products (CaptainXTR®), copper sulfate pentahydrate crystals, and EarthTec® are applied in a manner consistent with product labeling.

Application method: Copper-based products are applied according to label instructions.

ii. Aquatic herbicide: Sodium carbonate peroxyhydrate (e.g., PAK®27).

Application method: PAK®27 is applied to the EBA according to label instructions.

e. Decision to Use Herbicides

A comprehensive early warning plan developed cooperatively between DWR and Metropolitan Water District of Southern California (MWD) minimizes the quantity of aquatic herbicides required to control taste and odor production and helps to determine optimal timing of the application. The strategy involves ongoing weekly or biweekly monitoring of the taste and odor compounds, MIB and geosmin, in the aqueduct, reservoirs, and MWD's water treatment plants. Elevated levels of MIB or geosmin trigger additional high frequency monitoring at additional locations.

Secondary site evaluations and pre-treatment monitoring are routinely done. The decision to treat the Aqueduct with aquatic herbicides is made after evaluating the results of taste and odor analysis by Solid Phase Micro-extraction (SPME). The application dose rate of herbicide is determined by water flow rate in the aqueduct following label instructions.

f. Herbicide Dose and Determination

Copper–based herbicides and sodium carbonate peroxyhydrate are applied in a manner consistent with product labeling.

g. Gates and Control Structures

Not applicable.

h. Exception Period

The Department of Water Resources was granted a section 5.3 exception. Application of copper to the East Branch Aqueduct would be carried out only on an as-needed basis during the year, after other options have been exhausted. Application of copper sulfate or EarthTec® to the aqueduct is required at regular intervals throughout the growing season to prevent loss in water delivery capacity. However, copper treatments may also be necessary at other times of the year. An exception period does not apply to the use of sodium carbonate peroxyhydrate since copper is not an active ingredient of this algaecide.

i. Monitoring Plan

See Appendix A.

j. Procedures to Prevent Sample Contamination

Water quality sampling is conducted by trained DWR or MWD staff following established procedures designed to prevent contamination of samples. Sampling guidelines are contained in "Water Quality Field Manual for the State Water Project" produced by DWR.

Procedures that prevent sample contamination include:

- Use clean sample bottles that are non-reactive. Glass and polyethylene bottles are used for SWP water samples.
- Wear gloves that are powder-free vinyl to avoid the contamination associated with latex gloves.
- Samples are immediately placed in an ice chest away from contaminants as soon as the samples are taken.

k. Best Management Practices Implemented

Application: Southern Field Division has two licensed Pest Control Advisors (PCAs) and six to eight certified Qualified Applicators (QAC). These individuals are trained to ensure that algaecides and aquatic herbicides are applied at rates consistent with label requirements and in a manner that avoids potential adverse effects including, but not limited to, fish kills.

Off-flavor compounds, MIB and geosmin, produced by cyanobacteria in the East Branch of the California Aqueduct have been controlled with copper-based herbicides since about 1991.

Use of sodium carbonate peroxyhydrate (PAK®27) in the EBA was first considered in 2013. It is applied under the supervision of one of DWR's QACs or by a contract certified herbicide applicator.

Notification: Downstream water users are notified prior to a copper-based herbicide or sodium carbonate peroxyhydrate treatment. Additionally, a PCA will submit a written recommendation for use of the aquatic herbicide to the County Agricultural Commissioner.

Spill Prevention and Cleanup: Staff will apply aquatic herbicides according to label instructions in order to prevent spills. In the event of a spill, staff will follow the field division's established emergency response procedures and refer to the applicable material safety data sheet (MSDS) for instructions on containing and cleaning up the spill. Emergency response and MSDS procedures will be reviewed regularly. A copy of the emergency response procedures and material safety data sheets will be available during each treatment. Cleanup equipment will be kept in good working order and will be readily available at each application site.

Treatment: Prior to treatment, the water contractors are notified. Copper-based herbicides are applied during the daylight hours of maximum photosynthetic activity to optimize copper uptake by attached cyanobacteria. Sodium carbonate peroxyhydrate is applied to the water's surface using a broadcast spreader with a hopper to control the rate of application.

Access: There are limited recreational activities in the East Branch Aqueduct, and most sections are inaccessible to the public due to locked gates.

Minimize Treatment Area: Only those specific sections or Aqueduct "pools" where attached cyanobacteria grow are treated to minimize cost, use, and secondary impacts.

l. Possible Alternatives to Algaecides and Aquatic Herbicide Use

i. Evaluation of Management Options

(1) No Action

If East Branch Aqueduct was not treated with aquatic herbicides, elevated concentrations of taste and odor compounds would severely impact the quality of water delivered to MWD. A "no action" option is therefore not feasible.

(2) Prevention

Nutrient Control. Some preventive measures involve limiting or eliminating nutrients that support aquatic weed and algal growth. Due to the vast size of the Sacramento-San Joaquin Delta and the numerous inflows, controlling upstream nutrient loading is not a realistic preventive control option for the East Branch Aqueduct.

(3) Mechanical or Physical Methods

Mechanical Removal. DWR has evaluated physical and mechanical methods to control aquatic weeds. Mechanical removal such as dragging a large chain with a crane along the aqueduct has been evaluated. The method would be expensive, labor intensive and result in potential damage to the concrete aqueduct lining. In addition, the chain could not be used upstream of any water turnouts. The procedure would break off large amounts of attached algae that could clog the water intakes.

(4) Cultural Methods

Drawdown. Lowering the water level with drawdown is a potential method to control some species of algae by desiccation; however, cyanobacteria are also extremely tolerant to desiccation. One major drawback is that a long period of several weeks would be necessary and a drawdown of that duration would be difficult due to demands on water conveyance and pumping. An additional problem with drawdown is that damage to the concrete aqueduct panels was found when the water level in pools was reduced to below where the cyanobacteria grow. Therefore, drawdown is not feasible to control attached cyanobacteria in the East Branch Aqueduct.

(5) Biological Control Agents

Introduction of Weed Eating Fish. Grass carp/white amur (*Ctenopharyngodon idella* Val.) have been approved for stocking by the California Department of Fish and Wildlife under controlled conditions where the water body is a closed system. Water from the East Branch Aqueduct could not be isolated from Silverwood Lake and Lake Perris where the carp could graze on native aquatic vegetation and also compete with native fishes. Therefore, grass carp would not be an alternative to copper-based herbicides in managing taste and odor production in the East Branch Aqueduct.

(6) Algaecides and Aquatic Herbicides

Aquatic Herbicide Treatments. Copper-based herbicides have proven to be effective at reducing the targeted taste and odor producing cyanobacteria with minimal adverse effects to non-target organisms. Sodium carbonate peroxyhydrate (e.g., PAK®27) has proven to be an environmentally safe algaecide that is effective at reducing target cyanobacteria without adverse effects on non-target species. There are no alternatives to aquatic herbicides that are effective at controlling attached cyanobacteria and registered for use in California. If the East Branch Aqueduct was not treated, taste and odor products produced by attached cyanobacteria would negatively impact the quality of water delivered to Metropolitan Water District.

ii. Decision Matrix to Select the Most Appropriate Formulation

The decision matrix below evaluates the algal control options identified for the East Branch Aqueduct (section i: “Evaluation of Management Options” above).

Decision Making Criteria	No Action	Prevention	Mechanical or Physical	Cultural Methods	Biological Agents	Algaecides and Aquatic Herbicides
Is the impact to the environment low or easily mitigated?	Yes	Yes	Yes	Yes	Yes	Yes
Is the cost of this option reasonable?	N/A	No	No	No	No	Yes
Has (have) the method(s) been effectively implemented at this site?	No	No	No	No	No	Yes
Option(s) selected for the East Branch Aqueduct.						X

8. PYRAMID LAKE

a. Site Description

Pyramid Lake is a reservoir on the West Branch of the California Aqueduct at Milepost (MP) 14.10 within the boundaries of the Los Angeles Regional Water Quality Control Board, Region 4 (Figure 10). It has a surface area of 1,300 acres, a storage capacity of 171,200 acre-feet (AF), a length of 25,300 feet, and 21 miles of shoreline.

As a SWP reservoir, Pyramid Lake stores water that is delivered to the City of Los Angeles and other cities of Southern California. It also provides regulated storage for Castaic Powerplant, flood protection along Piru Creek, emergency storage for water deliveries from the West Branch, and various recreational uses including fishing, swimming, and boating.

b. Application and Treatment Areas

i. Aquatic Weeds

Application Area: Every year the application area will be determined based on the results of a vegetation survey and after analysis of impacts to beneficial uses.

Treatment Area: The specific area is variable and dependent on the location of aquatic weeds. For each application, a map will be submitted in the annual report to the State Water Resources Control Board showing the application area, treatment area, immediately adjacent areas, and water bodies receiving treated water (where applicable).

ii. Algae

Application Area: The application area is dependent on the location of the source of taste and odor production as determined by Solid Phase Microextraction analysis (SPME).

Treatment Area: The specific area is variable and dependent on the location of the source of taste and odor production as determined by monitoring and SPME analysis. For each application, a map will be submitted in the annual report to the State Water Resources Control Board showing the application area, treatment area, immediately adjacent areas, and water bodies receiving treated water (where applicable).

c. Aquatic Weeds and Algae Controlled and Rationale

i. Background

Aquatic herbicides are applied to Pyramid Lake to manage taste and odor problems produced by cyanobacteria. In recent years, Pyramid Lake has experienced an increasing number of algal blooms. Production of 2-methylisoborneol (MIB) and geosmin by cyanoHabs results in earthy, musty, and fishy tastes and odors in the water supply. In addition, some species of cyanobacteria produce algal toxins that may be harmful to human and animal health. Cyanobacteria species identified in the lake have included *Microcystis* sp., *Gloeotrichia* sp., and *Anabaena* sp.

Pyramid Lake is subject to infestations of aquatic weeds including coontail (*Ceratohyllum* demersum), Eurasian watermilfoil (*Myriophyllum spicatum*), and sago pondweed (*Stuckenia pectinata*). Problems associated with coontail include crowding out of other plant species and interference with recreational uses of the lake. Eurasian watermilfoil can grow up to one foot per week and reach the lake surface from depths of up to 25 feet. It forms dense mats that clog the lake surface. This species, if uncontrolled, shades out native aquatic plants in the lake. The native species then die back and may be replaced by non-native species. Eurasian watermilfoil beds can become so dense in Pyramid Lake that they create a hazard for swimmers who become entangled in the plants.

ii. Control Tolerances

(1) Algae

MIB less than 5 ng/L and geosmin less than10 ng/L are not detected in drinking water by most customers.

Taste and odor production is monitored weekly using SPME. The taste and odor causing substances, MIB and geosmin are reported in parts per trillion (ng/L) concentrations.

(2) Aquatic Weeds

Control tolerances for aquatic weeds are based on a number of factors. Beneficial uses and the impact of the weed growth on those uses is a primary determining factor when using integrated aquatic plant management technologies to control weed growth. The factors critical to Pyramid Lake are:

- Eurasian watermilfoil is a non-native invasive aquatic weed that has been described by the U.S. Congress Office of Technology as a "harmful non-indigenous species."
- Eurasian watermilfoil alters the water quality and species diversity of Pyramid Lake.

- Heavy infestations of weeds such as Eurasian watermilfoil have been shown to cause taste and odor problems in drinking water supplies.
- As this invasive weed spreads from lake to lake on boat trailers, the presence of this weed in Pyramid Lake is a threat to all other water bodies in the region that might be visited by vessels leaving the lake.

The tolerance for invasive aquatic species should be extremely low and eradication of this class of plants is often a desired outcome, if technically possible. The tolerance for the presence of aquatic weed growth, particularly coontail and Eurasian watermilfoil, in the community beach areas is zero. The presence of dense plant beds is a direct threat to swimmer safety as described above.

d. Herbicides and Application Method

i. Aquatic herbicide: Copper-based herbicides. Copper-based herbicides have proven to be effective at reducing the target algae in SWP water bodies without adverse effects on non-target organisms.

Application method: Copper-based compounds will be applied aerially by helicopter following product label instructions. Chelated copper products (CaptainXTR®) and EarthTec® will be applied in a manner consistent with product labeling. Alternatively, copper-based herbicides may be applied by boat, either by DWR staff or contractors.

ii. Aquatic herbicide: Diquat. Diquat is a contact herbicide that is effective at controlling a broad spectrum of aquatic weeds. Diquat applications typically provide weed control within seven to ten days. Water bodies treated with diquat may be reopened for swimming just after application. Depending on the size of the treatment, water from the treatment area cannot be used for irrigation for 24 to 72 hours.

Application method: Diquat is applied through injection hoses into the treatment area. Applications are made following label instructions.

iii. Aquatic herbicide: Endothall. Endothall is a fast-acting contact herbicide that is effective at controlling weeds. Endothall works by disrupting the plant's biochemical processes at the cellular level. The dipotassium salt of endothall is used for control of aquatic weeds and is the active ingredient in Aquathol® K (liquid formulation) and Aquathol® Super K Granular.

Application method: Granular formulations of endothall, will be applied by boat using a pellet blower. Liquid formulations of endothall will be applied through injection hoses into the treatment area. Applications will be made following label instructions.

iv. Aquatic herbicide: Fluridone. Fluridone (e.g., Sonar®) is a slow-acting systemic herbicide used to control broad-leaved submerged aquatic vegetation (SAV), including Eurasian watermilfoil. Fluridone works by inhibiting the weed's ability to produce carotene, resulting in the degradation of chlorophyll and finally the death of the plant. Since this is a slow process, it is necessary to maintain an adequate concentration of the chemical for a sufficient period of time in order to effectively control aquatic weeds.

Fluridone, applied at the approved concentration rate in accordance with label instructions, has not been found to be toxic to waterfowl and wildlife. The label does not

restrict the use of fluridone-treated water for swimming, fishing, or drinking water. However, there is a restriction against the use of fluridone within 1/4 mile of any potable water intake.

Application method: Fluridone will be applied when the target SAV begins active growth. Fluridone will be applied to the nearshore area of the lake from a GPS guided application vessel using a granular pellet blower following label instructions.

v. **Aquatic herbicide: Imazamox.** Imazamox is a derivative of ammonium salt of imazamox, the active ingredient in the herbicide Clearcast®. Imazamox is a selective herbicide that controls floating, emergent, and shoreline weed species while allowing non-target species to colonize. The chemical is absorbed through the leaves, stems, and roots of aquatic weeds. Once absorbed by a plant, imazamox inhibits an enzyme essential to the plant's synthesis of three-branched chain amino acids.

As indicated in the U.S. EPA Ecotoxicity Database, imazamox has low toxicity to aquatic life. Imazamox has been granted a tolerance exemption by the U.S. EPA, meaning that there are no food residue limits in fish, shellfish, crustaceans, or irrigated crops.

Application method: Imazamox will be applied to the nearshore areas from a GPS guided application vessel and following the product label instructions.

vi. **Aquatic herbicide: Sodium carbonate peroxyhydrate.** Sodium carbonate peroxyhydrate (e.g., PAK®27) is approved for use as an algaecide in California and by the U.S. Environmental Protection Agency (EPA). PAK®27 is also approved under NSF/ANSI Standard 60 (drinking water treatment chemicals). All ingredients in PAK®27 have either Generally Recognized as Safe (GRAS) food additive status from the U.S. Food and Drug Administration (FDA) or exemptions from tolerances from the U.S. EPA.

Sodium carbonate peroxyhydrate is an addition compound of sodium carbonate and hydrogen peroxide (H_2O_2). The nominal amount of sodium carbonate peroxyhydrate is 85% in PAK®27 which corresponds to 27.6% H_2O_2. The approved application rate is 3 to 100 pounds per acre-foot.

Application method: Boat. Applications are conducted by DWR or an approved aquatic herbicide applicator following label instructions.

vii. **Aquatic herbicide: Triclopyr.** Triclopyr (e.g., Renovate®) is a systemic broadleaf herbicide. This product is effective against Eurasian watermilfoil and is not a restricted use material. Triclopyr is approved by the EPA for use in potable water reservoirs provided setback buffers are created and maintained between the application site and the location of the intake. The set back distance is a function of the rate selected for use. The buffers allow dilution to occur and ensure that herbicide ingredients that might reach the intake will be below the applicable federal drinking water tolerances. Triclopyr is a desirable tool for controlling Eurasian watermilfoil because of the systemic and selective nature of the herbicide.

Application method: Triclopyr is applied to Pyramid Lake near shore to control aquatic weeds including sago pondweed (*Stuckenia pectinata*) and Eurasian watermilfoil (*Myriophyllum spicatum*) that grow in the littoral zone. The amount of herbicide applied

varies and is a function of the surface area of the treatment site, average water depth of the site, and recommended application rate. Renovate® OTF granular formulation, or other triclopyr product, is applied from a GPS guided application vessel using a combination of granular pellet blower and eductor systems following label instructions.

e. Decision To Use Herbicides

i. Algae - DWR's decision to apply aquatic algaecides in Pyramid Lake is based on microscope analysis of algae species composition and biomass and the chemical analysis of MIB and geosmin. When results indicate that concentrations of taste and odor compounds or algal biomass exceed the control tolerances (see c above), an aquatic herbicide application will be scheduled.

Early detection of increasing levels of algal biomass and taste and odor compounds allows Pyramid Lake to be treated early before populations of nuisance cyanoHabs reach maximum growth. The result is that much lower quantities of herbicides are needed to reduce algal biomass and control the taste and odor producing algae.

If algal blooms are not treated before the control tolerances are reached, taste and odor issues pose a problem for customers in a large service area. Algal blooms also have the potential to cause low dissolved oxygen levels, which can lead to fish kills. An additional concern at Pyramid Lake is the potential for algal blooms to produce cyanotoxins such as microcystin. If cyanotoxins reach critical levels, they can cause health problems in humans and animals that use the lake.

ii. SAV - The decision to apply aquatic herbicides is made when aquatic weeds have the potential to negatively affect the beneficial uses of the lake. Early treatment of aquatic weeds before the plant populations reach maximum biomass will allow DWR to reduce the quantity of aquatic herbicide needed to control the nuisance species.

f. Herbicide Dose and Determination

When selecting an aquatic herbicide for application, DWR will consider factors such as the species to be controlled and the beneficial uses of the lake to ensure the most appropriate herbicide is applied. The selected aquatic herbicide (sodium carbonate peroxyhydrate, imazamox, fluridone, or triclopyr) will be applied according to the label instructions. The target species in Pyramid Lake are planktonic and attached cyanobacteria and aquatic weeds such as Eurasian watermilfoil. The total application dose depends on the water depth and volume.

g. Gates and Control Structures

Reservoir releases will be restricted prior to application of the aquatic herbicide and the outlet valves will remain closed for a sufficient time period to meet the specifications of the product label.

h. Exception Period

In 2004, DWR was granted a section 5.3 exception to treat several SWP water bodies with copper-based herbicides. In 2014, DWR applied for a section 5.3 exception to apply copper to Pyramid Lake. Application of copper-based herbicides to the reservoir at regular intervals

throughout the growing season will help prevent loss in water delivery capacity. Application of copper to Pyramid Lake would be carried out only on an as-needed basis during the year. An exception period does not apply to the use of diquat, endothall, fluridone, imazamox, sodium carbonate peroxyhydrate, and triclopyr since copper is not an active ingredient of these aquatic herbicides.

i. Monitoring Plan

See Appendix A.

j. Procedures to Prevent Sample Contamination

Water quality sampling is conducted by trained DWR staff or a contracted Certified Pesticide Applicator following established procedures designed to prevent contamination of samples. Sampling guidelines are contained in "Water Quality Field Manual for the State Water Project" produced by DWR.

Procedures that prevent sample contamination include:

- Use clean sample bottles that are non-reactive. Glass and polyethylene bottles are used for SWP water samples.
- Wear gloves that are powder-free vinyl to avoid the contamination associated with latex gloves.
- Samples are immediately placed in an ice chest away from contaminants as soon as the samples are taken.

k. Best Management Practices

Application: Copper-based herbicides, diquat, endothall, fluridone, imazamox, sodium carbonate peroxyhydrate (PAK®27), and triclopyr are applied under the supervision of a certified herbicide applicator by Clean Lakes, Inc., Aqua Technex, or DWR staff. DWR's Southern Field Division has two licensed Pest Control Advisors (PCAs) and six to eight certified Qualified Applicators (QAC). These individuals are trained to ensure that aquatic herbicides are applied at rates consistent with label requirements, in a manner that avoids potential adverse effects (including, but not limited to, fish kills), and following proper storage and disposal practices.

Notification: Water contractors are notified by email at least 48 hours prior to a treatment. The notification includes the treatment date and time and date and time when releases will resume from Pyramid Lake. Notices are posted to inform the public of lake closures. Additionally, a PCA will submit a written recommendation for use of the aquatic herbicide to the County Agricultural Commissioner.

Treatment: Granular formulations of endothall, fluridone and triclopyr are applied by boat using a pellet blower. Diquat, endothall (Aquathol®K), and imazamox (e.g., Clearcast®) are aqueous formulations that are applied by subsurface hoses to submerged vegetation. Imazamox may also be broadcast sprayed. Sodium carbonate peroxyhydrate (PAK®27) is dispensed by subsurface hoses by boat to maximize the effectiveness of the algaecide.

Spill Prevention and Cleanup: Staff will apply aquatic herbicides according to label instructions in order to prevent spills. In the event of a spill, staff will follow the field division's established emergency response procedures and refer to the applicable material

safety data sheet (MSDS) for instructions on containing and cleaning up the spill. Emergency response and MSDS procedures will be reviewed regularly. A copy of the emergency response procedures and material safety data sheets will be available during each treatment. Cleanup equipment will be kept in good working order and will be readily available at each application site.

Water Quality Monitoring: Monitoring is conducted before, during and after treatments as outlined in Appendix A. In addition, water quality is monitored at Pyramid Lake at least quarterly, and the analytical results are available online through DWR's Water Data Library.

Access: Pyramid Lake is open to the public for recreational use. The lake will be closed to the public during aquatic herbicide applications.

Post-Treatment: The efficacy of the treatment is evaluated one week after the application. Algae are surveyed to determine the effectiveness of the treatment at reducing cyanoHabs. Taste and odor compounds produced by cyanobacteria are monitored on an episodic basis. After treating the lake for aquatic weeds, post-treatment will involve an evaluation of weed population to determine the effectiveness of the treatment.

l. Possible Alternatives to Algaecides and Aquatic Herbicide Use

i. Evaluation of Management Options

(1) No Action

If Pyramid Lake was not treated with aquatic herbicides, elevated concentrations of taste and odor compounds would severely impact the quality of water delivered to water contractors. The potential of cyanobacteria found in the lake to produce harmful cyanotoxins requires that DWR take action to control the cyanobacteria. Additionally, aquatic weeds must be controlled due to the numerous problems they may cause such as negative impacts to water quality and entanglement hazards for swimmers at the lake. A "no action" option is therefore not feasible.

(2) Prevention

Nutrient Control. Some preventive measures involve limiting or eliminating nutrients that support aquatic weed and algal growth. Due to the vast size of the Sacramento-San Joaquin Delta and the numerous inflows, controlling upstream nutrient loading is not a realistic preventive control option for Pyramid Lake.

(3) Mechanical or Physical Methods

Planktonic algae such as the cyanobacteria found in Pyramid Lake are too small to be controlled by mechanical and physical methods.

Removal by Hand. Removal of weeds by hand using dive teams can be an effective method of controlling Eurasian watermilfoil and other aquatic plants under certain conditions. Pioneering infestations of Eurasian watermilfoil are generally targeted using this control method. Divers swim through the littoral area of the lake, and hand remove and bag the plant material and roots. The method provides rapid removal and clears the plants from the water column. One of the drawbacks of this

method is the expense of deploying divers. Many states require prevailing wages for this activity that can cost up to $100.00 per hour for a dive team. Due to budget constraints, this would not be a feasible option for Pyramid Lake.

Benthic Barriers. Benthic barriers are materials that come in sheets and are negatively buoyant. They can be attached to the bottom and rolled over the top of existing aquatic plants beds where they are then weighted or pinned to the lake bottom. These systems provide immediate and long term control of all aquatic vegetation where they are placed. One significant drawback is the generally the high costs of materials. These barriers cost from $0.75 to $1.00 per square foot installed. At this rate they are not cost effective for a lake the size of Pyramid Lake. In addition, barriers can trap gases between the lake sediment and the barrier causing them to lift into propellers or create areas that might be a threat to swimmers diving under the water line. Regular maintenance and inspections are required. As with the hand removal method, a major issue, aside from being costly and labor intensive, is that if the entire root structure of the plant is not removed, then control is not achieved. Therefore, benthic barriers are not a feasible alternative for Pyramid Lake.

(4) Cultural Methods

Drawdown. Drawdown is a potential method that entails lowering the water level to control algae by desiccation. The major drawback is that a longer period of two to three weeks would be necessary. A drawdown of that length of time would be difficult due to demands on Pyramid Lake for water supply and other uses. Therefore, drawdown is not feasible.

(5) Biological Control Agents

Introduction of Weed Eating Fish. Grass carp/white amur (*Ctenopharyngodon idella* Val.) have been approved for stocking by the California Department of Fish and Wildlife under controlled conditions where the water body is a closed system. However, feeding by this species is initially selective, and as sources of preferred weeds become scarce, feeding will continue on other plants which can result in reduction of native vegetation needed for game fish habitat. In addition, grass carp could not be contained in Pyramid Lake and could swim to adjoining waters where aquatic weed control was not needed. Therefore, grass carp would not be an alternative to aquatic algaecides and herbicides in managing algae in Pyramid Lake.

(6) Algaecides and Aquatic Herbicides

Diquat, fluridone, imazamox, sodium carbonate peroxyhydrate, and triclopyr have been proven to be environmentally safe herbicides that are effective at reducing target aquatic weeds and cyanobacteria without adverse effects on non-target species. If Pyramid Lake was not treated, aquatic weeds and cyanobacteria that produce taste and odor compounds would negatively impact the quality of water delivered to Metropolitan Water District.

ii. Decision Matrix to Select the Most Appropriate Formulation

The decision matrix below evaluates the algal control options identified for Pyramid Lake (section i: "Evaluation of Management Options" above).

Decision Making Criteria	No Action	Prevention	Mechanical or Physical	Cultural Methods	Biological Agents	Algaecides and Aquatic Herbicides
Is the impact to the environment low or easily mitigated?	Yes	Yes	Yes	Yes	Yes	Yes
Is the cost of this option reasonable?	N/A	No	No	No	No	Yes
Has (have) the method(s) been effectively implemented at this site?	No	No	No	No	No	No
Option(s) selected for Pyramid Lake.						X

9. CASTAIC LAKE

a. Site Description

Castaic Lake is the terminal reservoir on the West Branch of the California Aqueduct, located 45 miles northwest of Los Angeles and within the boundaries of the Los Angeles Regional Water Quality Control Board, Region 4 (Figure 11). The lake, completed in 1974, has four main purposes: 1) provides emergency storage in the event of shutdown of the California Aqueduct to the north, 2) acts as a regulatory storage facility for deliveries during normal operation, 3) provides recreation, and 4) provides fish and wildlife enhancement. The reservoir has a maximum operating storage of 323,702 acre-feet with a surface area of 2,235 acres.

b. Application and Treatment Areas

Application Area: The application area is dependent on the location of the source of taste and odor production as determined by SPME analysis.

Treatment Area: The specific area is variable and dependent on the location of the source of taste and odor production as determined by monitoring and SPME analysis. For each application, a map will be submitted in the annual report to the State Water Resources Control Board showing the application area, treatment area, immediately adjacent areas, and water bodies receiving treated water (where applicable).

c. Aquatic Weeds and Algae Controlled and Rationale

i. Background

Copper sulfate and EarthTec® are applied to Castaic Lake to manage taste and odor problems produced by planktonic cyanobacteria. Production of 2-methylisoborneol (MIB) and geosmin by cyanoHabs results in earthy, musty, and fishy tastes and odors in the water supply. In addition, some species of cyanobacteria can produce algal toxins that may be harmful to human health. High diatom abundance clogs filters in water treatment plants and reduces filter run times.

The Metropolitan Water District of Southern California (MWD), a cooperative of 26 cities and water agencies serving 18 million people in six counties, receives water from Castaic Lake at the Joseph Jensen Filtration Plant in Granada Hills. Production of taste and odor compounds in Castaic Lake could impact MWD member water agencies including the cities of Los Angeles, Beverly Hills, Burbank, Compton, Glendale, San Fernando, Santa Monica and Torrance, as well as the Central Basin and West Basin municipal water districts in Los Angeles County, and Calleguas Municipal Water District and Las Virgenes Municipal Water District in Ventura County.

ii. Control Tolerances

(1) Algae

Sensitive water customers can detect MIB at 5 ng/L and geosmin at 10 ng/L. Concentrations greater than the 5 and 10 ng/L levels will trigger complaints to the water agencies.

(2) Aquatic Weeds

Control tolerances for aquatic weeds are based on a number of factors. Beneficial uses and the impact of the weed growth on those uses is a primary determining factor when using integrated aquatic plant management technologies to control weed growth.

d. Herbicides and Application Method

i. Aquatic herbicide: Copper-based herbicides. Copper-based herbicides have proven to be effective at reducing the target algae in SWP water bodies without adverse effects on non-target organisms.

Application method: Copper sulfate pentahydrate will be applied aerially by helicopter following product label instructions. Chelated copper products (CaptainXTR®) and EarthTec® will be applied in a manner consistent with product labeling.

ii. Aquatic herbicide: Fluridone. Fluridone (e.g., Sonar®) is a slow-acting systemic herbicide used to control broad-leaved submerged aquatic vegetation (SAV), including Eurasian watermilfoil (*Myriophyllum spicatum*). Fluridone works by inhibiting the weed's ability to produce carotene, resulting in the degradation of chlorophyll and finally the death of the plant. Since this is a slow process, it is necessary to maintain an adequate

concentration of the chemical for a sufficient period of time in order to effectively control aquatic weeds.

Fluridone, applied at the approved concentration rate in accordance with label instructions, has not been found to be toxic to waterfowl and wildlife. The label does not restrict the use of fluridone-treated water for swimming, fishing, or drinking water. However, there is a restriction against the use of fluridone within 1/4 mile of any potable water intake.

Application method: Fluridone will be applied when the target SAV begins active growth. Fluridone will be applied to the nearshore area of the lake from a GPS guided application vessel using a granular pellet blower following product label instructions.

iii. **Aquatic herbicide: Imazamox.** Imazamox is a derivative of ammonium salt of imazamox, the active ingredient in the herbicide Clearcast®. Imazamox is a selective herbicide that controls floating, emergent, and shoreline weed species while allowing non-target species to colonize. The chemical is absorbed through the leaves, stems, and roots of aquatic weeds. Once absorbed by a plant, imazamox inhibits an enzyme essential to the plant's synthesis of three-branched chain amino acids.

As indicated in the U.S. EPA Ecotoxicity Database, imazamox has low toxicity to aquatic life. Imazamox has been granted a tolerance exemption by the U.S. EPA, meaning that there are no food residue limits in fish, shellfish, crustaceans, or irrigated crops.

Application method: Imazamox will be applied to the nearshore areas from a GPS guided application vessel and following the product label instructions.

iv. **Aquatic herbicide: Triclopyr.** Triclopyr (e.g., Renovate®) is a systemic broadleaf herbicide. This product is effective against Eurasian watermilfoil and is not a restricted use material. Triclopyr is approved by the EPA for use in potable water reservoirs provided setback buffers are created and maintained between the application site and the location of the intake. The set back distance is a function of the rate selected for use. The buffers allow dilution to occur and ensure that herbicide ingredients that might reach the intake will be below the applicable federal drinking water tolerances. Triclopyr is a desirable tool for controlling Eurasian watermilfoil because of the systemic and selective nature of the herbicide.

Application method: Triclopyr is applied to Castaic Lake near shore to control aquatic weeds that grow in the littoral zone. The amount of herbicide applied varies and is a function of the surface area of the treatment site, average water depth of the site, and recommended application rate. Renovate® OTF granular formulation, or other triclopyr product, is applied from a GPS guided application vessel using a combination of granular pellet blower and eductor systems following product label instructions.

e. Decision To Use Herbicides

A comprehensive early warning plan developed cooperatively between DWR and MWD minimizes the quantity of aquatic herbicide required to treat taste and odor events in Castaic Lake. The strategy involves ongoing weekly or biweekly monitoring of the taste and odor compounds MIB and geosmin in the reservoir and at MWD's water treatment plants. Elevated levels of MIB or geosmin trigger additional high frequency monitoring at multiple

locations and depths in the reservoir. In addition to SPME analysis for taste and odor compounds, phytoplankton abundance and composition are determined microscopically.

Early detection of increasing levels of MIB and geosmin allows Castaic Lake to be treated early before populations of cyanoHabs reach maximum growth. The result is that much lower quantities of aquatic herbicide are applied to successfully reduce the biomass of cyanobacteria and control the taste and odor event.

Secondary site evaluations and pre-treatment monitoring are routinely done. The concentrations of MIB and geosmin from SPME analysis and phytoplankton abundance from microscopic counts at multiple sampling locations are used to establish the location of the treatment zone**.** Since the spatial distribution of phytoplankton is heterogeneous, DWR is able to map the areas of highest taste and odor production and target those areas for treatment.

f. Herbicide Dose and Determination

When selecting an aquatic herbicide for application, DWR will consider factors such as the species to be controlled and the beneficial uses of the lake to ensure the most appropriate herbicide is applied. The selected aquatic herbicide (copper-based compounds, fluridone, imazamox, or triclopyr) will be applied according to the label instructions. The target species in Castaic Lake are aquatic weeds, planktonic and attached cyanobacteria, and diatoms. The total application dose depends on the water depth and volume.

The application area was determined from a USGS quad map of Castaic Lake which is about 2,240 total surface acres. To protect fish and wildlife, the application area excludes the following: the entire area extending 100 yards out from the shoreline into the reservoir, all reservoir coves, the upper portions of the North East arm, and the Inlet arms. The application area estimated from dimensions on a quad map is 1,200 surface acres or 55 percent of the total surface area of Castaic Lake.

Copper sulfate pentahydrate crystals are applied to Castaic Lake by aerial application using a spreader bucket suspended from a helicopter. The application is essentially a banding application in which the helicopter flies in pre-determined transects in the application zone. Transects are spaced about 50 - 75 yards apart and 400 - 600 pounds of copper sulfate is applied per transect.

The copper dose is determined based on the label recommendations and past experience of DWR biologists in controlling taste and odor causing algae. A normal treatment to control taste and odor producing cyanobacteria such as *Anabaena* would utilize about 16,000 lbs of copper sulfate pentahydrate. Since the material contains 25% copper, 4,000 lbs of active ingredient would be applied to the reservoir. The application area is 1,200 surface acres which includes the photoic zone and epilimnion. By direct observation, staff found that the copper granules dissolve in the uppermost 10 feet of the lake. Therefore, staff determined that 12,000 acre-feet of water is treated at a concentration of 0.12 ppm. The label recommendation is 0.25 - 0.50 ppm copper, depending on water hardness. Thus DWR applies copper sulfate at a concentration that is well below the lower range recommended on the product label.

g. Gates and Control Structures

Not applicable.

h. Exception Period

The Department of Water Resources was granted a section 5.3 exception. Application of copper to Castaic Lake would be carried out only on an as-needed basis during the year, after other options have been exhausted. An exception period does not apply to the use of fluridone, imazamox, or triclopyr because these herbicides do not contain copper.

i. Monitoring Plan

See Appendix A.

j. Procedures to Prevent Sample Contamination

Water quality sampling is conducted by trained DWR or MWD staff following established procedures designed to prevent contamination of samples. Sampling guidelines are contained in "Water Quality Field Manual for the State Water Project" produced by DWR.

Procedures that prevent sample contamination include:

- Use clean sample bottles that are non-reactive. Glass and polyethylene bottles are used for SWP water samples.
- Wear gloves that are powder-free vinyl to avoid the contamination associated with latex gloves.
- Samples are immediately placed in an ice chest away from contaminants as soon as the samples are taken.

k. Best Management Practices Implemented

Application: Southern Field Division (SFD) currently has two licensed Pest Control Advisors (PCA) and six to eight certified Qualified Applicators (QAC). These individuals are trained to ensure that algaecides and aquatic herbicides are applied at rates consistent with label requirements and in a manner that avoids potential adverse effects including, but not limited to, fish kills. Copper sulfate has been used intermittently since 1994 to control phytoplanktonic blue-green algae and diatoms in the drinking water supplied from Castaic Lake. Alternatively, fluridone, imazamox, or triclopyr may be applied according to label instructions.

Notification: MWD, Department of Fish and Wildlife, and the Department of Parks and Recreation are notified prior to the treatment. Additionally, a PCA will submit a written recommendation for use of the aquatic herbicide to the County Agricultural Commissioner.

Spill Prevention and Cleanup: Staff will apply aquatic herbicides according to label instructions in order to prevent spills. In the event of a spill, staff will follow the field division's established emergency response procedures and refer to the applicable material safety data sheet (MSDS) for instructions on containing and cleaning up the spill. Emergency response and MSDS procedures will be reviewed regularly. A copy of the emergency response procedures and material safety data sheets will be available during each treatment.

Cleanup equipment will be kept in good working order and will be readily available at each application site.

Treatment: Prior to treatment, MWD is notified and the reservoir is shut down to recreational users during the day of application.

Prior to scheduling the helicopter, DWR receives a weather forecast and monitor wind direction and speed. To minimize herbicide drift, the aerial application is cancelled if continuous wind velocity exceeds 10 mph.

Minimize Treatment *Area:* The smallest practicable area is treated to minimize chemical cost, use, and secondary impacts.

l. Possible Alternatives to Algaecides and Aquatic Herbicide Use

i. Evaluation of Management Options

(1) No Action

If Castaic Lake was not treated, attached algae would severely impact the quality of water delivered to MWD. A "no action" option is therefore not feasible.

(2) Prevention

Nutrient Control. Some preventive measures involve limiting or eliminating nutrients that support aquatic weed and algal growth. Due to the vast size of the Sacramento-San Joaquin Delta and the numerous inflows, controlling upstream nutrient loading is not a realistic preventive control option for Castaic Lake.

(3) Mechanical or Physical Methods

Planktonic algae such as the cyanobacteria found in Castaic Lake are too small to be controlled by mechanical and physical methods.

(4) Cultural Methods

Drawdown. Drawdown is a potential method that entails lowering the water level to control algae by desiccation. The major drawback is that a longer period of two to three weeks would be necessary. A drawdown of that length of time would be difficult due to demands on water supply. Therefore, drawdown is not feasible for Castaic Lake.

(5) Biological Control Agents

Introduction of Weed Eating Fish. Grass carp/white amur (*Ctenopharyngodon idella* Val.) have been approved for stocking by the California Department of Fish and Wildlife under controlled conditions where the water body is a closed system. However, feeding by this species is initially selective, and as sources of preferred weeds become scarce, feeding will continue on other plants which can result in reduction of native vegetation needed for game fish habitat. Therefore, grass carp would not be an alternative to copper sulfate in managing algae in Castaic Lake.

(6) Algaecides and Aquatic Herbicides

Copper sulfate has proven to be effective at reducing the target phytoplankton without adverse effects on non-target species. The early warning plan of high frequency monitoring has greatly reduced the quantity of copper applied to Castaic Lake. In addition, fluridone, imazamox, and triclopyr have been proven to be environmentally safe herbicides that are effective at reducing target aquatic weeds and cyanobacteria without adverse effects on non-target species. If Castaic Lake was not treated, aquatic weeds and cyanobacteria that produce taste and odor compounds would negatively impact the quality of water delivered to water contractors.

ii. Decision Matrix to Select the Most Appropriate Formulation

The decision matrix below evaluates the aquatic weed and algae control options identified for Castaic Lake (section i: "Evaluation of Management Options" above).

Decision Making Criteria	No Action	Prevention	Mechanical or Physical	Cultural Methods	Biological Agents	Algaecides and Aquatic Herbicides
Is the impact to the environment low or easily mitigated?	Yes	Yes	Yes	Yes	Yes	Yes
Is the cost of this option reasonable?	N/A	No	No	No	No	Yes
Has (have) the method(s) been effectively implemented at this site?	No	No	No	No	No	Yes
Option(s) selected for Castaic Lake.						X

10. SILVERWOOD LAKE

a. Site Description

Silverwood Lake is a SWP reservoir on the East Branch of the California Aqueduct at Milepost 405.70 within the boundaries of the Lahontan Regional Water Quality Control Board, Region 6 (Figure 12). Silverwood Lake is the highest reservoir in the State Water Project with an elevation of 3,350 feet. It has a surface area of 980 acres, a storage capacity of 75,000 acre-feet (AF), a length of 25,300 feet, and 13 miles of shoreline.

As a SWP reservoir, Silverwood Lake stores water that is delivered to water contractors in Southern California. These contractors are: Crestline-Lake Arrowhead Water Agency, Metropolitan Water District of Southern California (MWD), and San Bernardino Valley Municipal Water District. It also provides various recreational uses, including swimming, boating, water skiing, and fishing.

b. Application and Treatment Areas

i. Algae

Application Area: The application area is dependent on the location of the source of taste and odor production as determined by SPME analysis.

Treatment Area: The specific area is variable and dependent on the location of the source of taste and odor production as determined by monitoring and SPME analysis. For each application, a map will be submitted in the annual report to the State Water Resources Control Board showing the application area, treatment area, immediately adjacent areas, and water bodies receiving treated water (where applicable).

ii. Aquatic Weeds

Application Area: Every year the application area will be determined based on the results of a vegetation survey and after analysis of impacts to beneficial uses.

Treatment Area: The specific area is variable and dependent on the location of aquatic weeds. For each application, a map will be submitted in the annual report to the State Water Resources Control Board showing the application area, treatment area, immediately adjacent areas, and water bodies receiving treated water (where applicable).

c. Aquatic Weeds and Algae Controlled and Rationale

i. Background

When taste and odor compound concentrations are high in the East Branch Aqueduct and algae are not controlled with aquatic herbicides, unacceptably high concentrations of taste and odor compounds often result in Silverwood Lake. Algal production of geosmin in Silverwood Lake itself began in 2013, necessitating the treatment of the lake. In the summer of 2013, Silverwood Lake experienced a bloom of the species *Anabaena lemmermannii* that caused severe taste and odor problems.

ii. Control Tolerances

Sensitive water customers can detect MIB at 5 ng/L and geosmin at 10 ng/L. Concentrations greater than the 5 and 10 ng/L levels will trigger complaints to the water agencies.

d. Herbicides and Application Method

i. Aquatic herbicide: Copper-based herbicides. Chelated copper products (Komeen® or Nautique®), copper sulfate pentahydrate crystals, and EarthTec® will be applied in a manner consistent with product labeling.

Application method: Copper-based herbicides will be applied to the lake according to label instructions.

ii. **Aquatic herbicide: Diquat.** Diquat is a contact herbicide that is effective at controlling a broad spectrum of aquatic weeds. Diquat applications typically provide weed control within seven to ten days. Water bodies treated with diquat may be reopened for swimming just after application. Depending on the size of the treatment, water from the treatment area cannot be used for irrigation for 24 to 72 hours.

Application method: Diquat will be applied through injection hoses into the treatment area. Applications are made following label instructions.

iii. **Aquatic herbicide: Endothall.** Endothall is a fast-acting contact herbicide that is effective at controlling weeds. Endothall works by disrupting the plant's biochemical processes at the cellular level. The dipotassium salt of endothall is used for control of aquatic weeds and is the active ingredient in Aquathol® K (liquid formulation) and Aquathol® Super K Granular.

Application method: Granular formulations of endothall, will be applied by boat using a pellet blower. Liquid formulations of endothall will be applied through injection hoses into the treatment area. Applications will be made following label instructions.

iv. **Aquatic herbicide: Fluridone.** Fluridone (e.g., Sonar®) is a slow-acting systemic herbicide used to control broad-leaved submerged aquatic vegetation (SAV), including Eurasian watermilfoil (*Myriophyllum spicatum*). Fluridone works by inhibiting the weed's ability to produce carotene, resulting in the degradation of chlorophyll and finally the death of the plant. Since this is a slow process, it is necessary to maintain an adequate concentration of the chemical for a sufficient period of time in order to effectively control aquatic weeds.

Fluridone, applied at the approved concentration rate in accordance with label instructions, has not been found to be toxic to waterfowl and wildlife. The label does not restrict the use of fluridone-treated water for swimming, fishing, or drinking water. However, there is a restriction against the use of fluridone within 1/4 mile of any potable water intake.

Application method: Fluridone will be applied when the target SAV begins active growth. Fluridone will be applied to the nearshore area of the lake from a GPS guided application vessel using a granular pellet blower following label instructions.

v. **Aquatic herbicide: Imazamox.** Imazamox is a derivative of ammonium salt of imazamox, the active ingredient in the herbicide Clearcast®. Imazamox is a selective herbicide that controls floating, emergent, and shoreline weed species while allowing non-target species to colonize. The chemical is absorbed through the leaves, stems, and roots of aquatic weeds. Once absorbed by a plant, imazamox inhibits an enzyme essential to the plant's synthesis of three-branched chain amino acids.

As indicated in the U.S. EPA Ecotoxicity Database, imazamox has low toxicity to aquatic life. Imazamox has been granted a tolerance exemption by the U.S. EPA, meaning that there are no food residue limits in fish, shellfish, crustaceans, or irrigated crops.

Application method: Imazamox will be applied to the nearshore areas from a GPS guided application vessel and following the product label instructions.

vi. **Aquatic herbicide: Sodium carbonate peroxyhydrate.** Sodium carbonate peroxyhydrate (e.g., PAK®27) is approved for use as an algaecide in California and by the U.S. Environmental Protection Agency (EPA). PAK®27 is also approved under NSF/ANSI Standard 60 (drinking water treatment chemicals). All ingredients in PAK®27 have either Generally Recognized as Safe (GRAS) food additive status from the U.S. Food and Drug Administration (FDA) or exemptions from tolerances from the U.S. EPA.

Sodium carbonate peroxyhydrate is an addition compound of sodium carbonate and hydrogen peroxide (H_2O_2). The nominal amount of sodium carbonate peroxyhydrate is 85% in PAK®27 which corresponds to 27.6% H_2O_2. The approved application rate is 3 to 100 pounds per acre-foot.

Application method: Boat. Applications are conducted by DWR or a certified aquatic herbicide applicator, such as Clean Lakes, Inc., following label instructions. Clean Lakes, Inc.'s treatments involve an eductor system which uses a venturi effect to draw water through the system which pulls the algaecide (dry granular material) from a hopper and injects to the surface of the water body.

vii. **Aquatic herbicide: Triclopyr.** Triclopyr (e.g., Renovate®) is a systemic broadleaf herbicide. This product is effective against Eurasian watermilfoil and is not a restricted use material. Triclopyr is approved by the EPA for use in potable water reservoirs provided setback buffers are created and maintained between the application site and the location of the intake. The set back distance is a function of the rate selected for use. The buffers allow dilution to occur and ensure that herbicide ingredients that might reach the intake will be below the applicable federal drinking water tolerances. Triclopyr is a desirable tool for controlling Eurasian watermilfoil because of the systemic and selective nature of the herbicide.

Application method: Triclopyr is applied to Silverwood Lake near shore to control aquatic weeds that grow in the littoral zone. The amount of herbicide applied varies and is a function of the surface area of the treatment site, average water depth of the site, and recommended application rate. Renovate® OTF granular formulation, or other triclopyr product, is applied from a GPS guided application vessel using a combination of granular pellet blower and eductor systems following label instructions.

e. Decision To Use Herbicides

A comprehensive early warning plan developed cooperatively between DWR and MWD will minimize the quantity of aquatic herbicide required to control taste and odor production and helps to determine optimal timing of the application. The strategy involves ongoing weekly or biweekly monitoring of the taste and odor compounds, MIB and geosmin, in the aqueduct, reservoirs, and MWD's water treatment plants. Elevated levels of MIB or geosmin trigger additional high frequency monitoring at additional locations.

Early detection of increasing levels of MIB and geosmin allows Silverwood Lake to be treated early before populations of cyanoHabs reach maximum growth. The result is that much lower quantities of aquatic herbicide are applied to successfully reduce the biomass of cyanobacteria and control the taste and odor event.

Secondary site evaluations and pre-treatment monitoring are routinely done. The concentrations of MIB and geosmin from SPME analysis and phytoplankton abundance from microscopic counts at multiple sampling locations are used to establish the location of the treatment zone**.** Since the spatial distribution of phytoplankton is heterogeneous, DWR is able to map the areas of highest taste and odor production and target those areas for treatment.

If algal blooms are not treated before the control tolerances are reached, taste and odor issues pose a problem for customers in a large service area. Algal blooms also have the potential to cause low dissolved oxygen levels, which can lead to fish kills. An additional concern at Silverwood Lake is the potential for algal blooms to produce cyanotoxins such as Microcystin. If cyanotoxins reach critical levels, they can cause health problems in humans and animals that use the lake.

f. Herbicide Dose and Determination

After determining algal species and algal counts, the optimal treatment rate is calculated by a licensed pest control advisor. Aquatic herbicides will be applied in a manner consistent with product labeling.

g. Gates and Control Structures

Reservoir releases will be restricted prior to application of the aquatic herbicide and the outlet valves will remain closed for a sufficient time period to meet the specifications of the product label.

h. Exception Period

In 2004, DWR was granted a section 5.3 exception to treat several SWP water bodies with copper-based herbicides. In 2014, DWR applied for a section 5.3 exception to apply copper to Silverwood Lake. Application of copper-based herbicides to the reservoir at regular intervals throughout the growing season will help prevent loss in water delivery capacity. Application of copper to Silverwood Lake would be carried out only on an as-needed basis during the year. An exception period does not apply to the use of diquat, endothall, fluridone, imazamox, sodium carbonate peroxyhydrate, and triclopyr since copper is not an active ingredient of these aquatic herbicides.

i. Monitoring Plan

See Appendix A.

j. Procedures to Prevent Sample Contamination

Water quality sampling is conducted by trained DWR staff following established procedures designed to prevent contamination of samples. Sampling guidelines are contained in “Water Quality Field Manual for the State Water Project” produced by DWR.

Procedures that prevent sample contamination include:

- Use clean sample bottles that are non-reactive. Glass and polyethylene bottles are used for SWP water samples.

- Wear gloves that are powder-free vinyl to avoid the contamination associated with latex gloves.
- Samples are immediately placed in an ice chest away from contaminants as soon as the samples are taken.

k. Best Management Practices Implemented

Application: Copper-based herbicides, diquat, endothall, fluridone, imazamox, sodium carbonate peroxyhydrate (e.g., PAK®27), and triclopyr are applied under the supervision of a certified herbicide applicator by a contractor such as Clean Lakes, Inc. or Aqua Technex, or by DWR staff. DWR's Southern Field Division has two licensed Pest Control Advisors (PCAs) and six to eight certified Qualified Applicators (QAC). These individuals are trained to ensure that aquatic herbicides are applied at rates consistent with label requirements, in a manner that avoids potential adverse effects (including, but not limited to, fish kills), and following proper storage and disposal practices.

Notification: Water contractors are notified by email at least 48 hours prior to a treatment. The notification includes the treatment date and time and date and time when releases will resume from Silverwood Lake. Notices are posted to inform the public of lake closures. Additionally, a PCA will submit a written recommendation for use of the aquatic herbicide to the County Agricultural Commissioner.

Treatment: Granular formulations of endothall, fluridone and triclopyr are applied by boat using a pellet blower. Diquat, endothall (Aquathol®K), and imazamox (e.g., Clearcast®) are aqueous formulations that are broadcast sprayed or applied by subsurface hoses to submerged vegetation. Sodium carbonate peroxyhydrate (PAK®27) is dispensed by subsurface hoses by boat to maximize the effectiveness of the algaecide.

Spill Prevention and Cleanup: Staff will apply aquatic herbicides according to label instructions in order to prevent spills. In the event of a spill, staff will follow the field division's established emergency response procedures and refer to the applicable material safety data sheet (MSDS) for instructions on containing and cleaning up the spill. Emergency response and MSDS procedures will be reviewed regularly. A copy of the emergency response procedures and material safety data sheets will be available during each treatment. Cleanup equipment will be kept in good working order and will be readily available at each application site.

Water Quality Monitoring: Monitoring is conducted before, during and after treatments as outlined in Appendix A. In addition, water quality is monitored at Silverwood Lake at least quarterly, and the analytical results are available online through DWR's Water Data Library.

Access: Silverwood Lake is open to the public for recreational use. The lake will be closed to the public during aquatic herbicide applications.

Post-Treatment: The efficacy of the treatment is evaluated one week after the application. Algae are surveyed to determine the effectiveness of the treatment at reducing cyanoHabs. Taste and odor compounds produced by cyanobacteria are monitored on an episodic basis. After treating the lake for aquatic weeds, post-treatment will involve an evaluation of weed population to determine the effectiveness of the treatment.

l. Possible Alternatives to Algaecides and Aquatic Herbicide Use

i. Evaluation of Management Options

(1) No Action

If Silverwood Lake was not treated, algae would severely impact the quality of water delivered to MWD. A "no action" option is therefore not feasible.

(2) Prevention

Nutrient Control. Some preventive measures involve limiting or eliminating nutrients that support aquatic weed and algal growth. Due to the vast size of the Sacramento-San Joaquin Delta and the numerous inflows, controlling upstream nutrient loading is not a realistic preventive control option for Silverwood Lake.

(3) Mechanical or Physical Methods

Mechanical Aerators. Mechanical aerators oxygenate the water column and upper portions of lake sediment. One effect of this oxygenation is to prevent the release of reduced forms of phosphorus from bottom sediments back into the water. Reduction in phosphorus and other changes in water quality parameters are thought to decrease planktonic algal blooms. However, due to the inability to control nutrient inputs in Silverwood Lake, aeration is not likely to be an effective means of controlling algal blooms over the long term. Further, aeration is not a workable option for algae control in Silverwood Lake due to budgetary limits and lack of staff needed to maintain a large aeration system.

Planktonic algae such as the cyanobacteria found in Silverwood Lake are too small to be controlled by other mechanical and physical methods.

(4) Cultural Method

Drawdown. Lowering the water level with drawdown is a potential method to control some species of algae by desiccation. The major drawback is that a long period of several weeks would be necessary. Cyanobacteria are extremely tolerant to desiccation; therefore, drawdown is not feasible for Silverwood Lake.

(5) Biological Control Agents

Introduction of Weed Eating Fish. Grass carp/white amur (*Ctenopharyngodon idella* Val.) has been approved for stocking by the California Department of Fish and Wildlife under controlled conditions where the water body is a closed system. However, feeding by this species is initially selective, and as sources of preferred weeds become scarce, feeding will continue on other plants which can result in reduction of native vegetation needed for game fish habitat. Therefore, grass carp would not be a feasible alternative to algaecides to manage cyanoHabs algae in Silverwood Lake.

(6) Algaecides and Aquatic Herbicides

Fluridone, imazamox, sodium carbonate peroxyhydrate, and triclopyr have been proven to be environmentally safe herbicides that are effective at reducing target aquatic weeds and cyanobacteria without adverse effects on non-target species. If Silverwood Lake was not treated, taste and odor compounds produced by cyanobacteria would have severe impacts on the quality of water deliveries to water districts. The early warning plan of high frequency monitoring has greatly reduced the quantity of algaecides and aquatic herbicides applied to other SWP waters and is expected to be beneficial in minimizing the amount of aquatic herbicides used in Silverwood Lake.

ii. Decision Matrix to Select the Most Appropriate Formulation

The decision matrix below evaluates the aquatic weed and algae control options identified for Silverwood Lake (section i: "Evaluation of Management Options" above).

Decision Making Criteria	No Action	Prevention	Mechanical or Physical	Cultural Methods	Biological Agents	Algaecides and Aquatic Herbicides
Is the impact to the environment low or easily mitigated?	Yes	Yes	Yes	Yes	Yes	Yes
Is the cost of this option reasonable?	N/A	No	No	No	No	Yes
Has (have) the method(s) been effectively implemented at this site?	No	No	No	No	No	No
Option(s) selected for Silverwood Lake.						X

11. LAKE PERRIS

a. Site Description

Lake Perris is the terminal storage facility on the California Aqueduct, located in northwestern Riverside County about 13 miles southeast of the City of Riverside and within the boundaries of the Santa Ana Regional Water Quality Control Board, Region 8 (Figure 13). Completed in 1975, Lake Perris has a 131,450 acre-foot storage capacity and surface area of 2,320 acres. This shallow reservoir with a mean depth of about 50 feet is a multi-purpose facility that provides water supply, recreation, and fish and wildlife enhancement.

b. Application and Treatment Areas

i. Aquatic Weeds

Application Area: Every year the application area will be determined based on the results of a vegetation survey and after analysis of impacts to beneficial uses.

Treatment Area: The specific area is variable and dependent on the location of aquatic weeds. For each application, a map will be submitted in the annual report to the State Water Resources Control Board showing the application area, treatment area, immediately adjacent areas, and water bodies receiving treated water (where applicable).

ii. Algae

Application Area: The application area is dependent on the location of the source of taste and odor production as determined by Solid Phase Microextraction analysis (SPME).

Treatment Area: The specific area is variable and dependent on the location of the source of taste and odor production as determined by monitoring and SPME analysis. For each application, a map will be submitted in the annual report to the State Water Resources Control Board showing the application area, treatment area, immediately adjacent areas, and water bodies receiving treated water (where applicable).

c. Weeds Controlled and Rationale

i. Background

Taste and odor problems were first reported in Lake Perris in the late 1970s. Copper sulfate was applied at a low dose rate during the early copper treatments from 1978 to 1984. Major off-flavor events in Lake Perris are common due to the shallow depth of the lake and high concentrations of bio-available nitrogen and phosphorus. In 1987, the first helicopter application was done and copper application rates increased to 10,000 to 12,000 pounds per treatment. The cyanobacterial genera, *Synechococcus*, *Pseuodoanabaena*, and *Anabaena* were isolated as the primary contributors to off-flavor incidents in Lake Perris. Normally, only the area west of Alessandro Island is treated with copper sulfate.

ii. Control Tolerances

(1) Algae

Sensitive water customers can detect MIB at 5 ng/L and geosmin at 10 ng/L. Concentrations greater than the 5 and 10 ng/L levels will trigger complaints to the water agencies.

Taste and odor production is monitored weekly using SPME. The taste and odor causing substances, MIB and geosmin are reported in parts per trillion (ng/L) concentrations.

(2) Aquatic Weeds

Control tolerances for aquatic weeds are based on a number of factors. Beneficial uses and the impact of the weed growth on those uses is a primary determining factor when using integrated aquatic plant management technologies to control weed growth.

d. Herbicides and Application Method

i. Aquatic herbicide: Copper-based herbicides. Copper-based herbicides have proven to be effective at reducing the target algae in SWP water bodies without adverse effects on non-target organisms.

Application method: Copper sulfate pentahydrate is applied aerially by helicopter following product label instructions. Chelated copper products (CaptainXTR®), copper sulfate pentahydrate crystals, and EarthTec® are applied in a manner consistent with product labeling.

ii. Aquatic herbicide: Fluridone. Fluridone (e.g., Sonar®) is a slow-acting systemic herbicide used to control broad-leaved submerged aquatic vegetation (SAV), including Eurasian watermilfoil (*Myriophyllum spicatum*). Fluridone works by inhibiting the weed's ability to produce carotene, resulting in the degradation of chlorophyll and finally the death of the plant. Since this is a slow process, it is necessary to maintain an adequate concentration of the chemical for a sufficient period of time in order to effectively control aquatic weeds.

Fluridone, applied at the approved concentration rate in accordance with label instructions, has not been found to be toxic to waterfowl and wildlife. The label does not restrict the use of fluridone-treated water for swimming, fishing, or drinking water. However, there is a restriction against the use of fluridone within 1/4 mile of any potable water intake.

Application method: Fluridone will be applied when the target SAV begins active growth. Fluridone will be applied to the nearshore area of the lake from a GPS guided application vessel using a granular pellet blower following product label instructions.

iii. Aquatic herbicide: Imazamox. Imazamox is a derivative of ammonium salt of imazamox, the active ingredient in the herbicide Clearcast®. Imazamox is a selective herbicide that controls floating, emergent, and shoreline weed species while allowing non-target species to colonize. The chemical is absorbed through the leaves, stems, and roots of aquatic weeds. Once absorbed by a plant, imazamox inhibits an enzyme essential to the plant's synthesis of three-branched chain amino acids.

As indicated in the U.S. EPA Ecotoxicity Database, imazamox has low toxicity to aquatic life. Imazamox has been granted a tolerance exemption by the U.S. EPA, meaning that there are no food residue limits in fish, shellfish, crustaceans, or irrigated crops.

Application method: Imazamox will be applied to the nearshore areas from a GPS guided application vessel and following the product label instructions.

iv. **Aquatic herbicide: Triclopyr.** Triclopyr (e.g., Renovate®) is a systemic broadleaf herbicide. This product is effective against Eurasian Milfoil and is not a restricted use material. Triclopyr is approved by the EPA for use in potable water reservoirs provided setback buffers are created and maintained between the application site and the location of the intake. The set back distance is a function of the rate selected for use. The buffers allow dilution to occur and ensure that herbicide ingredients that might reach the intake will be below the applicable federal drinking water tolerances. Triclopyr is a desirable tool for controlling Eurasian watermilfoil because of the systemic and selective nature of the herbicide.

Application method: Triclopyr is applied to Lake Perris near shore to control aquatic weeds that grow in the littoral zone. The amount of herbicide applied varies and is a function of the surface area of the treatment site, average water depth of the site, and recommended application rate. Renovate® OTF granular formulation, or other triclopyr product, is applied from a GPS guided application vessel using a combination of granular pellet blower and eductor systems following product label instructions.

e. Decision to Use Herbicides

A comprehensive early warning plan developed cooperatively between DWR and Metropolitan Water District of Southern California (MWD) minimizes the quantity of aquatic herbicide required to treat taste and odor events in Lake Perris. The strategy involves ongoing weekly or biweekly monitoring of the taste and odor compounds MIB and geosmin in the reservoir and at MWD's water treatment plants. Elevated levels of MIB or geosmin trigger additional high frequency monitoring at multiple locations and depths in the reservoir. In addition to the SPME, phytoplankton abundance and composition are determined microscopically.

Early detection of increasing levels of MIB and geosmin allows Lake Perris to be treated early before populations of cyanobacteria reach maximum growth. The result is that much lower quantities of aquatic herbicide are applied to successfully reduce the biomass of cyanobacteria and control the taste and odor event.

Secondary site evaluations and pre-treatment monitoring are routinely done. The concentrations of MIB and geosmin from SPME and phytoplankton abundance from microscopic counts at multiple sampling locations are used to establish the location of the treatment zone. Since the spatial distribution of phytoplankton is heterogeneous, DWR is able to map the areas of highest taste and odor production and target those areas for treatment.

f. Herbicide Dose and Determination

Copper sulfate is applied in a manner consistent with product labeling.

g. Gates and Control Structures

Not applicable.

h. Exception Period

DWR was granted a section 5.3 exception. Application of copper to Lake Perris would be carried out only on an as-needed basis during the year, after other options have been exhausted. DWR was granted a section 5.3 exception. Application of copper to Lake Perris would be carried out only on an as-needed basis during the year, after other options have been exhausted. An exception period does not apply to the use of fluridone, imazamox, or triclopyr because these herbicides do not contain copper.

i. Monitoring Plan

See Appendix A.

j. Procedures to Prevent Sample Contamination

Water quality sampling is conducted by trained DWR or MWD staff following established procedures designed to prevent contamination of samples. Sampling guidelines are contained in "Water Quality Field Manual for the State Water Project" produced by DWR.

Procedures that prevent sample contamination include:

- Use clean sample bottles that are non-reactive. Glass and polyethylene bottles are used for SWP water samples.
- Wear gloves that are powder-free vinyl to avoid the contamination associated with latex gloves.
- Samples are immediately placed in an ice chest away from contaminants as soon as the samples are taken.

k. Best Management Practices Implemented

Application: Southern Field Division has two licensed Pest Control Advisors (PCAs) and six to eight certified Qualified Applicators (QAC). These individuals are trained to ensure that algaecides and aquatic herbicides are applied at rates consistent with label requirements and in a manner that avoids potential adverse effects including, but not limited to, fish kills.

Taste and odor problems were first reported in Lake Perris in the late 1970s. Major off-flavor events in Lake Perris are common due to the shallow depth of the lake and high concentrations of bio-available nitrogen and phosphorus. The cyanobacterial genera, *Synechococcus*, *Pseuodoanabaena*, and *Anabaena* were isolated as the primary contributors to off-flavor incidents in Lake Perris. Copper sulfate is applied according to label instructions by a licensed helicopter applicator. Alternatively, fluridone, imazamox, or triclopyr may be applied according to label instructions.

Notification: MWD, Department of Fish and Wildlife, and the Department of Parks and Recreation are notified prior to the treatment. Additionally, a PCA will submit a written recommendation for use of the aquatic herbicide to the County Agricultural Commissioner.

Spill Prevention and Cleanup: Staff will apply copper sulfate according to label instructions in order to prevent spills. In the event of a spill, staff will follow the field division's established emergency response procedures and refer to the applicable material safety data sheet (MSDS) for instructions on containing and cleaning up the spill. Emergency response and MSDS procedures will be reviewed regularly. A copy of the emergency response

procedures and material safety data sheets will be available during each treatment. Cleanup equipment will be kept in good working order and will be readily available at each application site.

Treatment: Prior to treatment, MWD is notified and the reservoir is shut down to recreational users during the day of application.

Prior to scheduling the helicopter for a copper sulfate treatment, DWR receives a weather forecast and monitor wind direction and speed. To minimize herbicide drift, the aerial application is cancelled if continuous wind velocity exceeds 10 mph.

Access: Lake Perris is open to the public for recreational use. The lake will be closed to the public during aquatic herbicide applications. Lake closure information is available online.

Minimize Treated Area: The smallest practicable area is treated to minimize chemical cost, use, and secondary impacts.

Post-Treatment: The efficacy of the treatment is evaluated one week after the application. Algae are surveyed to determine the effectiveness of the treatment at reducing cyanoHabs. Taste and odor compounds produced by cyanobacteria are monitored on an episodic basis. After treating the lake for aquatic weeds, post-treatment will involve an evaluation of weed population to determine the effectiveness of the treatment.

l. Possible Alternatives to Algaecides and Aquatic Herbicide Use

i. Evaluation of Management Options

(1) No Action

If Lake Perris was not treated, algae would severely impact the quality of water delivered to MWD. A “no action” option is, therefore, not feasible.

(2) Prevention

Nutrient Control. Some preventive measures involve limiting or eliminating nutrients that support aquatic weed and algal growth. Due to the vast size of the Sacramento-San Joaquin Delta and the numerous inflows, controlling upstream nutrient loading is not a realistic preventive control option for Lake Perris.

(3) Mechanical or Physical Methods

Mechanical Aerators. Mechanical aerators oxygenate the water column and upper portions of lake sediment. One effect of this oxygenation is to prevent the release of reduced forms of phosphorus from bottom sediments back into the water. Reduction in phosphorus and other changes in water quality parameters are thought to decrease planktonic algal blooms. While Lake Perris currently has an aeration system, due to the inability to control nutrient inputs in the lake, aeration alone cannot be relied upon as an effective means of controlling algal blooms over the long term. Further, aeration is not a workable option for algae control in Lake Perris due to budgetary limits and lack of staff needed to maintain a large aeration system.

Planktonic algae such as the cyanobacteria found in Lake Perris are too small to be controlled by other mechanical and physical methods.

(4) Cultural Method

Drawdown. Drawdown is a potential method that entails lowering the water level to control algae by desiccation. The major drawback is that a longer period of two to three weeks would be necessary. A drawdown of that length of time would be difficult due to demands on water supply. Therefore, drawdown is not feasible for Lake Perris.

(5) Biological Control Agents

Introduction of Weed Eating Fish. Grass carp/white amur (*Ctenopharyngodon idella* Val.) have been approved for stocking by the California Department of Fish and Wildlife under controlled conditions where the water body is a closed system. However, feeding by this species is initially selective, and as sources of preferred weeds become scarce, feeding will continue on other plants which can result in reduction of native vegetation needed for game fish habitat. Therefore, grass carp would not be a feasible alternative to copper sulfate in managing algae in Lake Perris.

(6) Algaecides and Aquatic Herbicides

Copper sulfate has proven to be effective at reducing the target phytoplankton without adverse effects on non-target species. The early warning plan of high frequency monitoring has greatly reduced the quantity of copper applied to Lake Perris. In addition, fluridone, imazamox, and triclopyr have been proven to be environmentally safe herbicides that are effective at reducing target aquatic weeds and cyanobacteria without adverse effects on non-target species. If Lake Perris was not treated, aquatic weeds and cyanobacteria that produce taste and odor compounds would negatively impact the quality of water delivered to water contractors.

ii. Decision Matrix to Select the Most Appropriate Formulation

The decision matrix below evaluates the aquatic weed and algae control options identified for Lake Perris (section i: “Evaluation of Management Options” above).

Decision Making Criteria	No Action	Prevention	Mechanical or Physical	Cultural Methods	Biological Agents	Algaecides and Aquatic Herbicides
Is the impact to the environment low or easily mitigated?	Yes	Yes	Yes	Yes	Yes	Yes
Is the cost of this option reasonable?	N/A	No	No	No	No	Yes
Has (have) the method(s) been effectively implemented at this site?	No	No	No	No	No	Yes
Option(s) selected for Lake Perris.						X

12. QUAIL LAKE

a. Site Description

Quail Lake is a reservoir of the State Water Project located in the Tejon Ranch area of western Antelope Valley in Los Angeles County (Figure 14). Quail Lake provides fish and wildlife habitat, recreation, and regulatory water storage for generating electricity at DWR's William E. Warne Powerplant during peak demand periods. The lake has a maximum volume of 7,600 acre-feet, and a surface area of 290 acres. It is within the boundaries of the Los Angeles Regional Water Quality Control Board (Region 4).

b. Application and Treatment Areas

i. Aquatic Weeds

Application Area: Every year the application area will be determined based on the results of a vegetation survey and after analysis of impacts to beneficial uses.

Treatment Area: The specific area is variable and dependent on the location of aquatic weeds. For each application, a map will be submitted in the annual report to the State Water Resources Control Board showing the application area, treatment area, immediately adjacent areas, and water bodies receiving treated water (where applicable).

ii. Algae

Application Area: The application area is dependent on the location of the source of taste and odor production as determined by Solid Phase Microextraction analysis (SPME).

Treatment Area: The specific area is variable and dependent on the location of the source of taste and odor production as determined by monitoring and SPME analysis. For each application, a map will be submitted in the annual report to the State Water Resources

Control Board showing the application area, treatment area, immediately adjacent areas, and water bodies receiving treated water (where applicable).

c. Aquatic Weeds and Algae Controlled and Rationale

i. Background

Aquatic herbicides are applied to Quail Lake to manage taste and odor problems produced by cyanobacteria. Production of 2-methylisoborneol (MIB) and geosmin by cyanoHabs results in earthy, musty, and fishy tastes and odors in the water supply. In addition, some species of cyanobacteria produce algal toxins that may be harmful to human and animal health. Cyanobacteria species identified in SWP reservoirs of southern California have included *Microcystis* sp., *Gloeotrichia* sp., and *Anabaena* sp.

Quail Lake is subject to infestations of aquatic weeds. If uncontrolled, invasive aquatic weeds can shade out native aquatic plants in the lake. The native species then die back and may be replaced by non-native species.

ii. Control Tolerances

(1) Algae

MIB less than 5 ng/L and geosmin less than10 ng/L are not detected in drinking water by most customers.

Taste and odor production is monitored weekly using SPME. The taste and odor causing substances, MIB and geosmin are reported in parts per trillion (ng/L) concentrations.

(2) Aquatic Weeds

Control tolerances for aquatic weeds are based on a number of factors. Beneficial uses and the impact of the weed growth on those uses is a primary determining factor when using integrated aquatic plant management technologies to control weed growth. The factors critical to Quail Lake are:

- Invasive aquatic weeds alter the water quality and species diversity of Quail Lake.
- Heavy infestations of weeds have been shown to cause taste and odor problems in drinking water supplies.
- Uncontrolled weed growth has the potential to interfere with water deliveries via the West Branch of the California Aqueduct.

d. Herbicides and Application Method

i. Aquatic herbicide: Copper-based herbicides.

Chelated copper products (Komeen® or Nautique®), copper sulfate pentahydrate crystals, and EarthTec® will be applied in a manner consistent with product labeling.

Application method: Copper-based herbicides will be applied to the lake according to label instructions.

ii. **Aquatic herbicide: Diquat.** Diquat is a contact herbicide that is effective at controlling a broad spectrum of aquatic weeds. Diquat applications typically provide weed control within seven to ten days. Depending on the size of the treatment, water from the treatment area cannot be used for irrigation for 24 to 72 hours.

Application method: Diquat will be applied through injection hoses into the treatment area. Applications are made following label instructions.

iii. **Aquatic herbicide: Endothall.** Endothall is a fast-acting contact herbicide that is effective at controlling weeds. Endothall works by disrupting the plant's biochemical processes at the cellular level. The dipotassium salt of endothall is used for control of aquatic weeds and is the active ingredient in Aquathol® K (liquid formulation) and Aquathol® Super K Granular.

Application method: Granular formulations of endothall, will be applied by boat using a pellet blower. Liquid formulations of endothall will be applied through injection hoses into the treatment area. Applications will be made following label instructions.

iv. **Aquatic herbicide: Fluridone.** Fluridone (e.g., Sonar®) is a slow-acting systemic herbicide used to control broad-leaved submerged aquatic vegetation (SAV), such as Eurasian watermilfoil. Fluridone works by inhibiting the weed's ability to produce carotene, resulting in the degradation of chlorophyll and finally the death of the plant. Since this is a slow process, it is necessary to maintain an adequate concentration of the chemical for a sufficient period of time in order to effectively control aquatic weeds.

Fluridone, applied at the approved concentration rate in accordance with label instructions, has not been found to be toxic to waterfowl and wildlife. The label does not restrict the use of fluridone-treated water for swimming, fishing, or drinking water. However, there is a restriction against the use of fluridone within 1/4 mile of any potable water intake.

Application method: Fluridone will be applied when the target SAV begins active growth. Fluridone will be applied to the nearshore area of the lake from a GPS guided application vessel using a granular pellet blower following label instructions.

v. **Aquatic herbicide: Imazamox.** Imazamox is a derivative of ammonium salt of imazamox, the active ingredient in the herbicide Clearcast®. Imazamox is a selective herbicide that controls floating, emergent, and shoreline weed species while allowing non-target species to colonize. The chemical is absorbed through the leaves, stems, and roots of aquatic weeds. Once absorbed by a plant, imazamox inhibits an enzyme essential to the plant's synthesis of three-branched chain amino acids.

As indicated in the U.S. EPA Ecotoxicity Database, imazamox has low toxicity to aquatic life. Imazamox has been granted a tolerance exemption by the U.S. EPA, meaning that there are no food residue limits in fish, shellfish, crustaceans, or irrigated crops.

Application method: Imazamox will be applied to the nearshore areas from a GPS guided application vessel and following the product label instructions.

vi. **Aquatic herbicide: Sodium carbonate peroxyhydrate.** Sodium carbonate peroxyhydrate (e.g., PAK®27) is approved for use as an algaecide in California and by

the U.S. Environmental Protection Agency (EPA). PAK®27 is also approved under NSF/ANSI Standard 60 (drinking water treatment chemicals). All ingredients in PAK®27 have either Generally Recognized as Safe (GRAS) food additive status from the U.S. Food and Drug Administration (FDA) or exemptions from tolerances from the U.S. EPA.

Sodium carbonate peroxyhydrate is an addition compound of sodium carbonate and hydrogen peroxide (H_2O_2). The nominal amount of sodium carbonate peroxyhydrate is 85% in PAK®27 which corresponds to 27.6% H_2O_2. The approved application rate is 3 to 100 pounds per acre-foot.

Application method: Boat. Applications are conducted by DWR or an approved aquatic herbicide applicator following label instructions.

vii. Aquatic herbicide: Triclopyr. Triclopyr (e.g., Renovate®) is a systemic broadleaf herbicide. This product is effective against aquatic weeds such as Eurasian watermilfoil and is not a restricted use material. Triclopyr is approved by the EPA for use in potable water reservoirs provided setback buffers are created and maintained between the application site and the location of the intake. The set back distance is a function of the rate selected for use. The buffers allow dilution to occur and ensure that herbicide ingredients that might reach the intake will be below the applicable federal drinking water tolerances. Triclopyr is a desirable tool for controlling aquatic weeds because of the systemic and selective nature of the herbicide.

Application method: Triclopyr will be applied to Quail Lake near shore to control aquatic weeds that grow in the littoral zone. The amount of herbicide applied varies and is a function of the surface area of the treatment site, average water depth of the site, and recommended application rate. Renovate® OTF granular formulation, or other triclopyr product, is applied from a GPS guided application vessel using a combination of granular pellet blower and eductor systems following label instructions.

e. Decision To Use Herbicides

i. Algae - DWR's decision to apply aquatic algaecides in Quail Lake is based on microscope analysis of algae species composition and biomass and the chemical analysis of MIB and geosmin. When results indicate that concentrations of taste and odor compounds or algal biomass exceed the control tolerances (see c above), an aquatic herbicide application will be scheduled.

Early detection of increasing levels of algal biomass and taste and odor compounds allows Quail Lake to be treated early before populations of nuisance cyanoHabs reach maximum growth. The result is that much lower quantities of herbicides are needed to reduce algal biomass and control the taste and odor producing algae.

ii. SAV - The decision to apply aquatic herbicides is made when aquatic weeds have the potential to negatively affect the beneficial uses of the lake. Early treatment of aquatic weeds before the plant populations reach maximum biomass will allow DWR to reduce the quantity of aquatic herbicide needed to control the nuisance species.

f. Herbicide Dose and Determination

When selecting a copper-based herbicide for application, DWR will consider factors such as the species to be controlled and the beneficial uses of the lake to ensure that copper is the most appropriate herbicide to achieve control of aquatic weeds or algae. Copper based herbicides will be applied according to the label instructions. The total application dose depends on the water depth and volume.

g. Gates and Control Structures

Reservoir releases will be restricted prior to application of the aquatic herbicide and the outlet valves will remain closed for a sufficient time period to meet the specifications of the product label.

h. Exception Period

In 2004, DWR was granted a section 5.3 exception to treat several SWP water bodies with copper-based herbicides. In 2014, DWR applied for a section 5.3 exception to apply copper to Quail Lake. Application of copper-based herbicides to the lake at regular intervals throughout the growing season will help prevent loss in water delivery capacity. Application of copper to Quail Lake would be carried out only on an as-needed basis during the year. An exception period does not apply to the use of diquat, endothall, fluridone, imazamox, sodium carbonate peroxyhydrate, and triclopyr since copper is not an active ingredient of these aquatic herbicides.

i. Monitoring Plan

See Appendix A.

j. Procedures to Prevent Sample Contamination

Water quality sampling is conducted by trained DWR staff or a contracted Certified Pesticide Applicator following established procedures designed to prevent contamination of samples. Sampling guidelines are contained in "Water Quality Field Manual for the State Water Project" produced by DWR.

Procedures that prevent sample contamination include:

- Use clean sample bottles that are non-reactive. Glass and polyethylene bottles are used for SWP water samples.
- Wear gloves that are powder-free vinyl to avoid the contamination associated with latex gloves.
- Samples are immediately placed in an ice chest away from contaminants as soon as the samples are taken.

k. Best Management Practices

Application: Copper-based compounds, diquat, endothall, fluridone, imazamox, sodium carbonate peroxyhydrate (PAK®27), and triclopyr are applied under the supervision of a certified herbicide applicator by a contractor such as Clean Lakes, Inc. or Aqua Technex, or by DWR staff. DWR's Southern Field Division has two licensed PCAs and six to eight QACs. These individuals are trained to ensure that aquatic herbicides are applied at rates

consistent with label requirements, in a manner that avoids potential adverse effects (including, but not limited to, fish kills), and following proper storage and disposal practices.

Notification: Water contractors are notified by email at least 48 hours prior to a treatment. The notification includes the treatment date and time and date and time when releases will resume from Quail Lake. Notices are posted to inform the public of lake closures. Additionally, a PCA will submit a written recommendation for use of the aquatic herbicide to the County Agricultural Commissioner.

Treatment: Boat. Aquatic herbicide applications are conducted by DWR or a certified aquatic herbicide applicator, such as Clean Lakes, Inc. or Aqua Technex, following label instructions.

Helicopter. Copper sulfate pentahydrate will be applied aerially by helicopter following product label instructions. DWR will obtain a weather forecast and monitor wind direction and speed prior to treatment. To minimize herbicide drift, the aerial application will be cancelled if continuous wind velocity exceeds 10 mph.

Spill Prevention and Cleanup: Staff will apply aquatic herbicides according to label instructions in order to prevent spills. In the event of a spill, staff will follow the field division's established emergency response procedures and refer to the applicable material safety data sheet (MSDS) for instructions on containing and cleaning up the spill. Emergency response and MSDS procedures will be reviewed regularly. A copy of the emergency response procedures and material safety data sheets will be available during each treatment. Cleanup equipment will be kept in good working order and will be readily available at each application site.

Water Quality Monitoring: Monitoring is conducted before, during and after treatments as outlined in Appendix A. In addition, water quality is monitored downstream at Pyramid Lake at least quarterly, and the analytical results are available online through DWR's Water Data Library (http://www.water.ca.gov/waterdatalibrary/).

Access: Quail Lake is open to the public for recreational use. The lake will be closed to the public during aquatic herbicide applications.

Post-Treatment: The efficacy of the treatment is evaluated one week after the application. Algae are surveyed to determine the effectiveness of the treatment at reducing cyanoHabs. Taste and odor compounds produced by cyanobacteria are monitored on an episodic basis. After treating the lake for aquatic weeds, post-treatment will involve an evaluation of weed population to determine the effectiveness of the treatment.

l. Possible Alternatives to Algaecides and Aquatic Herbicide Use

i. Evaluation of Management Options

(1) No Action

If Quail Lake was not treated with aquatic herbicides, elevated concentrations of taste and odor compounds would severely impact the quality of water delivered to water contractors. The potential of cyanobacteria found in the lake to produce harmful cyanotoxins requires that DWR take action to control the cyanobacteria.

Additionally, aquatic weeds must be controlled due to the numerous problems they may cause such as negative impacts to water quality and water conveyance. A "no action" option is therefore not feasible.

(2) Prevention

Nutrient Control. Some preventive measures involve limiting or eliminating nutrients that support aquatic weed and algal growth. Due to the vast size of the Sacramento-San Joaquin Delta and the numerous inflows, controlling upstream nutrient loading is not a realistic preventive control option for Quail Lake.

(3) Mechanical or Physical Methods

Planktonic algae are too small to be controlled by mechanical and physical methods.

Removal by Hand. Removal of weeds by hand using dive teams can be an effective method of controlling aquatic plants under certain conditions. Pioneering infestations of Eurasian watermilfoil are generally targeted using this control method. Divers swim through the littoral area of the lake, and hand remove and bag the plant material and roots. The method provides rapid removal and clears the plants from the water column. One of the drawbacks of this method is the expense of deploying divers. Many states require prevailing wages for this activity that can cost up to $100.00 per hour for a dive team. Due to budget constraints, this would not be a feasible option for Quail Lake.

Benthic Barriers. Benthic barriers are materials that come in sheets and are negatively buoyant. They can be attached to the bottom and rolled over the top of existing aquatic plants beds where they are then weighted or pinned to the lake bottom. These systems provide immediate and long term control of all aquatic vegetation where they are placed. One significant drawback is the generally the high costs of materials. These barriers cost from $0.75 to $1.00 per square foot installed. At this rate they are not cost effective for a lake the size of Quail Lake. Regular maintenance and inspections are required. As with the hand removal method, a major issue, aside from being costly and labor intensive, is that if the entire root structure of the plant is not removed, then control is not achieved. Therefore, benthic barriers are not a feasible alternative for Quail Lake.

(4) Cultural Methods

Drawdown. Drawdown is a potential method that entails lowering the water level to control algae by desiccation. The major drawback is that a longer period of two to three weeks would be necessary. A drawdown of that length of time would be difficult due to demands on Quail Lake for water supply and other uses. Therefore, drawdown is not feasible.

(5) Biological Control Agents

Introduction of Weed Eating Fish. Grass carp/white amur (*Ctenopharyngodon idella* Val.) have been approved for stocking by the California Department of Fish and Wildlife under controlled conditions where the water body is a closed system.

However, feeding by this species is initially selective, and as sources of preferred weeds become scarce, feeding will continue on other plants which can result in reduction of native vegetation needed for game fish habitat. In addition, grass carp could not be contained in Quail Lake and could swim to adjoining waters where aquatic weed control was not needed. Therefore, grass carp would not be an alternative to aquatic algaecides and herbicides in managing algae in Quail Lake.

(6) Algaecides and Aquatic Herbicides

Copper-based herbicides, diquat, endothall, fluridone, imazamox, sodium carbonate peroxyhydrate, and triclopyr have proven to be effective at reducing the target phytoplankton without adverse effects on non-target species. The early warning plan of high frequency monitoring will greatly reduced the quantity of aquatic herbicides applied to Quail Lake. If Quail Lake was not treated, aquatic weeds and cyanobacteria that produce taste and odor compounds would negatively impact the quality of water delivered to water contractors such as Metropolitan Water District.

ii. Decision Matrix to Select the Most Appropriate Formulation

The decision matrix below evaluates the algal control options identified for Quail Lake (section i: "Evaluation of Management Options" above).

Decision Making Criteria	No Action	Prevention	Mechanical or Physical	Cultural Methods	Biological Agents	Algaecides and Aquatic Herbicides
Is the impact to the environment low or easily mitigated?	Yes	Yes	Yes	Yes	Yes	Yes
Is the cost of this option reasonable?	N/A	No	Yes	No	No	Yes
Has (have) the method(s) been effectively implemented at this site?	No	No	No	No	No	Yes
Option(s) selected for Quail Lake.						X

13. CALIFORNIA AQUEDUCT

a. Site Description

The California Aqueduct conveys SWP water from the Sacramento-San Joaquin Delta to agricultural lands in the San Joaquin Valley and urban users in southern California. The portions of the California Aqueduct addressed in this APAP are:

- Intake Channel at milepost (MP) 0.93, from Skinner Delta Fish Protective Facility to Banks Pumping Plant (Figure 15),

- MP 249.65–250.99; spillway to Buena Vista Pumping Plant (Figure 16),
- MP 277.31–278.13; Arvin-Edison turnout to Teerink Pumping Plant (Figure 17),
- MP 279.05–280.45; Chrisman Headworks Road to Chrisman Pumping Plant (Figure 18), and
- MP 285.69–292.16; I-5 to Pastoria Creek Siphon (Figure 19).

b. Treatment Areas

Application Area: Treatments are triggered by excessive growth of aquatic weeds clogging trash racks and turnouts or elevated concentrations of tastes and odors produced by cyanobacteria. The location and source of taste and odor production is determined by Solid Phase Microextraction (SPME) analysis. Application will occur as needed in the areas identified under "Site Description."

Treatment Area: The specific area is variable and dependent on the location of the source of nuisance plants. Visual observations and reduction in measured flow rates are used to determine treatment areas for aquatic weeds. Taste and odor production is determined by monitoring and SPME analysis. For each application, a map will be submitted in the annual report to the State Water Resources Control Board showing the application area, treatment area, immediately adjacent areas, and water bodies receiving treated water (where applicable).

c. Weeds Controlled and Rationale

i. Background

Aquatic weeds have increased in abundance since DWR suspended application of aquatic herbicides in Clifton Court Forebay after 2006. A weed survey conducted in July 2014 showed that aquatic weeds were present in 91% of Clifton Court Forebay's surface area compared to only 38% in 2006. The weeds found in the forebay originate both from within the forebay itself and from the Sacramento-San Joaquin Delta. The weeds in Clifton Court Forebay break off and travel downstream where they clog the trash racks at the Skinner Fish Facility and Banks Pumping Plant. In the summer of 2014, aquatic weeds were so abundant that their accumulation on the panels of the fish louvers at Skinner Fish Facility caused several louvers to fail.

Since the window for treating Clifton Court is narrow due to requirements set by the U.S. Fish and Wildlife Service's biological assessment and because mechanical methods alone are costly and insufficient to control weeds, chemical treatment of the intake channel will be useful method of controlling weeds entering the Aqueduct from Clifton Court Forebay. These treatments will reduce impacts to SWP operations caused by weeds such as reduced pumping and increased outages at Banks Pumping Plant.

In the portions of the California Aqueduct from MP 249.65 to 292.16 identified under the "Site Description" section above, excessive weed growth has also negatively impacted SWP operations. *Cladophora* has contributed to reduced flows and low elevations in the Edmonston forebay, which in turn has impacted pumping schedules and water deliveries, particularly during the summers of 2013 and 2014.

ii. Control Tolerances

Taste and odor – MIB less than 5 ng/L and geosmin less than 10 ng/L are not detected by consumers in drinking water supplies.

Taste and odor production is monitored using Solid Phase Microextraction (SPME). The taste and odor causing substances, 2-methylisoborneol (MIB) and geosmin are reported in parts per trillion (ng/L) concentrations.

Filter clogging – High accumulation of aquatic weeds and algae on turnouts and trash racks at the pumping plants may result in complete plant shutdown or reduced pumping. Copper-based herbicides, endothall, or other chemicals identified in this APAP are applied when aquatic weeds and algae create operational problems.

d. Herbicides and Application Method

i. Aquatic herbicide: Copper-based herbicides. Chelated copper products (CaptainXTR®), copper sulfate pentahydrate crystals, and EarthTec® are applied in a manner consistent with product labeling.

Application method: Copper-based products are applied according to label instructions.

ii. Aquatic herbicide: Endothall (e.g., Aquathol®K). Endothall is a fast-acting contact herbicide that is effective at controlling weeds. Endothall works by disrupting the plant's biochemical processes at the cellular level. The dipotassium salt of endothall is used for control of aquatic weeds and is the active ingredient in Aquathol® K (liquid formulation) and Aquathol® Super K Granular.

Application method: Aquathol K is applied to the California Aqueduct according to label instructions.

e. Decision to Use Herbicides

The decision to treat the California Aqueduct with aquatic herbicides is made when water operations begin to be impacted by algae or aquatic weeds clogging turnouts and trash racks and reducing water flow. The application dose rate is determined by water flow rate in the Aqueduct and the target species.

Preliminary site evaluation is done to determine the timing of a copper-based or other aquatic herbicide application. Treatments are needed to control algae and aquatic weeds during the growth season which usually runs from April to October. The treatment schedule is based on visual inspection of the Aqueduct, accumulation of plant material on trash racks, and reduced flows at the pumping plants.

Copper-based herbicides have proven to be effective at reducing the target aquatic weeds and algae without adverse effects on non-target organisms in various water bodies of the SWP. There are no alternatives to copper-based herbicides and endothall that are as effective at controlling aquatic weeds and algae and registered for use in California. If the California Aqueduct was not treated, aquatic weeds and algae could severely impact deliveries to SWP water users especially during drought conditions.

f. Herbicide Dose and Determination

Copper–based herbicides, endothall, and other aquatic herbicides identified in this APAP are applied in a manner consistent with product labeling.

g. Gates and Control Structures

Not applicable.

h. Exception Period

Not applicable. DWR does not have a section 5.3 SIP exception for this specific water body.

i. Monitoring Plan

See Appendix A.

j. Procedures to Prevent Sample Contamination

Water quality sampling is conducted by trained DWR or MWD staff following established procedures designed to prevent contamination of samples. Sampling guidelines are contained in "Water Quality Field Manual for the State Water Project" produced by DWR.

Procedures that prevent sample contamination include:

- Use clean sample bottles that are non-reactive. Glass and polyethylene bottles are used for SWP water samples.
- Wear gloves that are powder-free vinyl to avoid the contamination associated with latex gloves.
- Samples are immediately placed in an ice chest away from contaminants as soon as the samples are taken.

k. Best Management Practices Implemented

Application: Delta Field Division has one licensed Pest Control Advisor (PCA) who also works in the San Luis Field Division and seven Certified Qualified Applicators (QAC). San Joaquin Field Division (SJFD) has two licensed Pest Control Advisors (PCA) and 15 Certified Qualified Applicators (QAC). These individuals are trained to ensure that algaecides and aquatic herbicides are applied at rates consistent with label requirements and in a manner that avoids potential adverse effects. Copper-based herbicides, endothall, or other aquatic herbicides identified in this APAP will be used to control clogging problems at trash racks and pumping plants caused by attached algae (*Cladophora*) and pondweeds. The aquatic herbicide applications are directed under the supervision of a PCA, and the use of chemical is consistent with label instructions in order to avoid adverse effects including, but not limited to, fish kills.

Spill Prevention and Cleanup: Staff will apply copper-based compounds and other aquatic herbicides identified in this APAP according to label instructions in order to prevent spills. In the event of a spill, staff will follow the field division's established emergency response procedures and refer to the applicable material safety data sheet (MSDS) for instructions on containing and cleaning up the spill. Emergency response and MSDS procedures will be reviewed regularly. A copy of the emergency response procedures and material safety data

sheets will be available during each treatment. Cleanup equipment will be kept in good working order and will be readily available at each application site.

Notification: Downstream water users that could be impacted by an aquatic herbicide application are notified prior to a treatment. The notified water users may include: Byron Bethany Irrigation District, Zone 7 Water Agency, Alameda County Water District, Santa Clara Valley Water Agency, South Bay Aqueduct water users, Metropolitan Water District, and Central Coast Water Agency, and Kern Water Agency. Additionally, a PCA will submit a written recommendation for use of the aquatic herbicide to the County Agricultural Commissioner.

Treatment: Aquatic herbicides are applied during the daylight hours of maximum photosynthetic activity to optimize herbicide uptake by the aquatic vegetation.

Access: There are no recreational activities in the California Aqueduct and most sections are inaccessible to the public with locked gates and fences.

l. Possible Alternatives to Algaecides and Aquatic Herbicide Use

i. Evaluation of Management Options

(1) No Action

If the California Aqueduct was not treated with aquatic herbicides, elevated concentrations of taste and odor compounds would severely impact the quality of water delivered to MWD. A “no action” option is therefore not feasible.

(2) Prevention

Nutrient Control. Some preventive measures involve limiting or eliminating nutrients that support aquatic weed and algal growth. Due to the vast size of the Sacramento-San Joaquin Delta and the numerous inflows, controlling upstream nutrient loading is not a realistic preventive control option for the California Aqueduct.

(3) Mechanical or Physical Methods

Mechanical Removal. DWR has evaluated physical and mechanical methods to control aquatic weeds. Mechanical removal such as dragging a large chain with a crane along the aqueduct has been evaluated. The method would be expensive, labor intensive and result in potential damage to the concrete aqueduct lining. In addition, the chain could not be used upstream of any water turnouts. The procedure would break off large amounts of attached algae that could clog the water intakes.

(4) Cultural Methods

Drawdown. Drawdown is a potential method that entails lowering the water level to control algae by desiccation. The major drawback is that a long period of two to three weeks would be necessary. A drawdown of that length of time would be

difficult due to demands on water conveyance and pumping. Therefore, drawdown is not feasible for the California Aqueduct.

(5) Biological Control Agents

Introduction of Weed Eating Fish. Triploid grass carp/white amur (*Ctenopharyngodon idella* Val.) have been approved for stocking by the California Department of Fish and Wildlife under controlled conditions where the water body is a closed system. Since the California Aqueduct is not a closed system, grass carp would not be an alternative to chemical control in managing algae and aquatic weeds.

(6) Algaecides and Aquatic Herbicides

Aquatic Herbicide Treatments. Aquatic herbicides have proven to be effective at reducing aquatic weeds and taste and odor producing cyanobacteria with minimal adverse effects to non-target organisms. Sodium carbonate peroxyhydrate (e.g., PAK®27) has proven to be an environmentally safe algaecide that is effective at reducing target cyanobacteria without adverse effects on non-target species. There are no alternatives to aquatic herbicides that are effective at controlling attached cyanobacteria and registered for use in California. If the California Aqueduct was not treated, taste and odor products produced by attached cyanobacteria would negatively impact the quality of water delivered to water users.

ii. Decision Matrix to Select the Most Appropriate Formulation

The decision matrix below evaluates the algal control options identified for the California Aqueduct (section i: "Evaluation of Management Options" above).

Decision Making Criteria	**No Action**	**Prevention**	**Mechanical or Physical**	**Cultural Methods**	**Biological Agents**	**Algaecides and Aquatic Herbicides**
Is the impact to the environment low or easily mitigated?	Yes	Yes	Yes	Yes	Yes	Yes
Is the cost of this option reasonable?	N/A	No	No	No	No	Yes
Has (have) the method(s) been effectively implemented at this site?	No	No	No	No	No	Yes
Option(s) selected for the California Aqueduct.						X

FIGURES

Figure 1. Map of South Bay Aqueduct Showing Location of Application and Treatment Areas

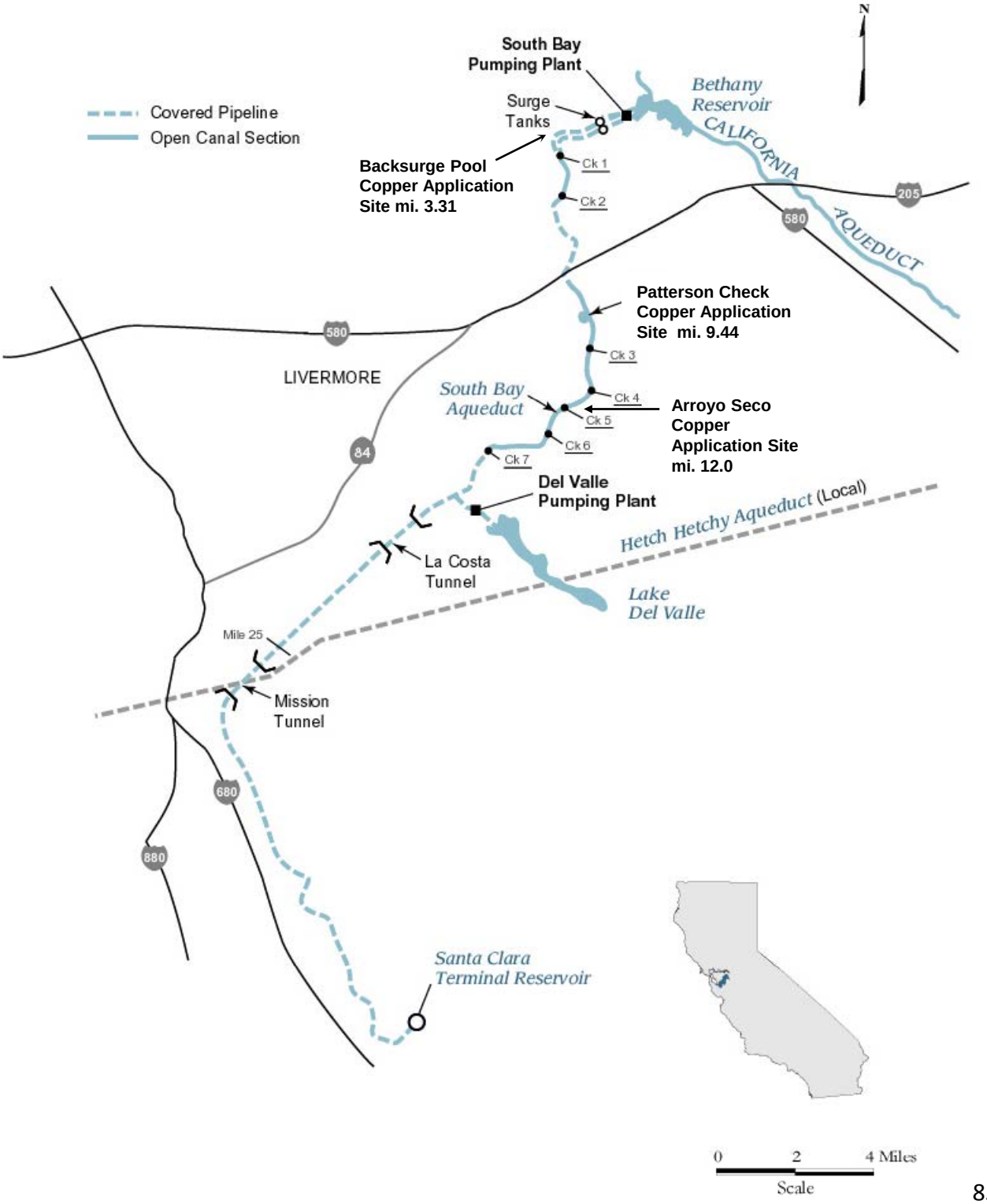


Figure 2. Map of Clifton Court Forebay Showing Location of Application and Treatment Areas for Copper Sulfate Application to Control Taste and Odor Producing Algae

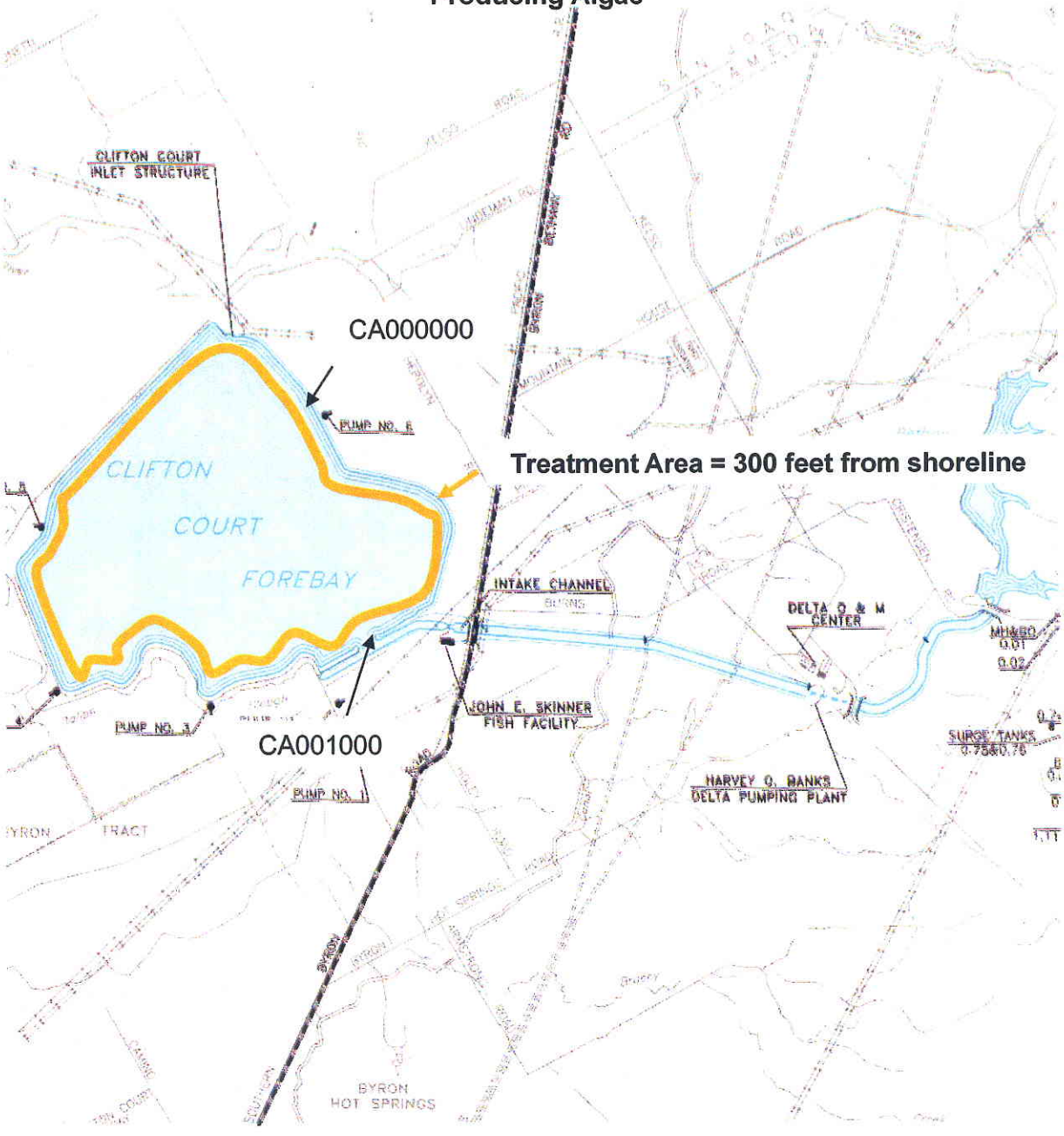


Figure 3. Patterson Reservoir Application Area

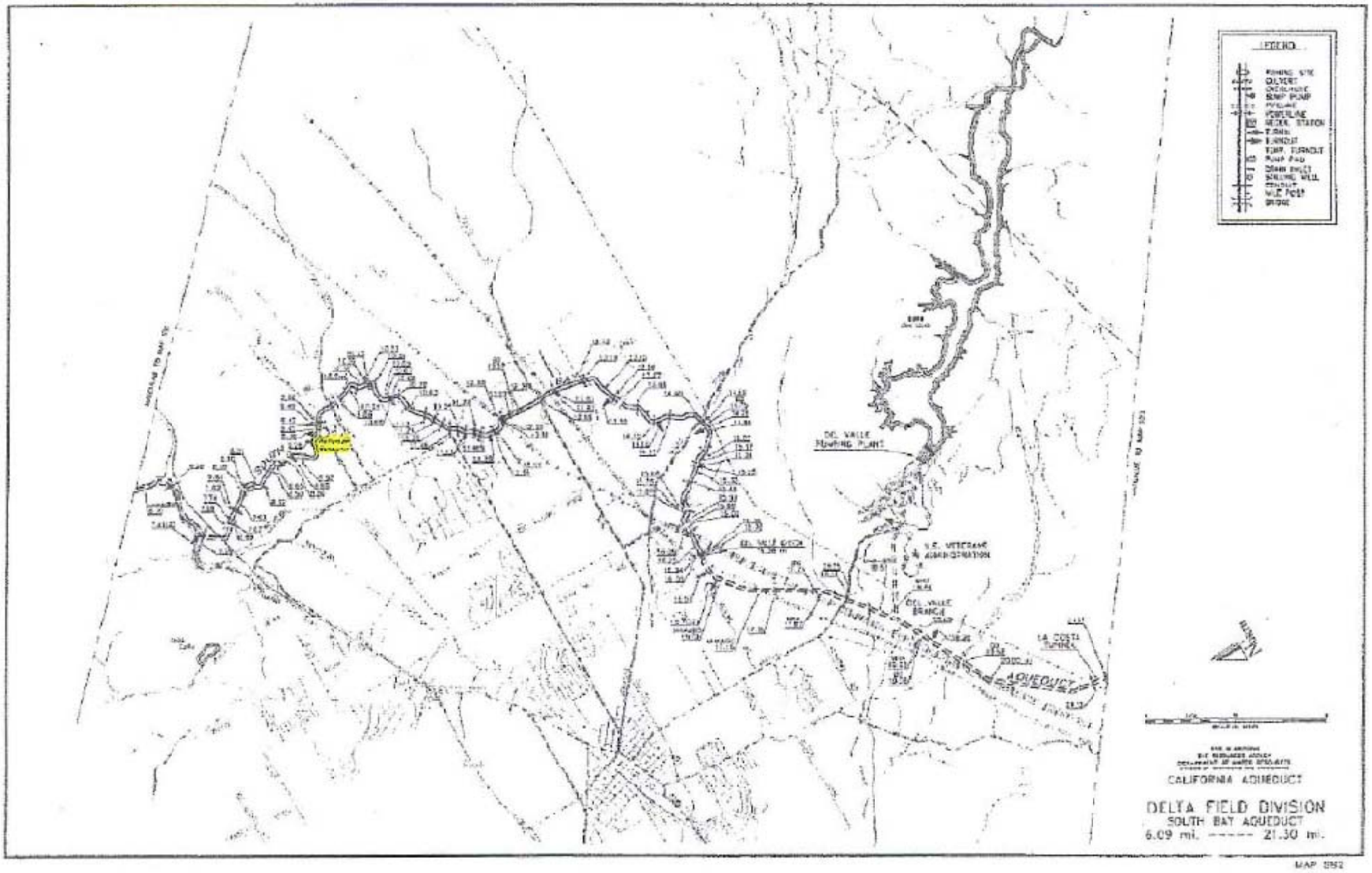


Figure 4. Map of Dyer Reservoir Application Site

N

0.7

Miles

Map Citations:
Main: ESRI Street Map
Inset: ESRI Street Map

Figure 5 - O'Neill Forebay Overview Map

Aquatic Pesticides Application Plan

Merced County, CA
121°2'53.37"W
37°4'46.103"N

Legend

Sampling Sites
Station Name
(Station Number)

Figure 6. Map of Coastal Branch Aqueduct Showing Location of Treatment and Application Areas

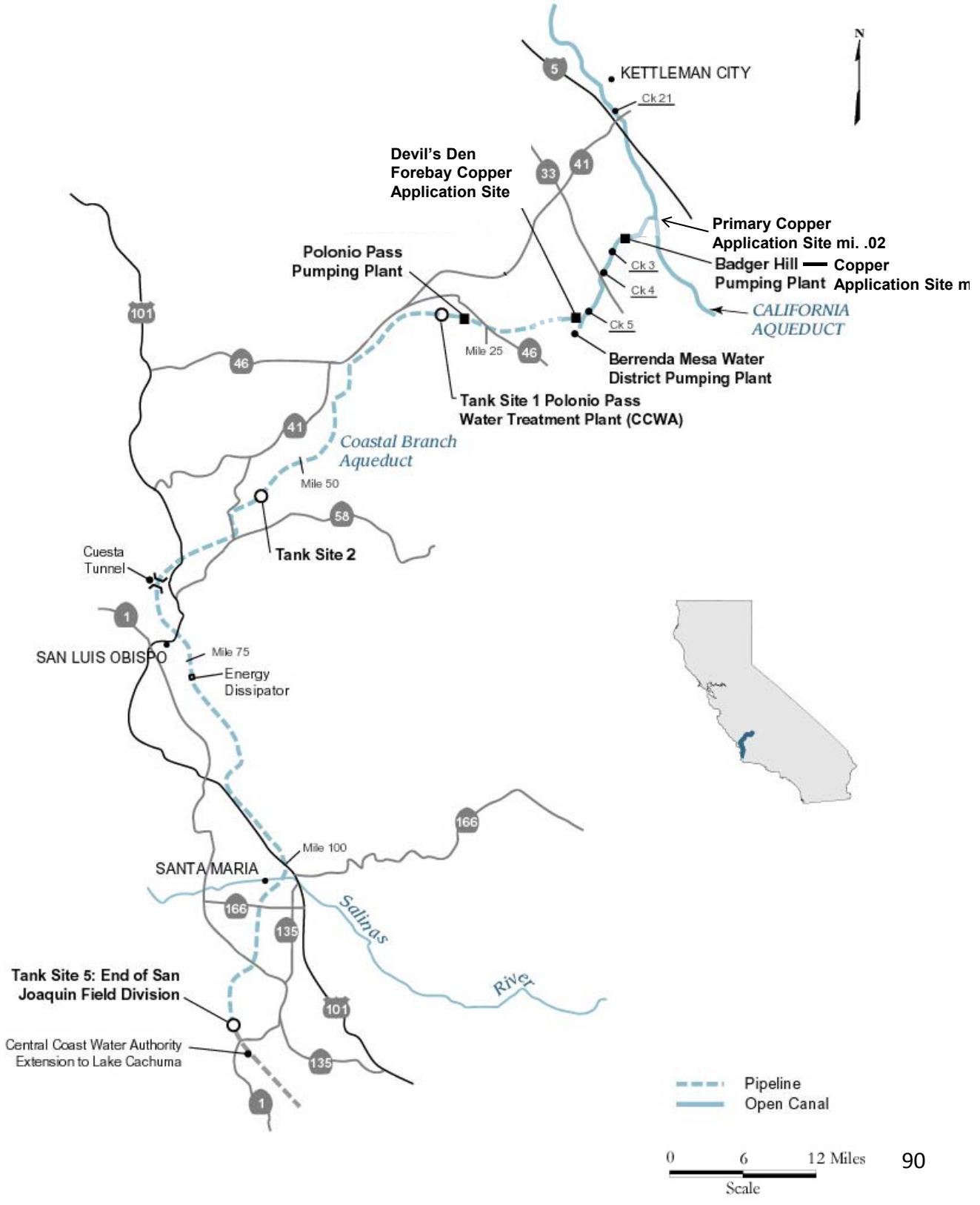


Figure 7. East Branch California Aqueduct from Miles 328.82 to 343.05 Showing Location of Application Sites (Pools 49, 50, 51, and 52) and Event and Post Event Sampling Sites

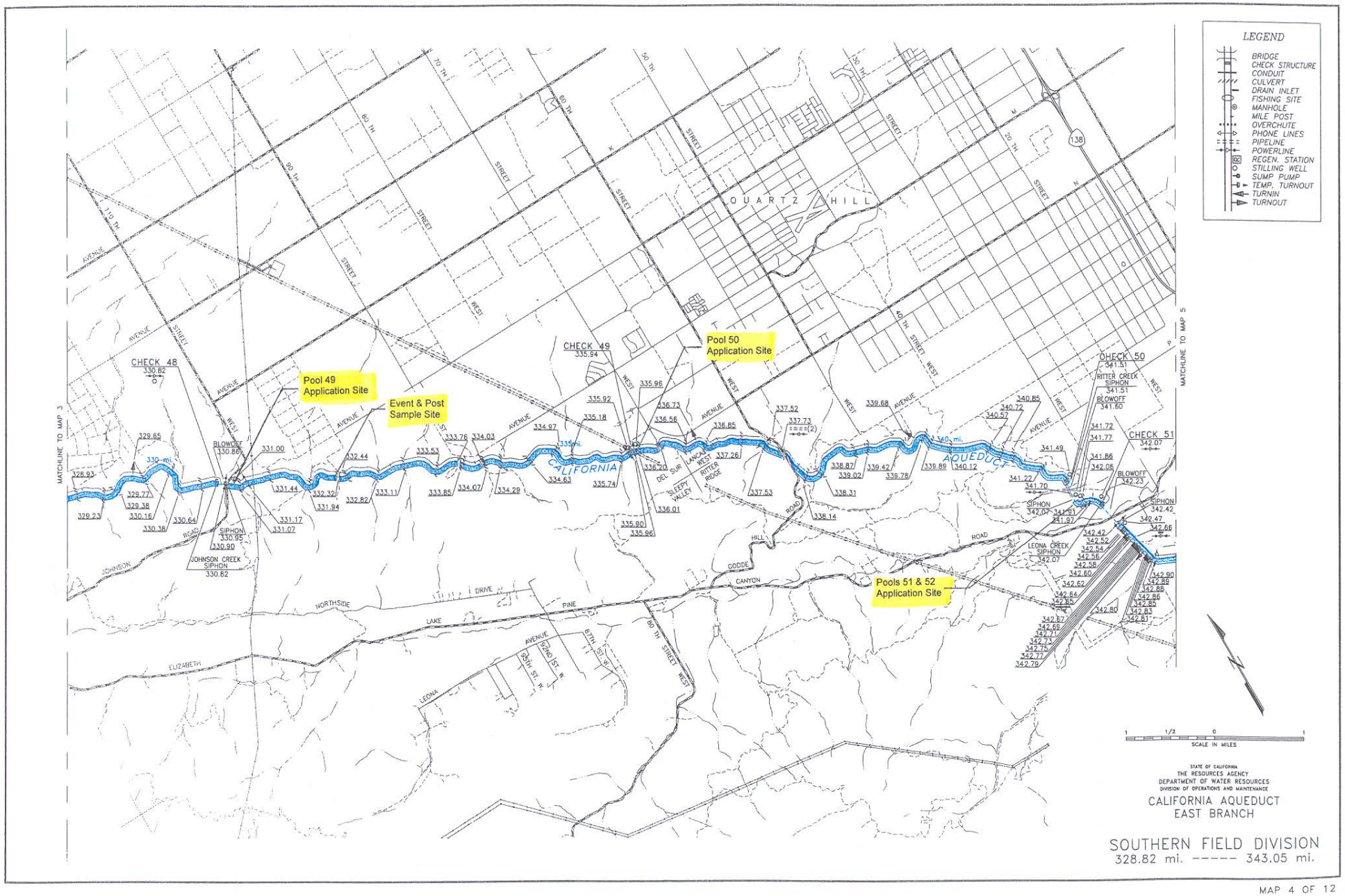


Figure 8. East Branch California Aqueduct from Miles 371.37 to 383.52 Showing Location of Application Sites (Pools 61 and 62)

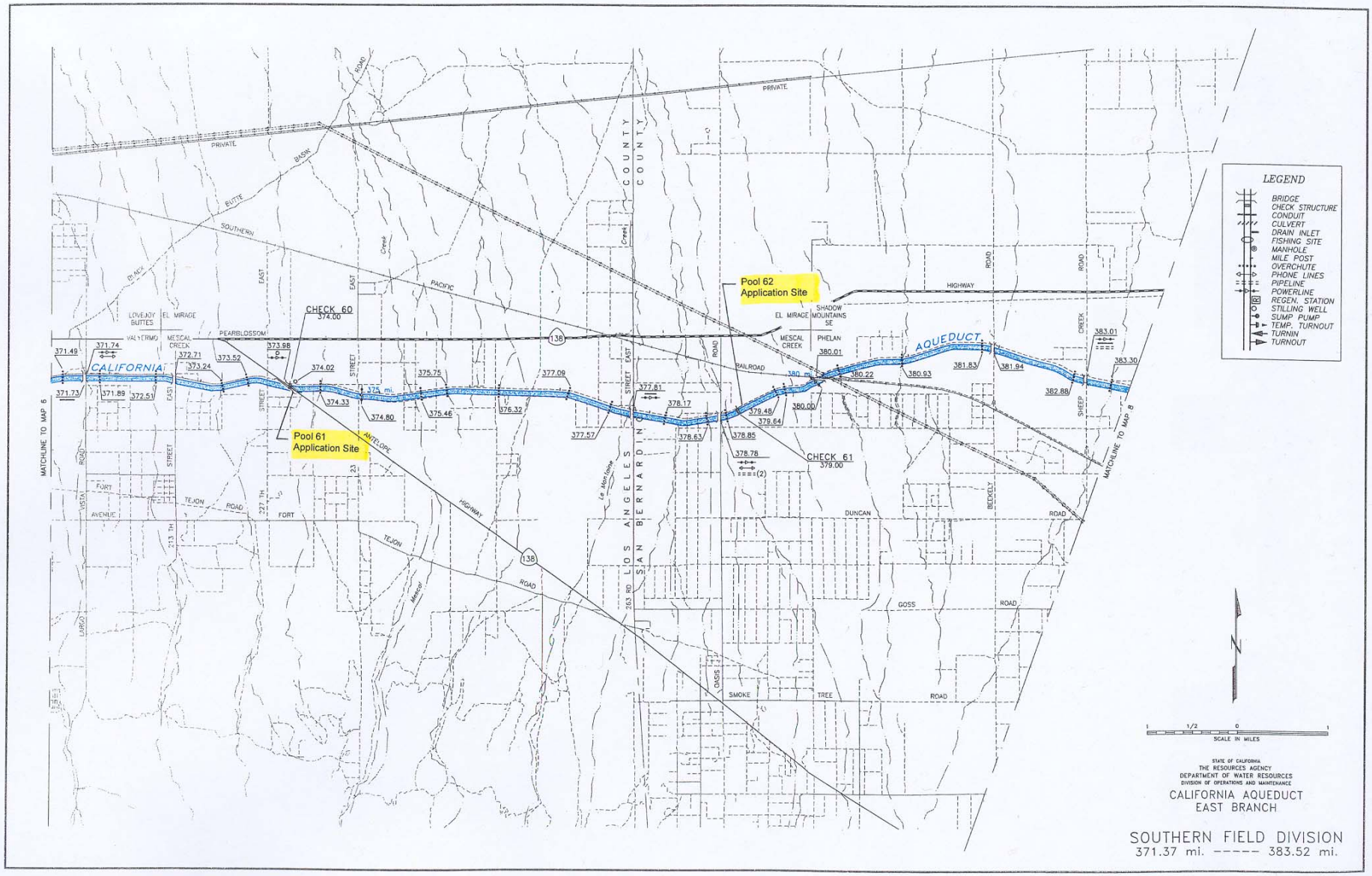
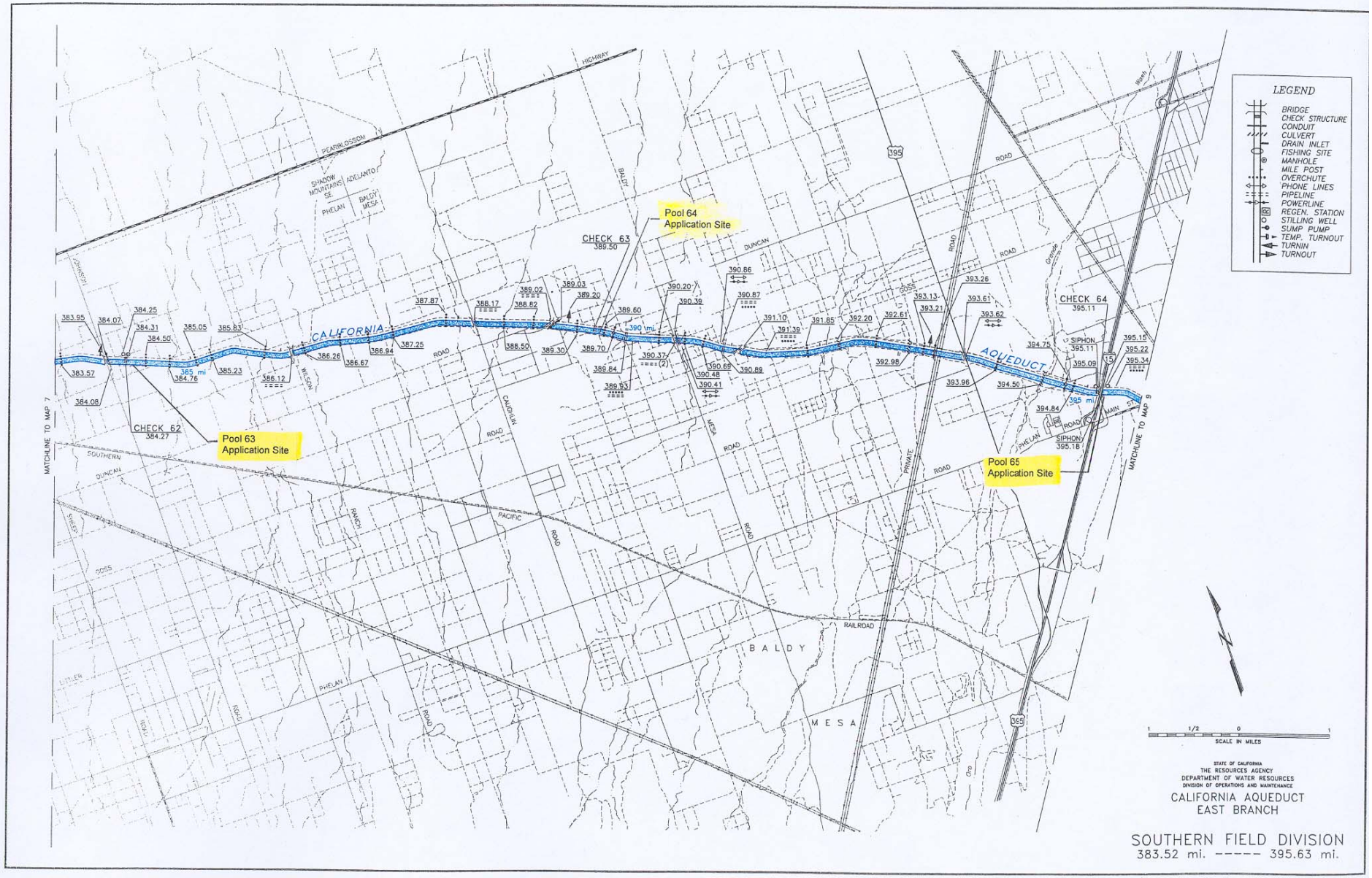


Figure 9. East Branch California Aqueduct from Miles 383.52 to 395.63 Showing Location of Application Sites (Pools 63 and 65)



N

0.5

Miles

Map Citations:
Main: ESRI Street Map
Inset: ESRI Street Map

Figure 10 - Pyramid Lake Overview Map

Aquatic Pesticides Application Plan

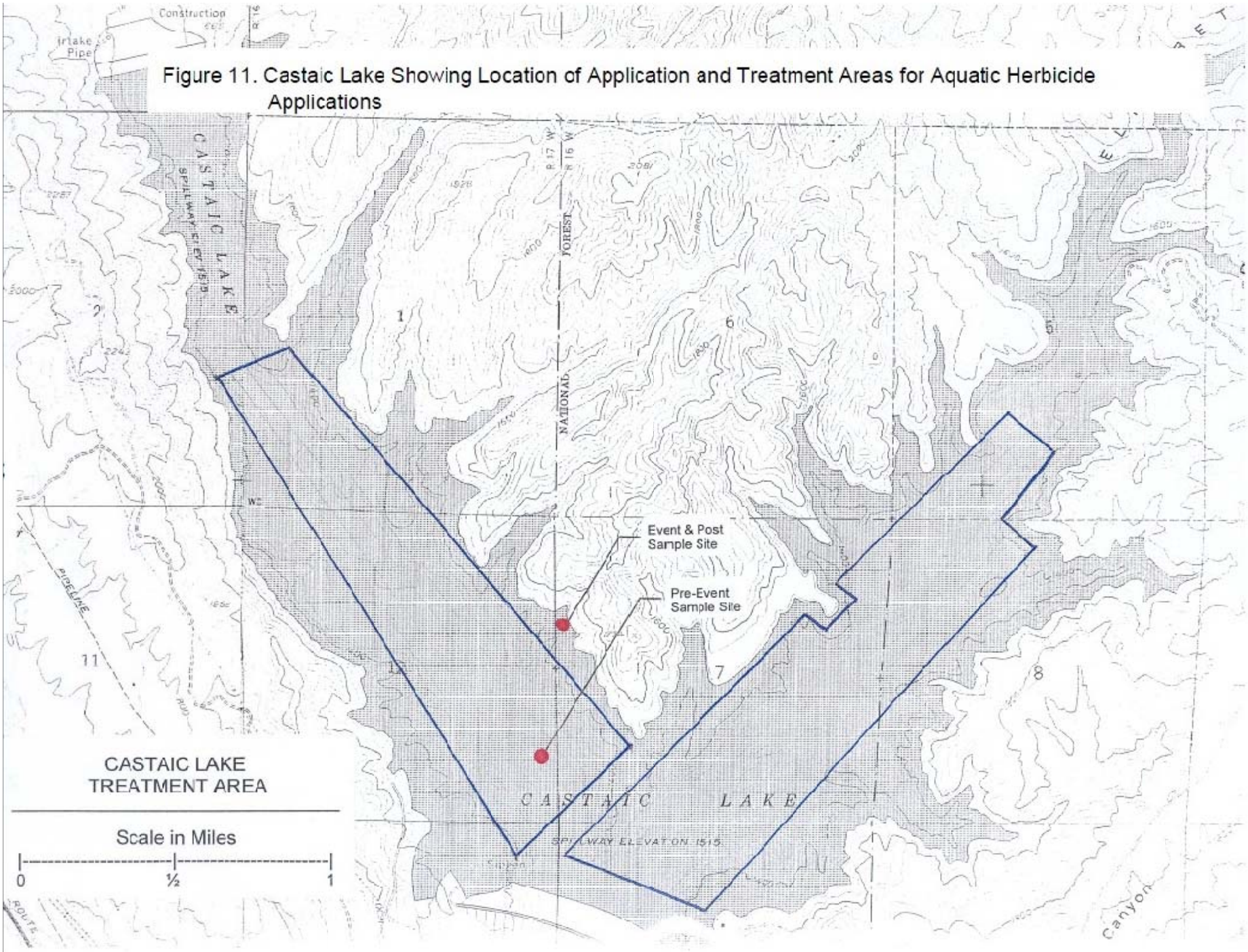
Los Angeles County, CA
118°46'19.483"W
34°39'14.054"N

Legend

Sampling Sites

Station Name
(Station Number)

Figure 11. Castaic Lake Showing Location of Application and Treatment Areas for Aquatic Herbicide Applications



N

0.5

Miles

Map Citations:
Main: ESRI Street Map
Inset: ESRI Street Map

Figure 12 - Silverwood Lake Overview Map

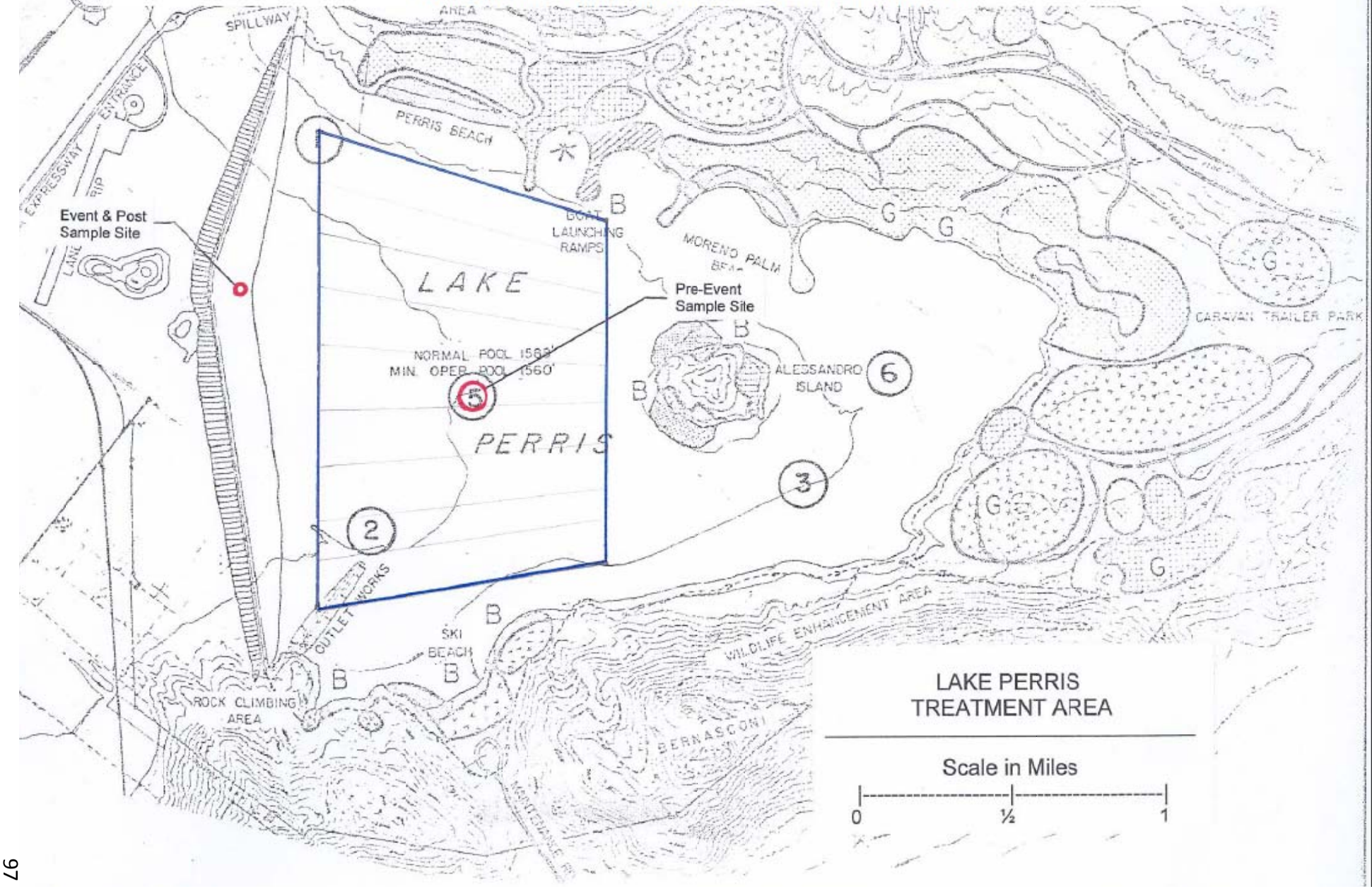
Aquatic Pesticides Application Plan

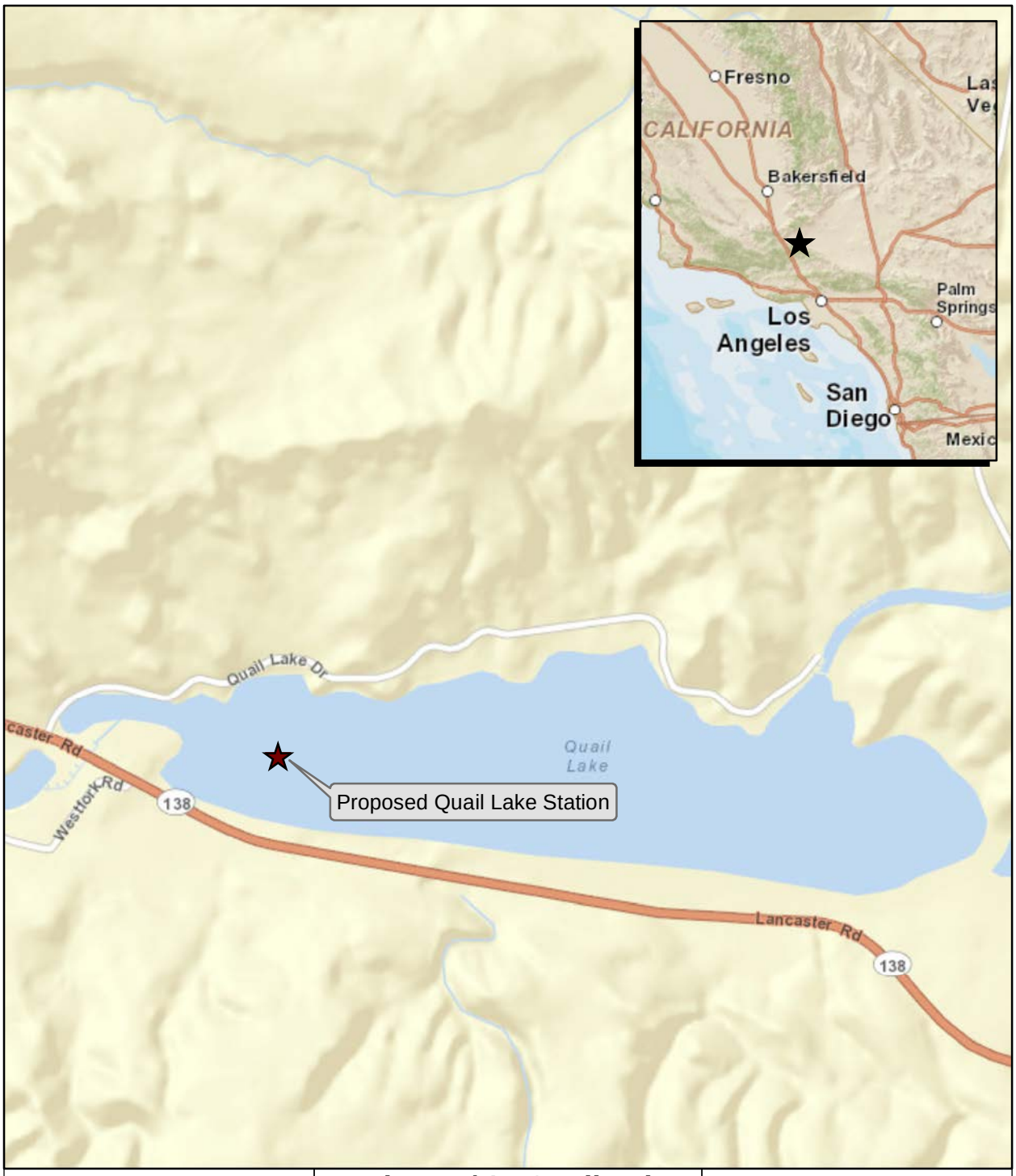
San Bernardino County, CA
117°19'29.851"W
34°17'30.214"N

Legend

Sampling Sites
Station Name
(Station Number)

Figure 13. Map of Lake Perris showing location of Application and Treatment Areas for Copper Sulfate Application to Control Taste and Odor Producing Algae





N

0.3

Miles

Map Citations:
Main: ESRI Street Map
Inset: ESRI Street Map

Figure 14 - Quail Lake Overview Map

Aquatic Pesticides Application Plan

Los Angeles County, CA
118°44'49.629"W
34°46'18.156"N

Legend

Sampling Sites

N

0.7

Miles

Map Citations:
Main: ESRI Street Map
Inset: ESRI Street Map

Figure 15 - Intake Channel Overview Map

Aquatic Pesticides Application Plan

Contra Costa, CA
121°36'25.372"W
37°48'43.564"N

N

1

Miles

Map Citations:
Main: ESRI Street Map
Inset: ESRI Street Map

Figure 16 - Weir to BVPP Overview Map

Aquatic Pesticides Application Plan

Kern, CA
119°20'44.324"W
35°10'13.228"N

N

0.5

Miles

Map Citations:
Main: ESRI Street Map
Inset: ESRI Street Map

Figure 17 - AE turnout to Teerink PP Overview Map

Aquatic Pesticides Application Plan

Kern, CA
119°0'45.768"W
35°2'8.008"N

N

0.5

Miles

Map Citations:
Main: ESRI Street Map
Inset: ESRI Street Map

Figure 18 - Headworks Rd. to CPP Overview Map

Aquatic Pesticides Application Plan

Kern, CA
118°59'3.485"W
35°1'18.773"N

N

1

Miles

Map Citations:
Main: ESRI Street Map
Inset: ESRI Street Map

Figure 19 - I-5 to Pastoria Creek Siphon Overview Map

Aquatic Pesticides Application Plan

Kern, CA
118°53'26.707"W
34°56'46.043"N

APPENDIX A

MONITORING PLAN

Selection of Monitoring Sites

The Monitoring and Reporting Program for Water Quality Order No. 2013-0002-DWQ sets a sampling frequency as stated below:

> "Collect samples from a minimum of six application events for each active ingredient in each environmental setting (flowing water and non-flowing water) per year, except for glyphosate. If there are less than six application events in a year, collect samples during each application event for each active ingredient in each environmental setting (flowing water and non-flowing water). If the results from six consecutive sampling events show concentrations that are less than the receiving water limitation/trigger for an active ingredient in an environmental setting, sampling shall be reduced to one application event per year for that active ingredient in that environmental setting."

DWR applies aquatic herbicides to non-flowing and flowing application sites as shown in the table below.

Site type	Aquatic herbicide	Application sites (number)
1. **Non-flowing (reservoirs):**		
Clifton Court Forebay	• copper-based compounds: o chelated copper (Komeen®, Nautique®) o copper sulfate o EarthTec®	1
Patterson Reservoir	• copper-based compounds: o copper sulfate o EarthTec® • imazamox	1
Dyer Reservoir	• copper-based compounds: o copper sulfate o EarthTec® • imazamox • sodium carbonate peroxyhydrate	1

Site type	Aquatic herbicide	Application sites (number)

O'Neill Forebay	• copper-based compounds:
	  o chelated copper (Komeen®, Nautique®)
	  o copper sulfate
	  o EarthTec®
	• diquat
	• endothall
	• fluridone
	• imazamox
	• triclopyr
		1

Coastal Branch Aqueduct Forebays	• sodium carbonate peroxyhydrate	1 - 3

Pyramid Lake	• copper-based compounds:
	  o chelated copper (Komeen®, Nautique®)
	  o copper sulfate
	  o EarthTec®
	• diquat
	• endothall
	• fluridone
	• imazamox
	• sodium carbonate peroxyhydrate
	• triclopyr
		1

Castaic Lake	• copper-based compounds:
	  o chelated copper (Komeen®, Nautique®)
	  o copper sulfate
	  o EarthTec®
	• fluridone
	• imazamox
	• triclopyr
		1

Site type	Aquatic herbicide	Application sites (number)
Silverwood Lake	• copper-based compounds: o chelated copper (Komeen®, Nautique®) o copper sulfate o EarthTec® • diquat • endothall • fluridone • imazamox • sodium carbonate peroxyhydrate • triclopyr	1
Lake Perris	• copper-based compounds: o chelated copper (Komeen®, Nautique®) o copper sulfate o EarthTec® • fluridone, • imazamox, • triclopyr	1
Quail Lake	• copper-based compounds: o chelated copper (Komeen®, Nautique®) o copper sulfate o EarthTec® • diquat • endothall • fluridone • imazamox • sodium carbonate peroxyhydrate • triclopyr	1
2. Flowing (aqueduct):		
South Bay Aqueduct	• copper-based compounds: o copper sulfate o EarthTec®	2 - 4

Site type	Aquatic herbicide	Application sites (number)
Coastal Branch Aqueduct	• copper-based compounds: o chelated copper (Komeen®, Nautique®) o copper sulfate o EarthTec®	1 - 3
East Branch Aqueduct	• copper-based compounds: o chelated copper (Komeen®, Nautique®) o copper sulfate o EarthTec® • sodium carbonate peroxyhydrate	5 – 10
California Aqueduct	• copper-based compounds: o chelated copper (Komeen®, Nautique®) o copper sulfate o EarthTec® • endothall	1 - 5

a. Non-Flowing (Reservoirs): Samples will be collected at Clifton Court Forebay, Patterson Reservoir, Dyer Reservoir, O'Neill Forebay, forebays of the Coastal Branch Aqueduct, Pyramid Lake, Castaic Lake, Silverwood Lake, Lake Perris, and Quail Lake. There is one application site at each reservoir. Samples will be collected for at least six applications per year for each active ingredient in the non-flowing environmental setting or during every application event if the total number of events is less than six. If the results for six consecutive applications show concentrations of the active ingredient below the receiving water limitation, then the frequency will be reduced to once a year for the non-flowing environmental setting.

The applicable active ingredients to be analyzed are: dissolved copper, diquat, fluridone, imazamox, and triclopyr. Sodium carbonate peroxyhydrate (e.g., PAK®27, Phycomycin, and Green Clean) does not have a receiving water limitation or monitoring trigger in the General Permit. Therefore, DWR will not monitor concentrations of the active ingredient sodium carbonate peroxyhydrate.

Physical, chemical, and visual monitoring parameters are shown in Tables A1 and A2. Visual observations only (Table A2) will be done at the Coastal Branch Aqueduct forebays. All laboratory analyses will be conducted by a laboratory certified by the California Department of Public Health (CDPH) for such analyses. Laboratory results will be reported in the annual report to the State Water Resources Control Board. Records will be maintained for a minimum of three years from the date of sample measurement or report.

b. Flowing (Aqueducts): Samples will be collected at the South Bay Aqueduct and East Branch Aqueduct. Samples will be collected for at least six applications per year for each active ingredient. The samples will be collected from at least one of the aqueduct sites to determine the effects of the chemical treatment in a flowing environment. If the results for six consecutive applications show concentrations of the active ingredient copper below the receiving water limitation, then the frequency will be reduced to once a year for the flowing environmental setting. Sodium carbonate peroxyhydrate (e.g., PAK®27, Phycomycin, and Green Clean) does not have a receiving water limitation or monitoring trigger in the General Permit. Therefore, DWR will not monitor concentrations of the active ingredient sodium carbonate peroxyhydrate.

Physical, chemical, and visual monitoring parameters are shown in Tables A1 and A2. Visual observations only (Table A2) will be done at the Coastal Branch Aqueduct. All laboratory analyses will be conducted by a laboratory certified by CDPH to do such analyses. Laboratory results will be reported in the annual report to the State Water Resourced Control Board. Records will be maintained for a minimum of three years from the date of sample measurement or report.

TABLE A1

PHYSICAL AND CHEMICAL MONITORING PARAMETERS

Constituent/ Parameter	Sampling Method	Analytical Method
1. Water temperature (°F) 2. pH (number) 3. Turbidity (NTU) 4. Electrical Conductivity (umhos/cm) 5. Active ingredient[2] (ug/L) 6. Dissolved Oxygen (mg/L) 7. Hardness (mg/L) (if copper monitored)	Grab[1]	See USEPA Guidelines

[1] Samples will be collected at three feet below the surface of the water body or at mid water column depth if the depth is less than three feet, as stipulated in Table C-1 Monitoring Requirements of Order No. 2013-0002-DWQ.
[2] Dissolved copper, diquat, endothall, fluridone, imazamox, and triclopyr.

TABLE A2

VISUAL MONITORING PARAMETERS IN THE SWP

Parameter	Description
1. Monitoring area	Reservoir Aqueduct
2. Appearance of waterway	Sheen Color Clarity
3. Weather conditions	Fog Wind Rain

<u>Types of Monitoring Required (Water Quality Order 2013-0002-DWQ)</u>

a. Background Monitoring

Background monitoring samples shall be collected upstream at the time of the application event or in the application area just prior to (up to 24 hours in advance of) the application event.

b. Event Monitoring

Event monitoring samples shall be collected immediately downstream of the treatment area in flowing waters or immediately outside of the treatment area in non-flowing waters, immediately after the application event, but after sufficient time has elapsed such that treated water would have exited the treatment area.

c. Post-Event Monitoring

Post-event samples shall be collected within the treatment area and within one week after the application event.

<u>State Water Project Monitoring for Water Quality Order 2013-0002-DWQ</u>

1. Type: Reservoir (Non-flowing environmental setting)

a. Clifton Court Forebay

Aquatic Herbicides Applied: copper-based herbicides (chelated compounds [Nautique® and Komeen®], copper sulfate pentahydrate, and EarthTec®).

Treatment Area: Copper-based herbicides are applied to the smallest area possible that provides relief to State Water Project operations The treatment area is variable for each application event. A map will be submitted in the annual report to the State Water Resources Control Board showing the application area, treatment area, and water bodies receiving treatment water (where applicable).

Monitoring: Refer to Table A3 for monitoring sample types, timing of sample collection, and sample location.

NOTE: There are currently no treatments planned due to the listing of the North American green sturgeon (*Acipenser medirostris*).

b. Patterson Reservoir

Aquatic Herbicides Applied: copper-based herbicides (copper sulfate pentahydrate and EarthTec®) and imazamox.

Treatment Area: The specific area is variable and dependent on the location of the algae as determined by monitoring. For each application event, a map will be submitted in the annual report to the State Water Resources Control Board showing the application area and treatment area.

Monitoring: Refer to Table A3 for monitoring sample types, timing of sample collection, and sample location.

c. Dyer Reservoir

Aquatic Herbicides Applied: copper-based herbicides (copper sulfate pentahydrate and EarthTec®), imazamox, and sodium carbonate peroxyhydrate.

Treatment Area: The specific area is variable and dependent on the location of the algae as determined by monitoring. For each application event, a map will be submitted in the annual report to the State Water Resources Control Board showing the application area and treatment area.

Monitoring: Refer to Table A3 for monitoring sample types, timing of sample collection, and sample location.

d. O'Neill Forebay

Aquatic Herbicides Applied: copper-based herbicides (chelated compounds [Nautique® and Komeen®], copper sulfate pentahydrate, and EarthTec®), diquat, endothall, fluridone, imazamox, and triclopyr.

Treatment Area: The specific area is variable and dependent on the location of the algae as determined by monitoring. For each application event, a map will be submitted in the annual report to the State Water Resources Control Board showing the application area and treatment area.

Monitoring: Refer to Table A3 for monitoring sample types, timing of sample collection, and sample location.

e. Forebays of the Coastal Branch Aqueduct

Aquatic Herbicide Applied: sodium carbonate peroxyhydrate.

Treatment Area: The specific area is variable and dependent on the location of the algae as determined by monitoring. For each application event, a map will be submitted in the annual report to the State Water Resources Control Board showing the application area and treatment area.

Monitoring: Refer to Table A3 for monitoring sample types, timing of sample collection, and sample location.

f. Pyramid Lake

Aquatic Herbicides Applied: copper-based herbicides (chelated compounds [Nautique® and Komeen®], copper sulfate pentahydrate, and EarthTec®), diquat, endothall, fluridone, imazamox, sodium carbonate peroxyhydrate, and triclopyr.

Treatment Area: The specific area is variable and dependent on the location of the algae as determined by monitoring. For each application event, a map will be submitted in the annual report to the State Water Resources Control Board showing the application area and treatment area.

Monitoring: Refer to Table A3 for monitoring sample types, timing of sample collection, and sample location.

g. Castaic Lake

Aquatic Herbicides Applied: copper-based herbicides (chelated compounds [Nautique® and Komeen®], copper sulfate pentahydrate, and EarthTec®), fluridone, imazamox, and triclopyr.

Treatment Area: The specific area is variable and dependent on the location of the source of taste and odor production as determined by monitoring. For each application event, a map will be submitted in the annual report to the State Water Resources Control Board showing the application area, treatment area, and water bodies receiving treated water (where applicable).

Monitoring: Refer to Table A3 for monitoring sample types, timing of sample collection, and sample location.

h. Silverwood Lake

Aquatic Herbicides Applied: copper-based herbicides (chelated compounds [Nautique® and Komeen®], copper sulfate pentahydrate, and EarthTec®), diquat, endothall, fluridone, imazamox, sodium carbonate peroxyhydrate, and triclopyr.

Treatment Area: The treatment area is variable and dependent on the location of the source of taste and odor production as determined by monitoring. For each application event, a map will be submitted in the annual report to the State Water Resources Control Board showing the application area, treatment area, and water bodies receiving treatment water (where applicable).

Monitoring: Refer to Table A3 for monitoring sample types, timing of sample collection, and sample location.

i. Lake Perris

Aquatic Herbicides Applied: copper-based herbicides (chelated compounds [Nautique® and Komeen®], copper sulfate pentahydrate, and EarthTec®), fluridone, imazamox, and triclopyr.

Treatment Area: The treatment area is variable and dependent on the location of the source of taste and odor production as determined by monitoring. For each application event, a map will be submitted in the annual report to the State Water Resources Control Board showing the application area, treatment area, and water bodies receiving treatment water (where applicable).

Monitoring: Refer to Table A3 for monitoring sample types, timing of sample collection, and sample location.

j. Quail Lake

Aquatic Herbicides Applied: copper-based herbicides (chelated compounds [Nautique® and Komeen®], copper sulfate pentahydrate, and EarthTec®), diquat, endothall, fluridone, imazamox, sodium carbonate peroxyhydrate, and triclopyr.

Treatment Area: The specific area is variable and dependent on the location of the algae as determined by monitoring. For each application event, a map will be submitted in the annual report submitted to the State Water Resources Control Board showing the application area and treatment area.

Monitoring: Refer to Table A3 for monitoring sample types, timing of sample collection, and sample locations.

2. Type: Aqueduct (flowing water)

a. South Bay Aqueduct (SBA)

Aquatic Herbicide Applied: copper sulfate pentahydrate and EarthTec®.

Treatment Area: Copper sulfate is applied at a maximum of three locations in the open portion of the SBA. The treatment area is defined from the Backsurge Pool at Milepost (MP) 3.3 to MP 16.0.

Monitoring: Refer to Table A3 for monitoring sample types, timing of sample collection, and sample location.

b. Coastal Branch Aqueduct

Aquatic Herbicides Applied: copper-based herbicides (chelated compounds [Nautique® and Komeen®], copper sulfate pentahydrate, and EarthTec®).

Treatment Area: The aqueduct from MP 0.2 near the confluence with the California Aqueduct to Devil's Den Pumping Plant at MP 14.9.

Monitoring: Refer to Table A3 for monitoring sample types, timing of sample collection, and sample location.

c. East Branch Aqueduct

Aquatic Herbicides Applied: copper-based herbicides (chelated compounds [Nautique® and Komeen®], copper sulfate pentahydrate, and EarthTec®) and sodium carbonate peroxyhydrate (e.g., PAK®27).

Treatment Area: The specific area is variable and dependent on the location of the source of taste and odor production as determined by monitoring and laboratory analysis of samples for MIB and geosmin. For each application event, a map will be included in the annual report to the State Water Resources Control Board showing the application area, treatment area, and water bodies receiving treated water (where applicable).

Monitoring: Refer to Table A3 for monitoring sample types, timing of sample collection, and sample location.

d. California Aqueduct

Aquatic Herbicides Applied: copper-based herbicides (chelated compounds [Nautique® and Komeen®], copper sulfate pentahydrate, and EarthTec®), endothall, and other aquatic herbicides identified in this APAP.

Treatment Area: The areas identified for treatment are:

- Intake Channel at milepost (MP) 0.93, from Skinner Delta Fish Protective Facility to Banks Pumping Plant,
- MP 249.65–250.99; spillway to Buena Vista Pumping Plant,
- MP 277.31–278.13; Arvin-Edison turnout to Teerink Pumping Plant,
- MP 279.05–280.45; Chrisman headwork road to Chrisman Pumping Plant, and
- MP 285.69–292.16; I-5 to Pastoria Creek Siphon.

For each application event, a map will be included in the annual report to the State Water Resources Control Board showing the application area, treatment area, and water bodies receiving treated water (where applicable).

Monitoring: Refer to Table A3 for monitoring sample types, timing of sample collection, and sample location.

TABLE A3

MONITORING IN THE SWP: Timing and Location

Sample Type	Timing of Sample Collection	Sample Location	
		Reservoir (non-flowing)	**Aqueduct (flowing)**
Background	Samples shown in Tables A1 and A2 will be collected within 24 hours prior to the application event.	Samples shown in Tables A1 and A2 will be collected within the application area.	Samples shown in Tables A1 and A2 will be collected within the application area.
Event	Samples shown in Tables A1 and A2 will be collected after the application event.	Samples shown in Tables A1 and A2 will be collected outside of the treatment area after the application event. For Clifton Court Forebay treatments, samples will be collected in the intake channel to Harvey O. Banks Pumping Plant downstream of the treatment area. For Lake Perris samples, the collection location will be the reservoir outlet station (PE002) in the application area.	Samples shown in Tables A1 and A2 will be collected outside of the treatment area after the application event.
Post-event	*Reservoirs*: Samples shown in Tables A1 and A2 will be collected within seven days after the application event, or when treatment is deemed complete. When treating with copper compounds, treatment will likely be complete within two – three weeks. *Aqueducts*: Samples shown in Tables A1 and A2 will be collected within seven days after the application event.	Samples shown in Tables A1 and A2 will be collected within the treatment area.	Samples shown in Tables A1 and A2 will be collected within the treatment area.