RECLAMATION

Managing Water in the West

Final Environmental Assessment

Zebra Mussel Eradication Project for San Justo Reservoir, Hollister Conduit, and San Benito County Water Distribution System

EA-09-010

U.S. Department of the Interior
Bureau of Reclamation
South-Central California Area Office

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Mission Statements

The mission of the Department of the Interior is to conserve and manage the Nation's natural resources and cultural heritage for the benefit and enjoyment of the American people, provide scientific and other information about natural resources and natural hazards to address societal challenges and create opportunities for the American people, and honor the Nation's trust responsibilities or special commitments to American Indians, Alaska Natives, and affiliated island communities to help them prosper.

The mission of the Bureau of Reclamation is to manage, develop, and protect water and related resources in an environmentally and economically sound manner in the interest of the American public.

Contents

Section 1 Introduction

The Bureau of Reclamation (Reclamation) provided the public with an opportunity to comment on the Draft Finding of No Significant Impact (FONSI) and Draft Environmental Assessment (EA) between March 18, 2015 and April 16, 2015. Two comment letters were received. The comment letters and Reclamation's response to comments are included in Appendix I. Changes between this Final EA and the Draft EA, which are not minor editorial changes, are indicated by vertical lines in the left margin of this document.

1.1 Background

San Justo Reservoir, located southwest of Hollister, California, is used primarily for off-stream water storage as part of the San Felipe Division of the Central Valley Project (CVP). The reservoir was built and is owned by the Bureau of Reclamation (Reclamation) and is operated by the San Benito County Water District (San Benito). Water is primarily for irrigation and municipal uses and services 23,700 acres.

San Justo Reservoir receives CVP water out of San Luis Reservoir by way of the Pacheco Bifurcation structure and through the Hollister Conduit. Water can be diverted at various points along the Hollister Conduit to recipients by way of the San Benito distribution system and subsystems (distribution system). The conduit and distribution system are composed of more than 90 miles of total piping with various turnouts, flow control structures, and booster pumps. During high summer demand, water stored in San Justo Reservoir is delivered to recipients through pump-assisted flows through the Hollister Conduit and distribution system. Water from San Justo does not flow past the Pacheco Bifurcation and does not re-enter San Luis Reservoir; all flows out of San Justo terminate at various end-use locations.

The invasive exotic zebra mussel (*Dreissena polymorpha*) was detected at San Justo Reservoir in 2008, and the reservoir has since been closed to recreational access to prevent potential spread. Adult zebra mussels were also found to infest the Hollister Conduit at multiple locations in 2009.

A multi-agency group, including members from Reclamation, California Department of Fish and Wildlife (formerly, Department of Fish and Game), California Department of Water Resources, San Benito County, Santa Clara Valley Water District, and San Benito County Water District have proposed and evaluated actions to eradicate zebra mussels from San Justo Reservoir, the Hollister Conduit and the distribution system.

1.1.1 Previous Eradication Projects

There are three known zebra mussel and one quagga mussel eradication projects in lacustrine systems in the United States: 1) Millbrook Quarry, Virginia, 2) Base Lake at Offutt Air Force Base, Nebraska, 3) Lake Zorinsky, Nebraska, and 4) Billmeyer Quarry, Pennsylvania. The Millbrook Quarry and Offutt Air Force Base projects each used chemical treatment for eradication. Control at Lake Zorinsky, Nebraska was affected through reservoir drawdown. Billmeyer Quarry also used chemical treatment for eradication.

Millbrook Quarry, Virginia

Millbrook Quarry, located within Prince William County, Virginia, was previously used as a road stone quarry but has operated as a dive training site since the early 1970s. The quarry is approximately 12 acres in size and 93 feet deep (Virginia Department of Game and Inland Fisheries [Virginia DGIF] 2005 and 2011). In 2002, zebra mussels were confirmed to be present in the quarry which was the first reported presence in Virginia. Baseline data was collected in order to determine the most feasible method of treatment. Several methods were excluded from further analysis due to environmental concerns, technical infeasibility, logistics, or expense and included: treatment with chlorine, treatment with copper sulfate, pH shift, dewatering of the quarry, and increase in salinity. Two options, treatment with the molluscicide Spectrus CT-1300-Clamtrol© and potassium, were initially found to be feasible for eradication, but potassium was chosen as the treatment method to be implemented at the quarry.

Treatment with potassium chloride at the quarry included pumping 174,000 kilograms (kg) of potassium chloride solution into the quarry through a diffuser assembly from a work boat over a three week period in 2006 (Virginia DGIF 2011). The cost to treat the 12-acre Virginia quarry with potassium chloride in 2006 was approximately $365,000. To ensure lethal concentrations of potassium a target dose of 100 parts per million (ppm) throughout the water column was established. The use of a whole-lake target dose concentration of 100 ppm potassium was used in order to ensure that at least 50 ppm potassium was achieved at the lake margins or deep areas that may have experienced incomplete mixing. Virginia DGIF sampled at various depths and locations during and after treatment and found that concentrations in the quarry ranged from 98 ppm to 115 ppm potassium (Virginia DGIF 2011). Various methods were used to determine zebra mussel eradication after treatment including: remotely operated vehicles, diver observation, bioassay, and direct examination of mussels removed from substrate. None of the sampled or observed mussels were found alive and, after 31 days of exposure to concentrations within the quarry, all mussels used in bioassay were dead (Virginia DGIF 2011). There were no observed non-molluscan aquatic wildlife, vegetation, or terrestrial wildlife harmed during or after treatment at the quarry (Virginia DGIF 2011).

Offutt Air Force Base, Nebraska

Offutt Air Force Base, located in Sarpy County, Nebraska, contains a recreational Base Lake that was created during the construction of the main runway at the Base. The Base Lake is approximately 117 acres in size with an average depth of 15 feet (URS 2008). In 2006, zebra mussel shells were observed along the shoreline of the lake and closer examination of rocks and other hard surfaces confirmed the presence of live mussels. Although, potassium chloride was found to be successful at Millbrook Quarry for eradication of zebra mussels, the application of potassium chloride at Lake Offutt was determined to be cost prohibitive due to price increases in potassium and the quantity of potassium chloride that would be required to bring the average concentration of potassium to 100 ppm (approximately 340 tons). Additionally, the logistics of transporting, storing, and applying 340 tons of potassium chloride made this treatment option infeasible. Consequently, copper sulfate was chosen as the most feasible treatment method for eradication of zebra mussels within Base Lake (URS 2008).

Copper sulfate was first applied at Base Lake in the fall of 2008 and a second application was applied in the spring of 2009. Copper sulfate was dispersed from a barge using aquatic herbicide spreaders over a 30-hour period until a concentration of 1 ppm copper was achieved. The inlet channel and ponded areas upstream of the lake were also treated to prevent mussel migration (URS 2008). After application of copper sulfate, bioassays of six live colonies were placed at various locations around the lake and monitored 24 hours, 72 hours, and 168 hours after treatment. By 168 hours 100% mortality was achieved. Water samples were collected in three locations around the lake and examined for veliger larvae. No veliger (live or shells) were found in the water samples. Both treatments, in the fall of 2008 and spring of 2009, were monitored in the same manner and concluded the same results. Copper sulfate did have a negative impact on local fish populations eliminating about 41,500 pounds of various fish species after both treatments (URS 2008).

Monitoring by veliger tows and settling tiles has continued annually since initial treatment. Although boat restrictions have been enforced since treatment, five zebra mussels were found attached to settling tiles within the lake in 2010 indicating that eradication was not successful (Schainost 2011). The military spent about $482,000 in 2008 and '09 in the unsuccessful effort to eradicate the mussel.

Zorinsky Lake, Nebraska

Zorinsky Lake is approximately 255 acres and is located in suburban Omaha, Nebraska. In November 2010, zebra mussels were reported from the reservoir. Eradication of zebra mussels was attempted by drawing down the reservoir, subjecting mussels in the drawdown zone to ambient temperatures (below 32 °F during the winter) and desiccation. The reservoir was drawn down approximately 17 feet, exposing mussels over an approximate 7-month period, from December 2010 to July 2011. A survey of eight sites within the upper 10 feet of the reservoir revealed 907 dead mussels. The reservoir was reflooded in July 2011.

Live mussels were reportedly discovered in May, 2016 (http://neinvasives.com/species/aquatics/zebra-and-quagga-mussels; accessed September 6, 2019), but it is uncertain whether this may have been a re-infestation.

Billmeyer Quarry, Pennsylvania

Billmeyer Quarry is approximately 30 acres and is located in rural Pennsylvania, approximately 19 miles from Lancaster, Pennsylvania. The lake has a maximum depth of approximately 120 feet. Stratification occurs during the winter and ice forms on the surface. The substrate of the reservoir is rocky and quagga mussels (*Dreissena bugensis*) were first confirmed in the lake in 2005. Eradication of quagga mussels from the entire lake was attempted by applying EarthTec QZ^{TM} (Copper sulfate pentahydrate) at a copper concentration of 0.2 ppm to 50% of the surface area, localizing application of the material near the shoreline and letting it disperse. Dives of the lake prior to treatment revealed that most mussels were apparently located in the upper ~ 10 ft of the reservoir and near the shoreline. Dissolved copper concentrations were monitored and when they dropped below 0.1 ppm, the dose required to theoretically replenish the concentration to 0.2 ppm was calculated and re-applied (Hammond and Ferris 2019 *in press*).[1]

[1] https://earthsciencelabs.com/wp-content/uploads/2019/07/Hammond-and-Ferris-2019-EarthTec-QZ-effort-to-eradicate-quaggas-from-entire-Pennsylvania-lake.pdf; (accessed September 6, 2019).

Three separate treatments were applied over a 37-day period and mussel mortality was assessed using caged adult mussels that were suspended at different depths throughout the lake. The last caged mussel died 40 days after initiation of the effort in a cage placed at approximately 30 feet. Subsequent evaluation by plankton tows from July through September 2018 and analyzed by microscopy revealed no live mussel veligers, but a rich fauna of zooplankton. The cumulative sum of product applied throughout the entire course of treatment was equivalent to 0.44 ppm as copper as calculated on the full volume of the lake, or less than half the concentration EPA allows (1.0 mg/L) in a single algaecide treatment.

1.1.2 Proposed Eradication at San Justo Reservoir

In 2008, Reclamation, California Department of Fish and Wildlife, San Benito, and additional outside technical experts formed a working group to evaluate methods for eradicating zebra mussels within the San Justo Reservoir, the Hollister Conduit, and San Benito's water distribution system. Several methods were considered for the eradication project. Millbrook Quarry was, and continues to be, the best known successful eradication attempt within the United States. Desiccation is being considered in combination with chemical treatment of the San Justo Reservoir because of the added need to eliminate mussels from the San Benito Conduit and associated distribution system. Like Millbrook Quarry, treatment with potassium chloride (as potash slurry) was found to be the chemical most well suited for eradication of zebra mussels within this system.

As a California public agency, San Benito prepared an Initial Study, pursuant to the California Environmental Quality Act, for the eradication project at San Justo Reservoir. A Notice of Determination was filed in San Benito County on May 31, 2012.

San Justo Comparison to Millbrook Quarry, Lake Zorinsky and Billmeyer Quarry

At the time of treatment, Millbrook Quarry was 95 feet deep and held approximately 614 acre-feet (AF) of water. The quarry required 18 days to add 144 tons of potash (as 174,000 gallons of potash slurry delivered via two tank trucks per day) to reach an average potassium concentration of 104 ppm with a range between 98 ppm and 115 ppm (Virginia DGIF 2005). During treatment (January to February), Millbrook Quarry water temperatures varied between 42.4°F to 56.3°F and 100% zebra mussel mortality was observed between 6 and 31 days for bioassay and 53 days for resident mussels within the quarry.

In contrast, San Justo Reservoir is currently held at a surface elevation of 485 feet with a maximum depth of 96 feet, area of 175 acres, and volume of 7,445 AF. At this volume, it is expected that 978 tons of potassium (delivered to the site in approximately 1.9 million gallons of solution) would be required to reach the target dosage of 100 ppm potassium (Cohen 2008). At 10 truckloads per day it is expected to take between 37 and 51 days (with or without weekends), respectively to complete dosing. Lesser amounts of potash would be required if San Justo Reservoir is drawn down.

Lake Zorinsky is approximately 255 surface acres, greater in size than San Justo Reservoir, Millbrook Quarry, and Billmeyer Quarry. However, like San Justo Reservoir, the bottom substrate is not hard and is mostly silty material. Additionally, its deepest waters lack oxygen during warm summer temperatures. Although the number of mussels inhabiting the bottom of Lake Zorinsky was not known at the time of drawdown, the drawdown was presumably employed because of its relative low cost and ease of rapid implementation. Silty bottoms are not preferred by zebra mussels, which utilize hard substrates for attachment and does poorly in anoxic conditions. San Justo Reservoir has mostly a silty bottom, although some structure (e.g. the outlet works, rocks, and sunken debris) at the bottom of the reservoir could provide attachment substrates for zebra mussels. Additionally, zebra mussels are known to attach/embed in compacted soil in San Justo Reservoir.

The Billmeyer Quarry study concerned eradication efforts for the quagga mussel (another Dreissenid mussel) using an ionic copper solution known as EarthTec QZ. Billmeyer Quarry has approximately 30 surface acres, which is 145 acres smaller than San Justo. The average depth is approximately 115 feet and volume is approximately 1,459.23 AF. The quarry had a "pronounced thermocline at 8-11 meters depth", which affected the ability of the treatment to mix within the water column (Hammond and Ferris 2019, in press). This resulted in higher mussel mortality above and below the thermocline, but a longer timeframe for morality within the thermocline. This study also suggested that negative effects to non-target species (both of micro-invertebrates and aquatic life in higher trophic levels) were relatively low during and after treatment.

1.1.3 Review of Potassium Toxicity Literature

Potassium chloride is an inorganic salt. It is not subject to further degradation processes in the environment and has been shown to be one of the most selective chemicals tested against zebra mussels (International Programme on Chemical Safety 2001; Waller et al. 1993). Review of toxicology literature on the effects of elevated potassium concentrations on zebra mussels and other aquatic organisms is similar to the findings from the Millbrook Quarry eradication project. As shown in Table 1, zebra mussels are generally more sensitive to elevated potassium concentrations with expected mortality occurring at 100 ppm. Results also indicate that increased water temperature during treatment with potassium is likely to significantly increase toxicity in zebra mussels. Bivalve toxicity was increased 10-fold when water temperature was increased from 50 degrees Fahrenheit (°F) to 68°F (Aquatic Sciences 1996).

Table 1 Summary of Toxicity Literature for General Reservoir Organisms

Taxonomic Group	Species	Toxicity	Potassium (ppm)	Literature Source
Crustaceans	Water flea (*Ceriodaphnia dubia*)	LC50 Mortality No effect	630 299-596 193	EPA 2009a EPA 2009a Aquatic Sciences 1997
	Scud/Amphipod (*Hyallela azteca*)	LC50 (4 day)	134-630	EPA 2009a
	Crayfish (*Orconectes limosus*)	LC50 (30 day)	330-450	EPA 2009a
Aquatic Insects	Midge (*Chironomis tentans*)	LC50 (4 day)	1,250-6,830	EPA 2009a
Worms	Sludge worm (*Tubifex tubifex*)	LC50 (4 day)	813*	EPA 2009a
	Oligochaete worm (*Nais variabilis*)	LC50 (2 day)	65-75*	EPA 2009a
Snails	Freshwater snail (*Physa heterostropha*)	LC50	940	Daum et al. 1977

Taxonomic Group	Species	Toxicity	Potassium (ppm)	Literature Source
	Ram's horn snail (*Bimophalaria alexandrina*)	Lethal	1,000-2,600	EPA 2009a
BIVALVES	Clam (*Corbicula fluminea*)	LC50	225	Anderson et al. 1976
	Zebra mussel (*Dreissena polymorpha*)	95% mortality LC50 (1 day)	100 138	Aquatic Sciences 1996 Fisher et al. 1991
FISH	Bluegill sunfish (*Lepomis macrochirus*)	LC50 (4 day) LC50	951-2,010 2,010	EPA 2009a Daum et al. 1977
	Mosquitofish (*Gambusia affinis*)	LC50 (4 day)	435-485	EPA 2009a
	Fathead minnow (*Pimephales promelas*)	LC50 (4 day) Lethal No effect Near zero	880 1,191 302 299	EPA 2009a EPA 2009a Aquatic Sciences 1997 EPA 2009a
	Common carp (Cyprinus carpio)	Lethal	5,910-6,590	EPA 2009a
	Channel catfish (*Ictalurus punctatus*)	LC50 (2 day)	720	EPA 2009a
	Rainbow trout (*Oncorhynchus mykiss*)	No effect (7 day)	500-1,000	EPA 2009a
AMPHIBIANS	Ornate narrow-mouthed frog (*Microphyla ornata*)	LC50 (4 day) Lethal	1,414-2,539 2,000	EPA 2009a EPA 2009a
	Bullfrog (*Rana breviceps*)	Mortality	1,000-10,000	Kegley et al. 2010

*Test conditions for worms did not allow normal burial within substrate which may have produced the low toxicity values.
EPA = Environmental Protection Agency

A variety of aquatic species, including certain fish and invertebrates appear to be less susceptible than zebra mussels to the effects of potassium toxicity. In contrast to zebra mussels, no mortality is expected for several common fish species in the 300 to 1,000 ppm potassium range or for planktonic crustaceans at approximately 200 ppm (Table 1). Several invertebrates and fish show LC50[2] endpoints far higher than those for zebra mussels. See Appendix A for a review of zebra mussel toxicology literature.

Derivatives of potassium (e.g. potassium dihydrogen phosphate and potassium chloride) have been shown to kill zebra mussels at relatively low concentration without affecting most nontarget organisms (Fischer et al. 1991). Potassium appears to kill mussels by destroying the integrity of the mussels' gill tissue leading to asphyxiation (Fischer et al. 1991).

Although there is a general lack of significant toxicity information on typical reservoir fish or other invertebrates at target concentrations of 100 ppm potassium, no non-molluscan aquatic wildlife, vegetation, or terrestrial wildlife were harmed during or after treatment at Millbrook Quarry. Virginia DGIF found that turtles, fish, aquatic insects, and snails all "continued to thrive" post treatment (Virginia DGIF 2011).

[2] An LC50 value is the lethal concentration of a toxic substance required to kill 50 percent of the members of a test population.

Potassium Toxicity to Humans

Potassium chloride is an essential constituent of the human body for intracellular osmotic pressure and buffering, cell permeability, acid-base balance, muscle contraction and nerve function. Acute oral toxicity of potassium chloride in mammals is low (LC50 = 3,020 milligrams per kg [mg/kg]). In humans, potassium chloride is rapidly excreted in the absence of any pre-existing kidney or circulatory system dysfunction (see Material and Safety Data Sheet in Appendix B).

1.1.4 Pilot Study at San Justo Reservoir

In 2010, Reclamation and San Benito conducted a shoreline desiccation pilot study at San Justo Reservoir (Chapman & Gruenhagen 2010). The purpose of the study was to investigate mortality of zebra mussels in relation to desiccation time during the cool wet months of winter, when conditions are more favorable to survival of exposed mussels. Survival of different size classes of mussels in "exposed" and in "sheltered" sites was evaluated. The study found that some mussels appeared to be alive after 20 days of desiccation on the shoreline, although most mussels were dead following 40 days of desiccation. A small fraction of the mussels observed after 40 days of desiccation still had flesh inside a tightly closed shell and it was unknown whether or not these mussels would have revived once re-submerged. Consequently, given the expected expense of an eradication attempt, Chapman and Gruenhagen (2010) recommended using the longest desiccation (drying) time possible, ideally three months, and timing treatment during the warmest period of the year when zebra mussels would be actively feeding and rate of desiccation would be at a maximum.

1.1.5 Dreissenid Mussel Sampling within San Luis Reservoir and O'Neill Forebay

In 2010, the Reclamation Mussel Task Force collected and analyzed 3,326 water samples from 347 water bodies located within the 17 western states for presence of quagga mussels (*D. bugensis*) and zebra mussels (Reclamation 2011b). Tow-net samples from each water body were collected at multiple locations during the 2011 warm season, generally on a monthly basis. Samples were sent to Reclamation's Denver Technical Service Center (Technical Service Center) Mussel Laboratory for testing. Each sample was analyzed to detect the presence of dreissenid mussels using one or more of the following procedures: cross-polarizing light microscopy, imaging-flow cytometry, scanning electron microscopy, as well as polymerase chain reaction testing for mussel DNA (Reclamation 2011b).

Cross polarizing light microscopy of samples from San Luis Reservoir and O'Neill Forebay tested by Reclamation's Technical Service Center were negative for dreissenids, although polymerase chain reaction results were positive (D. Hosler, pers. comm.). Additional examination of the positive samples, using light microscopy, but not cross polarizing light, was conducted by a mussel expert. Based upon that examination, the expert confirmed quagga mussels to be present in samples from San Luis Reservoir (D. Hosler, pers. comm.). However, polymerase chain reaction testing of DNA from these same samples by the State of California (through Scripps Institute) did not confirm Reclamation's Technical Service Center's results and there is inconsistency in the body of results from all samples. At this time, the State of California does not consider the results obtained for San Luis Reservoir and O'Neill Forebay indicative of the presence of quagga mussels (S. Ellis, pers. comm.). In addition, subsequent testing by CDFW for the presence of quagga mussels in San Luis Reservoir has been negative.

The eradication of zebra mussels from San Justo Reservoir does not preclude future infestation by quagga mussels, or zebra mussels, for that matter. Should quagga mussels be confirmed present in the San Luis Reservoir or in O'Neill Forebay additional planning and environmental analysis may be required before a decision is made to take action regarding mussels in San Justo Reservoir. San Justo Reservoir receives its water from San Luis Reservoir, therefore, quagga mussels, if present, could end up in San Justo Reservoir in the future.

1.2 Need for the Proposed Action

Reclamation and San Benito need to prevent further spread of zebra mussels and to reduce or eliminate impacts to the San Justo Reservoir, the Hollister Conduit and San Benito's water distribution system (Figure 1). The purpose of the Proposed Action is to eradicate zebra mussels within these systems and take steps to help prevent future infestation and maintain the operation of the facilities.

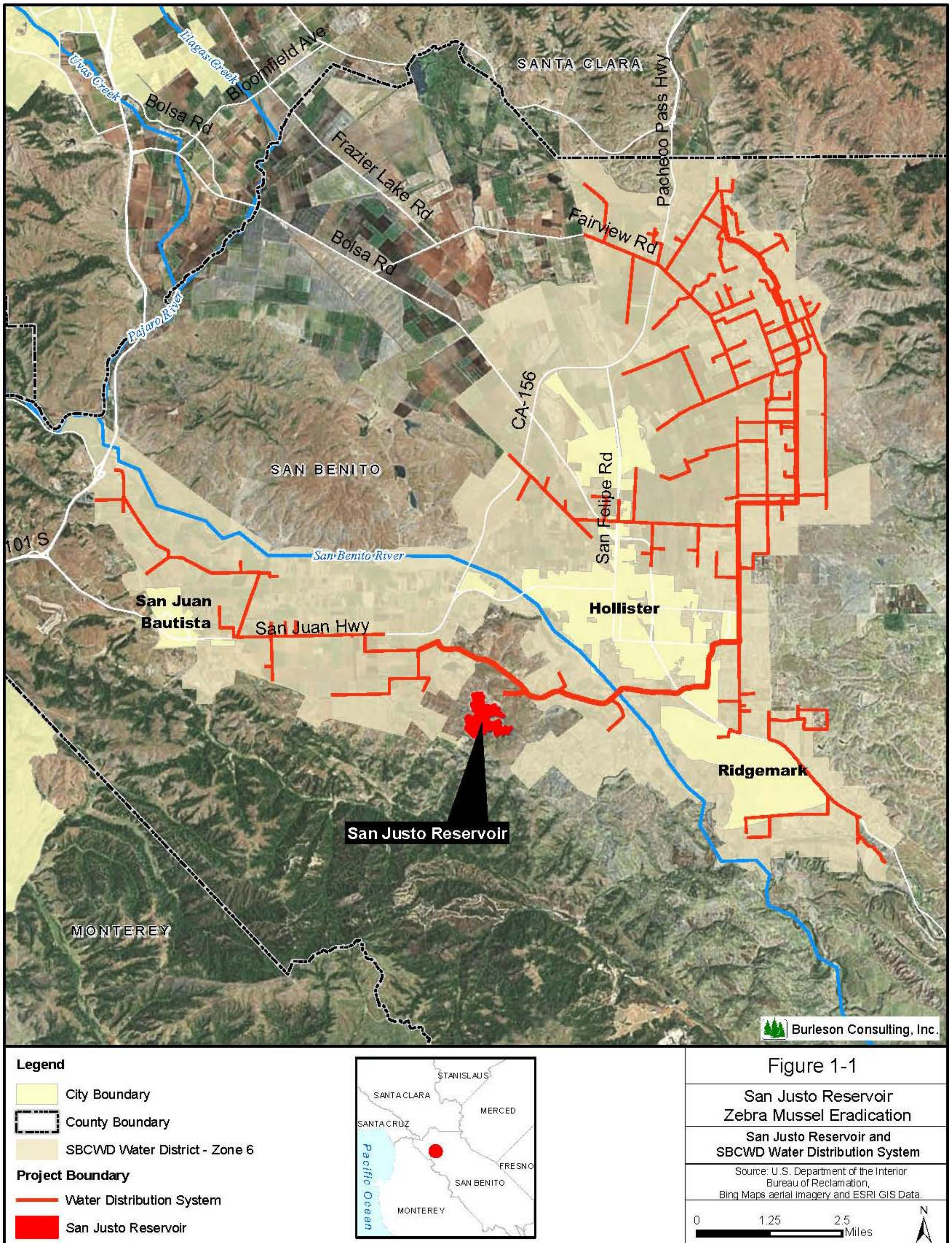

Figure 1 San Justo Reservoir and San Benito's Water Distribution System

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Section 2 Alternatives Including the Proposed Action

This EA considers two possible actions: the No Action Alternative and the Proposed Action. The No Action Alternative reflects future conditions without the Proposed Action and serves as a basis of comparison for determining potential effects to the human environment.

2.1 No Action Alternative

Reclamation and San Benito would not conduct a zebra mussel eradication project for San Justo Reservoir, the Hollister Conduit, and the San Benito subsystems. Zebra mussels would continue to be present within these systems. Damage from zebra mussel infestation could lead to system failure and substantial repair costs as well as increasing the potential for spread. Further spread of zebra mussels would be environmentally and economically damaging.

2.2 Proposed Action

Reclamation and San Benito propose to conduct a zebra mussel eradication project for San Justo Reservoir, the Hollister Conduit, and the San Benito Distribution System by treating these systems with potash, a mined product that consists almost entirely of potassium chloride (see Appendix C for Final Eradication Plan).

2.2.1 Zebra Mussel Eradication Treatment

San Justo Reservoir Treatment

Prior to treatment, San Justo Reservoir would be drawn down to a surface elevation between 430 and 470 feet. Lower water levels would require application of less potash, reducing cost for this material. The water released from the reservoir would be sent through the existing San Benito water delivery system for use by San Benito County water users. Once the desired drawdown elevation is reached in the reservoir, the inlet/outlet valve connecting the reservoir to the water distribution system would be closed to isolate the reservoir.

Treatment of the reservoir would consist of infusing the remaining water with a potash solution pumped from land-based storage tanks to floating supply lines attached to work boats in the reservoir outfitted with diffuser assemblies. Potash also may be pumped to barges, which could also supply work boats. Potash would either be brought in as a ready-to-use solution or a dry mix that would require mixing onsite prior to treatment. All land-based storage tanks would be placed on existing pavement with temporary spill containment infrastructure (Figure 2).

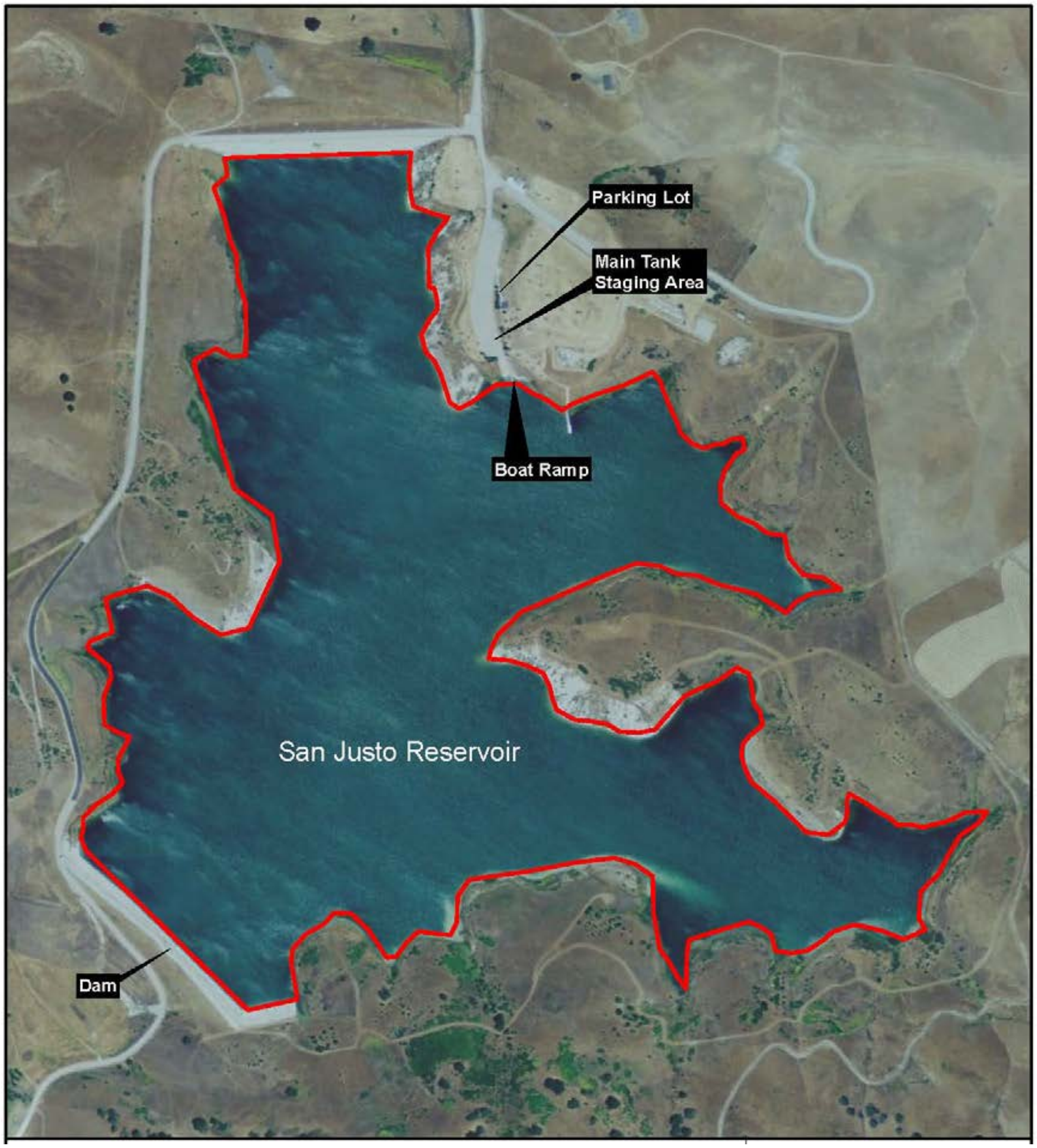

Figure 2 San Justo Reservoir Project Components

Approximately 255,358 to 1,224,506 kg (depending on reservoir elevation) of potash would be needed to achieve the desired minimum concentration of 100 ppm potassium ion and maximum concentration of 115 ppm of potassium ion in the reservoir (Table 2). Injection and monitoring would be done within different zones and at different depths within the reservoir to ensure the entire water column reaches the desired minimum concentration for a minimum of 30 days. Sampling would be conducted during the treatment period to verify that concentrations of potassium chloride in the water were maintained at approximately 100 ppm. If concentrations of potassium drop below 95 ppm, water sampling would be increased to daily collection and testing. If concentrations of potassium ion did not return to 100 ppm within 2 days, then additional potassium chloride would be added to reach the target concentration requirement of 100 ppm and the length of treatment time increased commensurately for the period of days for which 100 ppm was not maintained. Additionally, if during the period of treatment, the concentration was not maintained for 95% of days in the treatment period, additional potassium muriate would be added to ensure that 95% of the treatment days would have had the treatment concentration of 100 ppm potassium ion (minimum) to 115 ppm (maximum) for a minimum of 30 days. However, the reservoir shoreline desiccation portion of the eradication will be the timeframe driver, requiring 60 to 90 days.

Table 2 Calculated Potash Quantities Required to Reach 100 ppm Potassium per Reservoir Water Surface Elevation

Reservoir Elevation (feet)	Reservoir Volume (AF)	Muriate of Potash* (kg)
430	1,055	255,358
431	1,117	270,364
432	1,181	285,855
433	1,247	301,830
434	1,314	318,047
435	1,383	334,748
436	1,454	351,934
437	1,526	369,361
438	1,600	387,272
439	1,676	405,668
440	1,754	424,547
441	1,834	443,911
442	1,916	463,758
443	1,999	483,848
444	2,084	504,422
445	2,171	525,480
446	2,260	547,022
447	2,351	569,048
448	2,445	591,800
449	2,540	614,795
450	2,638	638,515
451	2,738	662,719
452	2,840	687,408
453	2,945	712,823
454	3,053	738,964
455	3,162	765,347
456	3,273	792,214
457	3,386	819,565
458	3,501	847,400
459	3,619	875,961
460	3,739	905,007
461	3,862	934,778
462	3,986	964,792
463	4,113	995,531
464	4,242	1,026,755
465	4,373	1,058,463
466	4,506	1,090,655
467	4,641	1,123,331
468	4,778	1,156,491
469	4,917	1,190,136

Reservoir Elevation (feet)	Reservoir Volume (AF)	Muriate of Potash* (kg)
470	5,059	1,224,506
*Muriate of Potash contains about 98% potassium chloride		

Water Distribution System Treatment

If the reservoir has not been lowered below the point where pressure would move water into the water distribution system (hydraulic gradeline of the reservoir, approximately 462 feet) and the reservoir has reached the minimum 100 ppm potassium concentration, a second drawdown of the reservoir would occur to 455 feet. This would send treated water from the reservoir into the closed water distribution system to treat the system. Potassium concentrations would be tested at the endpoints of the water distribution system to ensure treated water at 100 ppm potassium has moved through the entire system. If portions of the system indicate concentrations of less than 100 ppm, chemical feed systems would be established to deliver additional potash solution to reach the minimum potassium concentration of 100 ppm throughout the entire pipeline system (Figure 3).

If the reservoir is drawn down below 462 AF, then the chemical feed systems mentioned above would be established for treatment of the water distribution system in the same locations (Figure 3). Chemical feed systems would consist of potash solution storage tanks and chemical feed pumps with temporary spill containment placed within previously disturbed access rights-of-way. It is possible that some treated water would be bled off from the water distribution system in order to ensure movement of treated water throughout the system. Any treated water would be used primarily for agriculture, as potash is used commonly as a fertilizer. Water bled away would be done in a manner so that it would not reach a waterway, or would provide habitat capable of supporting mussels.

Treatment Time Period

Treatment of San Justo Reservoir and the water distribution system would be done over two to three months beginning in late summer (August or September) once potassium reaches the minimum 100 ppm concentration (a minimum of 30 days at this minimum concentration would occur in all potentially infested waters, e.g., the reservoir and delivery system). Earliest start time would be August 2020 but could occur late summer in following years, depending on funding and permitting requirements.

Equipment and Staging

Staging areas for treatment and monitoring of the reservoir would be located within the existing paved parking area at the reservoir (Figure 2). Any staging needed for treatment of the water distribution system would be within existing, previously disturbed, access roads. No ground disturbing activities would occur under the Proposed Action.

Equipment needed for the Proposed Action would include transfer trailer rigs, spill containment infrastructure, loading transfer equipment, tanks with mixing equipment, liquid/slurry pump systems from tanks to workboats, workboats, supply barges, diffuser system with hoses, mixing equipment, electrical generators, and gasoline/diesel pumps as needed.

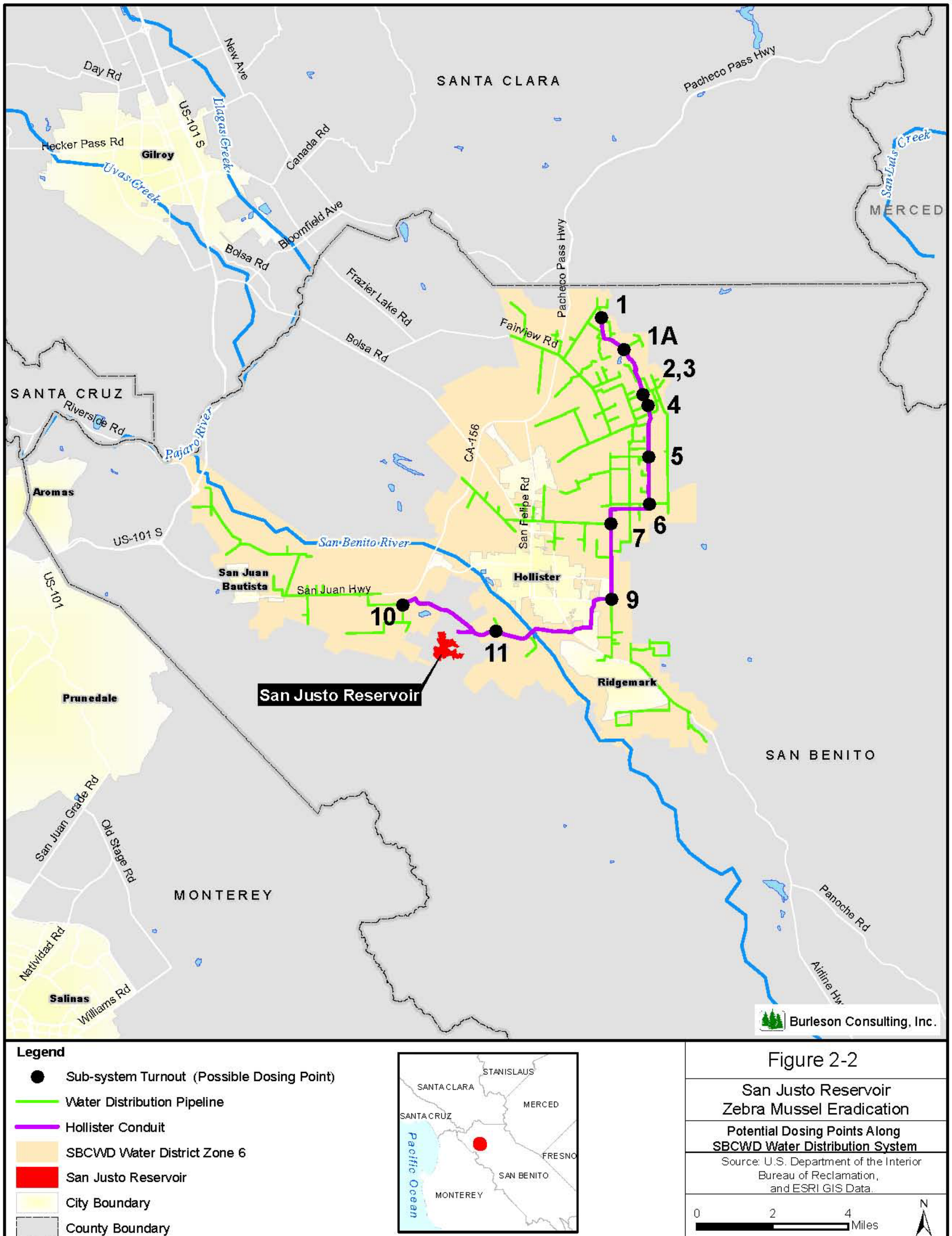

Figure 3 Potential Dosing Points along Hollister Conduit and San Benito Distribution System

Equipment Decontamination

Equipment used during the eradication program that comes into contact with water from the reservoir or distribution system would be required to undergo decontamination consistent with the Bay Area Consortium's *Zebra and Quagga Mussel Coordinated Prevention Plan* (see Appendix D). No equipment would be moved from site without undergoing decontamination and inspection.

Potassium Concentration Monitoring during Treatment

Reclamation and San Benito would conduct a monitoring program during treatment of San Justo Reservoir and the water distribution system to confirm zebra mussel mortality and eradication. Potassium concentrations would be monitored at various locations in San Justo Reservoir and at various points along the water distribution system before, during, and after "charging" with potash. Monitoring would continue throughout the treatment period to ensure that potassium levels remain at or above the minimum 100 ppm treatment level. See Appendix E for a complete description of the Monitoring Program.

Monitoring of San Justo Reservoir would include:

- San Justo Reservoir shoreline surveys
- Substrate sampling with settling plates for settling zebra mussels
- Vertical and horizontal plankton tows for veligers
- Zebra mussel bioassay
- Visual inspection of the reservoir by divers or underwater remotely operated vehicles

Monitoring of the Hollister Conduit and San Benito water distribution system would include:

- Biobox monitoring at various locations along the system, including at system discharge points
- Bioassays of sentinel mussels
- Visual inspection at locations of known or suspected zebra mussel infestation to determine their presence and behavioral response assays for evaluating mortality or suspected mortality
- Visual inspection of the water distribution system using remotely operated vehicles at select locations when safe access is possible

Long-Term Monitoring Post Treatment

For the Millbrook Quarry eradication project, which was conducted in a relatively homogenous habitat that is considerably smaller than San Justo Reservoir, complete mussel mortality (100%) was achieved after 30 days of treatment with a minimum 98 ppm potassium ion concentration at a water temperature of 39°F (Virginia DGIF 2005 and 2011). As described previously, potassium toxicity rates on zebra mussels have been shown to increase with increased temperature as well as exposure time (Fisher et al. 1991, Waller et al. 1996, Aquatic Sciences Inc. 1996). San Justo Reservoir's water temperatures historically go no lower than 53°F and the associated water distribution system is similar to that of the reservoir. It is expected that treatment of San Justo Reservoir, the Hollister Conduit, and San Benito's subsystems with a minimum 100 ppm potassium concentration at approximately 50°F over a two to three month period should achieve complete mortality of all zebra mussels present in the system, even if concentrations are not maintained throughout.

Eradication of zebra mussels in the reservoir and the water distribution system would be confirmed by long-term monitoring as described in Appendix E. Long-term (2 to 3 years minimum) monitoring would be similar to that described for treatment monitoring including:

- San Justo Reservoir shoreline surveys
- Substrate sampling with settling plates for settling zebra mussels
- Vertical and horizontal plankton tows for veligers
- Zebra mussel bioassay
- Visual inspection of the reservoir by divers or underwater remotely operated vehicles

Once mortality of zebra mussels in the reservoir and the water distribution system is confirmed through bio-assay checks of mussels and the treatment period has ended, the inlet/outlet valve would be opened and the reservoir refilled with water from San Luis Reservoir to its seasonal operating elevation. A portion of the treated water in the water distribution system would be sent into the reservoir as this water is brought into the system. The remaining water would be delivered primarily to agricultural water users.

Reclamation and San Benito will prepare a zebra mussel re-infestation prevention program that would be consistent with the Bay Area Consortium's *Zebra and Quagga Mussel Coordinated Prevention Plan* (Appendix D).

2.2.2 Environmental Commitments

Reclamation and San Benito would implement the following environmental protection measures to reduce or avoid environmental consequences associated with the Proposed Action (Table 3). Environmental consequences for resource areas assume the measures specified would be fully implemented.

Table 3 Environmental Protection Measures and Commitments

Resource	Protection Measure
Water Resources	Hazardous materials would not be drained onto the ground, San Justo Reservoir, or into drainage areas. All waste, including trash and litter, garbage, other solid waste, petroleum products, and other potentially hazardous materials, would be removed to a disposal facility permitted to accept such materials.
Water Resources	Construction materials would not be stockpiled or deposited near San Justo Reservoir where they could be washed away by high water or storm runoff or can encroach, in any way, upon the watercourse.
Water Resources	Fueling, cleaning, and maintenance of equipment would not be allowed except in designated areas located as far from the San Justo Reservoir as possible. Secondary containment would be utilized as appropriate to minimize chance for spill.
Biological Resources	If seepage to the pond west of the dam and adjacent to the reservoir is reduced during drawdown and treatment, supplemental water, meeting Title 22 drinking water standards, would be brought in to ensure pond levels do not draw below baseline conditions, if drawdown is determined to be detrimental to California red-legged frog in consultation with U.S. Fish and Wildlife Service (Service 2010). This would continue until baseline seepage to the pond is returned. In order to prevent potential impacts to frogs, the supplemental water source would not

Resource	Protection Measure
	exceed 5 ppb copper concentration and would be tested in advance of initiation of eradication efforts.
Biological Resources	Measures would be established related to restrictions on use of pesticides, vehicle speed limits, control of trash and hazardous materials, and placement of storage tanks.
Biological Resources	Grasslands or trees subjected to disturbance would be surveyed for nesting migratory birds prior to any disturbance and take of migratory birds in those areas would be avoided.
Biological Resources	If ground disturbing activities would be required, prior to conducting such work, standardized surveys for San Joaquin kit fox (Service 2011) would be conducted by a qualified biologist, and avoidance measures would be implemented to avoid any affects to kit fox.
Air Quality	The following measures would be implemented to reduce fugitive dust emissions: • Idling times would be minimized by either shutting equipment off when not in use or reducing the maximum idling time to 5 minutes (as required by the California Airborne Toxics Control Measure Title 13, Section 2485 of California Code of Regulations). • Use alternative fuel or catalyst-equipped diesel construction equipment.

2.2.3 Permits Required

San Benito is in the process of applying for a Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) permit for the use of potash for eradication of zebra mussels. Reclamation and San Benito would also apply for a FIFRA permit for long-term management of San Justo Reservoir and the distribution systems with potash should eradication prove unsuccessful.

2.2.4 Alternatives Considered but Eliminated from Further Analysis

Reclamation and San Benito considered alternative methods for treatment of San Justo Reservoir and the distribution systems. However, each method was eliminated from further analysis based on its inability to meet the purpose and need of the Proposed Action as well as its impacts on biological species, limited evidence of efficacy, availability, and cost.

Copper sulfate

At Offutt Air Force Base Copper sulfate was applied twice, but was not found to be successful in eradicating zebra mussels. In addition, this method was highly toxic to non-target organisms. Consequently, this method was eliminated from further analysis as it would not meet the need of the Proposed Action and would be environmentally damaging.

Other Copper formulations

Formulations of copper compounds other than copper sulfate are available for control of mussels. Since 2012, numerous bio-assays have been conducted to evaluate the efficacy of a variety of products for control of mussels. Two common formulations that have been experimented with include copper sulfate pentahydrate and copper triethanolamine complex. The efficacy of these materials is relatively high (often > 90%) towards quagga and zebra mussels. However, studies have shown that these copper compounds may be harmful to other aquatic species, such as fish (rainbow trout, goldfish, fathead minnow, green sunfish, bluegill sunfish), macroinvertebrates (shrimp species, water fleas, etc), and diatoms (Appendix F). Therefore, long-term effects of these materials and their suitability at the scale of San Justo Reservoir would require additional study. For registration information of these formulations in California, refer to Table 4.

Table 4 Copper Pesticide Formulations

Name	Active Ingredient	California Registration Number
Natrix (SePRO)	Copper ethanolamine complex and Copper triethanolamine complex	Not Registered
Captain (SePRO)	Copper ethanolamine complex and Copper triethanolamine complex	67690-9-AA
Earthtec (Earth Science Laboratory)	Copper sulfate pentahydrate	64962-1-ZH
Earthtec QZ (Earth Science Laboratory)	Copper sulfate pentahydrate	64963-1-ZL

Complete Reservoir Drawdown and Treatment of Dead Pool

Complete drawdown of the reservoir to dead pool and subsequent treatment of water within the dead pool (elevation 410 feet) with potassium chloride was considered but eliminated as an eradication method as maintaining a sufficient volume of water is necessary for San Benito to provide agricultural, municipal, and industrial water to its customers. Additionally, this method would not provide treated water through the distribution system to aid in eradication. Consequently, this method was eliminated from further consideration as complete drawdown would cause economic hardship to the communities dependent on this water supply and would cause desiccation of non-target organisms within the reservoir.

Pseudomonas-derived Biocide

A zebra mussel-specific biocide compound that is produced by a strain of *Pseudomonas fluorescens* bacteria has been developed by the New York State Museum and Marrone Organic Innovations, Inc. At present, the product is not commercially availability, the effectiveness of the method for eradication is less than 100 percent, and information on the toxicity to non-target organisms is being developed. In addition, sufficient quantities of the product to treat San Justo Reservoir and the distribution system is not currently available even if it could be used for eradication; therefore, this method has been eliminated from further analysis as it would not meet the need of the Proposed Action.

Potassium Chloride BioBullets

Potassium chloride BioBullets are a recently developed delivery system for biocide treatment of filter-feeding organisms. BioBullets encapsulate a biocide in an edible material in consumable-sized particles. At present, the product is costly, there is little information on the potential effects to non-target organisms, and the effectiveness on different life stages of zebra mussels are unknown. Consequently, this method was eliminated from further analysis as it would not meet the need of the Proposed Action.

A Mussel Population Management Program

A Mussel Population Management Program only alternative was determined to not meet the purpose and need of the project to eliminate the existing potential spread of zebra mussels from the San Justo Reservoir.

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Section 3 Affected Environment and Environmental Consequences

This section identifies the potentially affected environment and the environmental consequences involved with the Proposed Action and the No Action Alternative, in addition to environmental trends and conditions that currently exist.

3.1 Resources Eliminated from Further Analysis

Reclamation analyzed the affected environment and determined that the Proposed Action did not have the potential to cause direct, indirect, or cumulative adverse effects to the resources listed in Table 4.

Table 4 Resources Eliminated from Further Analysis

Resource	Reason Eliminated
Cultural Resources	Reclamation has determined that the Proposed Action has no potential to cause effects to historic properties pursuant to 36 CFR Part 800.3(a)(1) as the Proposed Action of eradicating zebra mussels would not alter or change any characteristics of San Justo Reservoir, Hollister Conduit, or the San Benito subsystems and the action would not involve ground-disturbing activities. See Appendix G for Reclamation's determination.
Indian Sacred Sites	The Proposed Action would not limit access to or ceremonial use of Indian sacred sites on Federal lands by Indian religious practitioners or significantly adversely affect the physical integrity of such sacred sites.
Indian Trust Assets	The Proposed Action would not impact Indian Trust Assets as there are none in the Proposed Action area.
Environmental Justice	The Proposed Action would not cause dislocation, changes in employment, or increase flood, drought, or disease nor would it disproportionately impact economically disadvantaged or minority populations. The Proposed Action may support and maintain jobs that low-income and disadvantaged populations rely upon through increased irrigation water supply reliability. Therefore, there may be a slight beneficial impact to minority or disadvantaged populations as a result of the Proposed Action.

3.2 Air Quality

3.2.1 Affected Environment

The Proposed Action area lies within the North Central Coast Air Basin under the jurisdiction of the Monterey Bay Unified Air Pollution Control District. The pollutants of greatest concern are carbon monoxide (CO), ozone (O_3), O_3 precursors such as volatile organic compounds (VOC), reactive organic gases (ROG) or nitrogen oxides (NO_x), inhalable particulate between 2.5 and 10 microns in diameter (PM_{10}), and particulate matter less than 2.5 microns in diameter ($PM_{2.5}$). There are no standards for NO_x; however, NO_x contributes to the standards for nitrogen dioxide (NO_2) and is an O_3 precursor.

The North Central Coast Air Basin is in attainment for all Federal standards but is in nonattainment for State standards for O_3 and PM_{10} (California Air Resources Board 2014).

3.2.2 Environmental Consequences

No Action

Under the No Action Alternative, there would be no impacts to air quality since conditions would remain the same as existing conditions.

Proposed Action

The Proposed Action would introduce short-term operational air emission sources from barge-mounted diesel generators and truck emissions associated with the delivery of potash slurry to the site. Emissions were estimated for the Proposed Action based on maximum preliminary design estimates which assumed that one 40-kilowatt, 53.6 horsepower, diesel engine generator would need to be operated on each of five barges. Operation of the engines would be for eight hours per day, up to 100 days per year in order to deliver the requisite amount of potash to treat the highest reservoir elevation (worst-case scenario) of 485-feet. Under this scenario, a 240-mile round trip (Fresno to Hollister) for a total of 374 deliveries using a 5,000 gallon tanker truck would be needed. Based on these assumptions and EPA Tier III emission factors for the barge engines, total emissions can be found in Table 5.

Table 5 Estimated Proposed Action Emissions

Source	NOx (tons)	CO (tons)	VOC (tons)	PM10 (tons)
Barge-mounted diesel generators	0.83[1]	0.88	--[1]	0.05
Delivery trucks	1.46	0.51	0.1	0.06
Total	**2.3**	**1.4**	**0.1**	**0.1**
Monterey Bay Unified Air Pollution Control District's *de minimis* thresholds (tons per year)	100	100	100	100

[1]Includes non-methane hydrocarbons, which also includes ROG/VOC.

As shown in Table 5, operational emissions would not exceed Monterey Bay Unified Air Pollution Control District's *de minimis* thresholds. Consequently, a conformity analysis pursuant to the Clean Air Act is not required.

Reclamation or San Benito would either register equipment with engines greater than 50 horsepower under the California Air Resources Board's Statewide Portable Equipment Registration Program or acquire individual operating permits from Monterey Bay Unified Air Pollution Control District prior to operation in accordance to Monterey Bay Unified Air Pollution Control District's rules. In addition, Reclamation would implement air quality protection measures (Table 2) to further minimize operational emissions. Therefore, the Proposed Action would not have adverse impacts on air quality.

Cumulative Impacts

Emissions from the Proposed Action are well below established *de minimis* thresholds and are expected to be temporary in duration. As a result, the Proposed Action is not expected to contribute to cumulative adverse impacts to air quality.

3.3 Biological Resources

3.3.1 Affected Environment

The topography surrounding San Justo Reservoir is comprised of steep open hill faces on all sides except for the southwest side which has a 1,116 foot long rock and earthen dam and the northern portion with an approximately 1,296 foot-long earthen dike (Reclamation 2011). Below each of these reservoir containments, land slopes to lower elevations terminating at a pond and ephemeral creek on the southwest side of the reservoir and into a privately owned moderately sized (1,700-foot by 850-foot) pond located north of the reservoir. The northern pond is outside the Proposed Action Area. On the northeast side of the reservoir lies an irrigated recreational area with an onsite residence trailer, picnic tables and shelters, a concession stand, a concrete paved boat ramp, and associated roadways and parking lots. The surrounding habitat is principally introduced annual grassland.

The southern pond (colloquially known as the frog pond), located about 785 feet southwest of the service road to the dam, is known to be occupied by California red-legged frogs. Water is pumped to the pond through a small pipe that connects to a sump that collects seepage water from the dam. At the southwestern end of the pond, the water runs over an earthen berm. The overflow is a shallow steady flow to the ephemeral creek that runs dry 500 feet from the pond. However, during the summer months, outflow from the pond can be minimal, likely due to reduced inflow and higher evapotranspiration from pond vegetation (primarily cattails, *Typha* sp., and duckweed, *Lemna* sp.) during the summer.

Special Status Species

A species list for the Proposed Action Area was received from the U.S. Fish and Wildlife Service (Service) Ventura Office (Consultation No. 81440-2009-SL-0399) on August 20, 2009. An updated list, including species from San Benito County, was downloaded from the Ventura Fish and Wildlife site (https://ecos.fws.gov/ipac/ accessed September 3, 2019 (Consultation No. 08EVEN00-2019-SLI-0765) (Table 6). The updated list did not change the species that were consulted on with the Service (Appendix H). The California Natural Diversity Database (CNDDB) was also queried for Federal- and state-listed species within five miles of the Proposed Action Area (California Department of Fish and Game 2019). Out of the 15 California Native Plant Society special-status plant species identified by the CNDDB, three are federally listed species (Table 6).

Table 6 Federally-listed and Candidate Species and Critical Habitat

Species	Status[1]	Effects[2]	Occurrence in the Project Vicinity[3] and Summary for ESA Determination
AMPHIBIANS			
California red-legged frog (*Rana draytonii*)	T	NLAA	**Present.** California red-legged frog breeding adults, juveniles, and larvae, occur in the vicinity of San Justo Reservoir, at the “frog pond.” Adults also have been recorded in the ephemeral creek west of the “frog pond” near the reservoir. Potential for adults to move overland in adjacent uplands is minimal during the dry season. Occurrence in the reservoir is unknown but improbable. Project activities would avoid the “frog pond” area, unless water levels there

Species	Status[1]	Effects[2]	Occurrence in the Project Vicinity[3] and Summary for ESA Determination
			decline in tandem with reservoir water levels and additional water needs to be supplied to the pond, in which case, the water delivered to the "frog pond" would be wholly beneficial.
California tiger salamander (*Ambystoma californiense*) Central DPS	T	NLAA	**Present.** Potential for California tiger salamander adults, juveniles, or larvae to occur in aquatic habitat at or adjacent to the "frog pond", but not likely during the project. Delivery of water to the "frog pond" would not occur during periods of likely use. The reservoir is not suitable habitat. Potential for adults/juveniles to occur in adjacent uplands. Project activities would occur in summer and fall when the species is likely in burrows in uplands. No construction or ground disturbance would occur in uplands. California tiger salamander movement across roads used for project access could occur but is unlikely during the project. Consequently, California tiger salamanders are not likely to be affected.
BIRDS			
California condor (*Gymnogyps californianus*)	E	NE	**Unlikely.** No CNDDB recorded occurrences in Action Area. Nesting occurs at Pinnacles National Monument, approximately 30 miles south of Action Area. Project activities at the reservoir, on roadways, and possibly at the "frog pond", and a small area of upland at the bifurcation structure at the San Benito Conduit, do not provide habitat for this species.
Least Bell's vireo (*Vireo bellii pusillus*)	E	NE	**Possible.** Suitable nesting and foraging habitat occurs within riparian lowlands at the ephemeral creek adjacent to the "frog pond", near the bifurcation structure at the San Benito Conduit, and along the distribution system. Project activities would not affect nesting or foraging should they occur at these areas or nearby.
Southwestern willow flycatcher (*Empidonax traillii extimus*)	E	NE	**Unlikely.** Nesting occurs in mosaic riparian habitat usually including willows (*Salix* spp.). Riparian habitat is present adjacent to the ephemeral creek near the "frog pond", but there are not records from the Action Area. Breeding primarily occurs further south in California and breeding and foraging would not be affected by project activities.
California Least tern (*Sterna antillarum browni*)	E	NLAA	**Present.** Reported from San Felipe and Paicines Lakes, approximately 10-11 miles from San Justo Reservoir. Not reported at San Justo Reservoir and no suitable nesting habitat there. Could irregularly visit the reservoir. Indirect effects on prey species are not likely to adversely affect the tern.
FISH			
South-Central California steelhead (*Oncorhynchus mykiss*)	T	NE	**Possible.** The Proposed Action would not affect waters potentially inhabited by individuals of this distinct population segment, which could include the San Benito River.

Species	Status[1]	Effects[2]	Occurrence in the Project Vicinity[3] and Summary for ESA Determination
INVERTEBRATES			
Vernal pool fairy shrimp (*Branchinecta lynchi*)	T	NE	**Absent.** No CNDDB occurrence documented within 5 miles of the Proposed project site. No suitable habitat (seasonal wetlands or vernal pools) present at the site.
MAMMALS			
San Joaquin kit fox (*Vulpes macrotis mutica*)	E	NLAA	**Possible.** Ground squirrels in the uplands surrounding the reservoir provide a potential prey base and their burrows provide potential denning opportunities for kit fox. Numerous burrows that are large enough to be utilized by kit fox have been found around the reservoir. If present, activities at the reservoir and additional vehicular traffic may result in minor disturbance.
PLANTS			
Marsh Sandwort (*Arenaria paludicola)*	E	NE	**Absent.** No CNDDB occurrences documented within twenty miles of the Proposed Action Area. This species does not occur in the Proposed Action Area.
REPTILES			
Blunt-nosed leopard lizard (*Gambelia silus*)	E	NE	**Absent.** No CNDDB occurrences documented within 5 miles of the Proposed Action site. Suitable habitat is not present at the Proposed Action Area.

[1] Status= Listing of Federally special status species
E: Listed as Endangered
T: Listed as Threatened
X: Critical Habitat
[2] Effects = Effect determination
NE: No Effect
NLAA: May affect, not likely to adversely affect
[3] In the vicinity of San Justo Reservoir, Hollister Conduit, and San Benito Distribution System - Definition Of Occurrence Indicators
Present: Species known to occur in area
Possible: Species recorded in area but habitat suboptimal or lacking entirely
Unlikely: Species recorded in area but habitat suboptimal or lacking entirely. Protocol-level surveys did not find evidence to support presence
Absent: Species not recorded in project vicinity and/or habitat requirements not met

Two plant and five animal species were considered to have at least some potential to occur within the region or have been recorded historically in the vicinity of the Proposed Action area and are described below

San Joaquin Woolly Threads

San Joaquin woolly threads (*Monolopia* (*=Lembertia*) *congdonii*) required habitat is alkali sink or sandy soils in Shadscale Scrub and Valley Grassland. The species is known from San Benito County and elsewhere in the Central Valley, and about one-half of the historical occurrences are extirpated. San Joaquin woolly threads are federally listed as endangered. Although the closest occurrence of this species reported by CNDDB exists in Fresno County, about 60 miles east of the Proposed Action Area, the Service (2009) lists the species as occurring within San Benito County. Within the Proposed Action area San Joaquin woolly threads has a low probability of occurrence in valley and foothill grasslands of the upland lands surrounding the reservoir.

Two-Fork Clover

Two-fork clover (*Trifolium amoenum*), federally listed as endangered, is typically found on heavy soils at elevations less than 328 feet in Coastal Bluff Scrub. The historic range of two-fork clover was from the western extreme of the Sacramento Valley in Solano County, west and north to Marin and Sonoma counties. Presently there is only a single extant population in northern Marin County. Nearby historical populations have been recorded and suitable habitat exists on site. The closest recorded occurrence is within the city limits of Gilroy, 8.7 miles north of the Proposed Action site in 1903, and is possibly extirpated (California Department of Fish and Game 2011). Within the Proposed Action area two-fork clover has a low probability of occurrence in the sunny open sites of valley and foothill grasslands in the upland lands surrounding the reservoir.

California Tiger Salamander

California tiger salamander (*Ambystoma californiense*) is known to occur on surrounding lands within one mile to the west of the reservoir in the permanent golf course ponds. In addition, there are over 40 additional occurrences reported within a five-mile radius of the San Justo Reservoir, the Hollister Conduit, and San Benito's water distribution system. Access to the Proposed Action Area from the known locations is present overland as dispersal barriers are absent. The uplands around water bodies, such as the ephemeral creek and ponds that lie in the golf course to the southwest of the reservoir, provide suitable upland aestivation habitat for California tiger salamander. Although California tiger salamander could attempt to breed in the reservoir, the habitat is very poor for breeding because of an abundance of predators, such as warm water fishes and bullfrogs, which are known to occupy the reservoir and would prey upon California tiger salamander.

California Red-Legged Frog

California red-legged frog (*Rana draytonii*) is federally listed as threatened. The Proposed Action area does not fall within federally designated California red-legged frog Critical Habitat. The closest unit is Critical Habitat Unit SNB-1 in San Benito County (Service 2010), located about 300 feet southwest of the "frog pond". Critical Habitat Unit STC-2 is located north of the San Benito primarily within Santa Clara County (Service 2010).

Numerous California red-legged frog occurrence records have been documented within one mile of San Justo Reservoir, the Hollister Conduit, and the additional San Benito conveyance subsystems (CNDDB 2013). The species has been recorded from the "frog pond" as recently as July 2011, although its relative abundance at this site may have declined in recent years (Reclamation 2011c).

The Proposed Action Area could potentially include the "frog pond" and the ephemeral creek west of there. Uplands below the dam also may be used by this species. Other areas in the vicinity, but outside the Proposed Action Area, where breeding could potentially occur include the pond at the Pacific Scientific Energetic Materials Company and ponds within the San Juan Oaks Golf Club, golf course, off Union Road (Figure 4). Areas in between these ponds could serve as dispersal habitat. Although the reservoir may provide breeding habitat for California red-legged frog at the fringes where cattails and bulrush (*Scirpus* sp.) provide cover, numerous predators in the reservoir, including warm water fishes (especially large-mouth bass, *Micropterus salmoides*) and bullfrogs (*Rana catesbeiana*) greatly reduce any chance for colonizing this habitat or successfully breeding there.

Figure 4 Map of California Red-legged Frog Habitat

California condor

Nesting habitat for the California condor (*Gymnogyps californianus*) does not exist in the Proposed Action Area. The lands surrounding San Justo Reservoir, the Hollister Conduit, and San Benito subsystems include open grasslands that could provide foraging habitat for this species and are within the potential foraging range of California condors that roost and nest in the Big Sur area of Monterey County and at Pinnacles National Monument. However, it would be uncommon for condors from those areas to occur at San Justo Reservoir or in the Proposed Action Area. Areas within the Proposed Action Area would not be expected to provide nesting, roosting or foraging opportunities for this species.

California Least Tern

California least terns (*Sterna antillarum browni*) have been reported from San Felipe Lake and Paicines Lake (K. Van Vuren; http://fog.ccsf.edu/~jmorlan/sbtsites.htm, accessed Nov. 25, 2015). Both these lakes are shallow and are located approximately 10 to 11 miles from San Justo Reservoir. The species is found mainly along the Pacific Coast of California, from San Francisco southward to Baja California (Service 2006). They nest in loose colonies on relatively open beaches kept free of vegetation (Service 2006). The grassy vegetated or large rock rip-rapped shoreline does around the reservoir does not provide suitable nesting habitat for the species. Although the reservoir could provide foraging habitat, California least terns have not been recorded at San Justo Reservoir. It would be highly unusual for California least terns to visit San Justo Reservoir because no nesting habitat is available. During the project, if visitation occurred, it would likely be a migrant passing through. Any change in prey (e.g., fish) abundance resulting from treatment of the reservoir would be unlikely and would be insignificant to such an individual. Any effects are therefore discountable or insignificant and the project is not likely to adversely affect this species.

Least Bell's vireo

The Least Bell's vireo (*Vireo bellii pusillus*), federally listed endangered, has suitable nesting and foraging habitat present within the riparian areas around the San Justo Reservoir, Hollister Conduit, and San Benito subsystems. Although there is potential for this species to occur in the Proposed Action Area, the species is uncommon in the region and project activities would avoid the riparian habitat, and surrounding upland habitat where this species could forage.

San Joaquin Kit Fox

The San Joaquin kit fox (*Vulpes macrotis mutica*), federally listed as endangered and state listed as threatened. Although upland habitat in the vicinity of the reservoir is suitable for this species, this species has not been seen at the reservoir. Suitable habitat surrounding the San Justo Reservoir, Hollister Conduit, and San Benito subsystems includes open grassland with abundant ground squirrel activity and associated burrows. The ground squirrels provide a potential prey base and their burrows provide potential denning opportunities for kit fox. San Joaquin kit fox is considered to have a moderate potential to occur in the vicinity. Records of occurrence for the species include lands east of Hollister, and approximately 2 to 3 miles west of San Justo Reservoir.

Migratory Birds

Large trees along riparian areas adjacent to the Proposed Action Area (e.g., cottonwood, sycamore, valley oak, and willow) and also those within the grasslands surrounding the San Justo Reservoir, Hollister Conduit, and San Benito subsystems provide suitable nesting and foraging habitat for raptors, passerines, and non-passerine land birds protected under the Federal Migratory Bird Treaty Act. Additionally, grassland nesting birds may occur where suitable habitat is present.

3.3.2 Environmental Consequences

No Action

Continued infestation of the reservoir and San Benito's distribution system could result in system failure and require significant responses. Supply of water to the "frog pond" could be compromised. This could adversely affect California red-legged frogs as San Justo reservoir provides water to the "frog pond" that contains this species. California tiger salamander could also be adversely affected because they have potential to use the "frog pond".

Proposed Action

The Proposed Action would result in the addition of potassium chloride to San Justo Reservoir, Hollister Conduit, and San Benito's distribution system and would coincide with a lowering of reservoir water levels. Boats/barges would be active on the reservoir and additional vehicular traffic would occur on roads to and from the Reservoir. Staging and supply activities would occur at the paved parking area and boat launch ramp at the reservoir.

Direct effects to aquatic resources in the reservoir and distribution system would occur from the increased concentration of potassium and chloride in water in San Justo Reservoir and the distribution systems, in addition to the drawdown of water in the reservoir. Studies conducted on effects of potassium chloride on non-target organisms have shown that potassium concentrations toxic to zebra mussels (100 ppm) may affect other invertebrates but should not adversely affect fish or amphibians (Fisher et al. 1991, Waller et al. 1996, Aquatic Sciences Inc. 1996, CH2M Hill 2011), which is supported by results from the Millbrook Quarry treatment (Virginia DGIF 2005 and 2011). The only bivalve other than zebra mussels that has been observed in the San Justo Reservoir is the non-native Asian clam (*Corbicula fluminea*), which is also considered a pest species.

Thermal stratification and low oxygen conditions occur at depths below 30 feet beneath the surface in San Justo reservoir during the summer-to-fall period. The proposed application of potash solution is not expected to directly adversely affect aquatic life in the reservoir other than the two non-native bivalves (zebra mussel and Asian clam). However, the lowering of the reservoir and the reduced water oxygen content, coinciding with an increased density of oxygen dependent organisms in the water column, could lead to oxygen debt and increased mortality, similar to winter "die off" of fish in stratified frozen lakes. In addition, the decomposition of dead organisms could further reduce conditions for oxygen dependent organisms. If a major fish die off were to occur in the reservoir as a result of oxygen depletion, putrid smells could temporarily foul the area.

Migratory birds

No aquatic birds are known to nest at San Justo Reservoir. Drawdown of the reservoir could concentrate the availability of fish in the reservoir for piscivorous birds, although piscivorous birds are not known to nest at the reservoir. Redwing blackbirds (*Agelaius phoeniceus*) and marsh wrens (*Cistothorus palustris*) are suspected of nesting in cattails and bulrushes that occur in patches at the periphery of the reservoir. These areas are subject to fluctuating water levels and lowering the reservoir in August and September, which would not be expected to result in take of these species. Treated water in the reservoir, Hollister Conduit, and the San Benito distribution system would not result in take of migratory birds. There would be no construction or ground disturbance and so migratory birds would not be affected from such actions. Minor removal of rank annual vegetation in a small area at the bifurcation structure may occur to ensure fire safety. A survey for nesting migratory birds would be required at this site prior to initiating vegetation removal. If the survey revealed nesting migratory birds to be present in areas to be disturbed, measures would be implemented to avoid take.

Federally-listed Species

As described in Table 6, the majority of listed species that could potentially be affected do not occur within the Proposed Action Area and would not be affected. There are no listed species in the reservoir and the reservoir is not critical habitat. The Proposed Action includes minimal activities outside the reservoir proper, and they include primarily transport of materials on roads to delivery sites or the staging area at the paved parking lot and boat launch ramp at the reservoir. The Proposed Action does not include construction or ground disturbance in uplands surrounding the reservoir, Hollister Conduit, or the San Benito distribution system.

Reclamation initiated Endangered Species Act Section 7 consultation with the Service on potential affects to California tiger salamander, California red-legged frog, the San Joaquin kit fox, and the California least tern. Reclamation received a concurrence memo from the Service on June 29, 2016 which agreed with Reclamation's assessment that the Proposed Action "may affect, but is unlikely to adversely affect" these listed species.

California tiger salamander has the potential to occur at the "frog pond", although it would be unlikely to be present in the pond during the project. The reservoir is not suitable habitat but this species has the potential to occur in uplands surrounding the reservoir and along the distributions system and San Benito Conduit. California tiger salamander is active above ground in uplands in the late fall through spring, when it moves to aquatic breeding sites. As such, California tiger salamander may disperse across roads used for project access. However, because no construction or ground disturbance would occur in uplands, and it is improbably that California tiger salamander would be encountered by vehicles on roadways, effects from these project activities to California tiger salamander are discountable and California tiger salamander is therefore not likely to be adversely affected by the Proposed Action.

California red-legged frog occur in the "frog pond" that receives seepage water from San Justo dam. Other than by seepage, the pond is not connected to the reservoir. During reservoir drawdown, treatment, and reservoir refilling, the seepage water received by the pond would, if necessary, be augmented by clean, Title 22 water delivered by truck. Deliveries would match the average flow rate from seepage and maintain the pond at its normal depth. Seepage to the pond may have elevated potassium chloride levels, however, Title 22 water added to the pond during treatment would reduce potassium chloride concentrations. The potassium chloride concentrations in the seepage would expectedly return to levels closer to background rates after the reservoir is refilled with fresh water delivered to the reservoir from San Luis Reservoir. Depending on the initial drawdown amount and the amount refilled, concentrations would be reduced considerably in the first year. This could potentially be managed in subsequent years to continue dilution at an accelerated rate. The effects of potassium chloride on different life stages of the frog, *Microhyla ornata*, indicate that eggs and larvae are more susceptible than adults and some impacts may occur near concentrations of 141 ppm (Padhye and Ghate 1992). While concentrations in the reservoir would be less than this amount (i.e. 100ppm) during the project, and concentrations in the pond would likely lower still because of adherence to soil particles when moving through the soil, and effects from the potential addition of tank water, there could be an effect to adult California red-legged frog, although this would be expected to be minor as only adults might be exposed and at levels expectedly much lower than where larvae and eggs might be affected.

California least terns (*Sterna antillarum browni*) have been reported from San Felipe Lake and Paicines Lake (K. Van Vuren; http://fog.ccsf.edu/~jmorlan/sbtsites.htm, accessed Nov. 25, 2015). Both these lakes are shallow and are located approximately 10 to 11 miles from San Justo Reservoir. The species is found mainly along the Pacific Coast of California, from San Francisco southward to Baja California (Service 2006). They nest in loose colonies on relatively open beaches kept free of vegetation (Service 2006). The grassy vegetated or large rock rip-rapped shoreline around the reservoir does not provide suitable nesting habitat for the species. Although the reservoir could provide foraging habitat, California least terns have not been recorded at San Justo Reservoir. It would be highly unusual for California least terns to visit San Justo Reservoir because no nesting habitat is available. During the project, if visitation occurred, it would likely be a migrant passing through. Any change in prey (e.g., fish) abundance resulting from treatment of the reservoir would be unlikely and would be insignificant to such an individual. Any effects are therefore discountable or insignificant and the project is not likely to adversely affect this species.

California condor nesting habitat does not exist in the immediate vicinity of the project area. However, uplands surrounding the reservoir include open grasslands that may provide scavenging habitat. Any activity at the “frog pond” would be irregular, minimal and likely timed after the bird nesting season. Consequently, the Proposed Action would not adversely affect this species.

Although there is potential for Least Bell’s vireo to occur in the Proposed Action Area, the species is uncommon in the region and because project activities would avoid riparian habitat and surrounding upland habitat where this species could forage, there would be no construction or ground disturbance in uplands so there would be no effect to this species from the Proposed Action.

The upland habitat surrounding the reservoir is suitable for San Joaquin kit fox denning and foraging as there are numerous burrows and abundant beecheyi ground squirrels for prey. However, based on recent records, it is not likely San Joaquin kit fox would be present in the Proposed Action Area. Project activities occur primarily on the reservoir itself, which is not habitat for San Joaquin kit fox. The Proposed Action does not include construction or ground disturbance in uplands surrounding the reservoir, Hollister Conduit, or the San Benito distribution system which could potentially affect San Joaquin kit fox and the treated water would not affect San Joaquin kit fox, because San Joaquin kit fox acquire water from their prey and don’t generally require free water. There would be a temporary generalized increase in activity at the reservoir primarily from vehicular traffic, but the added traffic would add a minor amount of disturbance to the relatively high background levels of traffic on nearby Union Road which services the reservoir, or on the nearby State Highway 156. The San Joaquin kit fox is unlikely to be present and any effect due to the Proposed Action would be minor; consequently, the Proposed Action is not likely to adversely affect San Joaquin kit fox.

Cumulative Impacts

Eradication of zebra mussels within San Justo Reservoir, the Hollister Conduit, and the San Benito distribution system would prevent the spread of zebra mussels from the Proposed Action area to other systems. It would also reduce impacts to the biological community present within the reservoir; therefore, the Proposed Action is expected to have beneficial cumulative impacts on biological resources within and outside the Proposed Action area.

3.4 Global Climate Change

3.4.1 Affected Environment

Climate change refers to significant change in measures of climate (e.g., temperature, precipitation, or wind) lasting for decades or longer. Many environmental changes can contribute to climate change [changes in sun's intensity, changes in ocean circulation, deforestation, urbanization, burning fossil fuels, etc.] (EPA 2015a).

Gases that trap heat in the atmosphere are often called greenhouse gases. Some greenhouse gases, such as carbon dioxide (CO_2), occur naturally and are emitted to the atmosphere through natural processes and human activities. Other greenhouse gases (e.g., fluorinated gases) are created and emitted solely through human activities. The principal greenhouse gases that enter the atmosphere because of human activities are: CO_2, methane (CH_4), nitrous oxide, and fluorinated gasses (EPA 2015a).

During the past century, humans have substantially added to the amount of greenhouse gases in the atmosphere by burning fossil fuels such as coal, natural gas, oil and gasoline to power our cars, factories, utilities and appliances. The added gases, primarily CO_2 and CH_4, are enhancing the natural greenhouse effect, and likely contributing to an increase in global average temperature and related climate changes. At present, there are uncertainties associated with the science of climate change (EPA 2015b).

Climate change has only recently been widely recognized as an imminent threat to the global climate, economy, and population. As a result, the national, state, and local climate change regulatory setting is complex and evolving.

In 2006, the State of California issued the California Global Warming Solutions Act of 2006, widely known as Assembly Bill 32, which requires California Air Resources Board to develop and enforce regulations for the reporting and verification of statewide greenhouse gases emissions. CARB is further directed to set a greenhouse gases emission limit, based on 1990 levels, to be achieved by 2020.

In addition, the EPA has issued regulatory actions under the Clean Air Act as well as other statutory authorities to address climate change issues (EPA 2015c). In 2009, the EPA issued a rule (40 CFR Part 98) for mandatory reporting of greenhouse gases by large source emitters and suppliers that emit 25,000 metric tons or more of greenhouse gases [as CO_2 equivalents per year] (EPA 2009). The rule is intended to collect accurate and timely emissions data to guide future policy decisions on climate change and has undergone and is still undergoing revisions (EPA 2015c).

3.4.2 Environmental Consequences

No Action

Under the No Action Alternative, trends affecting climate change would continue as conditions would remain the same as existing conditions.

Proposed Action

The Proposed Action would introduce short-term greenhouse gases emissions primarily through the combustion of diesel fuel. There would also be a small amount of greenhouse gases emissions associated with electricity consumption by the eleven dosing pumps that may be needed to infuse potash into the distribution system.

Greenhouse gases emissions were estimated using the CARB-approved emissions modeling software (EMFAC 2007) for diesel delivery trucks as well as the EPA emission factors for diesel generators. Calculations are based on the same assumptions previously discussed in the Air Quality section. Greenhouse gases emissions associated with the operation of the dosing pump electric motors were calculated using the "current emissions" Pacific Gas and Electric emission factor (equal to the average of their 2005 to 2009 greenhouse gases emission factors, or 0.559 pound per kilowatt hour). Total estimated Proposed Action CO_2 emissions are presented in Table 7. To be consistent with accepted greenhouse gases convention, quantities are also presented in units of metric tons.

Table 7 Total Proposed Action greenhouse gases Emissions

Source	CO2 (tons)	CO_2 (metric tons)
Barge-mounted diesel generators	139.6	126.8
Delivery Trucks	159.9	145.2
Dosing Pumps	7.6	6.9
Total	**307.1**	**278.9**

Calculated CO_2 emissions are well below the EPA's threshold for annually reporting greenhouse gases emissions (25,000 metric tons per year); therefore, the Proposed Action would result in below *de minimis* impacts to global climate change.

Cumulative Impacts

Greenhouse gases impacts are considered to be cumulative impacts; however, the estimated CO_2 emissions from temporary use of barge-mounted diesel generators, delivery trucks, and dosing pumps for the Proposed Action is roughly 278.9 metric tons per year, which is well below the 25,000 metric tons per year threshold for reporting greenhouse gases emissions. As a result, the Proposed Action is not expected to contribute to cumulative adverse impacts to global climate change.

CVP water allocations are made dependent on hydrologic conditions and environmental requirements. Since Reclamation operations and allocations are flexible, any changes in hydrologic conditions due to global climate change would be addressed within Reclamation's operation flexibility and therefore water resource changes due to climate change would be the same with or without the Proposed Action.

3.5 Socioeconomic Resources

3.5.1 Affected Environment

The San Justo Reservoir is located about 1.7 miles west of the city of Hollister in San Benito County, California. The Hollister Conduit and the San Benito subsystems run beneath the City of Hollister. The City of Hollister had an estimated 2018 population of 39,749. The median household income between 2013 and 2017 was $77,823 and per capita income in 2013 was $25,876. Between 2013 and 2018, 11.1 percent of the population was below the poverty line (U.S. Census Bureau 2019).

3.5.2 Environmental Consequences

No Action

Continued infestation of the reservoir and San Benito's distribution system could adversely affect agricultural production and local employment should system failure occur. In addition, the cost of repairing water supply infrastructure or purchasing more costly water supplies would adversely affect San Benito and their customers.

Proposed Action

Eradication of zebra mussels would be beneficial to socioeconomic resources for San Benito and its service area as water supply reliability and infrastructure integrity would be maintained. There could be temporary disruption of water deliveries during treatment of the reservoir which could have minor impacts to agricultural and urban users; however, both agricultural and M&I supplies could be supplemented by groundwater supplies during treatment.

Up to 10,000 AF of San Benito's CVP carry-over water would potentially be unavailable due to curtailed San Justo Reservoir capacity to facilitate a lower-end eradication operating elevation of 430 feet. This translates to between 3,000 and 5,000 acres of arable land within San Benito's CVP service area that could potentially be affected. The effect experienced would increase as water level drops between 455 and 430 feet elevation. At lower elevations, groundwater may need to be used by growers. The local supplies of groundwater may be of less desirable quality and may affect crops. Responses could include lower crop yield, re-cropping with lower quality/lower yield crops, and/or fallowing arable land until carry-over transfer capacity to San Justo Reservoir is restored.

Cumulative Impacts

Eradication of zebra mussels from the San Justo Reservoir, the Hollister Conduit, and San Benito's distribution system would prevent the spread of zebra mussels from this system which would be cumulatively beneficial to economic resources both within the Proposed Action area and outside areas.

3.6 Water Resources

3.6.1 Affected Environment

San Justo dam and dike are the primary features of San Justo Reservoir. The dam is a zoned earth and rockfill dam, 151 feet high, with a crest 1,116 feet long. The dike is a zoned earth structure, 79 feet high, with a crest 1,296 feet long. The emergency spillway, located on the northeastern rim of the reservoir, is an open-cut channel lined with grass to protect against weathering and erosion. The outlet works, also located on the northeastern side of the reservoir, include a 1,500-foot-long tunnel, 688 feet of buried 60-inch-diameter pipe, and a 23.1-foot-diameter shaft about 135 feet deep that terminates at a gate (Reclamation 2010).

The reservoir's original capacity was 9,785 AF; however, due to seepage issues at the reservoir, San Benito has voluntarily reduced the operating level of the reservoir by approximately 15 feet to decrease seepage. Current volume of the reservoir is 7,445 AF. To control seepage, Reclamation installed a 40-millimeter-thick, high-density, polyethylene membrane liner in the reservoir which was covered with earthfill and other materials to protect it against damage. In addition, Reclamation has installed an extensive network of observation and interceptor wells around the reservoir to monitor and manage groundwater levels.

Water Quality

Primary Maximum Contaminant Levels (MCLs) and Secondary MCLs have been established as water quality standards for some constituents by the U.S. Environmental Protection Agency (EPA) and the California Department of Public Health (DPH). Primary MCLs are enforceable drinking water standards for public systems. Secondary MCLs are non-enforceable guidelines regulating contaminants that may cause cosmetic effects (such as skin or tooth discoloration) or aesthetic effects (such as taste, odor, or color) in drinking water. EPA recommends secondary standards to water systems but does not require systems to comply. However, states may choose to adopt them as enforceable standards (EPA 2015). Water quality testing results for San Justo Reservoir in 2018-19 are shown in Table 8.

Table 8 San Justo Reservoir Water Quality Testing

Analyte	Units	EPA MCL	DPH MCL	RL	5/15/19	2/19/19	11/15/18
Alkalinity	mg/L	NA	NA	3.0	80	79	77
Aluminum	µg/L	200*	1000	0.051	0.050	ND	0.058
Antimony	µg/L	6	6	2.0	ND	ND	ND
Arsenic	µg/L	10	10	2.0	ND	ND	2.1
Barium	µg/L	2000	1000	0.050	0.054	ND	ND
Beryllium	µg/L	4	4	1	ND	ND	ND
Cadmium	µg/L	5	5	1	ND	ND	ND
Calcium	mg/L	NA	NA	0.10	22.0	23.0	21
Chloride	mg/L	250*	NA	1.0	93	100	84
Chromium, total	µg/L	100	50	10	ND	ND	ND
Copper	µg/L	1300	1300	5	11	5.4	7.8
Cyanide	mg/L	0.2	1.5	0.0050	ND	ND	ND
Fluoride	mg/L	4	2	0.10	0.11	ND	ND
Iron	µg/L	300*	NA	0.030	0.098	0.081	0.10
Lead	µg/L	15	15	1.0	ND	ND	ND
Magnesium	mg/L	NA	NA	0.10	15	15	13
Manganese	µg/L	50*	NA	0.010	ND	ND	ND

Analyte	Units	EPA MCL	DPH MCL	RL	5/15/19	2/19/19	11/15/18
Mercury	µg/L	2	2	0.20	ND	ND	ND
Nickel	µg/L	NA	100	10	ND	ND	ND
Nitrate	mg/L	10	45	0.23	0.28	0.64	ND
Nitrite	mg/L	1	1	0.050	ND	ND	ND
pH	units	6.5-8.5*	NA	NA	7.6	7.9	7.7
Potassium	mg/L			2.0	3.8	3.9	3.5
Selenium	µg/L	50	50	2.0	ND	ND	ND
Silver	µg/L	100*	NA	10	ND	ND	ND
Specific Conductance	µmhos/cm2	NA	NA	1.0	540	620	490
Sulfate	mg/L	250*	NA	1.0	37	41	32
Thallium	µg/L	2	2	1.0	ND	ND	ND
Total Dissolved Solids	mg/L	500*	NA	5.0	290	310	260
Zinc	µg/L	5000*	NA	0.050	0.1	ND	ND

Source: California Department of Public Health 2015, EPA 2015, BSK Associates 2019
*Secondary MCL criteria are actually "Action Levels" under the lead and copper rule (22 CCR § 64672.3).
mg/L = milligram per liter
DPH = California Department of Public Health
EPA = U.S. Environmental Protection Agency
DPH = California Department of Public Health
NA = Not available
ND = Not detected

As shown in Table 5, no measured constituents in San Justo Reservoir exceeded either EPA or the California Department of Public Health primary MCLs for drinking water.

San Benito County Water District

San Benito has a San Felipe CVP contract for up to 43,800 AF from San Luis Reservoir (Contract No. 8-07-20-W0130). The majority of CVP water is delivered for agricultural purposes but some is also delivered for municipal and industrial (M&I) purposes.

San Benito operates and maintains both the Hollister Conduit and San Justo Reservoir, and participates in the operation and maintenance of pumping and conveyance facilities from San Luis Reservoir through a joint operating agreement with Santa Clara Valley Water District. The Pacheco Bifurcation Structure is an intertie between San Benito and Santa Clara systems. CVP water is delivered into Zone 6 of San Benito through a pressurized distribution system that extends from San Justo Reservoir to the district distribution system. Zone 6 is the only portion of San Benito that is authorized to receive CVP water. Ten turnouts along the Hollister Conduit connect to San Benito's distribution system which provides CVP water service to 23,700 acres (both agricultural and urban) in northern San Benito County. The turnouts include flow control structures and, in some cases, booster pump stations (Figure 3). There are also four percolation turnouts through which water can be released into Pacheco Creek, Tres Pinos Creek, or the San Benito River for groundwater recharge. These turnouts are controlled from locked structures. They are currently locked out and tagged out and isolated from use and from the supervisory control and data acquisition system controlling the pipeline. The same would apply for the eradication. One turnout is currently "mothballed" and non-functioning (Pacheco) and another (Ridgemark) is completely abandoned and has been so since prior to the zebra mussel infestation being discovered.

3.6.2 Environmental Consequences

No Action

Continued infestation of the reservoir and San Benito's distribution system could reduce flow or clog parts of the Hollister Conduit and San Benito subsystems resulting in lost water resources for agricultural and M&I users. Lost resources would likely be made up by additional groundwater pumping, potentially leading to further groundwater overdraft within an already impacted area. Furthermore, continued infestation would fail to eliminate the increased chance with time, of further spread of zebra mussels to other systems potentially causing significant damage to water resources and water systems.

Proposed Action

Implementation of the Proposed Action would treat the reservoir, distribution system, and percolation turnouts with sufficient potassium chloride to reach a minimum concentration of 100 ppm potassium and a maximum dosage of 115 ppm potassium. At 100 ppm, associated chloride concentration within the reservoir would be 91 ppm. EPA does not have an established drinking water MCL for potassium but does have a secondary drinking water MCL for chloride of 250 ppm (EPA 2011a). The average chloride concentration measured in San Justo Reservoir in 2014 was 102 ppm (Table 5); consequently, chloride concentrations during treatment would total approximately 194 ppm and would decrease over time as fresh water from San Luis Reservoir is brought into the system. As concentrations would be substantially below the 250 ppm MCL for chloride, the Proposed Action would not result in exceedance of EPA MCLs. At a maximum treatment dose of 115 ppm, potassium would pose no human health risks from ingestion or contact, nor will it harm any non-bivalve aquatic wildlife, vegetation, or terrestrial wildlife inhabiting or using the reservoir (CH2M HILL, 2011a). The reservoir water will continue to meet the EPA primary and secondary drinking water standards for both potassium and chloride; and a liter of the water will contain a fraction of the National Academy of Sciences recommended daily intake of potassium and chloride (approximately 2% of the recommended adult daily intake of potassium and less than 9% of the *Dietary Reference Intake for Water, Potassium, Chloride and Sulfate* (National Academies Press 2004). Potash is classified as a natural (nonsynthetic) substance by the federal National Organic Program Act (CFR Title 7, Part 205), and use of water on crops would be fully consistent with the National Organic Program.

The Central Coast Regional Water Quality Control Board (Regional Water Board) Basin Plan objectives for agricultural water specifies that chloride concentrations less than 142 ppm would not cause any problems from root adsorption but chloride concentrations between 142 and 355 ppm could cause moderate problems from root absorption (Regional Water Board 1994). In addition, Regional Water Board objectives specify that chloride concentrations less than 106 ppm would not cause problems for foliar absorption but that chloride concentrations above 106 ppm could cause moderate problems to crops (Regional Water Board 1994). Concentrations would be diluted over time as untreated water from San Luis Reservoir is brought into the system after treatment. Although actual benefits of dilution would increase or decrease depending on the initial draw down of the reservoir prior to treatment, water would only exceed criteria temporarily and would return to near baseline conditions over time.

Implementing the Proposed Action would cause the San Justo Reservoir, Hollister Conduit, and San Benito subsystems to be out of service for the 2- to 3-month treatment period beginning in August or September. Taking San Justo Reservoir out of service for treatment in non-peak demand months (October through May) would likely have no adverse impact on water users, as agricultural and M&I use are both relatively low. There may be temporary impacts to water supply during the beginning of the treatment period as it corresponds to the end of San Benito's peak demand period (June through September); however, San Benito's water users have groundwater resources that would be sufficient to meet demand during the treatment period (Pers. Comm. Dale Rosskamp 2011). As treatment is temporary and there are additional supplies available to water users during the treatment period, no adverse impacts to water supplies are expected.

Cumulative Impacts

Under the Proposed Action, temporary increases in chloride levels within surface and groundwater supplies would occur. However, expected chloride concentrations would not exceed EPA drinking water standards and would be further reduced over time by dilution with fresh water from San Luis Reservoir. There could be temporary impacts to crops from increased chloride levels but these would also be temporary and would be reduced over time as fresh water is brought into the system; therefore, this would be a short-term, temporary effect and no adverse cumulative impacts to water resources are expected.

Crops require set ratios of chemical nutrients and the potassium-ion concentration goal of 100 ppm has the potential to be more than required by growers and their crops (pers. comm. Dale Rosskamp). Consequently, the concentration of potassium related to the eradication project has the potential to cause an imbalance and block uptake of soil calcium and magnesium by plants, potentially affecting crop yields.

However, implementation of specific measures by San Benito would reduce this potential and help to insure that each grower potentially impacted would be able to offset any potential impacts to their crops. All District customers irrigating their lands with CVP "blue-valve" water, with elevated potassium concentrations equal to those received to eradicated dreissenid mussels would be notified by San Benito: (1) in advance of when the eradication is to occur: and (2) will be further notified of potassium concentrations at regular intervals during project execution.

Section 4 Consultation and Coordination

4.1 Public Review Period

Reclamation provided the public with an opportunity to comment on the Draft FONSI and Draft EA between March 18, 2015 and April 16, 2015. Two comment letters were received. The comment letters and Reclamation's response to comments are included in Appendix I. Following close of the public comment period, the EA was placed on hold pending finalization of the eradication plan. The eradication plan was finalized in June 2019 (Appendix C). As the finalized eradication plan did not change the project description analyzed in the EA or the determinations made therein, Reclamation is moving forward with completing the EA.

4.2 List of Agencies and Persons Consulted

Reclamation has consulted or coordinated with the following regarding the Proposed Action:

- California Department of Fish and Wildlife
- Department of Water Resources
- San Benito County
- San Benito County Water District
- Santa Clara Valley Water District
- U.S. Fish and Wildlife Service

4.3 Endangered Species Act (16 U.S.C. § 1531 et seq.)

Section 7 of the Endangered Species Act requires Federal agencies, in consultation with the Secretary of the Interior and/or Commerce, to ensure that their actions do not jeopardize the continued existence of endangered or threatened species, or result in the destruction or adverse modification of the critical habitat of these species.

No anadromous fishes or their critical habitat occur in the affected area; therefore, no consultation with the National Marine Fisheries Service is needed.

Reclamation consulted with the Service on the California red-legged frog, California tiger salamander, and San Joaquin kit fox. The Service concurred with Reclamation's determination that the Proposed Action may affect, but was not likely to adversely affect these species (Appendix H).

4.4 Executive Order 11312 – Invasive Species

Executive Order 13112 was issued to prevent the introduction of invasive species; provide for their control; and minimize the economic, ecological, and human health impacts that invasive species cause. The Proposed Action would minimize the economic, ecological, and human health impacts relating to the presence of zebra mussels within San Justo Reservoir and the San Benito distribution system. It would also help prevent the spread of zebra mussels from this system. Therefore, the Proposed Action is consistent with Executive Order 13112.

4.5 Federal Insecticide, Fungicide, and Rodenticide Act (7 U.S.C. § 136 et seq.)

The Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) (7 U.S.C. § 136 et seq.) provides for federal regulation of pesticide distribution, sale, and use. All pesticides distributed or sold in the United States must be registered (licensed) by EPA. Before EPA may register a pesticide under FIFRA, the applicant must show, among other things that using the pesticide according to specifications "will not generally cause unreasonable adverse effects on the environment."

FIFRA defines the term "unreasonable adverse effects on the environment" to mean: "(1) any unreasonable risk to man or the environment, taking into account the economic, social, and environmental costs and benefits of the use of any pesticide, or (2) a human dietary risk from residues that result from a use of a pesticide in or on any food inconsistent with the standard under section 408 of the Federal Food, Drug, and Cosmetic Act." Commonly consumed food commodities, animal feed items, and edible fats and oils as described in 40 CFR 180.950(a), (b), and (c) may be used as inert ingredients in FIFRA Section 25(b) pesticide products applied to food use sites (e.g., food crops, animals used for food) and in FIFRA Section 25(b) pesticide products applied to nonfood use sites (e.g., ornamental plants, highway right-of ways, rodent control). Potassium chloride is listed as acceptable for use as an inert ingredient under 40 CFR 180.950(e) in FIFRA Section 25(b) products applied to food use and/or nonfood use sites.

San Benito is in the process of obtaining a FIFRA permit for the use of potassium chloride as an eradication method for zebra mussels within the Proposed Action area.

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Appendix A: Potash Toxicology to Zebra Mussels and other Organisms

Review of Potash Toxicology to Zebra Mussels and Other Organisms

PREPARED FOR: San Benito County Water District

PREPARED BY: Earl Byron/CH2M HILL

REVIEWED BY: Sharook Madon/CH2M HILL

DATE: March 4, 2011

Background and Purpose

Zebra mussels (*Dreissena polymorpha*) are a non-native, freshwater, invasive species that have caused ecosystem disruptions and infrastructure fouling throughout eastern North America since their invasion from Europe in the late 1980s. San Justo Reservoir in San Benito County is the first record of their invasion in California waters. The relative hydrologic isolation of the reservoir and operational ability to isolate it as a virtually closed system presents the opportunity for eradication of the mussels in the reservoir before they are able to spread to other locations.

Zebra mussel control strategies have been well researched since the mussels' North American invasion and the history of control attempts have resulted in useful literature that can be applied to the San Justo project. In 2009, San Benito County Water District (SBCWD) and the Bureau of Reclamation (Reclamation), in concert with independent technical experts, evaluated alternatives for killing zebra mussels at San Justo Reservoir. After analysis of existing treatments, potash (potassium chloride, KCl) was selected as the primary molluscicide for the reservoir. Potential technologies and strategies for zebra mussel control in the Hollister Conduit and SBCWD Distribution System were evaluated, including potash (CH2M HILL 2009). Reclamation and SBCWD selected potash as the preferred chemical to concurrently dose the reservoir, conduit, and distribution system. As freshwater organisms, zebra mussels are particularly susceptible to potassium toxicity; they are known to be intolerant of elevated ion concentrations (Horoshov et al., 1992).

The purpose of this memorandum is to review and summarize toxicological information of KCl, as appropriate for the San Justo Reservoir mussel eradication program. The design of an effective KCl dosing strategy for the reservoir requires a documentation of the toxicology of KCl both to zebra mussels as well as to the co-located aquatic organisms and others (birds, mammals) that may use the reservoir. The goal is to be completely effective at eradication of the mussels but with the least damage to the associated biotic community. In addition, a pond immediately adjacent to the reservoir contains the listed California red-legged frog (*Rana draytonii*) and potentially, the California tiger salamander (*Ambystoma californiense*). Toxicity to these amphibian species is of particular concern because of their protected status.

Potash Toxicity for Zebra Mussel Control

The potential toxicity of KCl applications was evaluated to zebra mussels and representative members of the associated aquatic community at San Justo reservoir. Toxicity was evaluated both as documented in the example of a successful zebra mussel eradication resulting from KCl application and, more generally, from the toxicology literature.

Successful Eradication Example

The Millbrook Quarry, Virginia zebra mussel eradication example supports the use of potash at a target concentration of 100 ppm KCl (as potassium). Millbrook Quarry is the only example of a successful lake or reservoir eradication in the U.S except for the Offutt Air Force Base, Nebraska eradication that used copper sulfate. In the Millbrook case, an estimated whole-lake concentration of 100 ppm KCl was applied in order to ensure that at least 50 ppm KCl was achieved in the lake margin or deep areas or arms of the reservoir that may have experienced incomplete mixing. Incomplete mixing is of most concern in a reservoir application; the 50 ppm value was considered a minimum concentration necessary to kill all life stages of the mussel, which includes planktonic, water-column larvae (veligers) as well as substrate-attached juveniles and adults (Aquatic Sciences 2005). Monitoring results revealed that final measured concentrations in the quarry ranged from 98 to 115 ppm KCl (Virginia DGIF, 2006).

The Millbrook data indicated extreme toxicity to zebra mussels but much less toxicity to other organisms. There was a general lack of significant toxicity to reservoir fish or other invertebrates at target concentrations of 100 ppm KCl. Turtles, fish, aquatic insects, and snails were all observed to survive the Millbrook Quarry treatment (Virginia DGIF, 2006). The Millbrook eradication was judged 100% effective at both killing resident mussels and those in bioassay enclosures scattered around the lake while allowing the survival of the quarry's other aquatic life (Virginia DGIF, 2006; Watson and Fernald, 2007).

The Millbrook eradication example serves as a useful model for future attempts at whole-reservoir zebra mussel control, as in San Justo Reservoir. The target KCl concentrations of 100 ppm KCl proved effective at both eliminating the mussels and causing minimal harm to the rest of the aquatic community. In addition, in both the Millbrook and Offutt examples, the possibility of success of eradication using chemical treatments was enhanced by the small size and hydrologic isolation of the lakes. San Justo Reservoir is an offline water supply reservoir with a distribution system that allows for flow control; treated water will not flow to a natural stream system and allow the spread of mussels.

Toxicity Literature

In addition to zebra mussels, the toxicity of KCl concentrations in freshwater were examined for a range of organisms. The objective of this review was to characterize the toxicity levels of KCl to members of a typical reservoir biological community, as would be expected at San Justo Reservoir, as well as for amphibians as may be found in nearby ponds. The reservoir is known to have been stocked with non-native populations of trout, crappie, bass, bluegill, and catfish (San Benito County, 2010). Toxicity results were derived from a search of EPA's online toxicology database, ECOTOX (USEPA, 2009) as well as selected, additional toxicology articles.

Results are summarized in Table 1. Note that the primary sources available from the ECOTOX database are not presented here because they were not examined. Instead, the summary results from ECOTOX were screened by toxicant, organism, and type of toxicology endpoint to provide the results shown here.

Table 1. Toxicology endpoints and KCl concentrations for typical, reservoir organisms. Zebra mussels in bold, italics. No-effect concentrations are shaded. LC50 = Concentration showing 50% mortality over the test period.

Taxonomic Group	Species	Endpoint	KCl (mg/L)	Source
Crustaceans	*Ceriodaphnia dubia* (water flea)	LC50	630	ECOTOX
		Lethal	299-596	ECOTOX
		No-effect	193	Aquatic Sciences, 1997
	Hyallela azteca (scud)	LC50 (4 day)	134-630	ECOTOX
	Orconectes limosus (crayfish)	LC50 (30 day)	330 – 450	ECOTOX
Aquatic insect	*Chironomus tentans* (midge)	LC50 (4 day)	1,250 – 6,830	ECOTOX
Annelid Worms	*Tubifex tubifex*	LC50 (4 day)	813*	ECOTOX
	Nais variabilis	LC50 (2 day)	67 – 75*	ECOTOX
Snails	*Physa hertostropha*	LC50	940	Daum, et al., 1977
	Bimophalaria alexandrina	Lethal	1,000 – 2,600	ECOTOX
Bivalve molluscs	*Corbicula fluminea* (clam)	LC50	225	Anderson, et al., 1976
	Dreissena polymorpha (zebra mussel)	***95% mortality/56 hrs at 20^{o}C (approximate temperature for treatment)***	***100***	***Aquatic Sciences, 1996***
		LC50 (1 day)	***138***	***Fisher, et al., 1991***
Fish	*Lepomis macrochirus* (bluegill sunfish)	LC50 (4 day)	951 – 2,010	ECOTOX
		LC50	2,010	Daum, et al., 1977
	Gambusia affinis (mosquitofish)	LC50 (4 day)	435 - 485	ECOTOX

Table 1. Toxicology endpoints and KCl concentrations for typical, reservoir organisms. Zebra mussels in bold, italics. No-effect concentrations are shaded. LC50 = Concentration showing 50% mortality over the test period.

Taxonomic Group	Species	Endpoint	KCl (mg/L)	Source
	Pimephales promelas (fathead minnow)	LC50 (4 day)	880	ECOTOX
		Lethal	1,191	ECOTOX
		No-effect	302	Aquatic Sciences, 1997
		Near zero	299	ECOTOX
	Cyprinus carpio (carp)	Lethal	5,910 – 6,590	ECOTOX
	Ictalurus punctatus (catfish)	LC50 (2 day)	720	ECOTOX
	Oncorhynchus mykiss (rainbow trout)	No-effect (7 day)	500 – 1,000	ECOTOX
Amphibians	*Microphyla ornata* (frog)	LC50 (4 day)	1,414 – 2,539	ECOTOX
		Lethal	2,000	ECOTOX
	Rana breviceps (frog)	Mortality	1,000 – 10,000	Kegley et al., 2010

[*test conditions for worms did not allow their normal burial in substrate and may produce unnaturally low toxicity values]

Conclusions

A review of the toxicology literature for KCl, as summarized in Table 1, is generally supportive of the findings from the Millbrook Quarry zebra mussel eradication. Most toxicity information is available as LC50 values, and longer exposures were chosen to more closely reflect the field eradication plan (4 days or longer, if results were available). Also, lethal and no-effect concentrations were shown wherever available since the objective was to confirm the lethality of KCl to zebra mussels and safe concentrations for other organisms. As is shown in Table 1, zebra mussels are among the most sensitive aquatic organisms to KCl toxicity, with expected mortality in the 100 ppm range (as is being recommended for treatment dosage at San Justo Reservoir). However, the time of year for application is important because KCL toxicity is temperature dependent. Bivalve sensitivity to KCl increased 10-fold from 10 to 20 degrees centigrade water temperature (Aquatic Sciences, 1996). Although informative and comparative, laboratory toxicity tests that are typically 4 to 7 days are more limited in duration than the planned eradication for San Justo of 2 or more months. However, as seen in the Millbrook example, the target KCl concentrations produced a 100% zebra mussel kill after a month's exposure (Virginia DGIF, 2006). In addition, the Millbrook results suggest that the other aquatic invertebrates and fish in San Justo should survive the long-term duration of what, for them, is a sub-lethal dosage. Should any unexpected degradation of the San Justo fishery occur as a result of the mussel treatment, the affected non-native target fish could easily be re-stocked.

A variety of aquatic species of fish and invertebrates appear to be less susceptible than zebra mussels to the effects of KCl. In contrast to zebra mussels, no mortality is expected for fish in the 300 – 1,000 ppm KCl range or for planktonic crustaceans at approximately 200 ppm (Table 1). Most invertebrates and fish show LC50 endpoints far higher than those for zebra mussels. Note that worms show relatively low toxicity values, but that the values in Table 1 are probably unnaturally low due to the lack of natural sediment burial of the animals under test conditions. Although no-effect concentrations were unavailable for amphibians and most invertebrate groups, the toxicity values in Table 1 indicate that the potential for harmful effects to non-target species should be minimized with the planned dosage of 100 ppm KCl.

There is a particular concern for listed species of amphibians in the downstream pond. Note that the red-legged frog is known to be a pond resident while this general area is only known to be in the range of tiger salamanders (currently there is no actual record of their occurrence at the reservoir or pond). The amphibian data in Table 1 provides a direct surrogate toxicity estimate for red-legged frog and a close surrogate for tiger salamander. These types of literature surrogates are typical of what is used in assessing toxicity as part of Ecological Risk Assessments when exact species information is unavailable; the results shown in Table 1 indicate no likely impacts to amphibians as part of the implementation of this project.

The planned whole-reservoir target of 100 ppm KCl should be fatal to zebra mussels and potentially may affect some sensitive members or life stages of various members of the invertebrate community of San Justo Reservoir but should not adversely affect the reservoir fish or amphibian communities in the adjacent pond. These effects are comparable to the observations following the successful treatment of Millbrook Quarry, Virginia.

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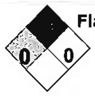
Appendix B: MSDS for Potash and Potassium Chloride

Agrium Material Safety Data Sheet

NFPA Classification	DOT / TDG Pictograms	WHMIS Classification	HMIS		PROTECTIVE CLOTHING
Flammability; Health 0; Reactivity 0; Specific Hazard 			Health	1	
			Flammability	0	
			Reactivity	0	
			PPE	A	

Section I. Chemical Product and Company Identification

PRODUCT NAME/ TRADE NAME	**Muriate of Potash**		
SYNONYM	This Material Safety Data Sheet applies to the following Agrium 0-0-60 or 0-0-62 Muriate of Potash products: Blender Coarse Grade Coarse Grade Granular Grade Industrial Standard Grade Special Standard Grade Specialty Coarse Grade Standard Grade Standard Grade, Low Sodium Chloride Turf Granular Water Soluble Please refer to the appropriate Product Specification Sheet for technical information on each product.	**MSDS NUMBER:**	**14083**
CHEMICAL NAME	Potassium chloride	**REVISION NUMBER**	4.8
CHEMICAL FAMILY	Inorganic salt.	**MSDS prepared by the Environment, Health and Safety Department on:**	**September 25, 2006**
CHEMICAL FORMULA	KCl: 95 - 100%; NaCl: 0 - 5%	**<u>24 HR EMERGENCY TELEPHONE NUMBER:</u>** **Transportation: 1-800-792-8311** **Medical: 1-888-670-8123**	
MATERIAL USES	Fertilizer and/or industrial use.		

MANUFACTURER	**SUPPLIER**
Agrium North American Wholesale 13131 Lake Fraser Drive, S.E. Calgary, Alberta, Canada T2J 7E8	Agrium North American Wholesale 13131 Lake Fraser Drive, S.E. Calgary, Alberta, Canada, T2J 7E8 Agrium U.S. Inc. Suite 1700, 4582 South Ulster St. Denver, Colorado, U.S.A., 80237

Section II. Hazardous Ingredients

		Exposure Limits (ACGIH)						
NAME	**CAS #**	**TLV-TWA mg/m^3**	**TLV-TWA ppm**	**STEL mg/m^3**	**STEL ppm**	**CEIL mg/m^3**	**CEIL ppm**	**% by Weight**
No regulated components.								

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ACGIH TLV notations:

- --- No assigned TLV
- (C) - Ceiling - the concentration not to be exceeded at any time
- (I) - measured as the Inhalable fraction of the aerosol
- (R) - measured as the Respirable fraction of the aerosol
- (T) - measured as the Thoracic fraction of the aerosol

TOXICOLOGICAL DATA ON INGREDIENTS	**Potash TFI Product Testing Program Results:** Acute oral toxicity: 2,600 mg/kg rat; 1,500 mg/kg mouse Ecotoxicity: Acute toxicity to fish, species unspecified, LC_{50}, 96hr: 2,010 mg/L Acute toxicity to aquatic invertibrates, Daphnia magna, 48hr TLm 337mg/L Toxicity to aquatic plants (algae) Chlorella vulgaris, NOEC=600 mg/L, 3-4 months This product and its components are not considered hazardous according to WHMIS (Canada) HSC, (United States) and DSCL (Europe).

Section III. Hazards Identification.

POTENTIAL ACUTE HEALTH EFFECTS	This product may irritate eyes and skin upon contact due to mechanical action and drying action. Inhalation of dust may produce irritation to the gastro-intestinal or respiratory tract. Ingestion of excessive quantities of this substance may produce irritation of the gastro-intestinal tract, characterized by irritation, nausea, vomiting and diarrhea. Potassium chloride is rapidly excreted from the body in the absence of pre-existing kidney or circulatory system disfunction making acute toxic effects very rare. Potassium chloride is used as a salt substitute in human sodium reduced diets and as an animal nutrition suppliment.
POTENTIAL CHRONIC HEALTH EFFECTS	There is no known effect from chronic exposure to this product in healthy individuals. The product is not carcinogenic, mutagenic or teratogenic. Individuals with existing kidney problems should minimize their exposure to this substance. Potassium chloride is used as a dietary supplement in food for human consumption and is classed as being "generally recognized as safe" when used in accordance with good manufacturing practice. 21 CFR 182.5622

Section IV. First Aid Measures

EYE CONTACT	May cause irritation by mechanical action. Immediately flush eyes with running water for at least 15 minutes, keeping eyelids open. Obtain medical attention if irritation persists.
MINOR SKIN CONTACT	May cause skin irritation. Wash contaminated skin with soap and water. Cover dry or irritated skin with a good quality skin lotion. If irritation persists, seek medical attention.
EXTENSIVE SKIN CONTACT	No additional information.
MINOR INHALATION	Over-exposure by inhalation may cause respiratory irritation. Allow the person to rest in a well ventilated area. Loosen tight clothing around the neck and waist. Obtain medical attention if irritation persists.
SEVERE INHALATION	No additional information.
SLIGHT INGESTION	Low toxicity. Do not induce vomiting. May cause digestive tract irritation, with accompanying nausea, vomiting and diarrhea. If spontaneous vomiting does occur, lower the head so that the vomit will not reenter the mouth and throat. If tolerated, give no more than 1 cup of milk or water to rinse the mouth and throat, dilute the stomach contents, and minimize irritation. No more than 8 ounces (1 cup) in adults and 4 ounces (1/2 cup) in children is recommended to minimize the risk of vomiting. Obtain medical attention if irritation persists.
EXTENSIVE INGESTION	No additional information.

Continued on Next Page

Section V. Fire and Explosion Data

THE PRODUCT IS	Non-flammable.
AUTO-IGNITION TEMPERATURE	Not applicable.
FLASH POINT	Not applicable.
FLAMMABILITY LIMITS	Not applicable.
PRODUCTS OF COMBUSTION	Not applicable.
FIRE HAZARD IN THE PRESENCE OF VARIOUS SUBSTANCES	Not applicable.
EXPLOSION HAZARD IN THE PRESENCE OF VARIOUS SUBSTANCES	This product is non-explosive.
FIRE FIGHTING MEDIA AND INSTRUCTIONS	Non-flammable. Use extinguishing media suitable for surrounding materials.
SPECIAL REMARKS ON FIRE HAZARDS	Non combustible.
SPECIAL REMARKS ON EXPLOSION HAZARDS	No additional remark.

Section VI. Accidental Release Measures

SMALL SPILL	Use appropriate tools to put spilled solid in a suitable container for intended use or disposal.
LARGE SPILL	Prevent additional discharge of material, if possible to do so without hazard. Prevent spills from entering sewers, watercourses, wells, etc. Recover and place material in suitable containers for recycle, reuse, or disposal. Ensure disposal complies with government requirements and local regulations.

Section VII. Handling and Storage

PRECAUTIONS	If user operations generate excessive dust, use ventilation to keep exposure to airborne contaminants below the exposure limit.
STORAGE	Contains moisture sensitive material; store in a dry place. Product will absorb moisture and will cake when dried.

Section VIII. Exposure Controls/Personal Protection

ENGINEERING CONTROLS	Use process enclosures, local exhaust ventilation, or other engineering controls to keep airborne levels below recommended exposure limits. If user operations generate dust use appropriate ventilation to keep exposure to airborne contaminants below the exposure limit.
PERSONAL PROTECTION	The selection of personal protective equipment varies depending upon conditions of use. As in all industrial areas, use safety glasses with side shields. Under well controlled conditions where exposures are below the occupational exposure limit, normal work clothing should suffice. However, appropriate protective clothing and respiratory protection must be available in the event of an emergency.
PERSONAL PROTECTION IN CASE OF LARGE RELEASE	Where significant skin and eye contact may occur as a result of prolonged or repeated exposures, wear long sleeved clothing, coveralls, leather gloves, and safety glasses with side shields. Use a filtering facepiece dust respirator if concentrations may exceed the occupational exposure limit. For U.S. work sites where respiratory protection is required, ensure that a respiratory protection meeting 29 CFR 1910.134 is in place.
EXPOSURE LIMITS	

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Saskatchewan TWA: 10 mg/m^3 Inhalable, 3 mg/m^3 Respirable, for Particulate Not Otherwise Classified.

Fed OSHA PEL: 15 mg/m^3 Total dust, 5 mg/m^3 Respirable fraction, for Particulates Not Otherwise Regulated.

Federal, State or Provincial exposure limits may vary by jurisdiction. Consult local authorities for acceptable exposure limits in your area.

Section IX. Physical and Chemical Properties

PHYSICAL STATE AND APPEARANCE	A crystalline solid ranging from translucent white to reddish-brown due to trace amounts of iron oxide in some products.		
MOLECULAR WEIGHT	74.55	**COLOR**	White to Brownish-red.
pH (10% SOLN/WATER)	9	**ODOR**	Odourless, however, product may have a slight oil odour due to dust suppression additive.
BOILING POINT	1411°C (2571.8°F)	**ODOR THRESHOLD**	Not applicable.
MELTING POINT	773.5°C (1424.3°F)	**TASTE**	Saline. (Strong.)
CRITICAL TEMPERATURE	Not applicable.	**VOLATILITY**	Not applicable.
SPECIFIC GRAVITY g/cc	1.984 (Water = 1)	**SOLUBILITY**	Readily soluble in hot water (56.7 g/100cc) Soluble in cold water (34.4 g/100cc)
BULK DENSITY kg/m^3 ; lbs/ft^3	Refer to the Product Specification Sheet for the density of each potash product.	**DISPERSION PROPERTIES**	See solubility in water.
VAPOR PRESSURE	Not applicable.	**WATER/OIL DIST. COEFF.**	Not applicable.
VAPOR DENSITY	Not applicable.		

Section X. Stability and Reactivity Data

STABILITY	The product is stable.
INSTABILITY TEMPERATURE	Not applicable.
CONDITIONS OF INSTABILITY	Not applicable.
INCOMPATABILITY WITH VARIOUS SUBSTANCES	Incompatable with bromine trifluouride or trichloride, potassium dichromate and sulfuric acid, or hot nitric acid.
CORROSIVITY	A salt. Dusts are corrosive to mild steel, aluminum, zinc, and copper. Solutions of potash are corrosive to 304 or 316 stainless steels, and may cause chloride induced stress cracking in these materials. Corrosive properties are highly dependent on operating parameters such as temperature and the strength of any solutions. Consult a metallurgical specialist regarding compatibility of materials of construction in handling systems.
SPECIAL REMARKS ON REACTIVITY	No additional remark.
SPECIAL REMARKS ON CORROSIVITY	Contact your sales representative or metallurgical specialist to ensure compatability with your equipment.

Continued on Next Page

Section XI. Toxicological Information

SIGNIFICANT ROUTES OF EXPOSURE	Ingestion. Inhalation.
TOXICITY TO ANIMALS	See Section II.
SPECIAL REMARKS ON TOXICITY TO ANIMALS	Not considered to be toxic to animals. Used as an animal feed supplement.
OTHER EFFECTS ON HUMANS	Our data base contains no additional remark on the toxicity of this product
SPECIAL REMARKS ON CHRONIC EFFECTS ON HUMANS	Not considered to be toxic for humans.
SPECIAL REMARKS ON OTHER EFFECTS ON HUMANS	No additional remark.

Section XII. Ecological Information

ECOTOXICITY	Low toxicity to fish and other water organisms. Spills of large quantities of this product may affect fresh water species.
BOD and COD	Not applicable.
PRODUCTS OF DEGRADATION	Not applicable. Material dissolves to give potassium and chloride ions.
TOXICITY OF THE PRODUCTS OF DEGRADATION	The product itself and its products of degradation are not toxic.
SPECIAL REMARKS ON THE PRODUCTS OF DEGRADATION	Product may degrade water quality and taste. Notify downstream water users. Will dissolve and disperse in water. Reclaiming material may not be viable.

Section XIII. Disposal Considerations

WASTE DISPOSAL OR RECYCLING	Recover and place material in a suitable container for intended use or disposal. Ensure disposal complies with government requirements and local regulations.

Section XIV. Transport Information

DOT / TDG CLASSIFICATION	Not controlled under TDG (Canada) or D.O.T. (U.S.A.)
PIN and Shipping Name	Not applicable.
SPECIAL PROVISIONS FOR TRANSPORT	Not applicable.
DOT (U.S.A) (Pictograms)	

Continued on Next Page

Section XV. Other Regulatory Information and Pictograms

OTHER REGULATIONS

CANADIAN ENVIRONMENTAL PROTECTION ACT (CEPA): This product is on the Domestic Substances List (DSL), and is acceptable for use under the provisions of CEPA.

Potassium Chloride used as a dietary supplement in food for human consumption is generally recognized as safe when used in accordance with good manufacturing practice. 21 CFR 182.5622 (4/1/93)
Substance added directly to human food affirmed as generally recognized as safe (GRAS). 21 CFR 184.1622 (4/1/93)
Manufacturers, packers, and distributors of drug and drug products for human use are responsible for complying with the labeling, certification, and usage requirements as prescribed by the Federal Food, Drug, and Cosmetic Act, as amended (secs 201-902, 52 Stat. 1040 et seq., as amended; 21 U.S.C. 321-392). 21 CFR 200-299, 300-499, 820, and 860 (4/1/93)
This product has been classified in accordance with the hazard criteria of the Controlled Products Regulations and is not subject to control under WHMIS (Canada), or the Hazcom Standard (US).

OTHER CLASSIFICATIONS

HCS (U.S.A.)	Not controlled under the HCS (United States).
DSCL (EEC)	Not controlled under DSCL (Europe).

National Fire Protection Association (U.S.A.)

Hazards presented under acute emergency conditions only:

Health

Fire Hazard
Reactivity
Specific Hazard

TDG (Pictograms - Canada)

DSCL (Europe) (Pictograms)

ADR (Europe) (Pictograms)

Section XVI. Other Information

REFERENCES

-Transportation of Dangerous Goods Act and Clear Language Regulations, current revision.
-Canada Gazette Part II, Vol. 122, No. 2 Registration SOR/88-64 31 December, 1987 Hazardous Products Act "Ingredient Disclosure List".
-Domestic Substances List, Canadian Environmental Protection Act.
-29 CFR Part 1910
-33 CFR Parts 151, 153, 154, 156
-40 CFR Parts 1-799
-46 CFR Part 153
-49 CFR Parts 1-199
-American Conference of Governmental Industrial Hygienists, Threshold Limit Values for Chemical Substances, 2006.
-NFPA 704, National Fire Codes Online, National Fire Protection Association, current edition at time of MSDS preparation.
-Corrosion Data Survey, Sixth Edition, 1985, National Association of Corrosion Engineers
-TOMES® System: Heitland G & Hurlbut KM (Eds) (electronic version): MICROMEDEX, Greenwood Village, Colorado, USA. Available at: http://csi.micromedex.com (2006). The TOMES® System includes MEDITEXT® Medical Management; HAZARDTEXT® Hazard Management; INFOTEXT® Documents; ERG2000 Emergency Response Guidebook Documents; REPROTEXT®: Heitland G & Hurlbut KM (Eds); CHRIS Hazardous Chemical Data:

Continued on Next Page

U.S. Department of Transportation, U.S. Coast Guard, Washington, D.C. (2006); HSDB: Hazardous Substances Data Bank. National Library of Medicine, Bethesda, Maryland (2006); IRIS: Integrated Risk Information.System. U.S. Environmental Protection Agency, Washington, D.C. (2006); NIOSH: Pocket Guide to Chemical Hazards. National Institute for Occupational Safety and Health, Cincinnati, Ohio (2006); OHM/TADS: Oil and Hazardous Materials Technical Assistance Data System. U.S. Environmental Protection Agency, Washington, D.C. (2006); REPROTOX®: Scialli A.R. Georgetown University Medical Center and Reproductive Toxicology Center, Columbia Hospital for Women Medical Center, Washington, D.C. (2006); RTECS®: Registry of Toxic Effects of Chemical Substances. National Institute for Occupational Safety and Health, Cincinnati, Ohio (2006); and SHEPARDS: Shepard T.H.: Shepard's Catalog of Teratogenic Agents (2006).

-The Fertilizer Institute Product Testing Program Results, March 2003

- Saskatchewan Labour, Occupational Health and Safety Division, Occupational Health and Safety Regulations

OTHER SPECIAL CONSIDERATIONS	HMIS information added in this revision.
FOR FURTHER SAFETY, HEALTH, OR ENVIRONMENTAL INFORMATION ON THIS PRODUCT, CONTACT	**AGRIUM** **Wholesale Environment, Health and Safety** **Telephone (780) 998-6906 or Fax (780) 998-6677**

NOTICE TO READER

The buyer assumes all risk in connection with the use of this material. The buyer assumes all responsibility for ensuring this material is used in a safe manner in compliance with applicable environmental, health and safety laws, policies and guidelines. Agrium Inc. assumes no responsibility or liability for the information supplied on this sheet, including any damages or injury caused thereby. Agrium Inc. does not warrant the fitness of this material for any particular use and assumes no responsibility for injury or damage caused directly or indirectly by or related to the use of the material. The information contained in this sheet is developed from what Agrium Inc. believes to be accurate and reliable sources, and is based on the opinions and facts available on the date of preparation.

Material Safety Data Sheet
Potassium Chloride Solution

Identity: Potassium Chloride Solution
Form/Aspect: KCl salts dissolved in water
Use: Electrolyte Solution for electrodes with a Calomel reference
Also sold separately as a solution for refill or storage of electrodes
Part #: AS-3120-C20-0250
Part #: AS-3120-C20-0500

Section I - General Information

Manufacturer:	Broadley-James Corporation, 19 Thomas, Irvine, CA 92618
Phone:	(949) 829-5555
Emergency Phone:	(949) 829-5555 Or (800) 288-2833
Date Prepared:	June 22, 2000

Section II - Ingredient Information

Potassium Chloride 28.3% OSHA PEL/ACGIH TLV: N/A
Cas. No.: 7447-40-7
Molecular Formula: KCl
Water Balance

***According to OSHA, this product should not be considered a hazardous material.**

Section III - Physical/Chemical Characteristics

Boiling Point:	N/A	Vapor Density (Water):	N/A
Melting Point:	N/A	Appearance/Odor:	Clear, odorless liquid
Water Solubility:	100% by weight	Specific Gravity ($H_20=1$):	1.15
Evaporation Rate:	N/A	Vapor Pressure: (mm Hg):	N/A

Section IV - Fire And Explosion Hazard Data

Flash Point: N/A
Extinguishing Media: Any
Special Fire Fighting Procedures: N/A

Unusual Fire & Explosion Hazards: None
Flammable Limits: LEL: N/A UEL: N/A

MSDS - Page 2

Identity: Potassium Chloride Solution
Part #: AS-3120-C20-0250
Part #: AS-3120-C20-0500

Section V - Reactivity Data

Stability: Stable — Conditions To Avoid: None Known
Hazardous Polymerization: Will Not Occur — Conditions To Avoid: None Known
Incompatibility: BrF_3
Hazardous Decomposition Or Byproducts: N/A

Section VI - Health Hazard Data

Exposure Limit: Potassium Chloride: Oral-Guinea Pig LD50: 2500 mg/kg
Route Of Entry: Inhalation: N/A Skin: N/A Ingestion: Yes
Carcinogenicity: NTP: N/A IARC Monogr: N/A OSHA Reg.: No
Health Hazards: None Known
Effects Of Overexposure: (See below)
Emergency & First Aid Procedures:
Oral: Large doses cause GI irritation, purging, weakness and circulatory problems. Contact a physician.

Section VII- Precautions For Safe Handling And Use

Spill Response: Pick up and wash down drain with excess of water.
Waste Disposal: Not regulated.
Precautions To Be Taken In Handling & Storage: Store in cool, dry place.
Other Precautions: N/A

Section VIII - Control Measures

Respiratory Protection: N/A
Protective Gloves: Optional
Other Protective Equipment: None Required
Ventilation: None
Eye Protection: Safety Glasses
Work/Hygienic Practices: Wash hands thoroughly before eating, drinking or smoking.

Key: N/A = Not Applicable Or Not Available
N/D = Not Determined

Appendix C: Reclamation’s Final Eradication Plan

RECLAMATION
Managing Water in the West

Final Feasibility-Level Eradication Plan: Zebra Mussels in San Justo Reservoir, Hollister Conduit, and Distribution System

Mid-Pacific Region

1.1.1

U.S. Department of the Interior
Bureau of Reclamation
Technical Service Center
Denver, CO

June 2019

Mission Statements

The mission of the Department of the Interior is to protect and provide access to our Nation's natural and cultural heritage and honor our trust responsibilities to Indian Tribes and our commitments to island communities.

The mission of the Bureau of Reclamation is to manage, develop, and protect water and related resources in an environmentally and economically sound manner in the interest of the American public.

DRAFT Eradication Plan: Zebra Mussels in San Justo Reservoir, Hollister Conduit, and Distribution System

Mid-Pacific Region

prepared by

Scott O’Meara, Ph.D., Botanist
Hydraulic Investigations & Lab Services, Technical Service Center, Bureau of Reclamation

Citation:

Reclamation (2019). DRAFT Feasibility Level Eradication Plan: Zebra Mussels in San Justo Reservoir, Hollister Conduit, and Distribution System, US Bureau of Reclamation, Technical Service Center, Denver, CO, June 2019.

Peer Review Certification: This document has been peer reviewed per guidelines established by the Technical Service Center and is believed to be in accordance with the service agreement and standards of the profession. Questions concerning this report should be addressed to Robert Einhellig, Group Manager of the Hydraulic Investigations & Laboratory Services Group (86-68560) at 303-445-2142.

PREPARED BY:

SCOTT O'MEARA Digitally signed by SCOTT O'MEARA Date: 2019.06.12 13:37:52 -06'00'

DATE: 06/12/2019

Scott O'Meara, Ph.D.
Botanist, Bureau of Reclamation Technical Services Center
Hydraulic Investigations & Lab Services, (86-68560)

PEER REVIEWED BY:

JACQUE KEELE Digitally signed by JACQUE KEELE Date: 2019.06.12 14:23:01 -06'00'

DATE: 06/12/2019

Jacque Keele, Ph.D.
Biologist, Bureau of Reclamation Technical Services Center
Hydraulic Investigations & Lab Services, (86-68560)

YALE PASSAMANECK Digitally signed by YALE PASSAMANECK Date: 2019.06.12 13:47:09 -06'00'

DATE: 06/12/2019

Yale Passamaneck, Ph.D.
Ecologist, Bureau of Reclamation Technical Services Center
Hydraulic Investigations & Lab Services, (86-68560)

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Appendices

Appendix A - Dose exposure responses of zebra mussels to potassium (potash), ex-situ study conducted at San Justo Reservoir

Appendix B - San Justo Reservoir elevation data, 2014-2018

Appendix C - San Justo Reservoir water quality data

Appendix D - Historical climate data summary, Hollister California

Appendix E - Eradication treatment monitoring protocols

Appendix F - Eradication treatment logistics

Appendix G - San Justo Reservoir area and capacity by elevation

NOTE: All units in this document are U.S.: U.S. liquid gallons, U.S. tons, etc.

1 Executive Summary

San Justo Reservoir is part of the San Felipe Division of the Central Valley Project in California and has been known to be infested with zebra mussels since 2008. Reservoir water is delivered for agricultural and municipal uses only; no surface water outflows from San Justo are connected to other water bodies, effectively creating an isolated zebra mussel infestation. The detection of invasive mussels at San Justo prompted closure of the area to public access in order to further prevent their potential spread. Because San Justo is essentially a terminal water body, it presents a relatively unique opportunity for eradication to eliminate the threat of invasive mussels and their spread.

This document details specifics for a zebra mussel eradication effort at San Justo Reservoir, initially investigated and presented in the Draft Finding of No Significant Impact (FONSI, Reclamation 2015). The selected alternative includes use of potassium solution (potash) to treat the reservoir and distribution system. Properties of potash such as toxicity and environmental impacts are reviewed and summarized in the draft FONSI. Basic components of the proposed eradication effort are as follows:

- Draw-down of the reservoir to 455 feet elevation, exposing shoreline mussels to desiccation and reducing the volume of water to be treated to approximately 3,000 acre-feet (97,755,000 gallons).
- Apply approximately 716,000 gallons of commercially acquired potassium solution (~ 12% potassium by weight) to San Justo Reservoir.
- Flush and charge the distribution piping system with treated water from San Justo Reservoir.
- Hold treated water within the reservoir and distribution system for approximately 45 days before resuming operations.
- Monitoring will be conducted to evaluate eradication treatment performance and results.

2 Introduction

2.1 San Justo Reservoir

San Justo Reservoir, located southwest of Hollister, California, is used primarily for off-stream water storage as part of the San Felipe Division of the Central Valley Project. The reservoir was built and is owned by the Bureau of Reclamation (Reclamation) and is operated by the San Benito County Water District (SBCWD). Water is primarily for irrigation and municipal uses and services 23,700 acres.

San Justo Reservoir receives water out of San Luis Reservoir by way of the Pacheco Bifurcation structure and through the Hollister Conduit. Water can be diverted at various points along the Hollister Conduit to recipients by way of the SBCWD distribution system and subsystems (distribution system). The conduit and distribution system are composed of more than 90 miles of total piping with various turnouts, flow control structures, and booster pumps.

During high summer demand, water stored in San Justo Reservoir is delivered to recipients through pump-assisted flows through the Hollister Conduit and distribution system. Water from San Justo does not flow past the Pacheco Bifurcation and does not re-enter San Luis Reservoir; all flows out of San Justo terminate at various end-use locations.

The invasive exotic zebra mussel (*Dreissena polymorpha*) was detected at San Justo Reservoir in 2008, and the reservoir has since been closed to recreational access to prevent potential spread. Adult zebra mussels were also found to infest the Hollister Conduit at multiple locations in 2009.

A multi-agency group, including members from the Bureau of Reclamation, California Department of Fish and Wildlife (formerly, Department of Fish and Game), California Department of Water Resources, San Benito and Santa Clara Valley Water Districts, and San Benito County have proposed and evaluated actions to eradicate zebra mussels from San Justo Reservoir, the Hollister Conduit and distribution system.

2.2 Open-Water Mussel Eradication Treatments

Mussel control or eradication treatments in large water bodies are inherently difficult and costly due to the scale of the treatment and volume of materials, potential impacts to beneficial organisms, and downstream use limitations. Various alternatives for eradicating invasive mussels at San Justo Reservoir are discussed in the Draft Finding of No Significant Impact (Reclamation 2015). Alternatives eliminated from further analysis included the use of copper-based pesticides, *Pseudomonas* bacterial derived biocide products, as well as a complete drawdown of the reservoir (desiccation) and programmatic mussel management (containment).

The proposed action for the eradication of mussels at San Justo Reservoir is the application of a potassium-based compound to the reservoir and distribution system. These compounds are commonly known as potash, which refers to a group of potassium-rich salts (primarily potassium chloride) that are commonly used as fertilizers. This method was selected based on the relatively low toxicity to non-target organisms, documented toxicity to invasive mussels, and previous successful use of this method for mussel eradication in other infested waterbodies.

2.3 San Justo Mussel Eradication

The scale of the effort to eliminate invasive mussels from San Justo Reservoir and the distribution system will be one of the largest yet conducted, with treated water volume estimated at 3,000 acre-feet and over 90 miles of associated pipe system. Successful mussel eradication at San Justo faces several intricacies: a substantial volume of water to be treated, extensive invasive zebra mussel populations, and a complex pipeline system. These aspects present a level of risk for eradication failure that is difficult to accurately quantify. Primarily, the ability to fully expose all mussels to water with sufficient potassium concentrations throughout the prescribed treatment period to cause complete mortality is unknown. Mussels will have the potential to "escape" treatment in various ways, including non-homogenous mixing and dispersal of the potassium solution, refugia areas within the drawdown zone, or incomplete charging of the distribution system.

Very small populations of surviving mussels would have the potential to completely re-infest the entire system in a relatively short period. For the eradication to succeed, treatments must ensure best possible concentration and contact times of treated water throughout the reservoir and connected systems. This includes San Justo Reservoir, the Hollister Conduit and distribution system as well as shoreline areas.

Timing of the eradication treatment has the potential to mitigate many of the potential risks described. Mixing could be improved by application of treatments shortly before the fall thermal stratification turnover, and/or extending the overall treatment duration. A longer, slow release of treated water through the distribution system would also reduce the potential for sub-lethal dose/exposure times. Drawdown of the reservoir earlier in the season would expose shorelines to hotter and drier weather, improving mussel desiccation and reducing potential refugia.

A feasible eradication effort must also coincide with ongoing water delivery and storage operations at San Justo Reservoir, which may necessitate sub-optimal timing and conditions in which to conduct the eradication treatments. This plan is based on the current consensus to conduct the eradication after seasonal water deliveries are completed, in the fall when the reservoir would typically be drawn down.

2.4 Eradication Plan Objectives

The objectives of this eradication plan are to:

- Provide the best feasible strategy for complete elimination of zebra mussels within San Justo Reservoir, the Hollister Conduit, and all distribution system components.
- Fully inform and describe known inherent risks for eradication failure for consideration in decision-making.
- Inform feasibility level cost estimation.

3 Reservoir Drawdown

The primary factor influencing eradication costs is the volume of potassium solution necessary to bring the reservoir water to the appropriate concentration. Drawing down the reservoir to reduce the total volume of water to be treated creates a more economically feasible - although still significant - amount of potassium solution necessary for mussel eradication.

Several drawdown scenarios for San Justo Reservoir were examined and indicated 455 feet as the minimum elevation below which adverse impacts would be seen by water users and stakeholders (Reclamation 2015) and is the current target elevation for the eradication treatment. If the eradication is conducted at higher elevations, accommodations would be necessary for increased treatment scale and could significantly increase costs as well as require modifications to equipment, number of personnel, and schedule.

Since January 2014 the reservoir elevation has fluctuated between 441 and 500 feet (Appendix B). Much of this history includes drought years where water was delivered out of San Justo from early spring through late fall/early winter, and then refilled during the winter off-season with water from San Luis Reservoir. High-water conditions such as seen in the 2016/2017 season may create challenges to drawing down San Justo reservoir for the mussel eradication effort as alternative storage may be limited. At present, conducting a drawdown to 455 feet is deemed to be feasible within 2 years of initiation.

The drawdown will be accomplished by delivering water to customers from San Justo and delaying inflows San Luis Reservoir; water will not discharge from San Justo Reservoir to rivers, creeks, or other open waters per the discontinued use of these turnouts (in effect since the discovery of invasive mussels at San Justo). Bathymetry indicates the capacity of the reservoir at the targeted elevation (455 feet) is approximately 3,000 acre-feet. The water treated in the reservoir will be used to flush the distribution system. The rate of drawdown will not exceed 1 foot of surface elevation per day to minimize stresses on the reservoir substrate. See Appendix G for San Justo Reservoir capacity and area by elevation tables.

Scheduling and implementation of the drawdown and reservoir refill will be conducted in coordination with San Benito County Water District and stakeholders so as to minimize the impacts to water users, costs of the eradication effort, and the risk of eradication failure.

3.1 Drawdown Holding Period

After the drawdown, the reservoir water will be treated with potassium solution, then flushed through the distribution system and held static for a minimum of 45 days after confirming all potassium concentrations are between 95-115 parts per million (ppm).

This holding period will meet the minimum requirements to reach complete mortality at historically low (down to 54° F) water temperatures (25 days, Reclamation 2016) as verified by on-site testing (Appendix A), the 60 day suggested minimum for shoreline desiccation (Chapman and Gruenhagen 2010), and fall within the available time-window between seasonal discontinuation of water deliveries and initiation of reservoir refill (generally October through December).

The 60-day minimum exposure time for shoreline mussel desiccation would be met by the combined duration (post-drawdown) of the active potassium solution dosing period (approximately 17 calendar days) followed by the 45-day minimum holding period. Lab tests (McMahon et al. 1993) imply adult zebra mussels may only require 10 days to desiccate to the point of complete mortality (extrapolated from McMahon et al. 1993 to typical air temperatures and relative humidity at San Justo during the eradication treatment), but these tests did not account for mussels in moist/muddy substrates or precipitation events. Ultimately the treatment duration should be adaptive based on frequent monitoring of potassium concentrations and mussel mortality observations.

At the conclusion of the holding period, assuming all short-term monitoring (see Section 5.1; Appendix E) indicates the eradication was successful, the reservoir will be refilled with water from San Luis Reservoir via the Hollister Conduit and resume typical operations, with additional long-term monitoring to confirm complete mussel extirpation from San Justo.

3.2 Exposed Shoreline

The reservoir drawdown will expose mussel populations established above 455 feet. Bathymetric analysis indicates the total area of exposed shoreline between 455- and 472-feet elevation is approximately 38.5 acres (472 feet was the maximum elevation the bathymetry was able to accurately capture surface contours due to the reservoir elevation at the time of the analysis). Zebra mussel colonization may extend on shoreline substrates up to 480 feet elevation or higher depending on reservoir operations, and the actual drawdown area may be larger depending on the seasonal starting elevation.

Desiccation is expected to cause mortality to the majority of the exposed mussels, but wet areas, particularly pockets within the reservoir armoring and along the perimeter of the immediate shoreline, may be able to support viable mussels through the eradication treatment period. The shoreline area will be monitored regularly as the drawdown progresses, by boat and/or on foot to determine the presence and extent of live mussels or viable refugia. Monitoring should continue until complete mortality is confirmed for all shoreline mussels (see Appendix E).

In the event of inadequate desiccation or incomplete mortality, contingency practices for treating shoreline mussels will be enacted (see Section 3.2.1). Best practices for shoreline treatments will depend on the topography of the exposed shoreline, weather conditions, and extent of observed presence/absence of live mussels or potential habitats.

3.2.1 Shoreline Treatments

Viable mussels found on the drawdown zone should initially be collected and placed in aquaria for use in live mussel assay monitoring (Section 5.1.2, Appendix E). Mussel-covered rocks can be gathered in small buckets or containers with reservoir water and kept alive for several hours. Placing containers in the reservoir and cutting holes in the buckets to allow water flow will increase the duration mussels may be temporarily stored before being moved to aquaria.

Live mussels required for monitoring should be collected from San Justo before the eradication treatment is initiated (see Appendix E). Remaining populations of viable mussels on the shoreline should be treated unless desiccation appears imminent.

Shoreline treatments will consist primarily of potassium solution application via backpack sprayer or high-pressure boat-mounted applicator. As a general guideline, assuming use of the same 12% by weight potassium solution applied for the reservoir treatment, 0.09 oz. of solution will need to be added to each gallon of untreated water to obtain 100 ppm potassium. Targeting treatment of wet or pooled shoreline areas at 2 to 3 times this rate is recommended to allow for a greater margin of error in visual field-estimations of the volume of water to be treated, provided this treatment is within limitations of approved permits for use of potassium as a pesticide.

Mechanical removal or physical destruction of adult mussels, such as using a blunt instrument or simply crushing them underfoot may be useful for small exposed colonies. Other methods to aid desiccation or prevent mussel survival may be acceptable upon review, provided the physical integrity of the reservoir will not be significantly affected.

4 Reservoir Treatment

4.1 Potassium Solution Supply and Storage

The proposed potassium solution for the eradication will be obtained from commercially available sources as a pre-mixed liquid consisting of muriate of potash, a mined potassium-rich salt, dissolved in water (solution = 12% potassium by weight). On a global level, potash is mined in significant quality and quantity in only a few countries. The continental U.S. is believed to contain one percent of the world's potash. In 2015, U.S. production was estimated at 815,700 tons, compared to global production of 44,753,800 tons. The largest known potash reserves are found in Canada (46% of global supply), with most mines located in central to south-central Saskatchewan (USGS 2017).

Fertilizer suppliers commonly deliver potassium for agricultural use in the form of potash solution, and various sources are available in the Central Valley of California. Off-site mixing and tanker-truck deliveries are services readily available in the vicinity of the project. However, due to the scale of product necessary for the eradication, acquisition of potash may require pre-planning and need to be initiated one or more years prior to conducting the treatment. For reference of scale, treating San Justo will require approximately 837 tons of potash, which equates to 0.1% of U.S. production in 2015 (0.002% of 2015 global production).

Specifications for the concentration of the potassium solution should be verified and calculations adjusted for any variations, as small changes in concentration may magnify to large alterations of the total volume of solution needed, delivery logistics and scheduling to treat the reservoir within the designated timeframe.

The eradication treatment will utilize solution-grade muriate of potash mixed with water off-site and delivered to the project area as a liquid (~ 12% potassium solution by weight) by way of 25-ton (5,000 gallon) tanker trucks. Multiple deliveries of potassium solution to the project site will need to occur on a daily basis.

Current estimates for potassium solution delivery minimum requirements:

- Total potassium solution at 12% potassium by weight: 716,000 gallons.
- Truckloads delivered per day: 12
- Total truckloads delivered: 144

Tanker-truck deliveries of potassium solution will be transferred to land-based storage tanks at several locations surrounding San Justo Reservoir, each equipped with spill containment, loading equipment/hookups, and liquid/slurry pump systems to deliver the solution to workboats. Storage tank volume should accommodate for a minimum of one full work-day of treatment.

Current estimates for potassium solution storage requirements include 4 storage tanks each with a minimum capacity of 15,000 gallons. Tank locations, as well as all staging areas and vehicle traffic will occur on existing paved or otherwise historically disturbed areas.

4.2 Potassium Solution Application

Various alternatives are available for the distribution of potassium solution to San Justo Reservoir. Basic requirements are workboats equipped with distribution/diffuser systems to dispense the potassium solution throughout various depths of the reservoir, or otherwise use practices to create a uniform distribution of potassium concentrations.

Storage, transfer, and delivery system will require specifications to meet the designated schedule obligations.

Workboat diffuser systems typically consist of one or multiple hoses, optionally perforated to some extent, and reaching at least 10 feet below the water surface. Longer hoses may be necessary to achieve full mixing of the potassium solution at depth, particularly below the thermocline (see Potassium Mixing and Distribution, Section 4.3 and Appendix C Figure C3 for water temperature profiles).

Connecting workboats directly to the land-based storage tanks with supply lines eliminates the necessity for separate chemical storage tanks and injection pumps on the boats, as well as time necessary to fill the workboat tanks from land-based storage. The Millbrook Quarry eradication effort found land-based tanks with ballasted/floatation-assisted supply hoses to workboats with diffuser systems to be an efficient method to deliver potassium solution to a water body (Dan Butts, personal communication, January 16, 2017). Workboat supply system specifications are expected to consist of 1-inch diameter by 2,000 feet long feed hoses, constructed of braided PVC or similar in multiple sections with quick connect cam-locks and shutoff valves. On-site fuel delivery and storage will also be necessary for workboat operation.

With supply hoses of 2,000 feet it is estimated that a minimum of 4 workboat distribution setups with 30 gallon per minute (gpm) chemical delivery pumps would be necessary to dose the reservoir within the prescribed timeframe (scheduling presented in Section 4.4; Table 4.1), as well as distribute the potassium solution over the entirety of the surface area of the reservoir (Figure 3.1).

Four stations are featured in Figure 3.1 as potential delivery locations; Station 3 may be unsuitable as it is located on a non-paved surface with more difficult access. Relocating Station 3 and use of longer supply hose (additional ~1,000 feet) will be necessary to reach the southeastern arm of the reservoir if the current location of Station 3 is deemed unacceptable.

Dosing rates and duration shall be within acceptable limits of those specified as follows:

- 4 workboats/delivery pumps at 30 gpm each, 8 hour working days = 57,600 gallons of potassium solution delivered to reservoir per day.
- 13 total working days to complete potassium application; approximately 17 calendar days.

Workboat entry to the reservoir under drawdown conditions will require temporary modifications below the existing boat ramp, as well as floating-dock/gangway installation for boat storage and personnel access.

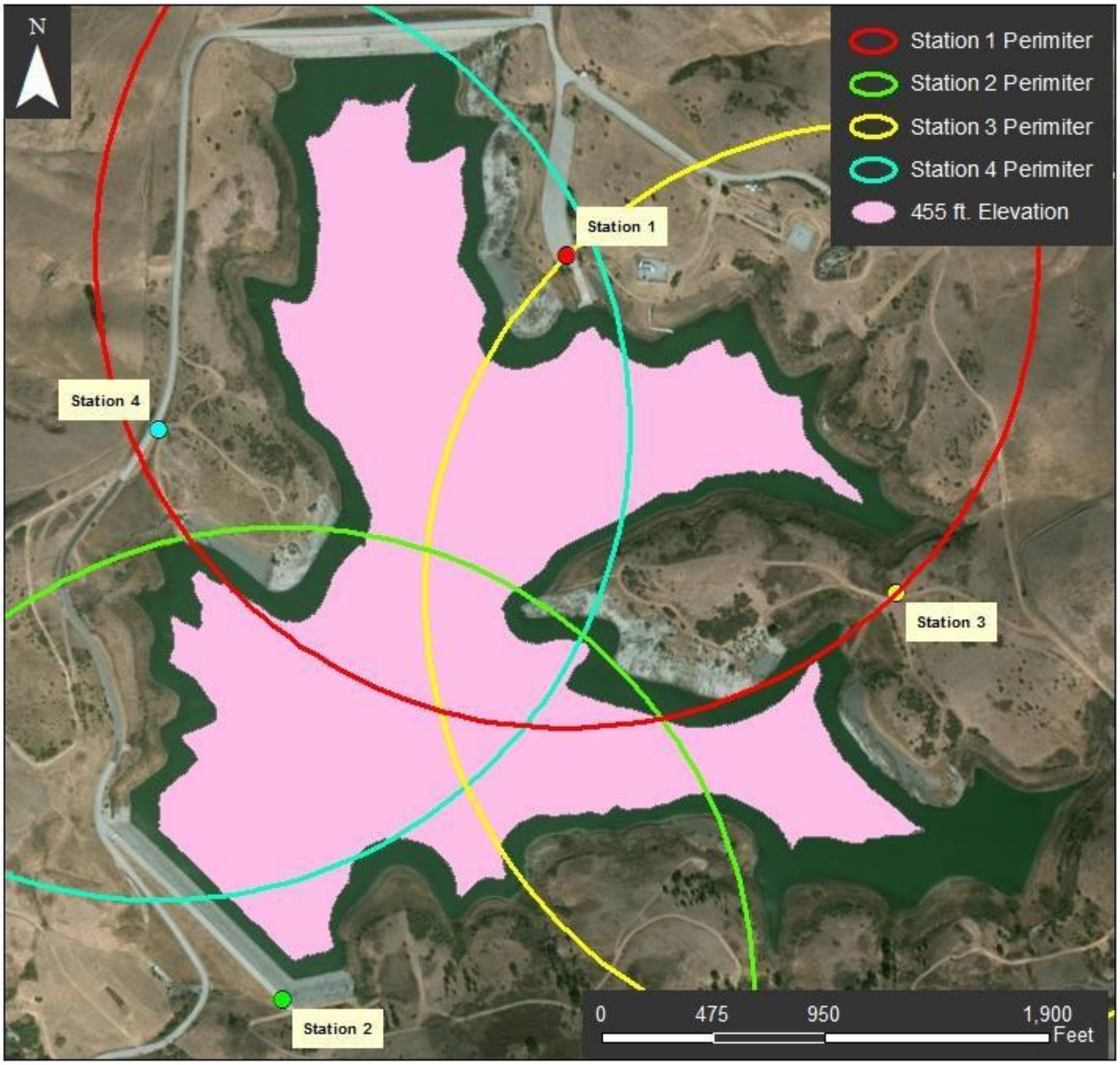

Figure 3.1. Potential location of potassium solution delivery stations and approximate range of workboats equipped with 2,000-foot supply hoses.

4.3 Potassium Mixing and Distribution

The ability to attain and maintain uniformly distributed concentrations of potassium throughout San Justo Reservoir is unknown. Previous eradication efforts using potassium solution have seen variable results: At Millbrook Quarry, complete mixing was verified within 24 hours of the treatment completion using only surface applications and distribution hoses less than 10 feet in length (ASI 1996).

Winter treatments were conducted at Christmas Lake by pumping potassium solution under surface ice. Monitoring results indicated vertical and horizontal stratifications of potassium concentrations, with "hot spots" accumulating at the deepest depths, attributed to the higher density of the potassium solution and low water temperatures. Efforts to mechanically mix the product under the ice were unsuccessful, and ultimately control of mussels was poor (Lund et al. 2017).

The timing of the potassium treatment at San Justo will coincide with cold but above freezing water temperatures, typically as low as 54º F (see Appendix C). Use of distribution hoses from workboats applying the potassium solution throughout the reservoir at various depths may not fully alleviate concentration of potassium at deeper parts of the reservoir, as was seen at Christmas Lake. Further investigation into mitigation measures to adequately mix potassium solution into colder temperature waters may be warranted.

Conducting the potassium treatment earlier in the season would present warmer water temperatures, and additionally the summer/fall temperature inversion could aid in mixing the potassium throughout the reservoir. However, the treatment timeframe is dictated by the San Benito County Water District operations and earlier-season treatments have been deemed impractical. Sufficient mixing of potassium at low water temperatures is therefore critical for the successful eradication of zebra mussels from San Justo Reservoir.

4.4 Holding Period and General Schedule

Reservoir applications are expected to begin in early October after the peak water-use season and completion of the drawdown. Total time required to apply potassium solution and bring San Justo Reservoir to the within acceptable concentrations is estimated at 13 working days or approximately 17 calendar days. General eradication preparation and reservoir treatment scheduling windows are presented in table 3.1.

It is recommended to conduct any preparatory staging and site setup work that will not interfere with ongoing operations in a timeframe that will allow the treatment to begin as soon as the drawdown target is reached. Modifications in number of storage/pumping stations and pump capacity may be explored to meet final budget and schedule requirements.

4.4.1 Contingency Timing and Duration

Resumption of normal operations should not be initiated until after all available data confirm no viable mussels exist within the reservoir or distribution system. This may require an extended time for potassium solution application and/or holding period beyond what is estimate in this plan. Potential interruptions to operations should be understood by all stakeholders and all contingency parameters determined.

Table 4.1 – Proposed schedule for San Justo Reservoir mussel eradication.

Milestone	Begin	End
Pre-Treatment Stage		
Reservoir drawdown	Fall/Winter Year -2	October Year 0
Mobilization and staging	~Year -1	Year 0
Treatment Stage (Year 0)		
Shoreline monitoring and treatments	Summer	Fall/Winter
Reservoir treatment	1-Oct to 15-Oct	19-Oct to 2-Nov
Reservoir holding period	20-Oct to 3-Nov	4-Dec to 18-Dec

5 Conduit and Distribution System Treatment

Once San Justo Reservoir is confirmed to be consistently within the target concentration range for potassium (95-115 ppm) throughout monitoring sites, the inlet/outlet valve will be opened to allow the conduit and distribution system to be flushed with treated water from the reservoir. Untreated water within the distribution system will need to be bled from multiple turnout locations to move full-concentration treated water to all wetted surfaces, and will be conducted so as not to cause any adverse impacts to water users or the environment.

The total volume of the distribution system is estimated at 80 to 90 acre-feet, or approximately 3% of the volume of treated water in the reservoir at 455 feet elevation. The San Benito County Water District estimates that charging the distribution system from 455 feet reservoir elevation would fully wet all but two of the subsystems. The remaining 2 subsystems will require injections of potassium solution at several locations. Two chemical feed stations are anticipated with roughly 500-gallon storage tanks necessary at each station. Chemical feed systems will consist of storage tanks and feed pumps with temporary spill containment.

Smaller systems such as residential “blue meters” and piping are extensive, numbering in the thousands, and may be very difficult if not impossible to fully charge with treated water for the duration of the treatment. These systems should be verified to be kept at positive pressure and/or equipped with backflow preventers to safeguard against re-infestation. It should be noted that these are preventative measures, and the systems may continue to harbor live mussels for many years, potentially indefinitely after the conclusion of the eradication treatment. This presents an unknown level risk to re-infest the distribution system and consequently San Justo Reservoir with invasive mussels, as mussels are motile to some extent as well as the possibility of system outages or malfunctions that would move or allow live mussels into the distribution system. Mitigation of this risk would require inspection, treatment and/or removal of all mussels from thousands of small-diameter (~2 inch) piping systems, and is assumed to be impractical or unattainable to conduct at this time. This risk is therefore inherent to the eradication effort and should be weighed accordingly.

6 Monitoring

Monitoring for water quality and mussel mortality/survival will be conducted at various sites and depths throughout the reservoir and distribution system on a weekly basis, before, during, and after the treatment. Monitoring protocols are presented in Appendix E.

6.1 Short-Term Monitoring

Short-term monitoring will be conducted to evaluate the eradication effort at San Justo Reservoir and provide input for any necessary strategic modifications. These protocols will be conducted prior-to, during, and immediately after the eradication treatments are conducted. The duration of short-term monitoring is somewhat flexible dependent on field conditions and other project schedules, but should generally begin within one year prior to treatment, then transition to long-term protocols after the conclusion of the eradication.

6.1.1 Water Quality Monitoring

Water quality monitoring will be conducted before (baseline), during and after treatments to confirm adequate potassium concentrations and record potential changes in other water quality parameters that may affect the dose-exposure necessary for eradication or any potential undesirable effects.

6.1.1.1 Reservoir Water Quality Monitoring

Water samples will be collected from various locations and depths within the reservoir at minimum on a weekly basis. More intensive sampling may be necessary dependent on deviations from expected levels through the treatment process.

Potassium concentrations will need to be monitored closely from multiple locations and depths to determine concentration levels and consistency of distribution. Samples will be collected at least once prior to treatment, then weekly during the application of potassium solution to the reservoir and the holding period. Concentrations of no less than 95 ppm and no greater than 115 ppm potassium throughout the water column are required for the eradication treatment. Monitoring results should provide rapid feedback to guide any necessary corrective modifications to the application process.

Other water quality parameters including temperature, dissolved oxygen, conductivity, pH, and turbidity will be regularly monitored with field instrumentation in coordination with sample collection for potassium concentration analysis. See Appendix E for the complete water quality monitoring protocol.

6.1.1.2 Distribution System Water Quality Monitoring

Various taps and hose bibs will be used to collect water samples throughout the distribution system. Monitoring parameters and protocols will mimic that of the reservoir. Potassium concentrations will be important to closely monitor at as many points as possible to verify full charging of the system with sufficient concentrations of treated water. Any deviations from expected levels noted within the system should initiate corrective application of potassium solution to the nearest upstream (towards San Justo) injection point, to be bled off through all potassium-deficient terminal ends of the system until acceptable concentrations are reached.

6.1.2 Mussel Monitoring

Mussels will be monitored as a verification of an adequate dose-exposure for complete mussel mortality. This includes shoreline surveys, artificial settlement substrates within the reservoir, plankton tows, and live mussels assays.

6.1.2.1 Shoreline Mussel Monitoring

Shoreline monitoring protocols are adapted from those used by Chapman and Gruenhagen (2010); general parameters and methods are summarized in Appendix F. Monitoring should be conducted regularly throughout the drawdown and eradication treatment. A combination of ground and boat surveys will likely be necessary to sufficiently access the entirety of the shoreline. Steep slopes or areas where the substrate is unstable or otherwise prohibitive to foot traffic should utilize boat surveys; ground surveys should be conducted as much as possible as this method will allow closer inspection of mussels and habitat.

Charging the distribution system with San Justo water at the end of the potassium dosing will lower the reservoir elevation from 455.0 feet to 454.2 feet, exposing approximately 1.8 acres of shoreline (estimates may vary at treatment elevations other than 455 feet). This thin band of exposed area may contain significant numbers of newly exposed mussels that, although exposed briefly to treated reservoir water, will have a shortened time period for desiccation. If reservoir potassium concentrations are confirmed to be at the appropriate levels and evenly distributed, any mussel refugia in these areas would be expected to contain lethal levels of potassium. However, this area should be targeted for additional treatment (see Section 3.2.1) during the holding period and treated appropriately if and where viable mussels are found.

6.1.2.2 Reservoir Mussel Monitoring

Mussels of all life stages will be monitored regularly at various locations and over the course of the eradication treatment. Specific methods for monitoring mortality include live mussel bioassays, plankton tows, visual inspection, and artificial settlement substrates.

Mussel bioassays are live adult mussels placed in mesh bags and exposed to treated water. Live mussels will need to be collected from San Justo prior to potassium dosing. Sufficient quantities of live mussels may be acquired more easily if collected during the drawdown process as mussels settled at deeper depths become accessible from shallows over time. Live mussels can be kept in aerated reservoir water for several months if water is changed regularly. Using chilled water in insulated aquaria will slow mussel metabolism and may extend viable retention times and may reduce necessary frequency of water changes.

For reservoir assays, mesh bags with live adult mussels will be strung from buoys at several locations and depths throughout the reservoir. Mussels should be examined and noted weekly for signs of intoxication or mortality. All mussels suspected dead will be placed in untreated reservoir water under aeration and observed after 72 hours to observe potential recovery. A triplicate set of live mussels will also be kept in a recovery jar without exposure to treated water as a control to verify recovery conditions are suitable. Monitoring will require qualified technicians and may involve substantial labor.

Plankton tows are high-volume filtered water samples that concentrate particulates and can be used to detect the presence of larval mussels. Tows are collected vertically from the just off the bottom substrate to the surface, taken in sets to acquire a standard total volume. Filtered samples are transferred to sample bottles, preserved and sent for laboratory analysis. See Appendix E for detailed planktonic mussel monitoring protocols.

Artificial substrates deployed from docks or buoys can be used to capture mussel settlement within the reservoir. Substrates are to be deployed within one week of the initiation of the application and monitored every two weeks. Mussel settlement observations will transition into the long-term monitoring phase, at which point they will emphasize efforts during the typical June through October peak settlement window at San Justo. The protocol for artificial substrate monitoring is discussed in detail in Appendix E.

At the completion of the eradication treatment, provided all other monitoring results indicate complete mortality of mussels, visual surveys conducted by divers or Remotely Operated Vehicle (ROV) video will be used to further validate the eradication effort.

6.1.2.3 Distribution System Monitoring

The Hollister Conduit will be monitored using bioboxes, which are essentially flow-through aquaria plumbed directly into the system. Inflow and outflow valves are installed to regulate flow at 2 gallons per minute, which allows enough retention time for mussels to settle.

Both mussel settlement monitoring and live mussel assays will be conducted in the bioboxes. Settlement is monitored by placing substrate plates (plastic or PVC) within the biobox; data collection protocol is identical to the buoy-deployed settlement monitoring plates. Live mussel assays for the distribution system comprises adult mussels in mesh bags placed in bioboxes. Protocols for mortality assessment including recovery and data collection are identical to the assays conducted in the reservoir.

Biobox outflow should be considered to be contaminated with viable mussels and must be discharged so as not to spread to water bodies, streams or other open waters. Bioboxes will be located within turnout/valve vaults; outflow will be delivered to designated waste areas by the sump system. Waste areas should be verified acceptable for discharge of both potassium-treated and mussel-infested water.

The total volume of water discharged per biobox on the distribution system over the course of the 45-day treatment period is estimated at 129,600 gallons (0.4 acre-feet). A minimum of 2 bioboxes located at the extreme ends of the distribution system (turnounts 1 and 10) are recommended. Additional bioboxes monitoring should be used if safe disposal of water can be accommodated.

Potassium concentrations should be verified from samples collected at all available taps from the Hollister Conduit, laterals, and all minor subsystems to ensure biobox conditions are relatable to the entirety of the distribution system.

A final visual inspection of the conduit will be conducted at manholes and by remotely operated cameras for presence of live mussels. See Appendix E for the complete distribution system mussel monitoring protocols.

6.2 Long-Term Monitoring

Final determination of eradication success or failure will require at least 2 full consecutive seasons of monitoring for presence of live mussels. A preliminary determination will be made at the conclusion of the visual mussel inspections, and if favorable will initiate monitoring strategies to shift from short-term to long-term protocols. Long-term monitoring will largely mimic short-term protocols but with efforts focused during the peak mussel settlement period at San Justo, June to October.

6.2.1 Genetic Analysis

It is suggested that the genetic profile of zebra mussels from San Justo Reservoir be obtained prior to treatment. Should mussels be found to re-infest the reservoir after the eradication, genetic information would be used in assessing eradication failure versus re-introduction from an external source.

7 Quarantine

All vehicles and equipment used for the eradication effort that come into contact with water from the reservoir or the distribution system, regardless of whether it has been treated with potassium solution, will undergo inspection and decontamination before moving off site. Inspection/decontamination will follow procedures presented in the Bureau of Reclamation Inspection and Cleaning Manual for Equipment and Vehicles to Prevent the Spread of Invasive Species and the California Department of Fish and Wildlife Aquatic Invasive Species Decontamination Protocol, available at:

https://www.usbr.gov/mussels/prevention/docs/EquipmentInspectionandCleaningManual2012.pdf.

https://nrm.dfg.ca.gov/FileHandler.ashx?DocumentID=43333&inline

Use of a high-pressure hot-water decontamination equipment will be necessary. A trailer-mounted mobile unit for on-site use is preferred; alternatively, all equipment and vehicles may be transported directly to the nearest decontamination station.

Care should be taken to either avoid contact with water or decontamination of all sampling equipment, boats, waders, or any other equipment for the duration of the eradication effort until data confirm the complete absence of invasive mussels. This will likely include an extended timeframe after the eradication effort is complete, the duration of which will be determined by the outcome of the monitoring effort and a consensus from all stakeholders. It is anticipated to be 2 years at a minimum, but likely longer.

Reclamation and San Benito have also committed to prepare a zebra mussel re-infestation prevention program, consistent with Bay Area Consortium's Zebra and Quagga Mussel Coordinated Prevention Plan.

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Appendix A Dose Exposure Responses of Zebra Mussels to Potassium (potash), Ex-Situ Study Conducted at San Justo Reservoir

A-1. Methods

Study design was a two-factor experiment, with water temperature and potassium dose as main factors. There were two levels for water temperature (54 °F and 72 °F) and five levels for potassium dose (0, 25, 50, 100, and 200 ppm). The 54 °F and 72 °F temperature treatments were created via a water bath using flow-through chillers, aquarium heaters, and plastic wading pools. We used 0 ppm potassium as a negative control and 200 ppm potassium as a positive control, expecting little to no mortality over the experiment at the 0-ppm dose and relatively fast and 100% mortality at the 200 ppm dose. There were five replicates for each treatment combination (total of 50 experimental units).

Each replicate was a one-quart glass jar containing ten adult zebra mussels and aerated with aquarium bubblers. Mussels were collected from the infested reservoir, examined and confirmed live, then sorted into one of 3 size classes: approximately <0.2 inches (small), 0.2-0.6 inches (medium), and >0.6 inches (large). Mussels were assigned at random to each replicate at the ratio of 7 large: 2 medium: to 1 small mussel, and each replicate was in turn assigned at random to a treatment combination.

For the first 3 weeks of the experiment, the number of mussels in each replicate that were dead and the number that were alive was recorded daily. The water in each replicate was replaced daily with fresh reservoir stock solutions of water dosed with the appropriate amount of muriate of potash. Each mussel in each replicate was observed to determine whether they were dead or alive. If a mussel exhibited symptoms characteristic of a dead mussel (e.g., gaping and unresponsive), it was removed from the treatment jar and placed into a separate jar supplied with untreated reservoir water (i.e., no MOP, 0 ppm potassium), allowing it to recover. A recovery jar was created for each experimental unit that yielded mussels that appeared dead on a given day. Mussel(s) that appeared dead were allowed to recover for 3 days and then were then observed again to verify their status (dead or alive). Any mussel(s) that had failed to recover (i.e., exhibit symptoms of a living mussel) after 3 days in the recovery conditions were recorded as dead (on the date it was removed from the treatment jar and placed in the recovery jar) and they were removed from the experiment. If a mussel recovered, it was deemed an inaccurate mortality assessment and removed from the experiment. Mussels exhibit levels of “intoxication” when exposed to potassium, where their shells gape and are unresponsive, but will return to normal after being placed in untreated water. Two of the experimental treatments were initially suspected to be dead but recovered after 24 hours. These treatments were re-created with new mussels from the reservoir, and the protocol modified for determination of live vs. dead mussels. None of the mussels recovered after being assessed as dead following the initial misclassification.

In addition to the number of dead and live mussels in each jar, water temperature, dissolved oxygen content, and the pH at the time of the observation were recorded. Also, the length of the shell for mussels that were determined confirmed to be dead was either measured directly, or the shell was photographed for later size measurement.

After three weeks of daily observations, the time between observations and water changes for the remaining live mussels was increased from 1 to 4 days through the duration of the study (total of 45 days). Observations were continued in order to determine potential long-term effects of treatment at lower temperatures and doses where mortality was low.

A-2. Results and Discussion

Both concentration of potassium and water temperature had considerable effects on mussel mortality. Dose-exposure curves for MOP treatments are presented in Figure A-1, and days required to reach complete mortality by treatment are presented in Table A-1. Control treatments (0 ppm) at both temperatures did not exhibit any mussel deaths, confirming mortality in treatment jars was caused by the MOP treatment and not an artifact of jar confinement, low oxygen/nutrient levels, etc. The 25 ppm treatments at both temperatures reached nominal mortality (2%) by the end of the 45-day trial.

At concentrations at and above 50 ppm the effects of water temperature were more apparent, with lower temperatures exhibiting slower mortality, likely the result of a slower metabolic rate and less-frequent feeding by the mussels, as they were observed to be generally more tightly shut in their shells at 54° F vs. 72° F. The 50-ppm treatment reached 100% mortality in 36 days at 72° F, whereas the 54° F/50 ppm treatments topped out at 42% mortality at the end of the 45 day trial. All mussels treated with 100 or 200 ppm potassium attained 100% mortality within the study period. Mussels exposed to both these concentrations in the warmer water treatments died off more quickly than the cooler water treatments.

These results suggest that eradication of zebra mussels at San Justo reservoir is feasible at 100 ppm potassium concentrations and should be able to eradicate mussels within the reservoir in just under 30 days, even in the later part of the season when temperatures are low. However, these tests were conducted in artificial environment and may not translate directly to reservoir-scale treatments. Water currents, thermal stratifications, and varying depths may prevent complete mixing of the applied MOP and cause a much longer holding period necessary to achieve the desired concentration throughout the reservoir and result in mussel eradication. Treatment with MOP when water temperatures are higher (late summer-early fall) will likely distribute throughout the reservoir more quickly and hit the mussels while they are more active metabolically, resulting in quicker eradication and potentially less risk of escapes (eradication failure).

Table A-1. Days to achieve 100% mussel mortality by potassium concentration and water temperature. Treatments with missing values did not reach 100% within the study period.

Treatment Concentration (ppm K)	Treatment Temperature (°F)	Days to 100% Mortality
0	54	-
25	54	-
50	54	-
100	54	25
200	54	17
0	72	-
25	72	-
50	72	36
100	72	8
200	72	6

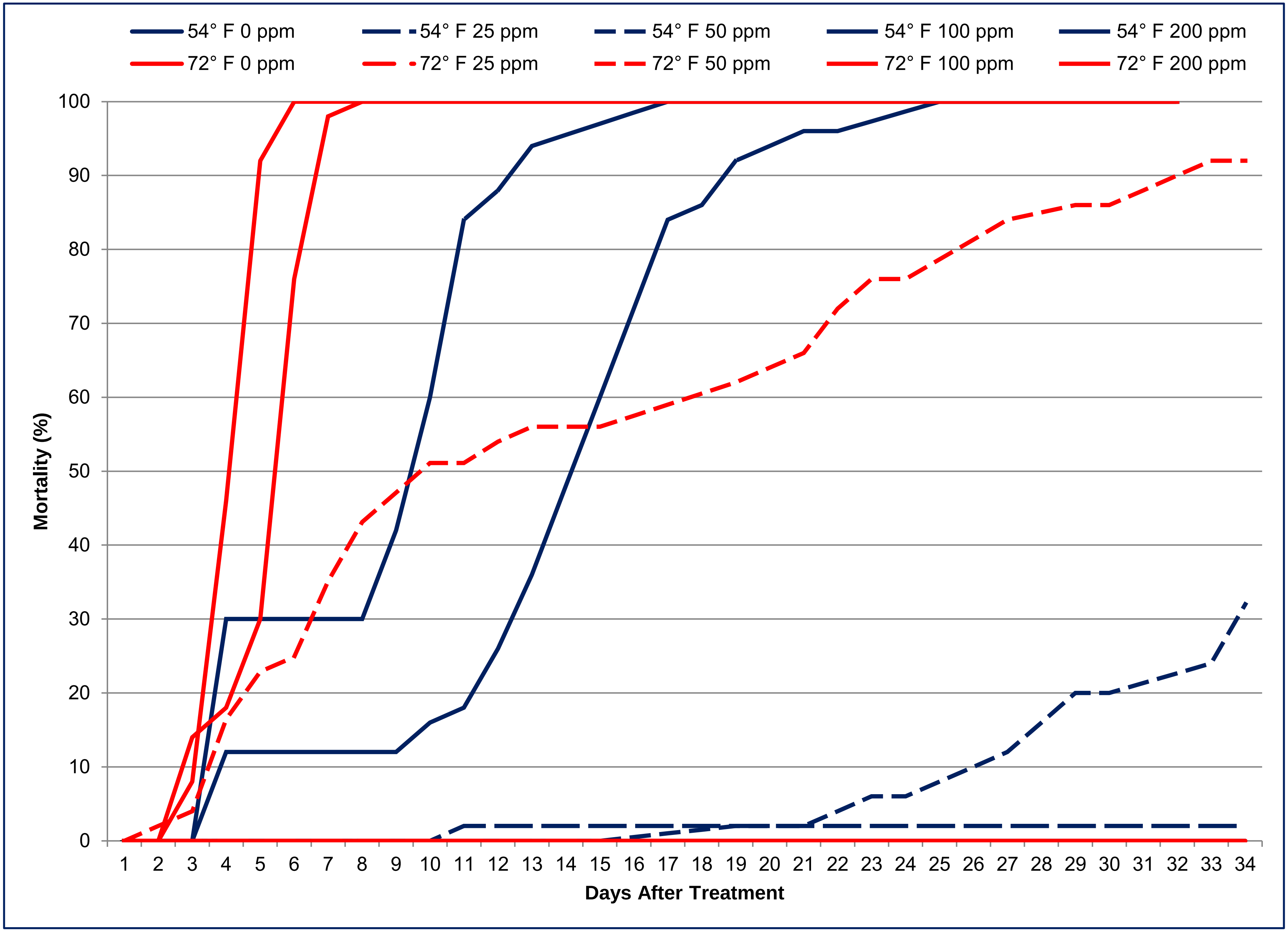
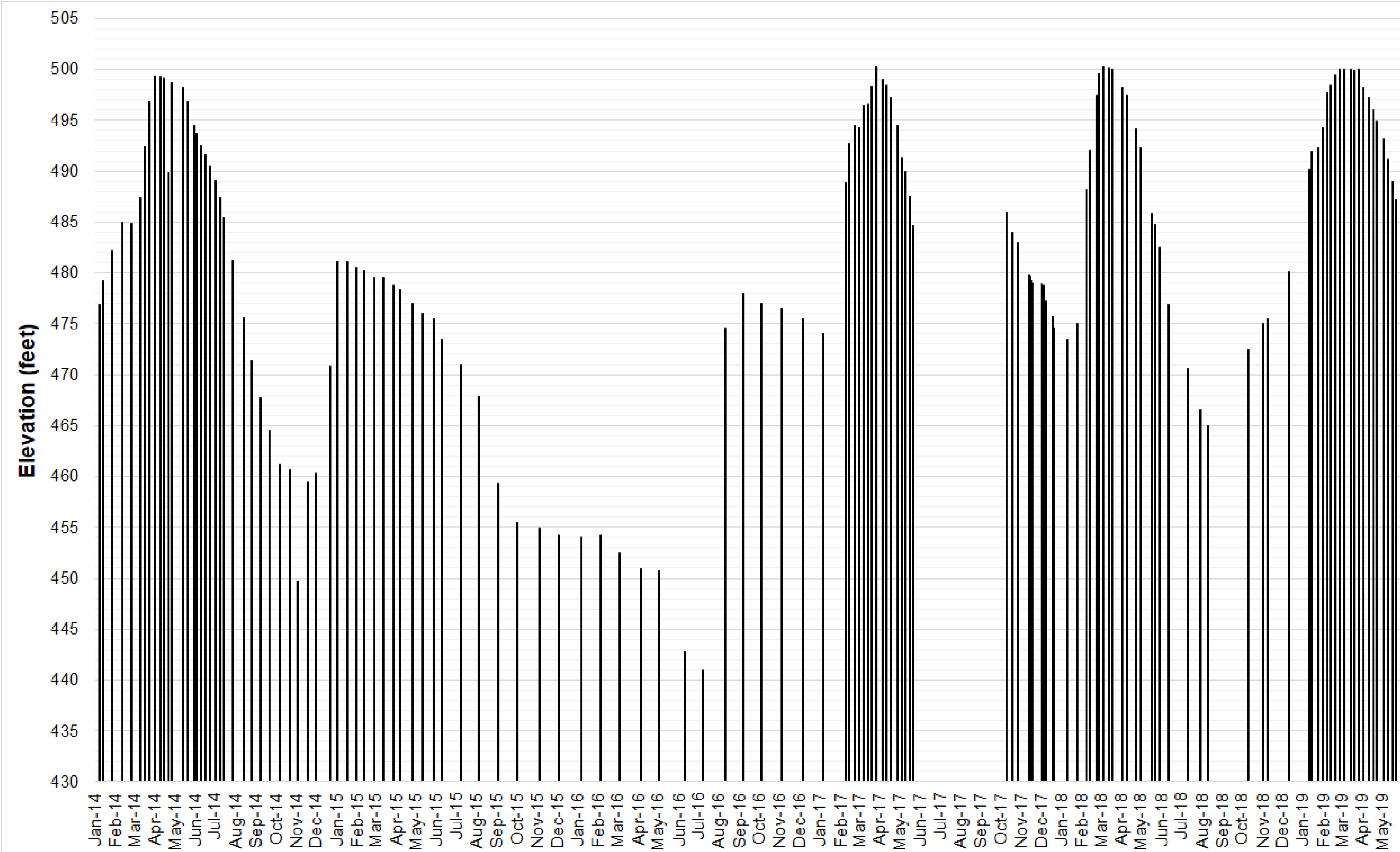


Figure A-1. Mean dose-exposure curves for mussels treated with potassium at 54° F and 72° F.

Appendix B San Justo Reservoir Elevations, January 2014 to May 2019



Appendix C San Justo Reservoir Water Quality Data

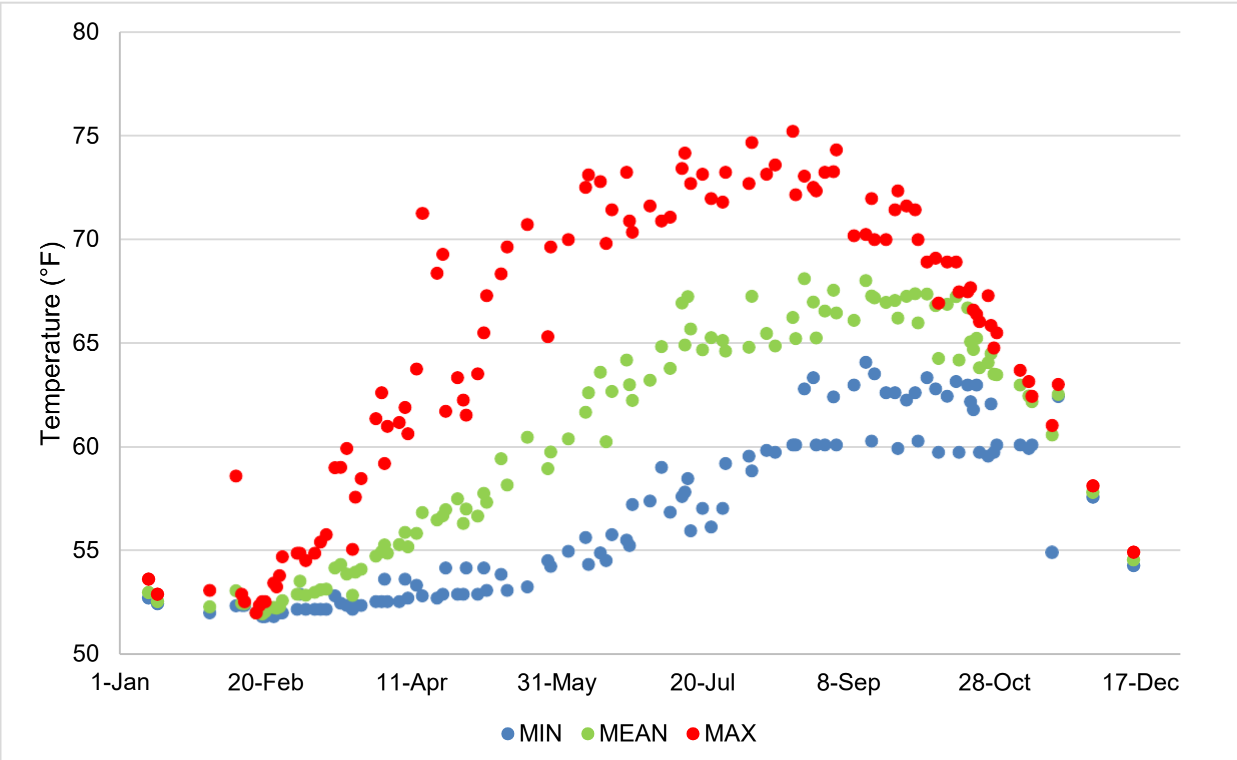
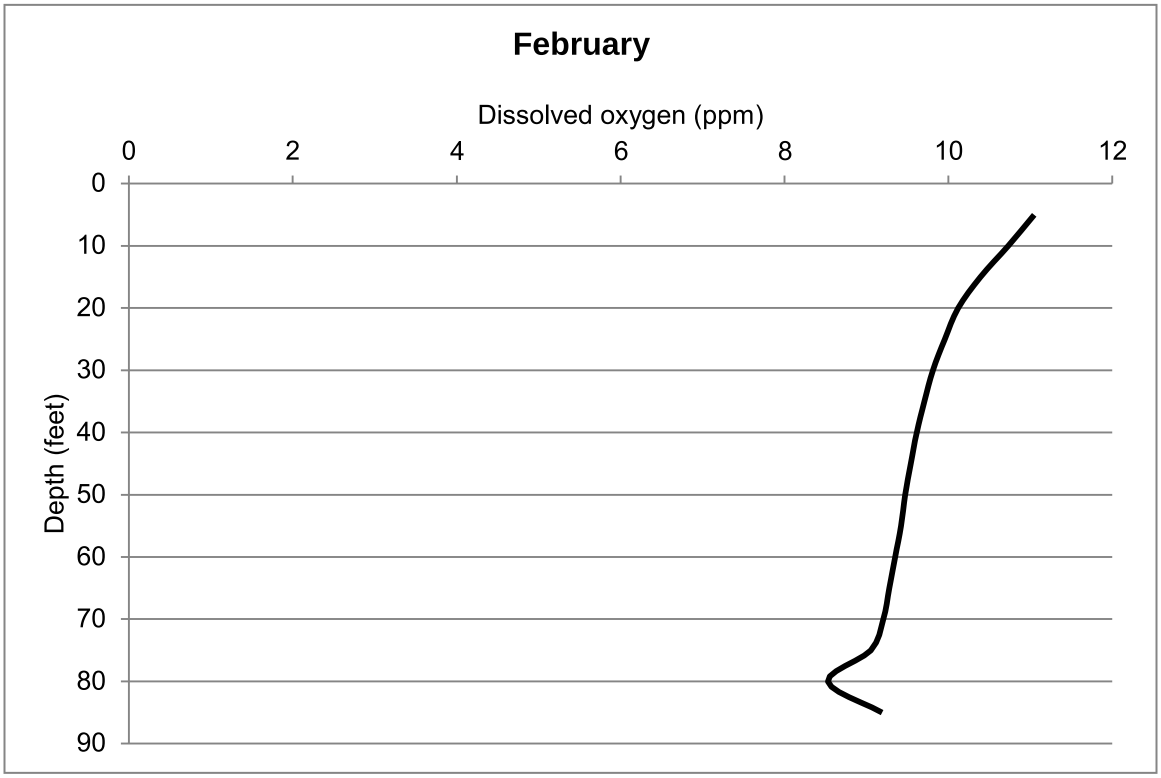


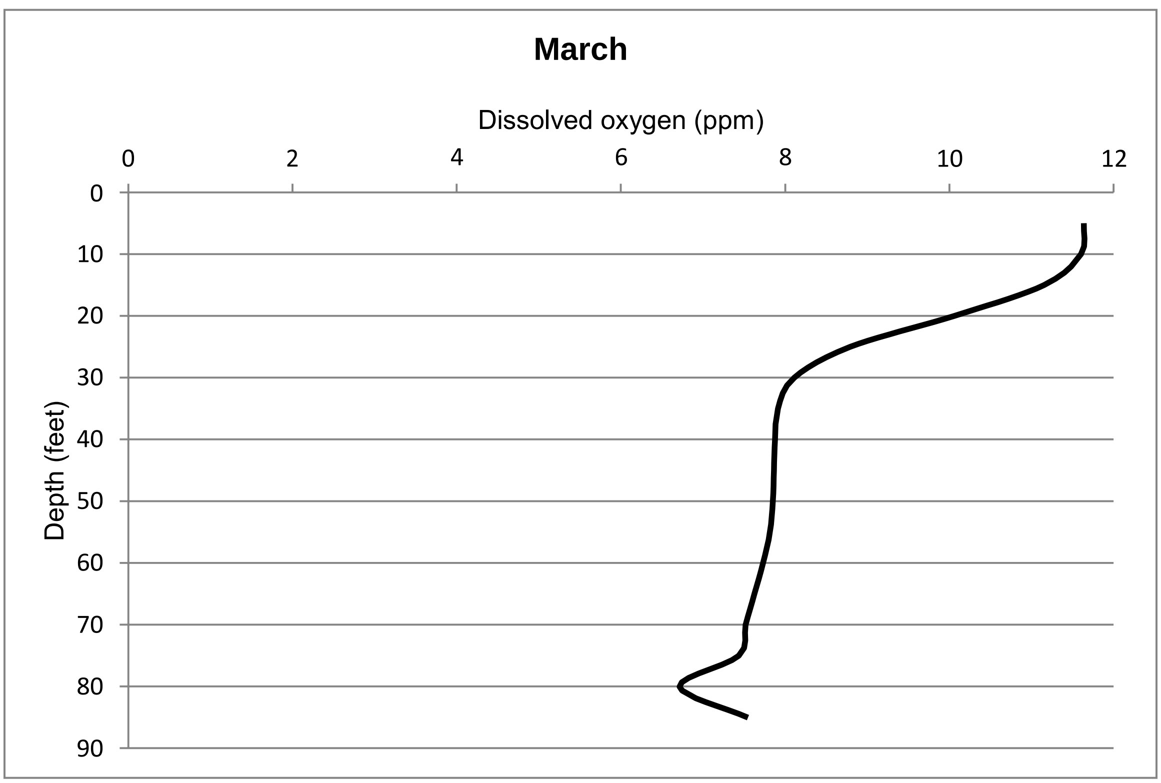
Figure C-1. San Justo Reservoir aggregate water temperature data compiled from vertical profiles and other available data, 2008-2011.

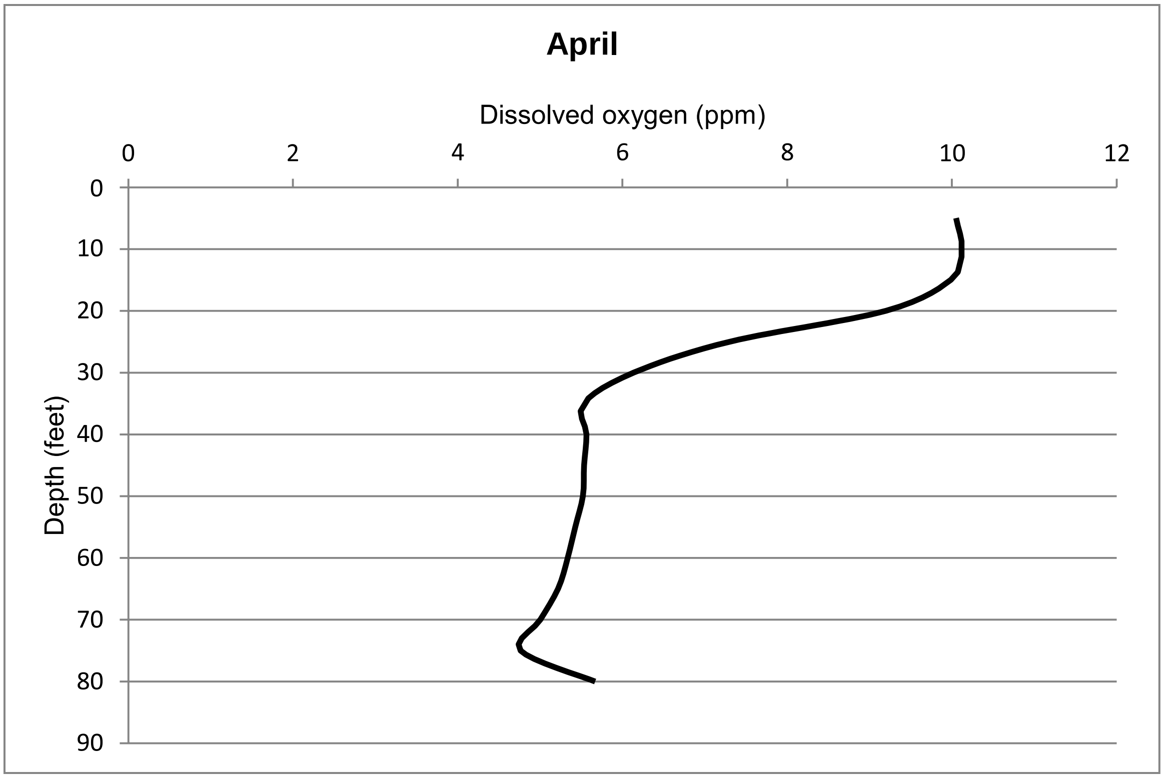
Table C-1. Existing water quality data, San Justo Reservoir

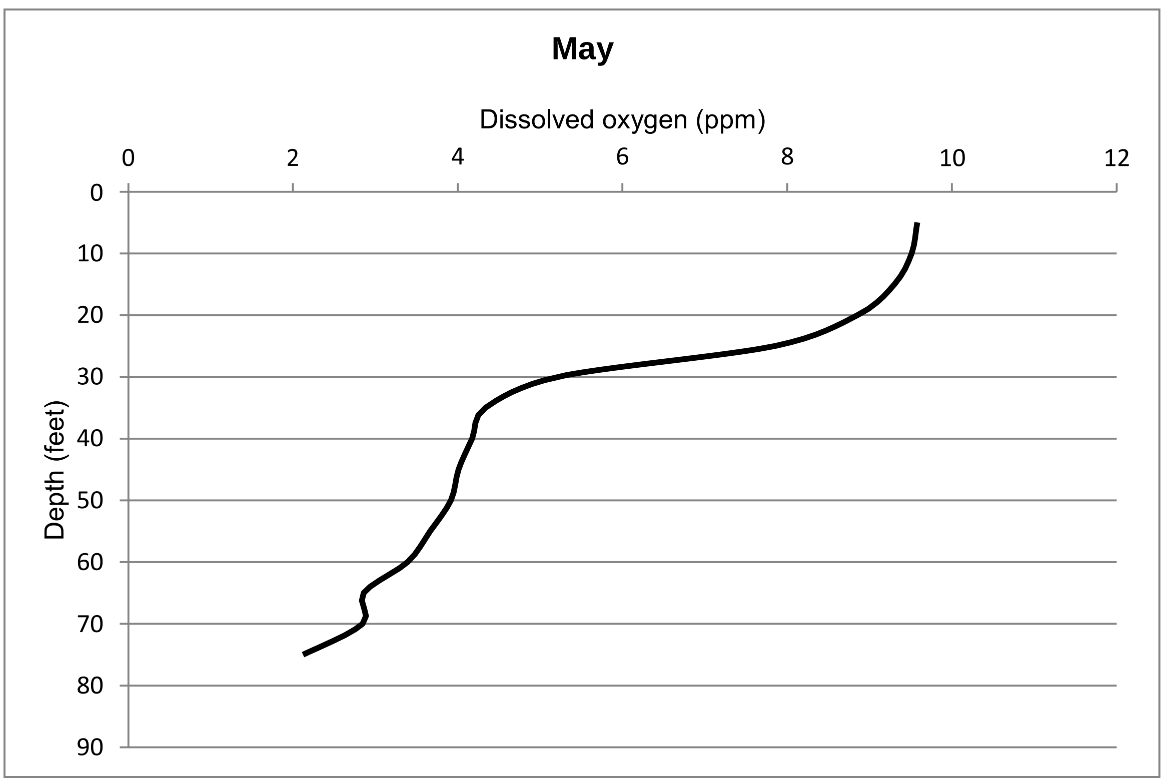
Parameter	Sample Date Range			Minimum	Average	Maximum	Units
Alkalinity	6/20/2012	-	7/27/2012	79	83	88	ppm $CaCO_3$
Calcium	5/19/2011	-	7/27/2012	9	16	21	ppm
pH	5/19/2011	-	7/27/2012	7.6	8.2	8.9	-
Turbidity	5/19/2011	-	5/19/2011	1.4	2.8	4.2	NTU

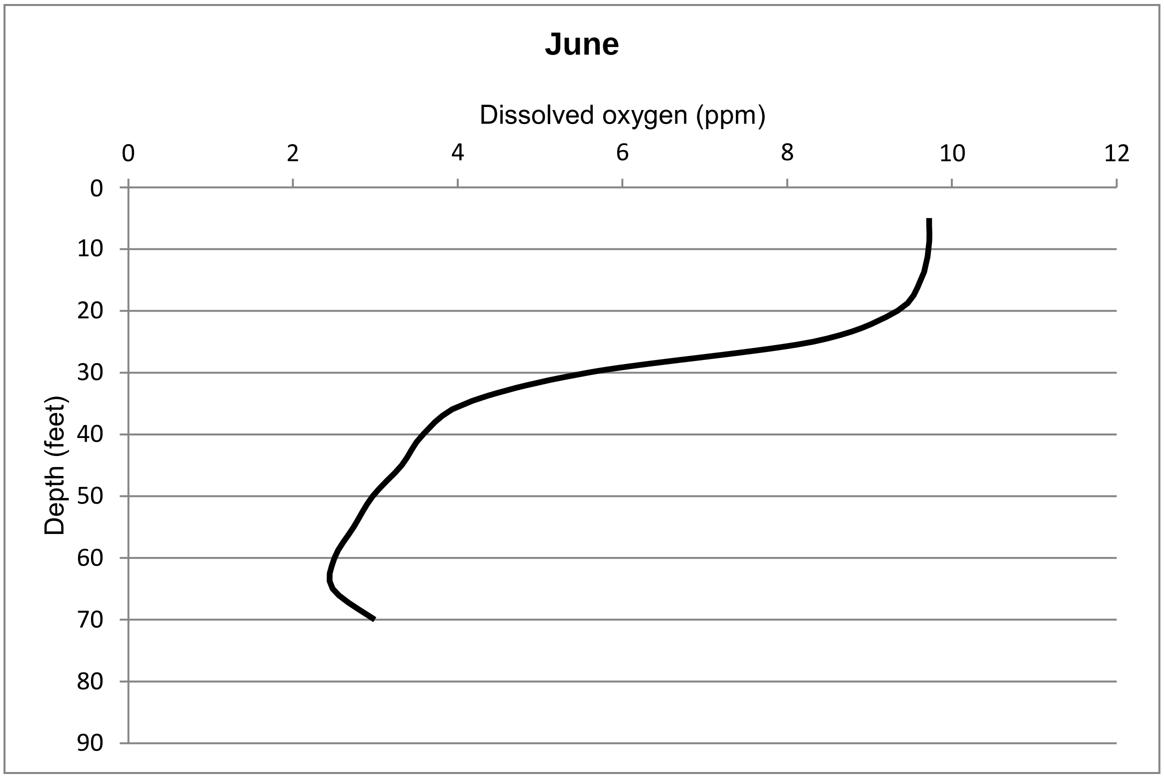
Figure C-2. Monthly dissolved oxygen profiles, San Justo Reservoir 2009-2010.

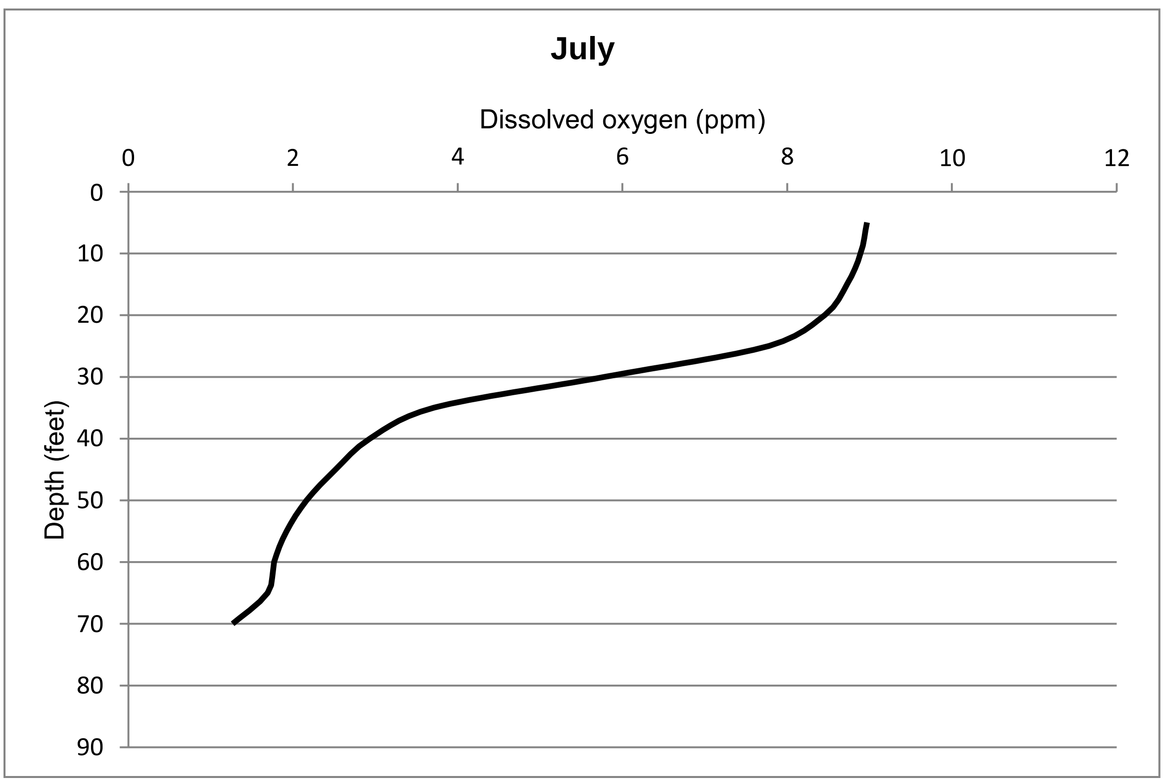


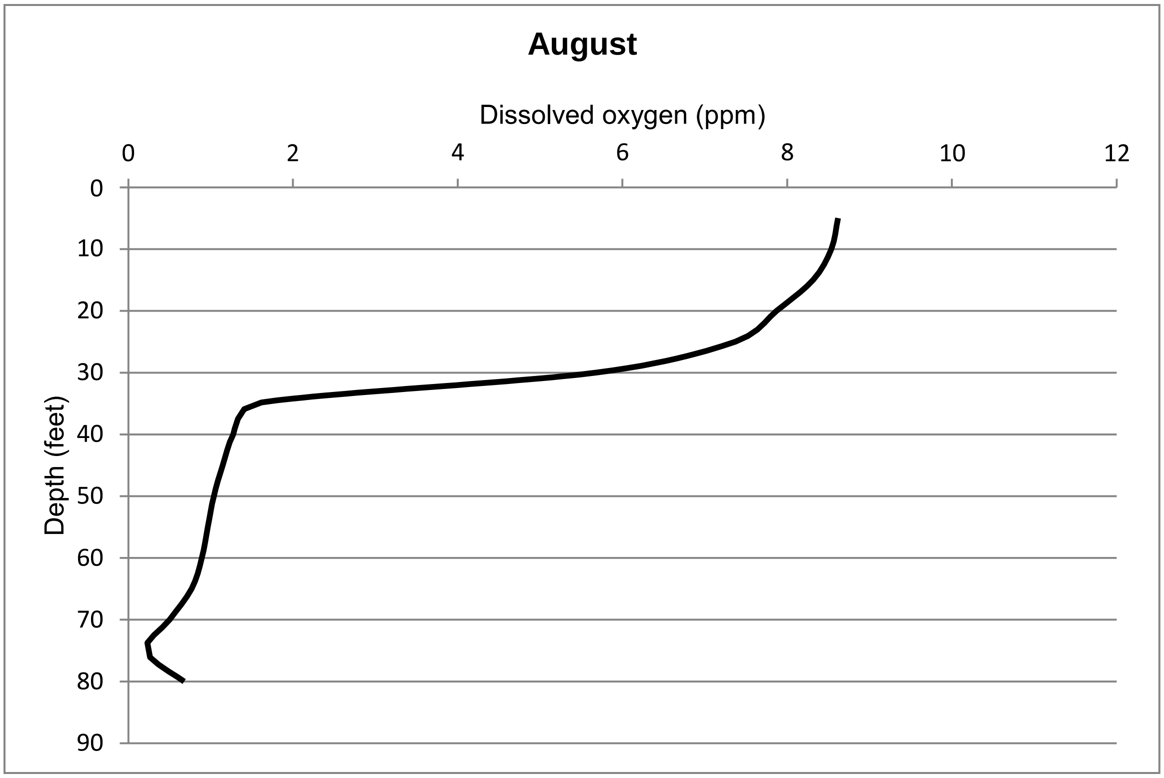


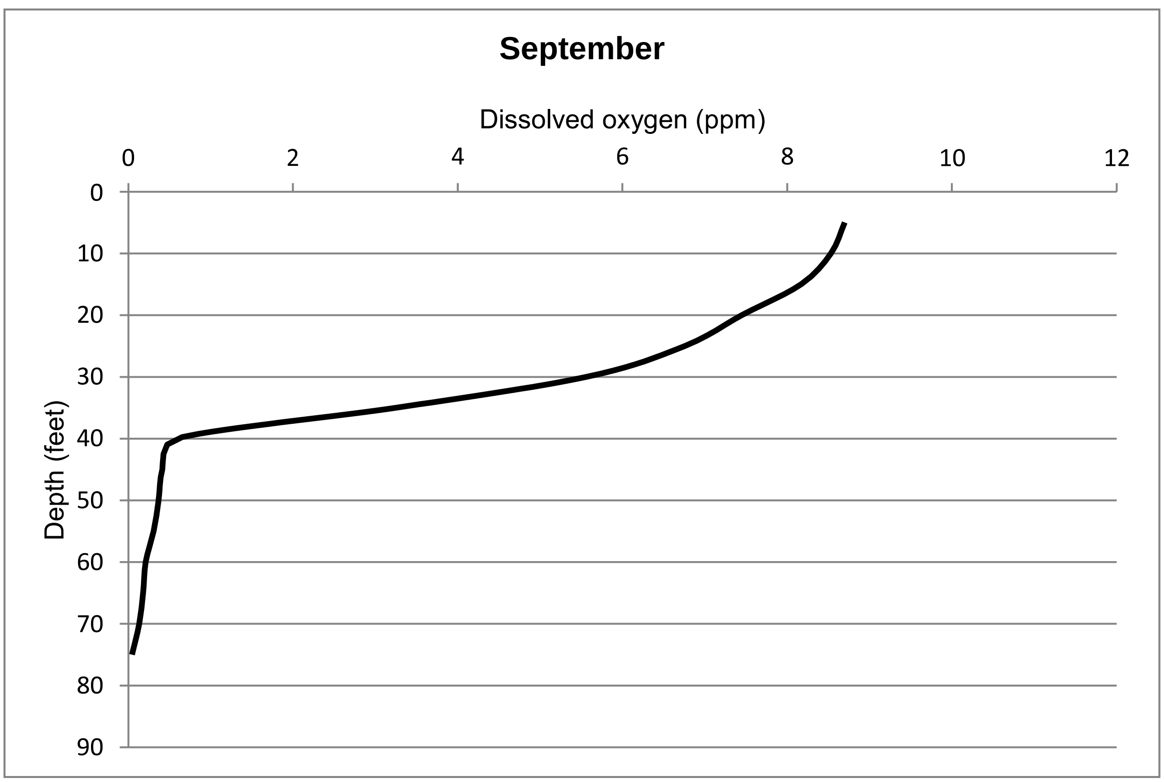

April
Dissolved oxygen (ppm)
0
2
4
6
8
10
12
Depth (feet)
0
10
20
30
40
50
60
70
80
90

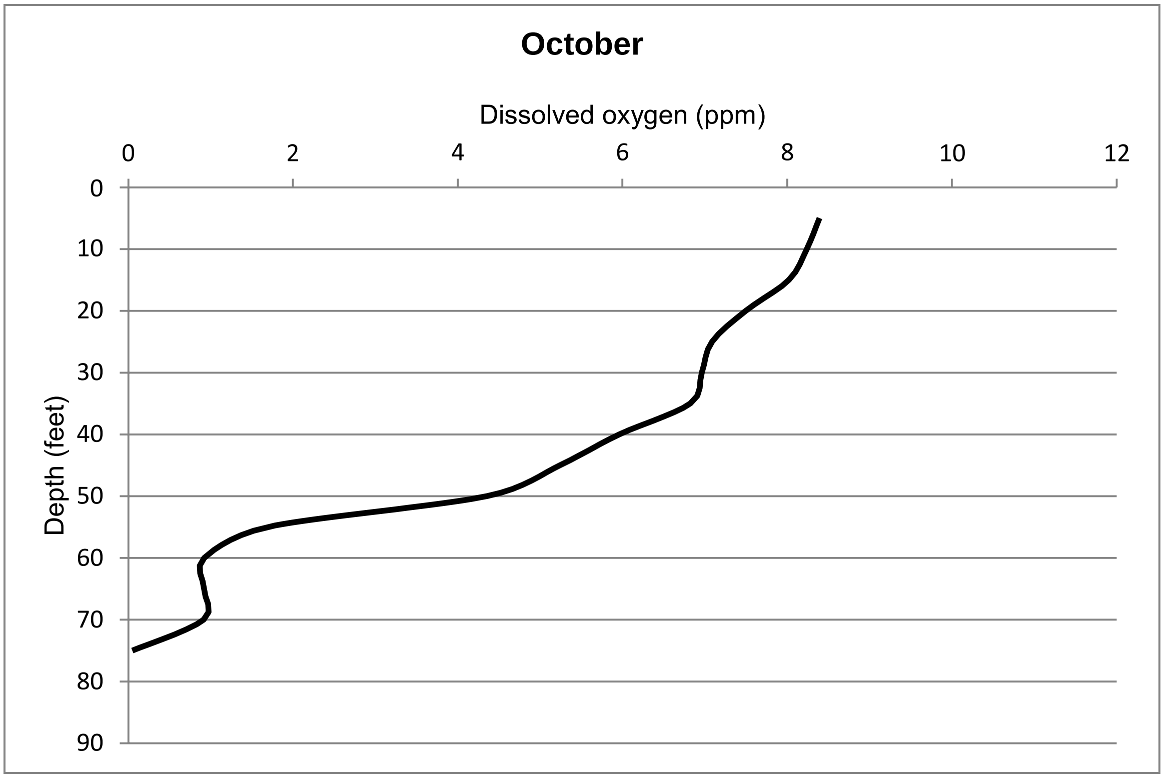

May
Dissolved oxygen (ppm)
0
2
4
6
8
10
12
Depth (feet)
0
10
20
30
40
50
60
70
80
90


June
Dissolved oxygen (ppm)
0
2
4
6
8
10
12
Depth (feet)
0
10
20
30
40
50
60
70
80
90

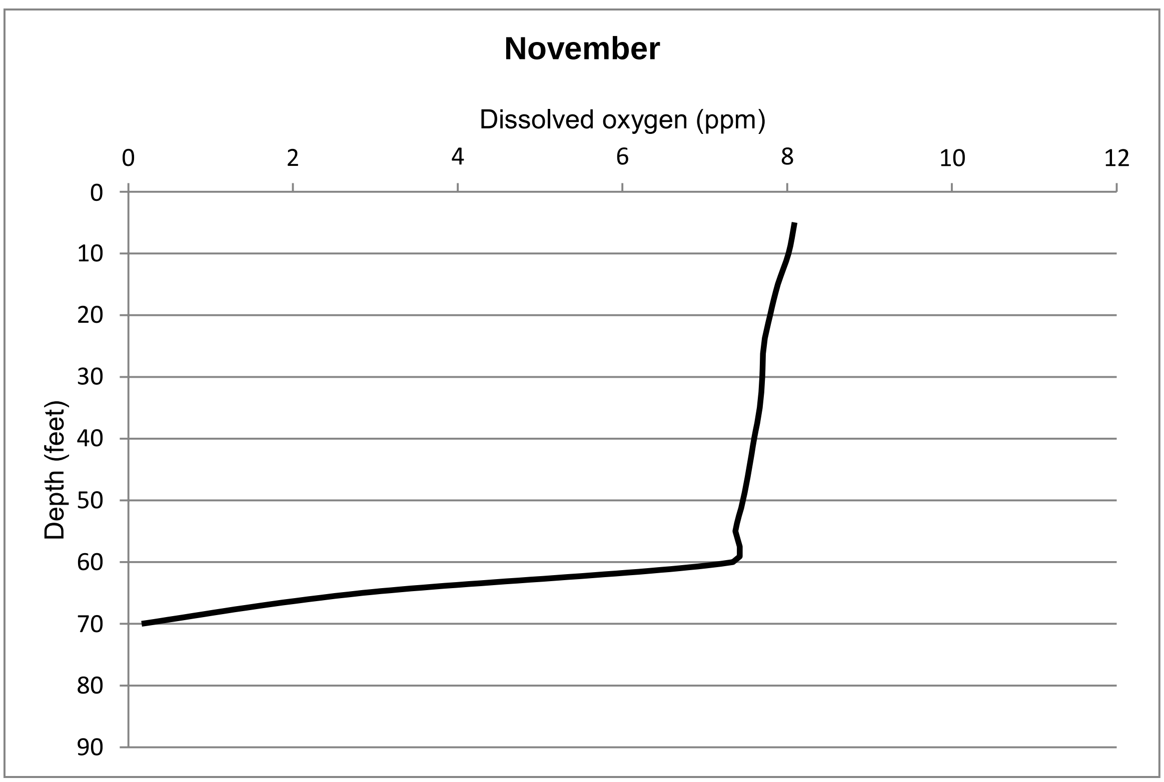

July
Dissolved oxygen (ppm)
0
2
4
6
8
10
12
Depth (feet)
0
10
20
30
40
50
60
70
80
90


August
Dissolved oxygen (ppm)
0
2
4
6
8
10
12
Depth (feet)
0
10
20
30
40
50
60
70
80
90


September
Dissolved oxygen (ppm)
0
2
4
6
8
10
12
Depth (feet)
0
10
20
30
40
50
60
70
80
90



October
Dissolved oxygen (ppm)
0
2
4
6
8
10
12
0
10
20
30
40
50
60
70
80
90
Depth (feet)



November
Dissolved oxygen (ppm)
0
2
4
6
8
10
12
0
10
20
30
40
50
60
70
80
90
Depth (feet)

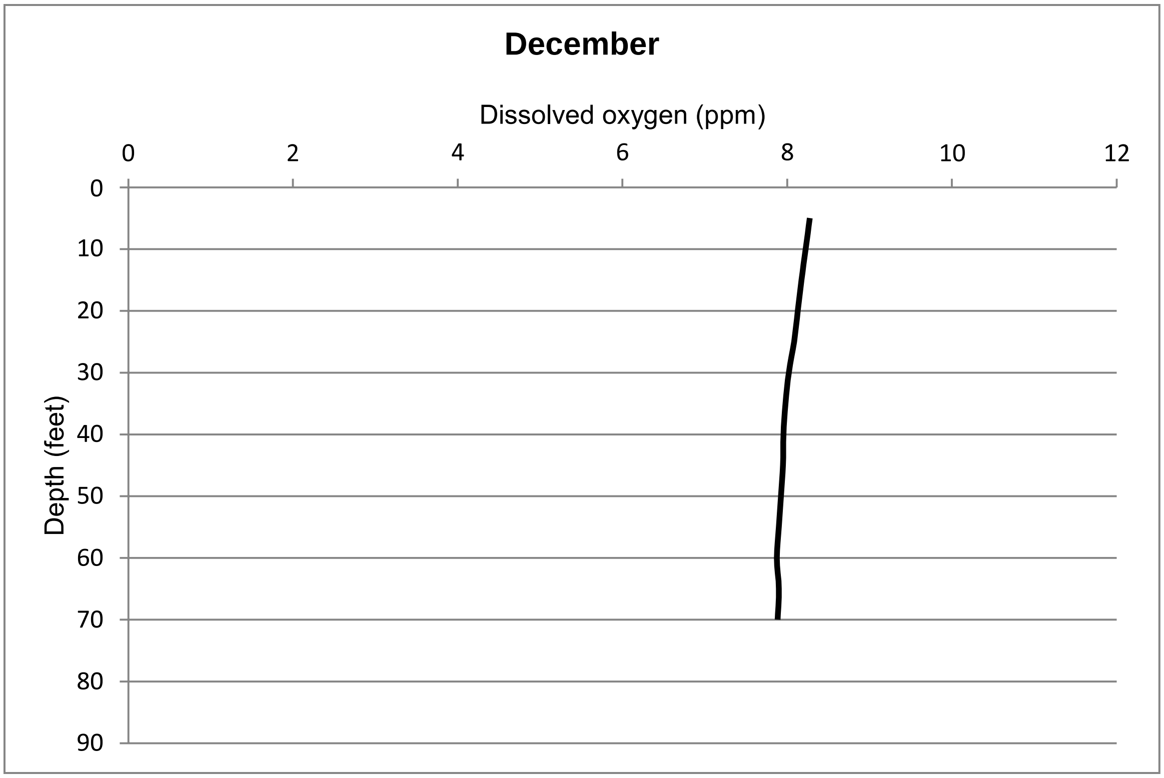
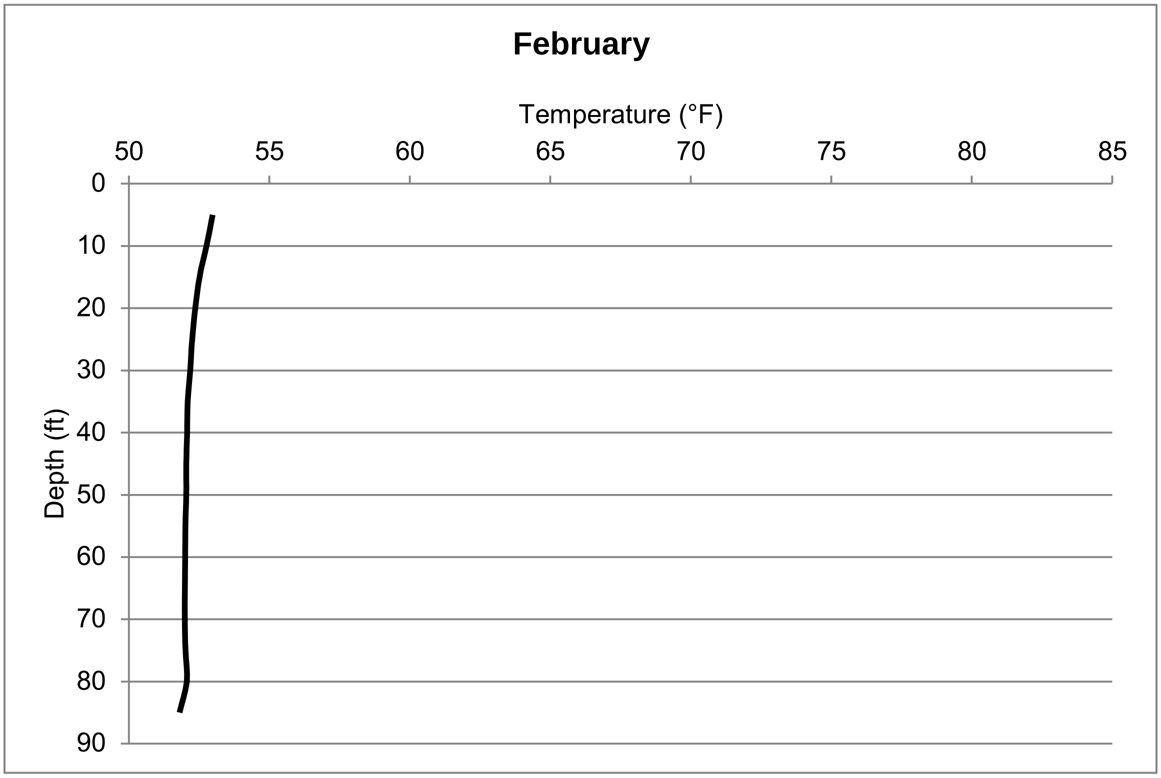
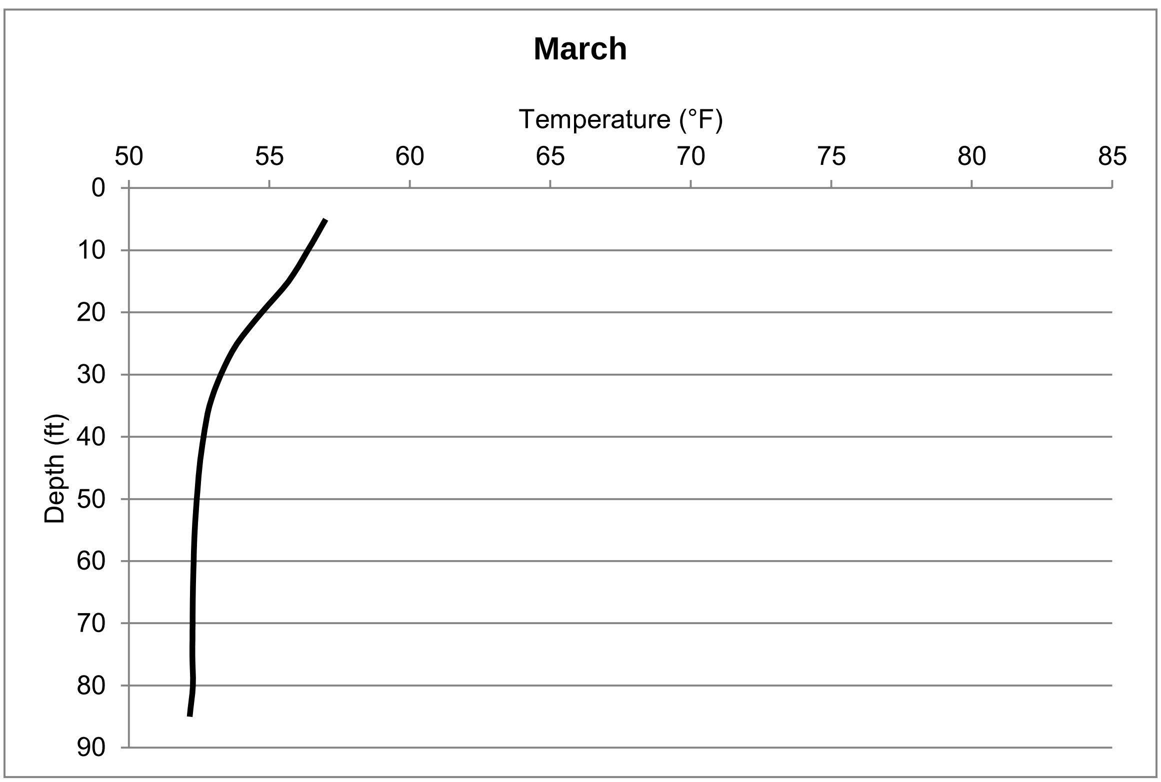
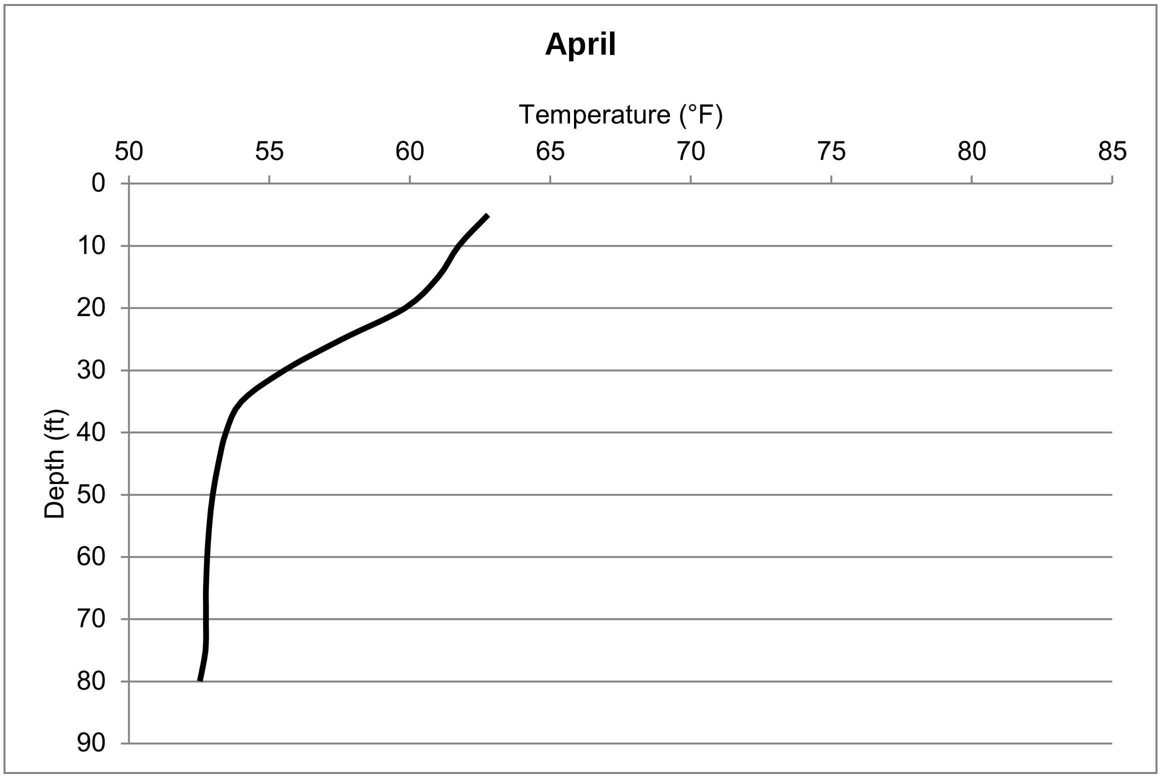
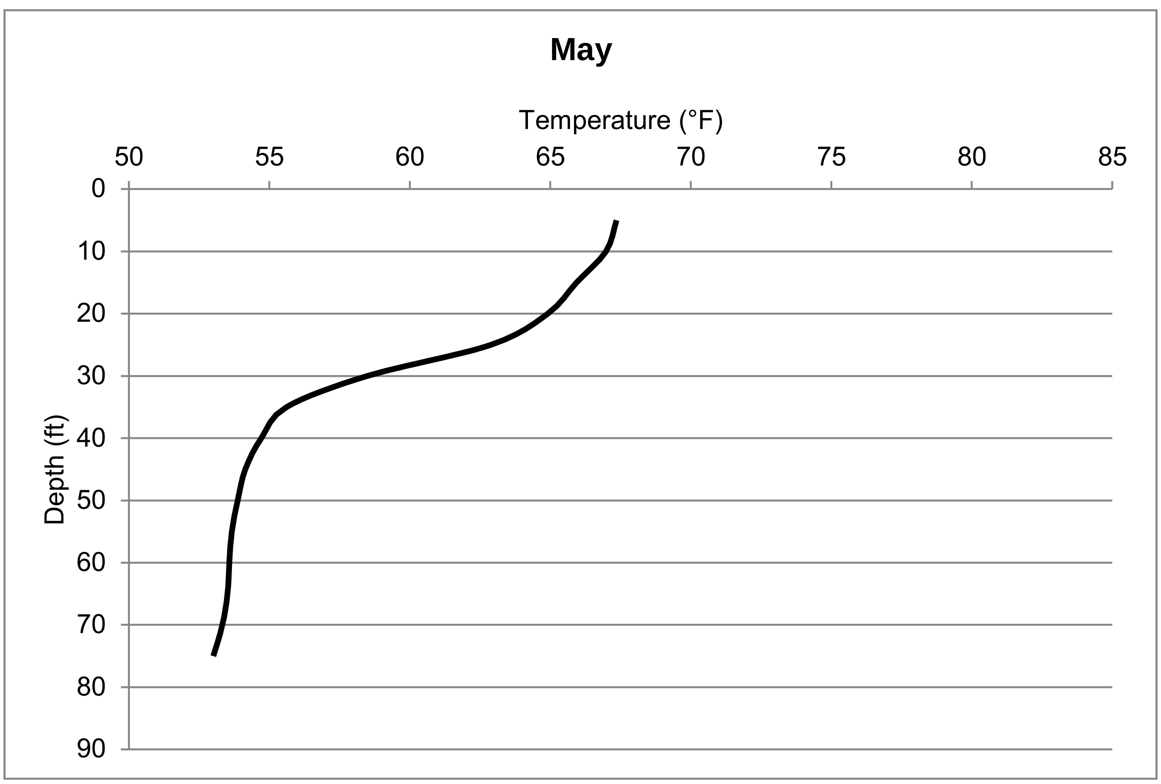

December
Dissolved oxygen (ppm)
0
2
4
6
8
10
12
Depth (feet)
0
10
20
30
40
50
60
70
80
90

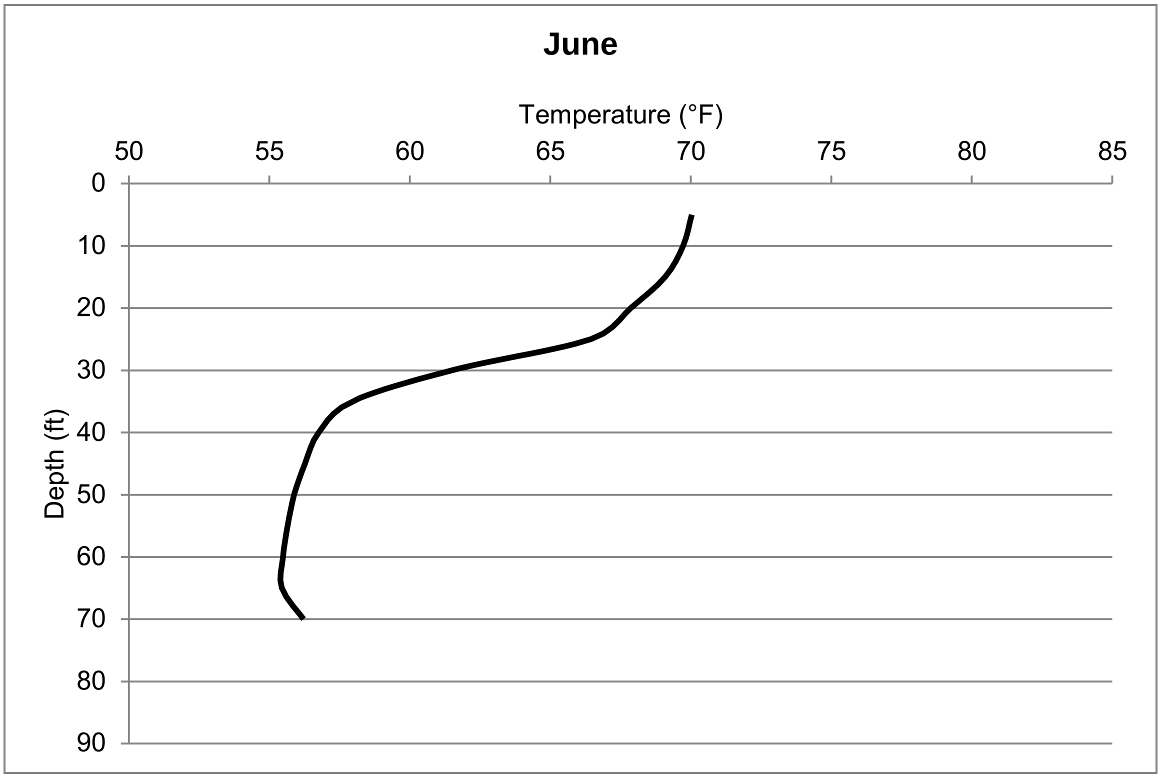
Figure C3. Monthly temperature profiles, San Justo Reservoir, 2009-2010

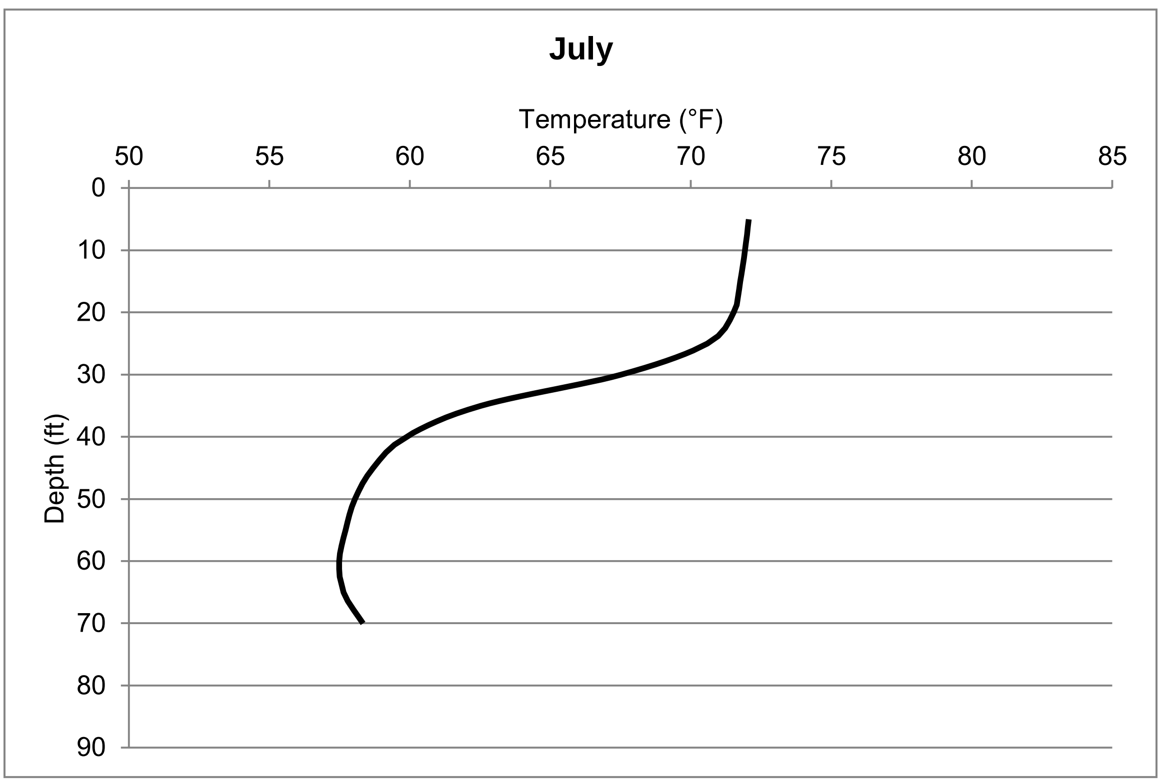





April
Temperature (°F)
50
55
60
65
70
75
80
85
0
10
20
30
40
50
60
70
80
90
Depth (ft)


May
Temperature (°F)
50
55
60
65
70
75
80
85
0
10
20
30
40
50
60
70
80
90
Depth (ft)


June
Temperature (°F)
50
55
60
65
70
75
80
85
0
10
20
30
40
50
60
70
80
90
Depth (ft)


July
Temperature (°F)
50
55
60
65
70
75
80
85
0
10
20
30
40
50
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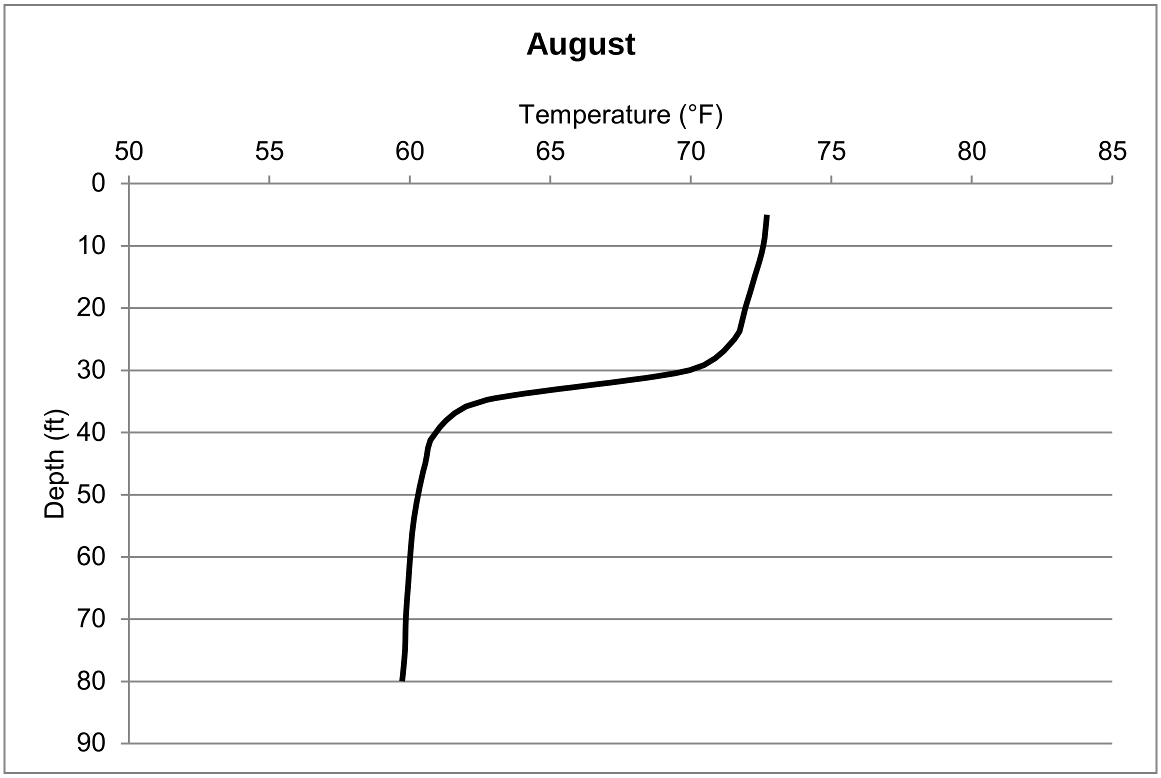
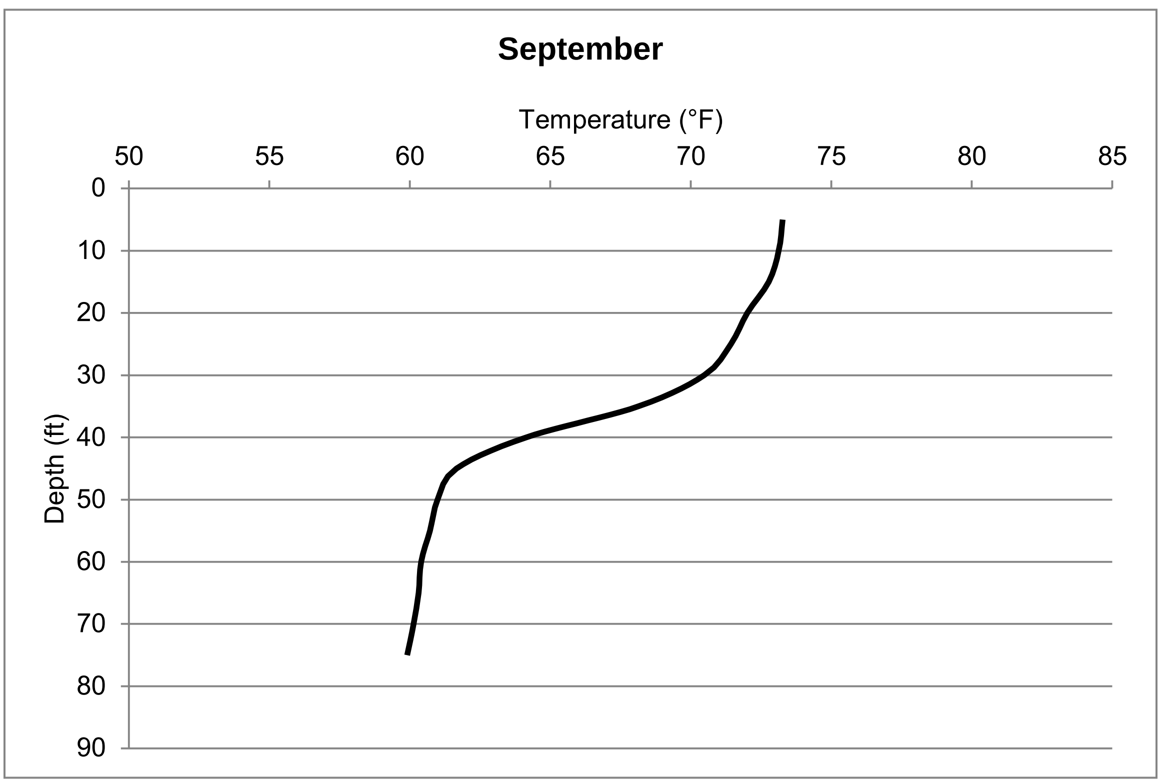
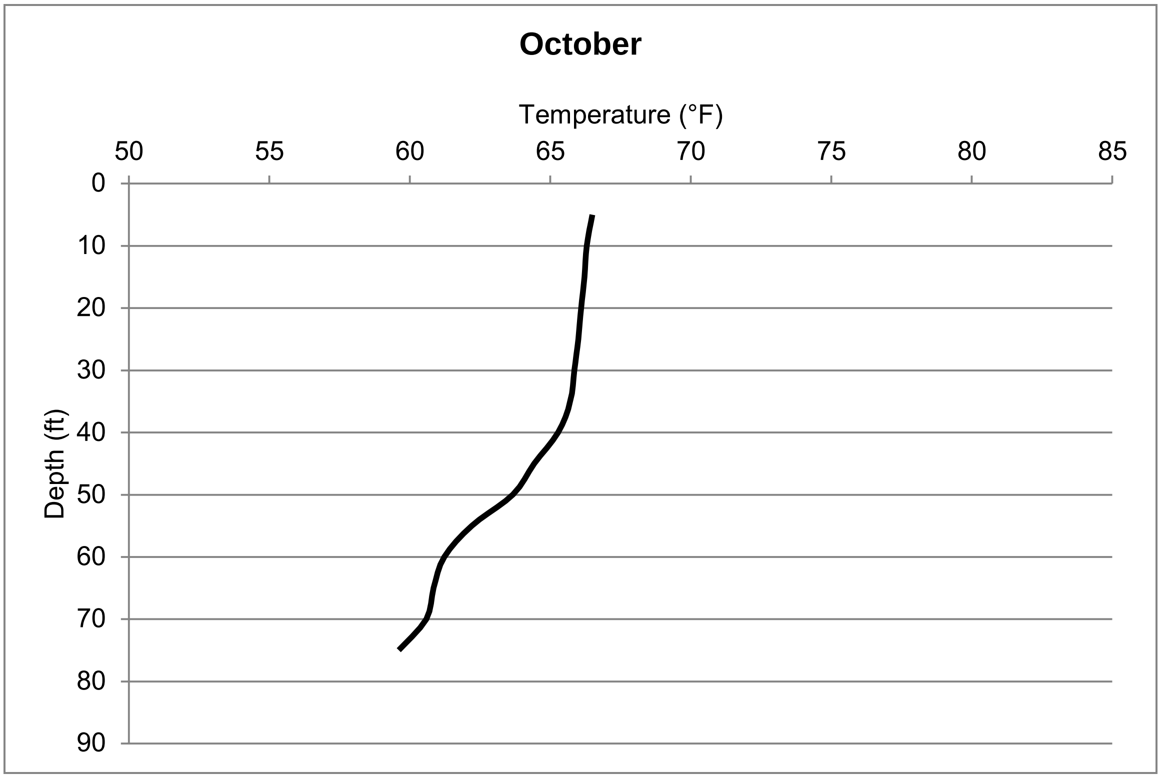
70
80
90
Depth (ft)


August
Temperature (°F)
50
55
60
65
70
75
80
85
0
10
20
30
40
50
60
70
80
90
Depth (ft)


September
Temperature (°F)
50
55
60
65
70
75
80
85
0
10
20
30
40
50
60
70
80
90
Depth (ft)


October
Temperature (°F)
50
55
60
65
70
75
80
85
0
10
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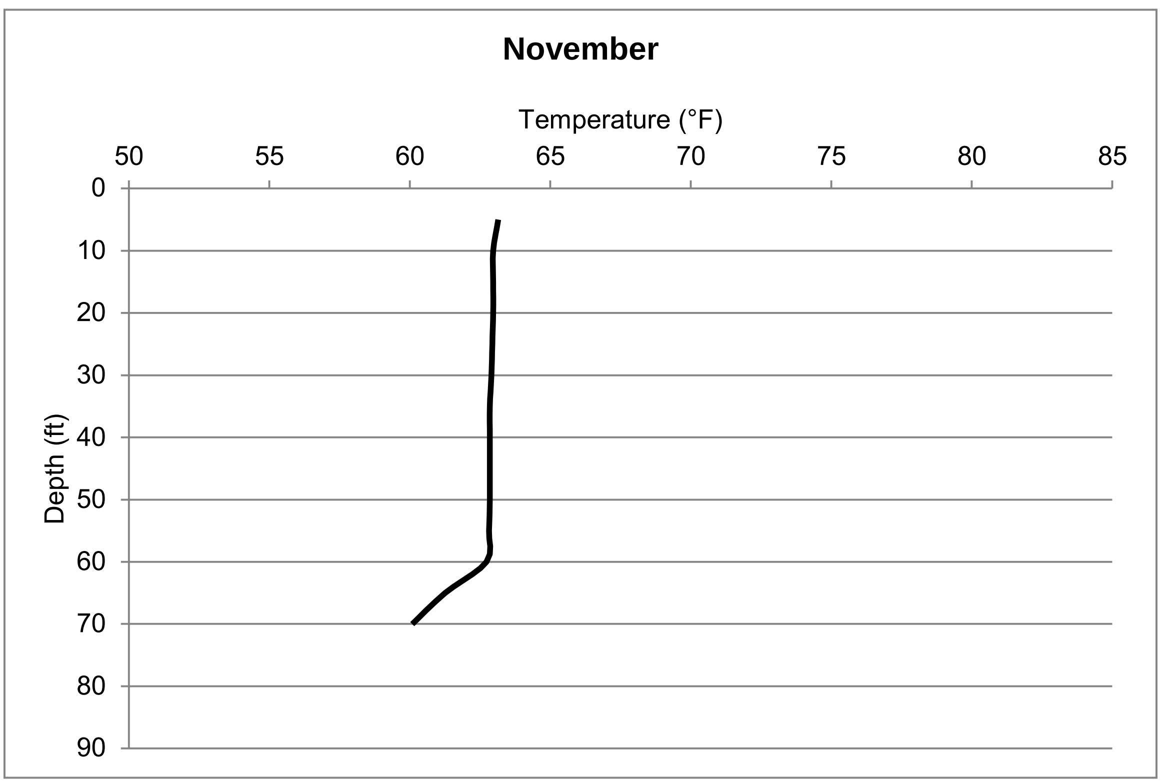
30
40
50
60
70
80
90
Depth (ft)


November
Temperature (°F)
50
55
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65
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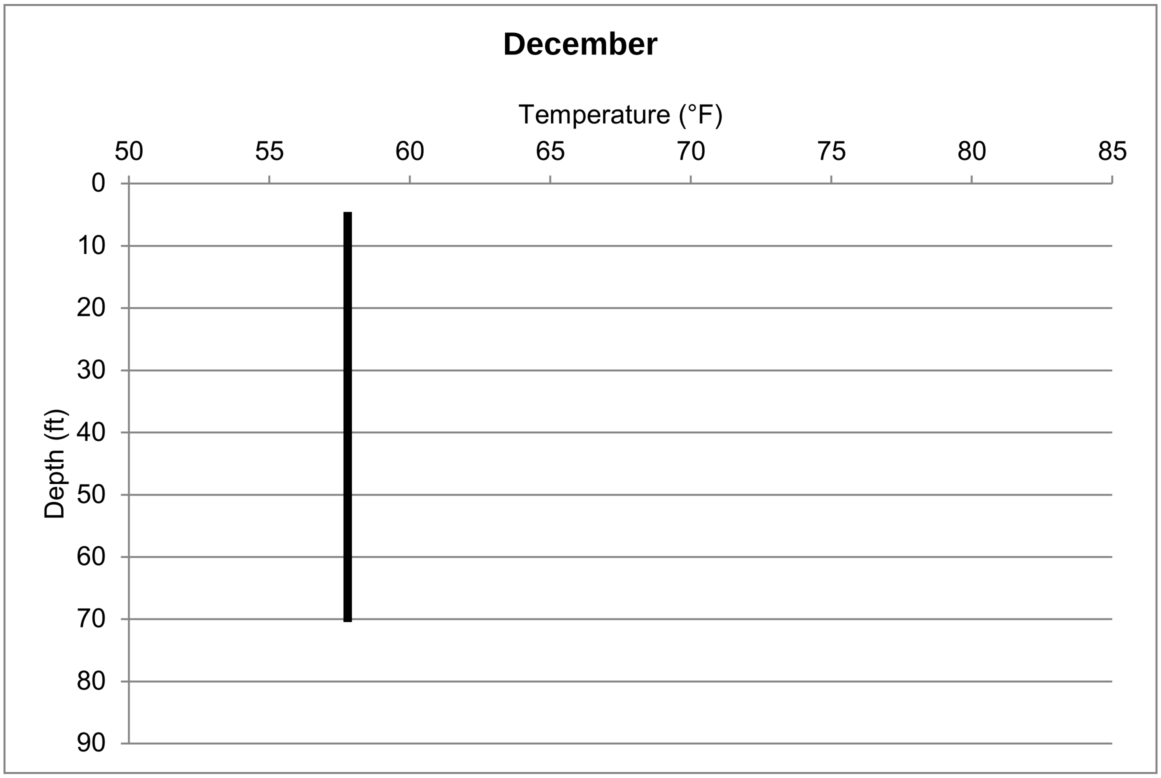
75
80
85
0
10
20
30
40
50
60
70
80
90
Depth (ft)


December
Temperature (°F)
50
55
60
65
70
75
80
85
Depth (ft)
0
10
20
30
40
50
60
70
80
90

Appendix D. Historical Climate Data Summary, Hollister California

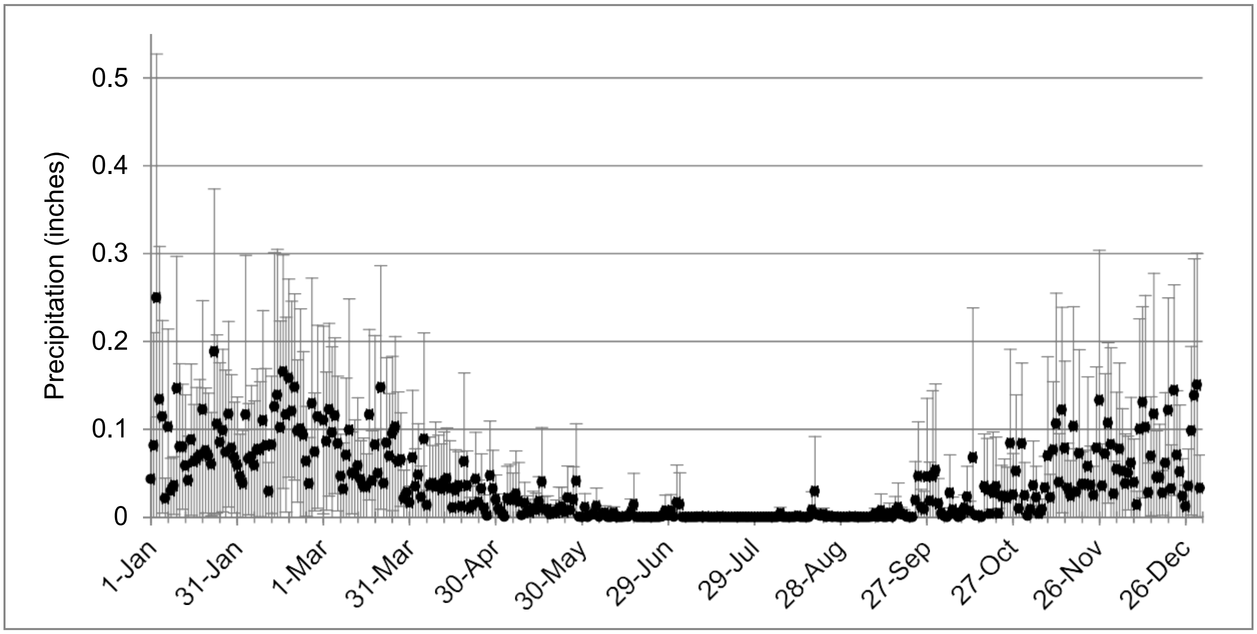


Figure D-1. 35 year daily precipitation means and 99% confidence intervals, Hollister weather station (2).

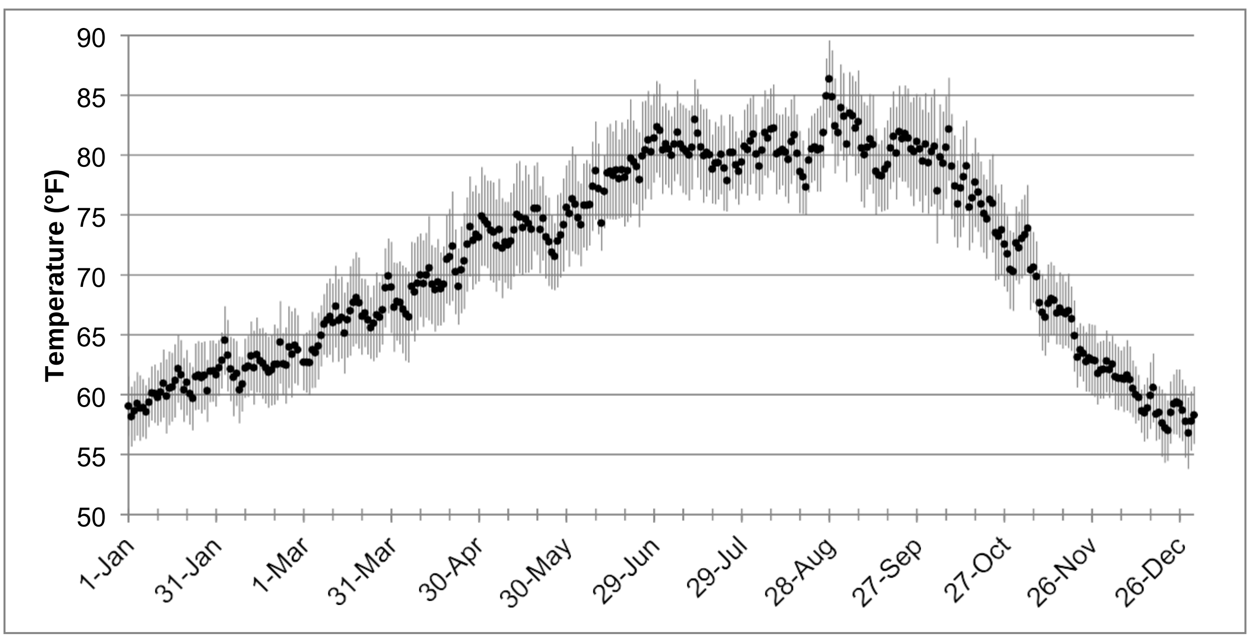


Figure D-2. 35 year daily temperature means and 99% confidence intervals, Hollister weather station (2).

NOTE - Further climate summary information for Hollister, CA can be found at:
https://weatherspark.com/y/1035/Average-Weather-in-Hollister-California-United-States-Year-Round

Appendix E. Eradication Treatment Monitoring

E-1 Decontamination

Sampling equipment will be dedicated for use at San Justo Reservoir for the duration necessary to provide sufficient data for the eradication, and will not be used for sampling other water bodies during this period. Dedicated equipment will alleviate any potential to spread mussels to new water bodies, but measures for decontamination should still be conducted regularly to provide accurate assessment of veliger distributions within the reservoir and over time.

E-2 Monitoring Overview

Eradication performance will be monitored using water quality parameters and zebra mussel presence, settlement, and mortality at multiple life stages. Parameters to be measured include:

- Water quality (field sonde)
- Potassium concentration (field and lab measurements)
- Shoreline adult mussel population surveys (visual)
- Shoreline temperature and humidity (sensors with data loggers)
- Adult mussel mortality (live mussel assays)
- Adult/juvenile mussel settlement (artificial settlement substrates)
- Larval mussel presence and viability (plankton tow net surveys)

Details regarding all sampling, timing, and duration is presented in table E-1.

E-3 Water Quality

Basic water quality data can be collected instantaneously in the field using a multi-parameter sonde and handheld meter. Water quality data should be collected from various locations throughout the reservoir at 5-foot depth increments. Suggested sampling locations and reservoir depths are presented in Figure E1. A full panel of water quality analysis should be conducted before, during, and after treatment to accurately describe treatment conditions.

E-3.1 Equipment

- Multiprobe water quality instrument (sonde) with probes for temperature, dissolved oxygen, pH, conductivity, and turbidity.
- Handheld readout/recorder with connecting cables.
- Protective cage and calibration solutions/cups.
- Additional miscellaneous supplies (batteries, electrical tape, buffer, etc).

E-3.2 Methods

- All probes should be calibrated before every sampling event per the specific multiprobe model's standard procedures.
- Calibrate DO and pressure/depth on site.
- Turn on handheld and activate per manufacturer's instructions.
- Enter sample information (location, date etc.) and collect the first sample just beneath the surface of the water.
- Lower sonde slowly, logging samples every 5 feet until the bottom is reached.
- Record the maximum depth.

E-3.2.1 Distribution System

Methods for the reservoir can also be used for point monitoring along the distribution system by collecting water samples from taps in a container and submerging the sonde. Suggested sampling points for distribution sampling are presented in figure E2.

E-4 Potassium Concentration

Field tests for potassium concentrations in the reservoir should be conducted daily during the potash application and weekly during the holding period. A Kemmerer or similar equipment should be used to collect water samples from different depths. These samples will be used for field testing and split for lab verification.

E-4.1 Equipment

- Kemmerer water sampler with drop-line marked at 1-foot intervals
- Samples bottles - cleaned, sanitized, and accurately labeled to avoid potential for contamination.
- Handheld field colorimeter and sample cells
- Reagent set for potassium up to ~115 ppm; dilution of sample may be necessary to achieve levels within suitable range for the field colorimeter
- 25 mL mixing cylinder with stopper
- Filtration setup (funnel, filter paper, vacuum pump, etc.)
- Squeeze bottles and DI water for rinsing Kemmerer.

E-4.2 Methods

- Dip a sample bottle from the boat to collect the surface sample.
- Lower the Kemmerer to the 5-foot mark on the drop-line and operate the sampler to collect the 5 foot depth sample.
- Pull up the Kemmerer and transfer to appropriate sample bottle.
- Rinse Kemmerer with deionized water
- Repeat Kemmerer sample collection and collect separate samples every 5 feet until the bottom of the reservoir is reached; collect a sample at the bottom if the depth is greater than 3 feet from the sample above it.

- All field test samples should be diluted as necessary, buffered and/or mixed with proper reagents and analyzed using the handheld colorimeter per the specific instrument specifications.
- Lab sample bottles should be sealed with electrical tape and prepared per specific instructions from the lab and shipped for analysis.

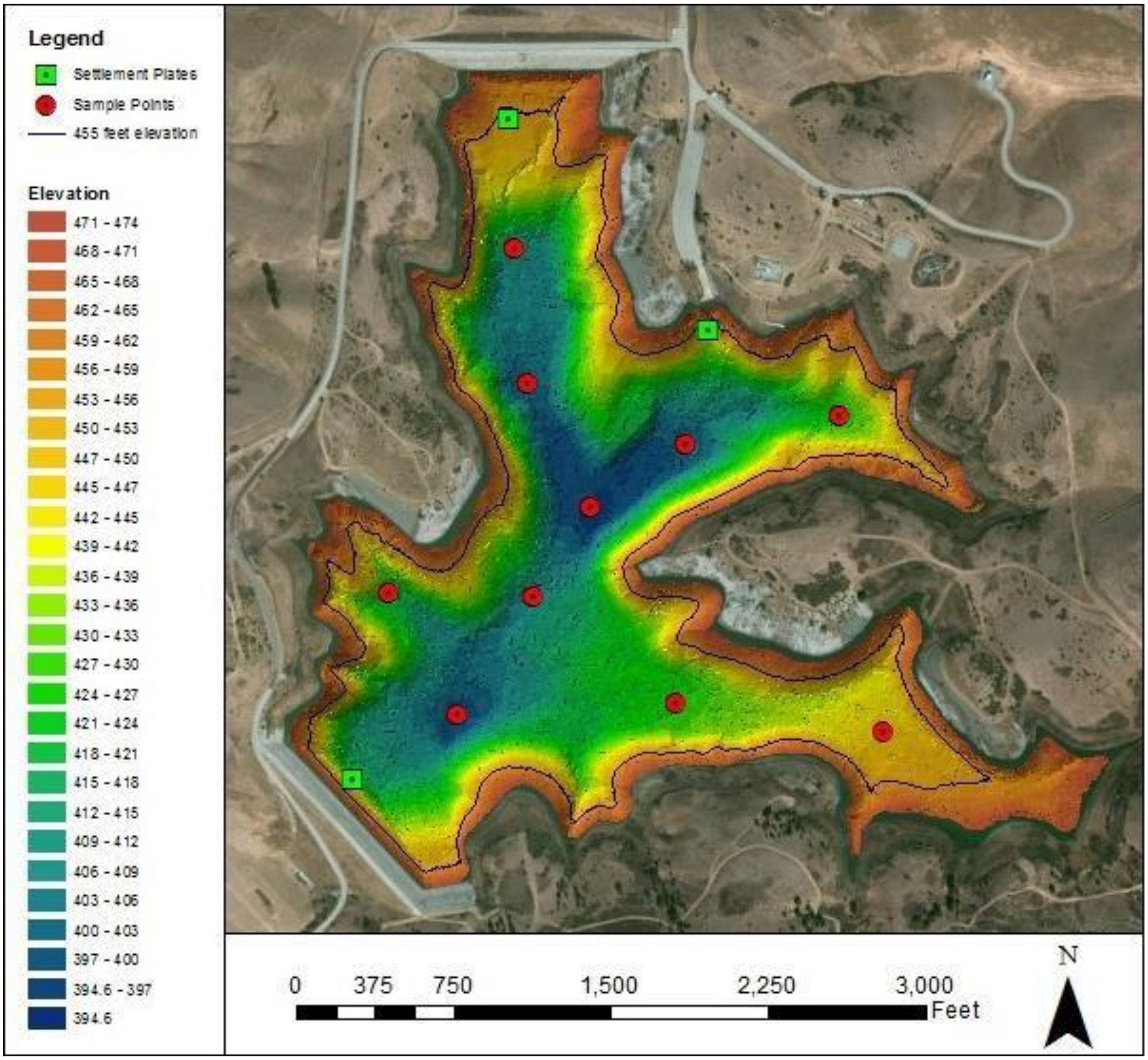


Figure E-1. Suggested monitoring locations, San Justo Reservoir.

E-5 Shoreline Monitoring

The shoreline of the reservoir should be visually inspected by a qualified biologist for live adult mussels or areas that could potentially provide isolated habitats. Data to be collected includes GPS points/polygons and ground marker or other physical on-site delineation of viable mussels and pools or wet areas that could harbor live mussels.

Shoreline surveys should be initiated approximately one month prior to the potash treatment and conducted every 2 weeks through the holding period. Variations in timing and schedule may be necessary to accommodate for drawdown rate, weather, or other factors.

Visual assessment of exposed shoreline area for the presence of mussels on a variety of substrates and potential habitat, including exposed crevices, pools, under-exposed or overhanging ledges, on and under loose rocks, attached to exposed vegetation, muddy surfaces, and any other substrates encountered. Surveys should be conducted a minimum of every two weeks.

- Pooled water or significantly wet areas should be physically marked and/or locations recorded by GPS for subsequent examination. Larger pools may be targeted for repeat monitoring and additional treatment.
- Subsets of the exposed shoreline mussel population should be checked for viability by prodding with a dull probe and noting any physical movement or response, and/or inspection of tissues.
- As a final check, one week prior to reservoir refill (post-treatment), any potential viable mussels (up to 100 viable individuals) should be collected, placed in aquaria with untreated reservoir water under aeration and checked daily for at least 72 hours to determine recovery/mortality. If mussels are found to be alive the duration of the treatment will be extended.
- Shoreline monitoring may be discontinued after the conclusion of the drawdown if four consecutive weeks of data collection show no live mussels or viable habitat.
- If shoreline treatments are deemed necessary, combining one or several of the final survey efforts with treatment may be desirable to improve efficiency and utilize real-time data.

E-5.1 Shoreline Microclimate Monitoring

Air temperature and humidity sensors with data logger will be placed in select areas to monitor potential refugia. High priority areas for microclimate monitoring include along armored faces of the dam and dike, and may be stratified by slope azimuth.

E-6 Mussel Settlement

Monitoring mussel settlement is a long-term strategy and may take several months for observable results due to the life-history of zebra mussels. In addition, the reservoir treatment will take place outside of the typical seasonal peak in mussel settlement. Nonetheless, settlement monitoring should be initiated during the short-term monitoring period as an additional metric for eradication performance.

E-6.1 Settlement Plates

Artificial substrates for settlement monitoring should be constructed using uniform-sized settlement plates made of plastic or PVC, strung together on rope or plastic-coated cable (figure E3). Plates should be spaced at 15-foot intervals, with the top plate approximately 5 feet below the surface and the bottom plate within 5 feet from the deepest depth. An anchor should be attached to the bottom of the line at a depth to ensure the sampling plates remain vertical in the water column. Settlement plates deployed from buoys will need anchors to reach to bottom with a slight amount of slack to keep the string of plates from wandering with water currents.

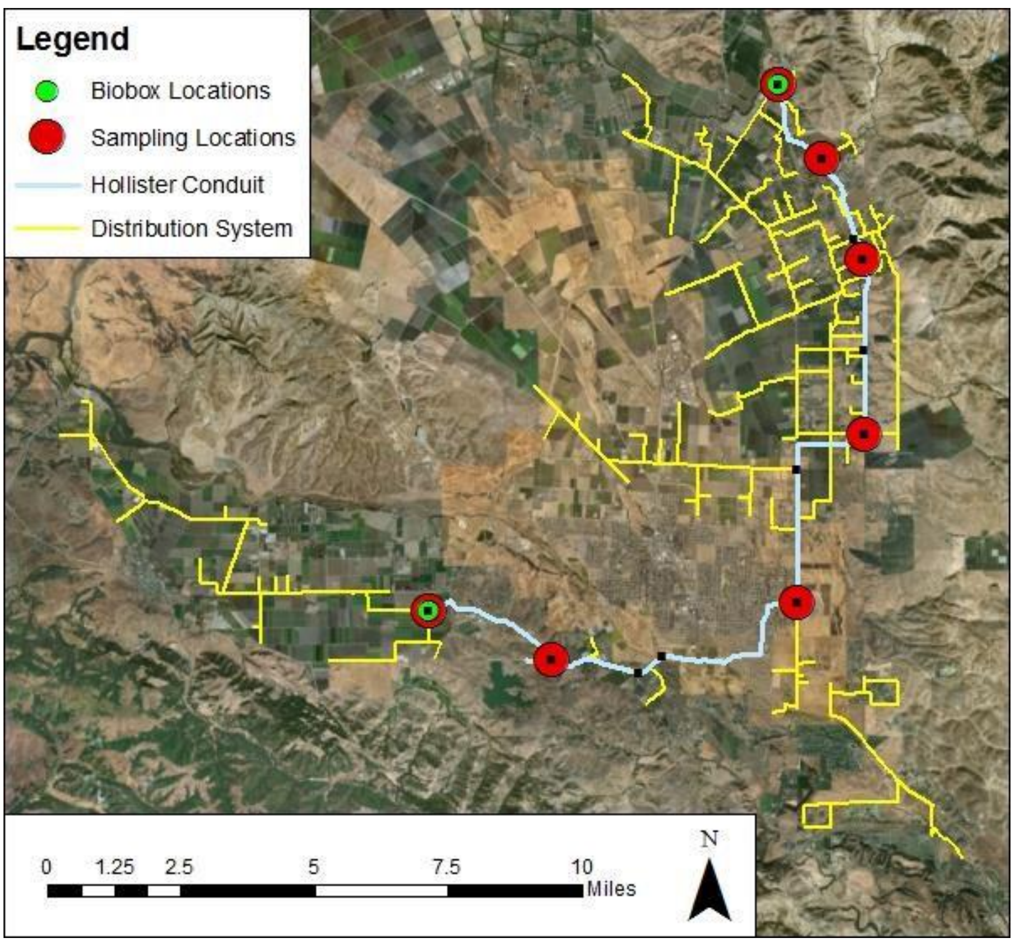


Figure E-2. Suggested monitoring locations, Hollister Conduit and Distribution System

Note that during the eradication treatment the maximum depth of the reservoir is estimated at 61 feet, but may be as much as 80 to 100 feet deep during the typical mussel settlement peak in June through October. Several options exist for accommodating elevation/depth fluctuations, including use of self-adjusting anchor buoys, regular relocation of the buoy and samplers to appropriate depths, or anchoring the stringer of settlement plates from above the water such as from the crest of the dam or a dock.

Recommended deployment sites and estimated depths for settlement plates are presented in figure E-1.

All settlement plates should be examined monthly during both the short and long-term monitoring phases.

E-6.2 Methods

- From a boat, pull one plate at a time out of the water. Plates should be handled carefully so as not to dislodge or crush any attached mussels.
- Visually inspect all sides and edges of each plate, as well as the rope/cable, anchor and any fasteners or hardware.
- Note and record any visible attached mussels.
- Lightly and methodically scrape the entirety of the surface of the settlement plate with a razor blade and collect all scrapings into a tray. Transfer to a water-tight sample bottle using multiple rinses with deionized water.
- Add baking soda and alcohol to preserve the sample and transport or ship to a qualified laboratory for microscopic analysis (see sample preservation under Mussel Veliger Monitoring).
- Replace the substrate stringer to its original location after all plates have been scraped.

E-6.3 Biobox Monitoring

Bio-boxes can be constructed from 35-L or larger coolers, which will help to maintain a consistent water temperature, and provide a dark location for settlement. The coolers are modified with inflow and outflow ports to allow continuous water flow through the biobox (Figure E4). The flow rate into each bio-box should be set at 7.6 L/ min (2 gal/ min), which will provide enough retention time for mussels to settle. A flow meter/ totalizer should be installed on the inflow to each bio-box to track the total flow into each box for comparison.

Settlement should be observed monthly during both short-term and long-term monitoring phases. Mussel settlement can be monitored by placing 10 settlement plates (approximately 15 cm x 15 cm) vertically in each bio-box. Settlement plates can be made of any material, but a smooth, plastic or PVC plates are easiest to scrape.

E-6.4 Methods

- Settled mussels can be detected by lightly scraping the surface of each plate with a razor blade and rinsing into a collection tray with DI water.
- The sample should be preserved and microscopically analyzed for total number of settled mussels.
- A water quality multi-probe can be used to monitor the temperature, dissolved oxygen, pH, and conductivity in each bio-box to detect water quality changes that might influence mussel survival.

Figure E3. An example of a stringer of settlement monitoring plates heavily colonized by quagga mussels.

E-7 Adult Mussel Bioassays

In order to directly observe adult mussel mortality resulting from potash treatment, captive live mussels will be exposed to treated water in the reservoir and distribution system, observed regularly for mortality and compared to mortality rates of untreated mussels kept in aquaria. Reservoir assays will suspend mussel bags from buoys at multiple depths. Bioboxes will be used to expose live mussels to treated water within the distribution system.

E-7.1 Methods

- Mussels should be collected prior to the potash treatment, verified live, and kept in aerated aquaria for use in the bioassays. Approximately 1,500 live mussels are desirable for the assays and controls, 500 from each size class; 2 to 3 times this number may need to be collected in order to acquire the appropriate number of viable individuals within each size class.
    - Size class ranges and quantity of mussels per bag may be modified to account for availability.
    - Classes are initially defined as small (<5 mm), medium (5-15 mm), and large (>15 mm).
    - The drawdown may kill off the majority of the larger mussel population, and smaller mussels (< 5 mm) may not be suitable to be remain within the mesh bags.
- Untreated water will also need to be collected and stored on site for maintaining controls.
- At the initiation of the potash treatment, mussels will be sorted into 3 size classes and 50 musses from each class placed into separate mesh bags.
- Clusters of 3 bags - one from each size class - will be suspended at three locations along a cable suspended from a buoy in the reservoir: 3 feet below the surface, middle of the water column, and 3 feet above the reservoir bottom.
- Anchors or tethers will be necessary to keep buoys in place. The reservoir elevation is expected to decline less than 1 foot over the course of the eradication treatment, so anchors at the end of buoy lines may be effective.
- Control bags (2 sets of the 3 size classes) should each be placed in separate aquaria or bioboxes, with either regular water changes or flow-through systems in place.
    - Chiller/heaters may be necessary to maintain water temperatures.
    - Daily water changes or 2 gal/min flow rate are recommended.
    - Water chemistry should be monitored to ensure conditions remain suitable to support viable mussels throughout the project.
- For observing mortality, bags should be collected from treated sited and kept in treated water throughout the observation and assessment process. Control mussels should be kept in untreated water at all times.
- Mussel assessments are to be conducted by a trained biologist, using stimulus response and/or tissue observations to discern intoxication/mortality condition.

E-8 Visual surveys

The reservoir bottom and underwater structures will be surveyed for mussel mortality using divers and/or underwater Remotely Operated Vehicles (ROVs) (USGS 2010). Groups of mussels potentially representing many size classes in a variety of locations and conditions in the reservoir can be checked in this manner for gaping and/or unresponsiveness, which are indicators of potential mortality. The use of divers has an advantage over ROVs because divers can perform both visual (gaping) and tactile (unresponsiveness to prodding) checks, and bring back groups of unresponsive gaping mussels to on-site aquaria containing untreated water to check for continued unresponsiveness. In contrast, ROVs can only offer a visual depiction of potential mortality (gaping mussels), but can also cover areas that may not necessarily accessible to divers.

- Inspections with divers and/or ROV can be conducted one month following the completion of potash treatment.
- Inspections should focus on areas where large masses of mussels are known to exist, such as indicated by previous sampling and surveys of the reservoir, and/or by observations of populations of stranded mussels along the shoreline exposed by lowering of the reservoir water level.
- Note specific locations where the surveys are conducted with GPS.
- Note if 100% of the mussels observed show a gaping response, and if not, estimate roughly what proportion are showing gaping response.
- Also note, in general, if the majority of gaping shells contain tissue or not. If divers are used, check for responsiveness and bring back samples of mussels for viability testing in aquaria containing untreated water.
- During the surveys, note if some mussels have closed shells. Subsequent surveys (weekly) may be required if a more than a third of the mussel shells are observed to be closed, or if some mussels are active and responsive.

Figure E-4. Example of a biobox setup in a modified cooler with mussel settlement substrates.

E-9 Larval Mussel Monitoring

Larval planktonic mussels (veligers) should be collected using net tows from various locations, likely a subset of the water quality monitoring points (Figure E1, total of 3 samples per day maximum). Collection of samples will be conducted in accordance with Bureau of Reclamation Technical Memorandum 86-68220-13-01, Field Protocol for Preparation of Water Samples for Dreissenid Veliger Detection, summarized below.

(https://www.usbr.gov/mussels/docs/FieldSOPPreparationandAnalysis.pdf, Revised 2013).

E-9.1 Equipment

- Plankton net with weighted COD-end piece made with 64 µm mesh; connected to rope reel marked every 1 meter up to 50 meters.
- Samples bottles
- Deionized water in squeeze bottle
- Bleach
- Vinegar
- Buckets or tubs for decontamination
- Baking soda (sodium bicarbonate)
- 70% isopropyl alcohol
- Sealable quart and gallon plastic bags
- Garbage bags
- Disposable diapers
- Insulated cooler
- Electrical tape
- Packaging tape

E-9.2 Field Prep

- Label bottles and lids with state (CA), water body (San Justo), sample site (see map), depth or length of tow, total number of tows, and date of sample collection.
- Inspect plankton tow net:
    - Look for holes, rips or tears, and make sure the mesh is firmly attached to the inside of cod end
    - Check metal/ PVC collar to make sure cod end screws on securely, and all knots securely tightened.
- Nets and cod ends should be decontaminated by submerging in vinegar between each sampling site, and soaked with bleach and rinsed after each sampling event.

E-9.3 Sample Collection - Reservoir

- Dip plankton tow net into the reservoir several times to rinse off the vinegar, making sure to keep the rim of the net hoop above the surface
- Refer to total depth from handheld multimeter, rounding down to nearest whole meter. This will be the depth to lower the plankton net for each tow. Record this depth
- Lower the plankton net slowly and straight down to the required depth; try not to disturb bottom sediment.
- Pull up the net slowly back to the surface; dunk the net two to three times again keeping the rim of the net above the surface – this will flush particles to the cod end. If the cod end is filled with sediment, discard the tow contents, rinse the net and resample at 0.5 meters above previous sample depth.
- Unscrew the cod end and gently swirl the sample to remove some of the water; pour the remaining water into the sample bottle.
- Repeat the plankton tow process five times.
- Using the squeeze bottle with deionized water, rinse the cod end and add rinsate to sample. Repeat for a total of three rinses. If there is too much water in the sample after any tow or after the rinse, pour some of the sample back into the cod end and swirl to reduce volume. Decant the sample back into the bottle and perform three rinses of the cod end. Make sure there is room in the bottle for alcohol to be added.
- Use a single sample bottle per sample location (5 tows), with 500 mL maximum sample volume including the alcohol preservative added at 25% of total sample volume.
- Add 0.2 grams of baking soda per 100 mL of sample and mix gently.
- Add alcohol to the sample to bring the sample to roughly 20% alcohol, mix gently.
- If shipping samples, seal sample containers with electrical tape
- Place sample in cooler with ice.

E-9.3 Sample Collection – Distribution System

- Larval mussel samples can be collected from the distribution system by running a standard volume of water (similar to plankton tows) from a tap through the net or simply the cod end piece.
- A catch-basin or flow meter should be used to determine actual volume of water filtered through the mesh.
- All other aspects of decontamination and sample preparation are the same as those conducted for the reservoir sampling.
- Dispose of all filtered water appropriately.

E-9.4 Sample Shipping

- Make sure the cooler is clean/dry, drain valve is taped closed and lined with a large trash bag to contain any leaks that may occur.
- Make sure that all labels are complete, easily legible and present on both the bottle and the lid. Lids should be wrapped tightly with electrical tape at the seam.
- Secure disposable diaper over sample bottle.

- Place samples in garbage bag lined cooler with blue ice packs to keep the samples chilled. Do not use regular ice, shipping companies will destroy any leaking packages.
- Close garbage bag tightly, and tie in a knot to close the bag
- Tape cooler lid and sides shut and affix shipping label.
- Overnight the cooler to the Reclamation lab for analysis; avoid shipping on Fridays if possible.

E-10 Long-Term Monitoring

Definitive confirmation of the success or failure to eradicate invasive mussels from San Justo will require long-term monitoring over a minimum of 2 consecutive years following the eradication and may be conducted indefinitely to monitor potential re-infestation should pubic access to the reservoir be reinstated. Long-term monitoring will be initiated at the start of the reservoir refill after the potash dosing, distribution system charging, holding period and final short-term assessments, and targeted during the June-October window when mussel settlement is most abundant.

E-10.1 Overview

- Water quality (field sonde)
- Adult mussel settlement (artificial settlement substrates)
- Larval mussel presence and viability (plankton tow net surveys)

E-10.2 Methods

All methods are identical to those conducted during the short-term monitoring phase.

E-10.3 Genetic Analysis

Genetic analysis of mussels at San Justo Reservoir can provide a valuable tool for evaluating the success of eradication efforts. Genetic tools developed during the recent sequencing of the zebra mussel genome by the University of Minnesota allows for differentiation of mussel population.

Genome by sequencing (GBS) techniques rely on fragmentation of genomic DNA by restriction enzymes, followed by massively parallelized DNA sequencing using widely available and inexpensive next generation sequencing (NGS). Sequences from numerous individuals are compared to identify differences in the DNA (single nucleotide polymorphisms/SNPs) that are unique to a population.

Should live mussels be detected in San Justo or the distribution system following eradication efforts, they could be compared to mussels collected before the eradication. This would allow determination of whether there had been incomplete mortality and a survivors from the original population, or a new introduction had occurred after eradication. Samples of mussels should be collected before the eradication effort occurs. These pre-eradication samples can be analyzed as part of the eradication effort or can be archived in a -112˚ F (-80˚ C) freezer for future use if needed.

E-11 Decontamination

It is recommended to treat all vehicles and equipment exposed to raw water at San Justo as if the reservoir was still infested until completion of the long-term monitoring phase. This means all boats, probes, nets, and other items used for monitoring should undergo appropriate decontamination procedures before entering or use in any other water body.

Table E-1. Summary of monitoring activities, duration and frequency for the San Justo Reservoir mussel eradication project.

Location	Target	Data Collected	Method	Duration		Frequency	
				Start	End	Short-Term	Long-Term
San Justo Reservoir Shoreline	Adult Mussels	Adult mussel and potentially suitable habitat presence/absence and location	Visual survey	At least one month prior to potash treatment	Until two consecutive surveys find no live mussels	Every 2 weeks	N/A
	Microclimate	Temperature and humidity	Deployed sensors with data loggers			Data logged hourly, loggers checked weekly	N/A
San Justo Reservoir	Water Quality	DO, temp, pH, conductivity, turbidity	Multiprobe/Sonde	At least one week prior to initiation of potash dosing	Through seasonal reservoir refill	Weekly	Monthly
	Potassium	Concentration	Field colorimeter	At least one week prior to initiation of potash dosing	Conclusion of holding period	Daily during potash dosing, weekly during holding period	N/A
			Lab	Initiation of potash dosing	Conclusion of holding period	Weekly	N/A
	Juvenile Mussels	Veliger counts	Plankton tow	After complete adult mussel mortality achieved	Through long-term monitoring phase	Every 2 weeks	Monthly
	Adult Mussels	Settlement	Settlement plates	At initiation of potash dosing	Through long-term monitoring phase	Every 3 weeks	Monthly
		Mortality	Bioassays	At initiation of potash dosing	Until complete mortality achieved	Every 2 weeks	N/A
Hollister Conduit and Distribution System	Water Quality	DO, temp, pH, conductivity, turbidity	Multiprobe/Sonde	At least one week prior to potash treatment	Through seasonal reservoir refill	weekly during holding period	Monthly
	Potassium	Concentration	Field colorimeter	Initiation of holding period	Conclusion of holding period	Weekly	N/A
			Lab	Initiation of holding period	Conclusion of holding period	Every 2 weeks	N/A
	Juvenile Mussels	Veliger counts	Filtered samples from taps	Initiation of holding period	Through long-term monitoring phase	Every 2 weeks	Monthly
	Adult Mussels	Settlement	Settlement plates	At initiation of potash dosing	Through long-term monitoring phase	Every 3 weeks	Monthly
		Mortality	Bioassays	At initiation of potash dosing	Until complete mortality achieved	Every 2 weeks	N/A

Appendix F. Potash Treatment Logistics

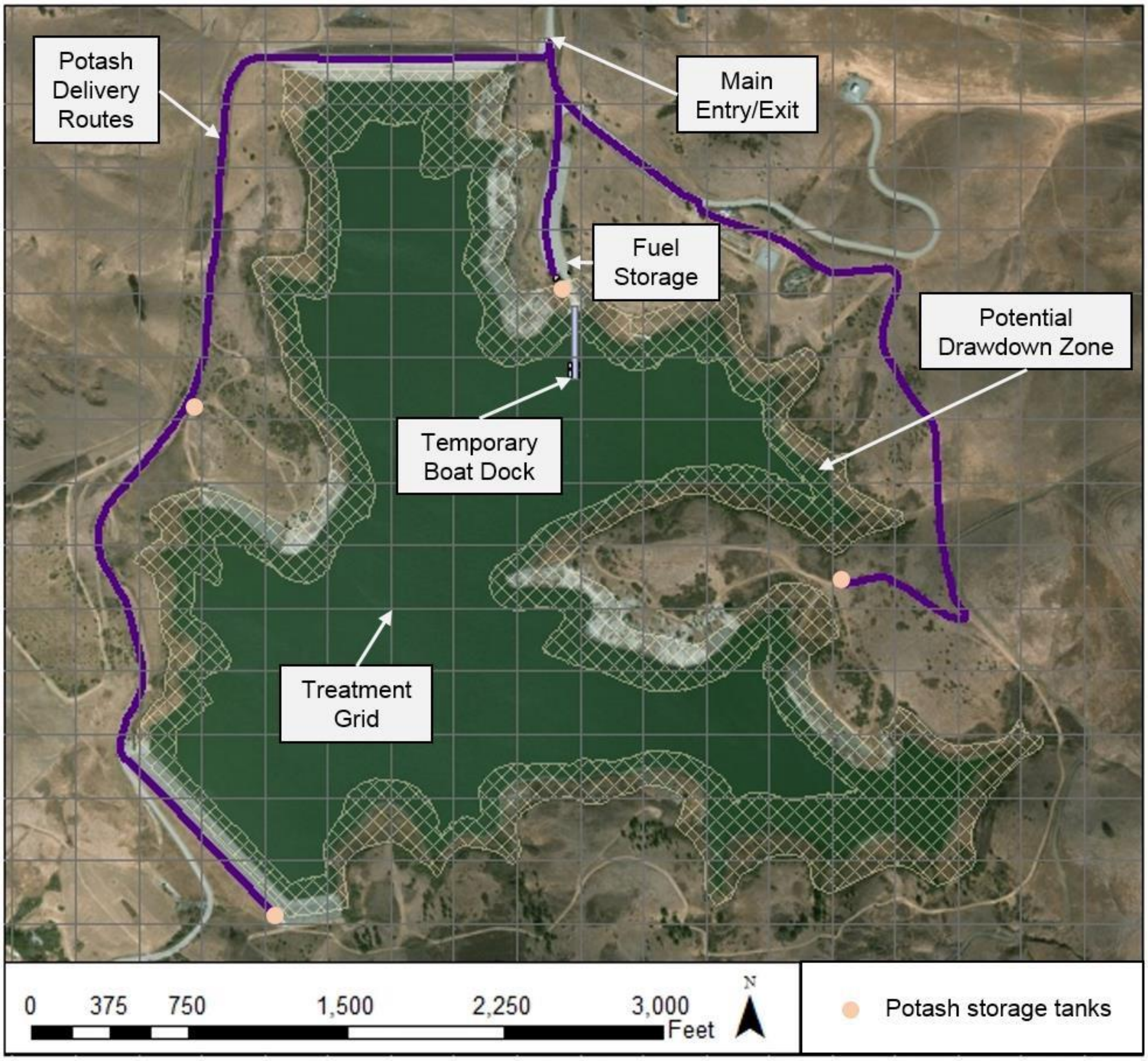
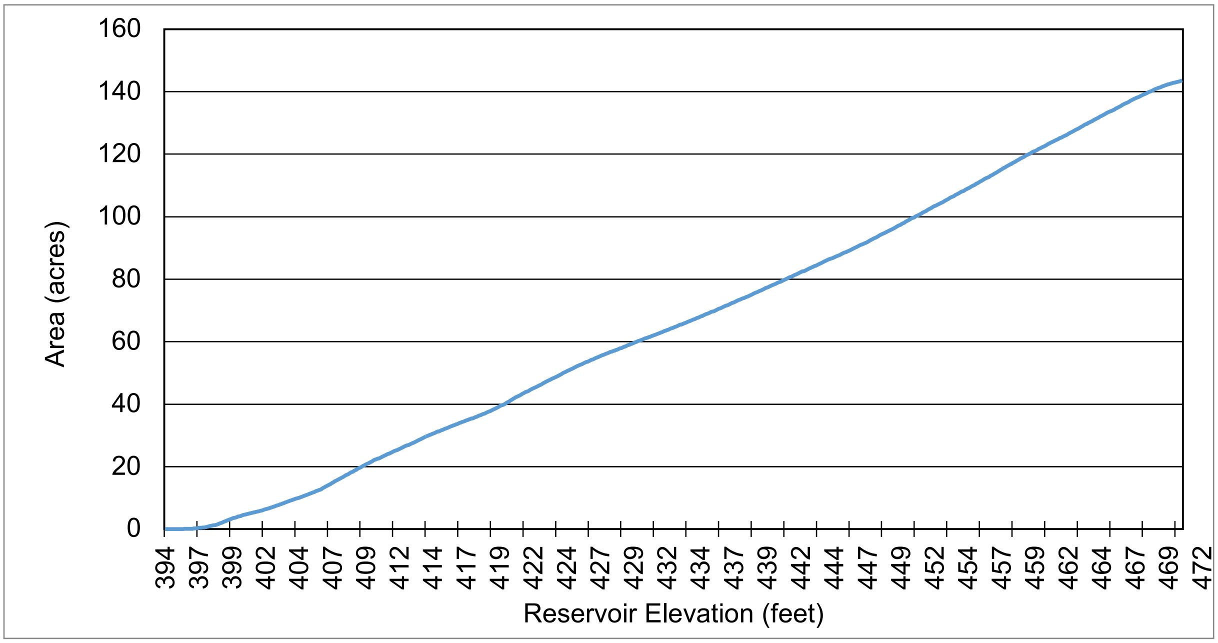
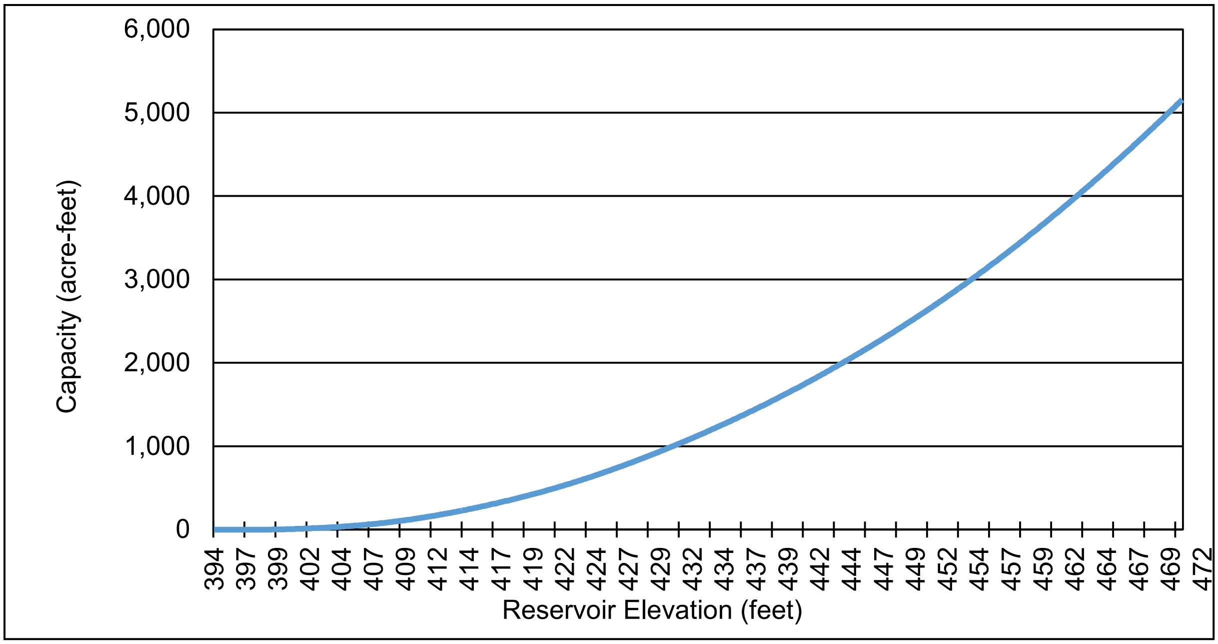


Figure F-1. Location map for potash storage tanks and delivery routes, fuel storage, and treatment grid. Treatment grid cells are 300 feet by 300 feet squares representing the approximate area to be covered per workboat per day during the potash treatment. Potential extent of the drawdown zone and temporary boat dock are also presented.

Appendix G San Justo Reservoir Area and Capacity by Elevation



Figrure G-1. San Justo Reservoir area by elevation.



Figrure G-2. San Justo Reservoir capacity by elevation.

Appendix D: Zebra and Quagga Mussel Coordinated Prevention Plan

Bay Area Consortium Zebra and Quagga Mussel

Coordinated Prevention Plan

SANTA CLARA COUNTY PARKS

Prepared By:
Kelly Klett, Management Analyst
Santa Clara County Parks and Recreation Department

In Cooperation With Our Regional Partners:

(Agency Logos To Be Added When Approved)

Table of Contents

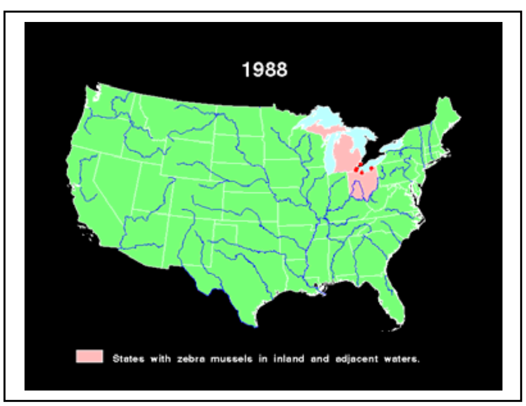
I. INTRODUCTION

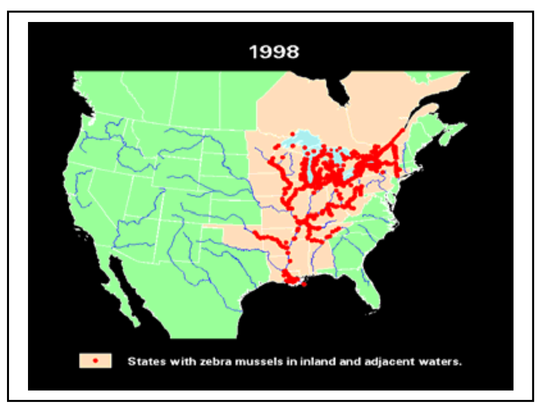
The Bay Area Regional Consortium Zebra and Quagga Mussel Coordinated Prevention Plan ('the Plan') is designed to provide guidance to water district and recreation manager's participating in the Bay Area Consortium ('the Consortium") to promote the mutual goal of preventing the introduction and spread of dreissenid mussels in the region and throughout the State.

The plan provides best practice guidelines based on information available at the time of writing to help improve efforts to prevent the introduction of dreissenid mussels into uninfested waterways within the Consortium's jurisdictional boundaries. Members of the Consortium agree to implement the vessel inspection and reservoir monitoring guidelines as outlined in this document to promote a coordinated prevention effort in the region.

II. BACKGROUND

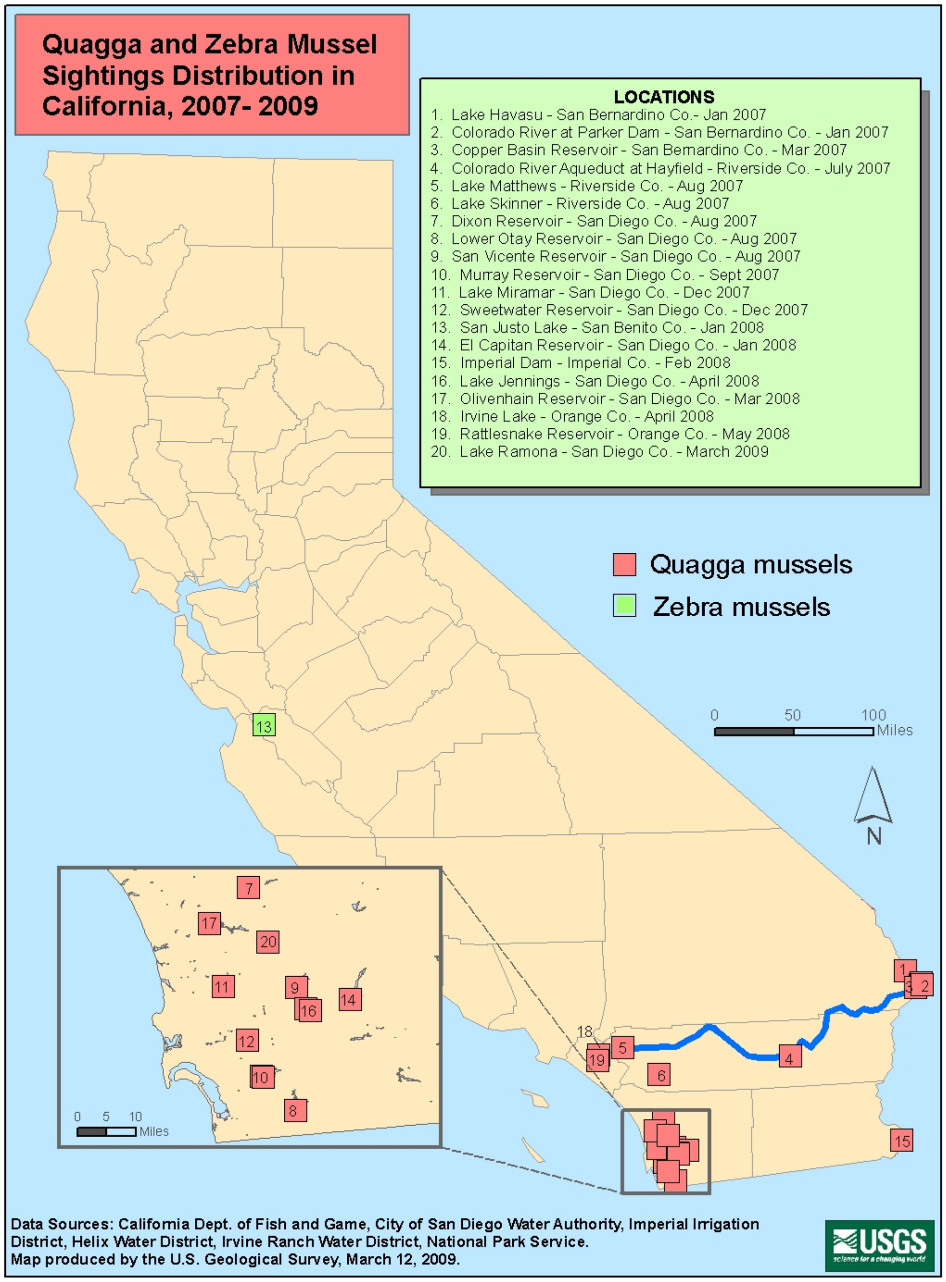
Zebra and quagga mussels are non-native dreissenid mussels from Europe. They reproduce prolifically, especially in warm western waters. Despite efforts to control their western expansion, they have begun to rapidly invade California fresh water systems. Zebra mussels were first discovered in Lake St. Claire in the Great Lake Regions in 1988. By 1992, they were found in all five of the Great Lakes.





In January 2007, two and a half decades later, quagga mussels were found in Lake Mead, west of the continental divide, despite the passage of the Non-indigenous Aquatic Nuisance Prevention and Control Act (NANPCA) in 1990; the subsequent amending National Invasive Species Act (NISA) in 1996; and, targeted and strategic efforts by U.S. Fish & Wildlife to prevent their westward movement (see, The 100th Meridian Initiative: A Strategic

Approach To Prevent The Westward Spread Of Zebra Mussels And Other Aquatic Nuisance Species). Since January 2007, quagga mussels have been found in reservoirs in Nevada, Arizona and throughout Southern California. Most Southern California waterways receiving raw water from the Colorado River are suspected of being infested.



In January 2008, the closely related zebra mussel was found in San Justo Reservoir, which is located in San Benito County near the Santa Clara County line. The proximity of this infestation, and the risk it poses the Consortium's waterways cannot be overstated. An unwanted introduction of this nuisance pest will severely impact fresh water systems that provide critical drinking water supplies, irrigation to local agriculture, power generation, and recreational benefits to Consortium customers and constituents.

In an effort to provide statewide guidance, the California Science Advisory Panel, comprising of members from the California Department of Fish and Game, the Department of Water Resources, the Department of Food and Agriculture, Department of Boating and Waterways, and the U.S. Fish and Wildlife Service made recommendations in a May 2007 Report: *California's Response to the Zebra / Quagga Mussel Invasion in the West*. In addition, Governor Schwarzenegger signed AB 1683 in October 2007, and AB 2065 in October 2008. Both bills contain legislation intended to control the spread of quagga and zebra mussel within the State.

III. METHOD AND RISK OF SPREAD

Invasive mussels spread easily to isolated waterways by attaching themselves to boats, personal watercraft and related equipment. Once established in a waterway, they can also be introduced to new areas by flowing downstream, or by importation of infested water.

Mature mussels, as seen on the boat motor to the right, can live out of water for weeks depending on humidity and temperature. Microscopic larvae, which are the greater risk as they are not as obvious as the depicted example, can sustain themselves in small quantities of water found in a vessel. Because of their viability away from water, the transfer of zebra and quagga mussels by trailered recreational boats is a real threat. Boats from infested waters can carry zebra mussels on their trailers, boat hulls, engines, props, drive trains, and anchor chains. Microscopic larvae can be carried in boat bilge water; live wells, bait buckets and engine cooling systems.

California has an interconnected water delivery system throughout the State, often flowing in from adjacent states. If one water agency's waterways become infested, all connected waterways are at risk of infestation.

Once introduced into a waterway, the mussels reproduce prolifically. One mature female mussel can produce over one million eggs per breeding cycle; and in warmer western waters they can breed more frequently. If just a few zebra or quagga mussels get into a fresh water system, they could multiply into hundreds of thousands, within months, and eventually decimate native aquatic populations, change water clarity, increase toxic algae blooms and undesirable vegetation, cripple water system infrastructure, including critical agricultural water delivery systems, disrupt recreational boating, and can potentially cost state and local water and recreation agencies and the agricultural industry millions of dollars annually in monitoring, maintenance, containment, infrastructure restoration, and eradication efforts.

IV. IMPACTS

A. Environmental Impacts

Once established, zebra and quagga mussels compete with native species for food, and permanently alter water chemistry, clarity, fisheries and habitat.

The mussels eat many of the microorganisms in the water, effectively taking out a bottom link in the food chain. The imbalance can lead to fewer large fish such as bass or trout and displace fish populations. They also filter about one liter of water per day. In mass quantity, they increase water clarity, allowing deeper light penetration, which encourages growth of benthic algae and aquatic vegetation, permanently changing the natural habitat.

B. Water Delivery / Power Generation / Agricultural Impacts

Zebra and quagga mussels foul drinking water delivery systems and pipes, power plant intakes, and agricultural and industrial facilities that use raw surface water, dramatically increasing maintenance and water delivery system costs across industries.

Zebra and quagga mussels latch inside pipes, valves and on dam surfaces, constricting and blocking pipes, decreasing water flow and creating a maintenance nightmare for water delivery systems, electricity-generating dams, water treatment plants, and agricultural producers.

Agricultural proponent's for invasive pest prevention efforts have asserted that every dollar spent on prevention saves twenty-four dollars in eradication efforts. However, considering the insidious nature of this pest, and the unlikeliness that it can be eradicated from a waterway once introduced, the ongoing costs to repair damage to water delivery infrastructure will be staggering.

C. Boating Recreation Impacts

Zebra and quagga mussels can cover boat hulls, cause drag, which increases fuel costs, ruin boat motors, and colonize on boating piers and launch ramps. Their presence or risk of spread can result in temporary and sometimes permanent closure of waterways to recreational boating.

The mussels easily attach and grow on engines, props, hulls, and other exterior parts of the vessel and trailer. They can live on a boat's cooling system and water intakes, causing decreased water flow, engine damage, and increased maintenance costs for vessel owners. They can cover piers, pilings, launch ramps and ultimately coat the water's edge with sharp, smelly shells.

As zebra and quagga mussels spread, local agencies are seeking direction from federal and state authority as to proper containment measures. Recently passed California Assembly Bill 1683 authorizes the California Department of Fish (CDFG) to inspect watercraft and water bodies for the presence of mussels. If mussels are detected, CDFG can order the closure of water system facilities, and recreational boating, until system operators have implemented an approved control and eradication plan. If funding is not available to implement an approved plan, recreational boating could be permanently banned thus affecting local businesses and markets tied to the local boating industry.

As of June 2009, more than 15 recreational boating waterways in California have been closed or restricted in some way due to the presence or threat of potential infestation of the zebra and quagga mussel.

D. Economic Impacts

According to reports posted by the CDFG, the zebra mussel has caused more than $5 billion dollars of damage in the Great Lake Region. According to a 1995 study, Economic Impact of Zebra Mussels, O'Neil, impacted facilities expended over $69 million in zebra mussel related expenses between 1988 and 1996. A U.S. study conducted by the Center for Aquatic Conservation at the University of Notre Dame and University of Wyoming suggests invasive species may be costing the Great Lakes region more than $200 million a year in losses to commercial fishing, sport fishing, and the area's water supply, see *http://sgnis.org/publicat/proceed/aide/pime2003.htm* (July 17, 2008). The USDA has surveyed economic impacts on their federal website, *http://www.invasivespeciesinfo.gov/aquatics/economic.shtml*. Various reports show starling and widespread economic impacts after these invasive species are introduced. And, in a letter to the Interior Secretary Dirk

Kempthorne, Honorable Senator Dianne Feinstein stated that “over the last twenty years quagga mussels and their cousin, the zebra mussel, have caused billions of dollars in damage in the Great Lakes and other water bodies south and east of the Missippippi River”.

Within the State, the Metropolitan Water District, which provides water to the Southern California region, allocated nearly $6 million dollars of emergency response funding after the quagga mussel was found in Nevada's Lake Mead in January 2007. The East Bay Regional Municipal Water District in Northern California budgeted $1.8 million dollars of emergency funding after the zebra mussel was found in nearby San Justo Reservoir in San Benito County in January 2008. And, the County of Santa Clara Parks and Recreation implemented a vessel inspection program to protect local waterways that has potential ongoing operational costs of $1 million dollar per year.

V. ACTION STATEMENT

Because the threat of introduction of this aquatic nuisance pest is a multijurisdictional problem, with staggering and undesirable economic, environmental, agricultural and recreational impacts, those agencies in the Bay Area who have chosen to become members of the Consortium have agreed to cooperate to implement a regional coordinated approach to prevent the introduction of zebra and quagga mussels. The following plan contains comprehensive guidelines for assessing risk, identifying potential vectors, implementing recreational boating inspection programs, monitoring reservoirs, and educating the public and shall form a basis of agreed uniformity for the members of the Consortium.

VI. Regulations and Regulatory Controls

A. Federal Regulations

Non-indigenous Aquatic Nuisance Prevention and Control Act (1990)

In general, the Non-indigenous Aquatic Nuisance Prevention and Control Act (NANPCA) is a Congressional act to prevent and control infestations of coastal inland waters of the United States by the zebra mussel and other nonindigenous aquatic species. The act addressed ballast water discharges by vessels in the United States, and set up various technical, advisory, and oversight agencies for setting guidelines and monitoring compliance.

National Invasive Species Act (1996)

The National Invasive Species Act reauthorized the Great Lakes ballast management program and expanded applicability to vessels with ballast tanks (as opposed to vessels which carry ballast water).

B. California State Regulations

Assembly Bill 1683 (Fish & Game Code §2301)

Signed into law in October 2007, and codified in the Fish & Game Code beginning with §2301, AB 1683 was designed to control the spread of zebra and quagga mussels within the State of California and authorized the Department of Fish & Game to inspect and quarantine infected boats, close recreational facilities, and restrict access to certain lakes. The bill gave local water operators an option to control their own waterways by implementing a dreissenid mussel monitoring and prevention program.

Section 2301 of the Fish & Game Code provides specific authority to cite a person who possesses, imports, ships or transports in the State, or causes to be planted within the waters of the State, zebra and quagga mussels; and, gives authority to conduct inspection of vehicles and vessels for the presence of zebra and quagga mussels, as well as authority to impound or quarantine any conveyance that carries zebra and quagga mussels.

Assembly Bill 2065 (Fish & Game Code §2302)

Signed into law in October 2008, AB 2065 augmented AB1683 by mandating the implementation of mussel monitoring and control plans at uninfested waterways where certain recreational boating or fishing activities are permitted. The bill specified that the owners or operators, managed privately or by a governmental agency, shall do the following:

1) Assess the vulnerability of the reservoir for the introduction of zebra and quagga mussels;
2) Develop and implement a program to prevent the introduction of zebra and quagga mussels which includes
    a. Public education
    b. Monitoring
    c. Management of recreation, boating or fishing activities that are permitted on the waterway.
3) Establish administrative penalties for failure to comply with legislated mandates.

Assembly Bill 1338 (Harbors and Navigation Code § 85.2 a - e)

Signed into law October 2008, the bill expanded the use of the money in the Harbors and Watercraft Revolving Fund to make it available upon appropriation, to the Department of Fish & Game and the Department of Food and Agriculture for activities addressing boating-related spread of invasive species.

California Fish and Game Code (§§2270-2272)

No live aquatic plant or animal may be imported into the state without prior written approval of the department pursuant to regulations adopted by the commission.

C. Local Regulations

In addition to State mandate and authority to implement and enforce vessel inspection programs, members of the Consortium may also need to review and codify specific local ordinances to support prevention efforts through local enforcement. Ordinances may include, but are not limited to, the ability to restrict access or close recreational areas, control hours or days of permissible recreational use, restrict the use of live bait, or prevent the use of a waterway by certain types of vessels. Each member of the Consortium shall review their agencies specific enforcement authority to insure appropriate ordinances are in place to support needed enforcement of agreed upon program guidelines.

VII. Vulnerability And Risk Assessment

Risk assessment includes determining which water bodies have established zebra or quagga mussels, and which water bodies in California, including those under operational jurisdiction of members of the Consortium, have a high probability of zebra mussel establishment based on a series of risk factors.

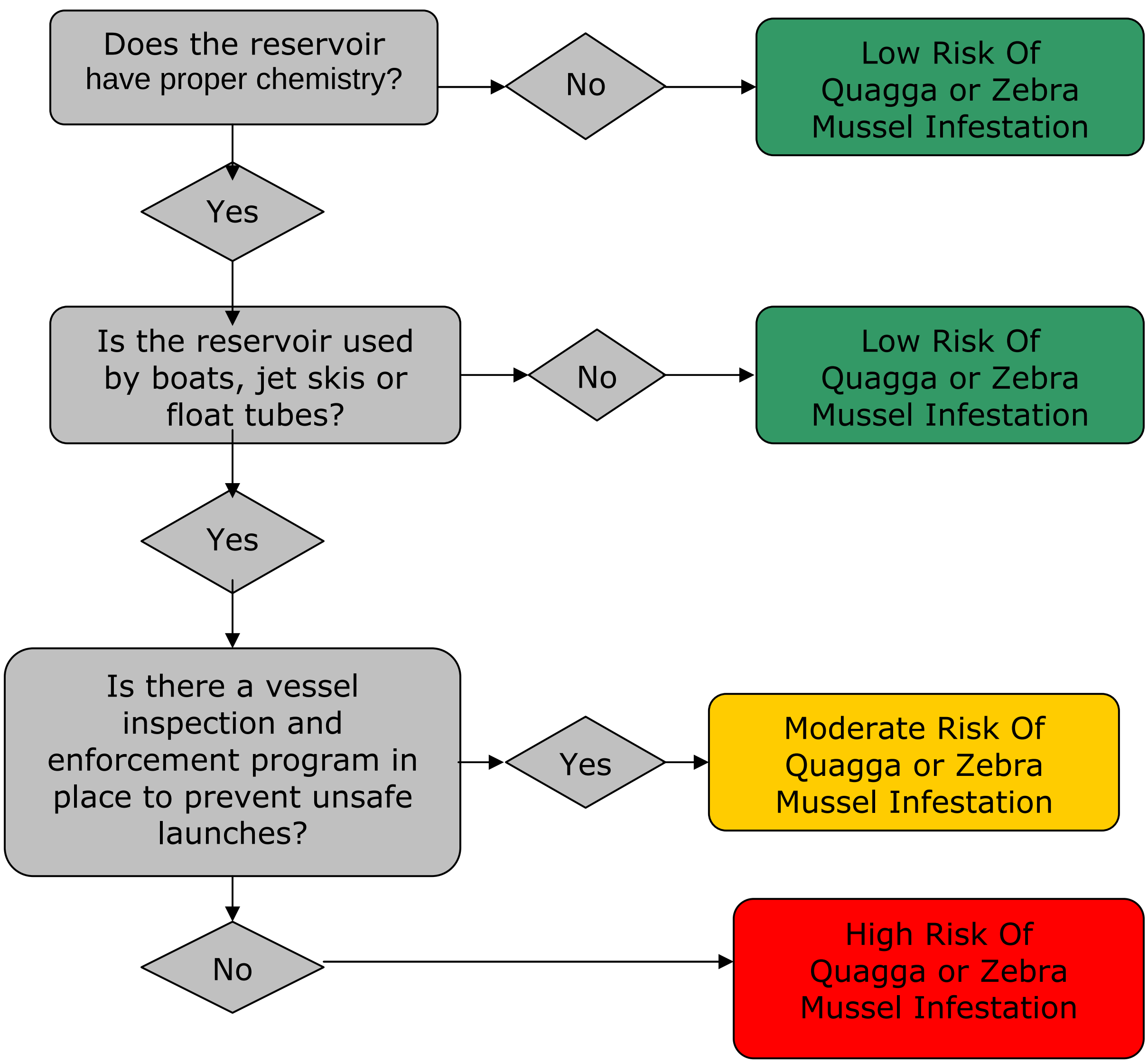
High risk areas for infestation have suitable zebra mussel habitat (based on substrate type, pH, and mineral availability), appropriate water temperatures for spawning, adequate food supplies, coupled with high levels of boating activity, lack of vessel control or inability to control recreational access, high risk importation of water, and absent or weak monitoring efforts.

Considering the rapid spread on the East Coast, any boat registered, launched or moored out-of-State is a threat when attempting to launch on local waters. In addition, because of the rapid spread in Southern California, any boat registered, launched or moored south of the Tehachapi Mountains or on San Justo Reservoir is also a risk.

In an August 2007 report, *Potential Distribution of Zebra and Quagga Mussels in California*, commissioned by the California Department of Fish and Game, author Andrew Cohen analyzed the risk of establishment of dreissenid mussels in certain state waters considering water body temperature, calcium concentrations, Ph, dissolved oxygen, and salinity. Based on his research, an assumption can be made that most watersheds and water bodies of the Central Coast that drain to the coast between San Francisco Bay and Ventura, and the San Francisco local watersheds are at high risk for colonization based on water chemistry.

In addition to scientific assessment, reservoirs can be assessed for risk based on the recreational access and whether that access is being adequately controlled.

A. Recreational Boating Risk Assessment Flow Chart



Based on risk assessment, the members of the Consortium can collectively make consistent and transparent determinations related to recreational boating access.

As of February 2008, based on current known infestations, the Consortium has agreed to the following quarantine guidelines:

Subject To Indefinite Launching Ban - **Extremely High Risk Vessels**

- Commercially Hauled Vessels
- Vessels Registered Out-Of-State
- Vessels Registered In Any County South Of The Tehachapi Mountains
    - Imperial
    - Kern
    - Los Angeles
    - Orange
    - San Bernardino
    - San Diego
    - San Luis Obispo*
    - Santa Barbara
    - Riverside
    - Ventura

*Note: Members of the Consortium recognize that Monterey County will have a challenge managing Nacimiento Lake as it has multiple uncontrolled vessel entry points that cross two Counties: Monterey and San Luis Obispo. The Consortium agrees to work with Monterey County in developing vessel inspection protocols that will allow some form of access to Consortium waters, while still properly assessing and controlling risk.

Subject To 30 Day Quarantine **– Moderate To High Risk Vessels**

Vessels <u>registered within the current permissible Consortium area</u>, but which have been launched in infested or high risk waters in the last 30 Days.

Infested or high risk waters include the following:

- Any waters out-of-state
- Any waters in a County south of the Tehachapi Mountains
- San Justo Reservoir

Subject To 5 Day Quarantine - **Moderate Risk Vessels**

Vessels registered within the current permissible Consortium area, which have not launched in an infested or high risk area, and appear at a Vessel Inspection Station wet or dirty, and un-banded, will be subject to quarantine for 5 days.

VIII. Prevention – Controlling Vectors

A. Recreational Boating - Vessel Inspection Procedures

Consistency in how vessels are inspected within the Consortium boundaries assists each agency as well as the public. The boating visitor will learn what is expected and the standard and method of inspection at one reservoir will be the same at another whether within one agency's jurisdiction, or at a sister agency's reservoir. In addition, by applying the same inspection standards, the Consortium can have confidence that allowing boats from other jurisdictions does not pose an undue risk.

To promote multi-jurisdictional consistency, boating community education, and risk reduction, the members of the Consortium agree to implement vessel inspection programs on their recreational waters and model their program after the following vessel inspection guidelines (see also Appendix B – Vessel Inspection Flowchart):

Vessel Inspection Program Definitions

> ***Vessel* -** A vessel includes trailered boats, jet skis, car top kayaks, inflatable boats, dingys and float tubes. All vessels and any associated trailer, water toys, and related equipment aboard the vessel that will or may enter the water are subject to inspection.
>
> ***Live Time Database* -** The live time database is that internet based system that the Consortium members agree to use to facilitate real time information sharing and tracking of vessel inspection activities at all waterways within the Consortium's jurisdictional boundaries.

- **Determine where the boat is registered.**
  - o Verify actual registration papers.
    - ▪ Owner / operator of a vessel with assigned CF# must present a current, valid registration card. Do not accept any other form of ID.
    - ▪ Owner / operator of a vessel with no CF# must present a current, valid vehicle registration or California Driver's License. Do not accept any other form of ID.
  - o If documentation shows the vessel is registered out-of -state, or in a county South of the Tehachapi Mountains, immediately fail the vessel.
    - ▪ Give failure/ indefinite quarantine notice (see sample Appendix D).

        - Immediately enter the failure into the shared access live time database.

    - All others continue with inspection.

        Note: A vessel with a CF# that is registered from a permissible area, yet towed by a vehicle registered from an impermissible area may still launch as long as the rear of the vehicle is clean and dry. In this situation, the vessel registration controls.

        A vessel without a CF#, brought in by a vehicle registered from an impermissible area may not launch. In this situation, because the vessel is undocumented, the vehicle registration controls.

- **Determine where the vessel has been recently launched.**

    - Out-of-state, South of Tehachapi Mountains or an infested or high risk water way, issue a 30-day quarantine from date of inspection.
        - Give failure / 30 –day quarantine notice.
        - Give *How To Clean And Dry Your Boat* notice (Appendix E).
        - Immediately enter the failure into the live time database.

    - All others continue with inspection.

- **Confirm the boat has not been previously quarantined.**

    - Check live time database to determine if vessel is clear for inspection.

    - Has a previously issued quarantine period expired?
        - If not, do not inspect until quarantine period has expired.
        - If so, confirm the boat has been properly cleaned and dry for the requisite period. If the vessel has been placed on an indefinite quarantine for suspected quagga or zebra mussel, secure a written or verbal release from Fish & Game or proof from the vessel owner that the vessel was been properly decontaminated before releasing from quarantine . Continue with inspection.

- **If not yet entered into the** live time database**,** collect the signed Vessel Inspection Intake Form (see sample Appendix C).

    - Confirm form has been properly filled out and signed.

    - Enter all information into the live time database.

- **Offer visitor DF&G "Don't Move A Mussel" handout or similar "FAQ Sheet"** to promote visitor education (see Appendix F).

- **Perform visual and manual inspection. Inspection shall include the following areas:**

  - Boat Deck
  - Boat Hull
  - Bilge & Bait Wells
  - Motor
  - Trailer
  - Fishing Equipment
  - Water Toys And Equipment That Will Or May Enter The Water
  - Rear of Vehicle

- **Record results of the inspection in the Live Time Database.**

  - If the boat is not in the live time database enter all necessary data from the intake form into the database.

  - If the boat is in the database, and passes inspection, note clear to launch.

  - If boat fails for failure to be clean and dry enter a failure / and give a 5-day quarantine notice.

  - If boat fails for suspected presence of invasive mussels, give permanent failure / quarantine notice and notify appropriate park staff so DF&G can be contacted. Enter the failure into the live time database.

    Note: If Fish & Game can not immediately send a warden or biologist to inspect the vessel on site, the vessel owner / operator will be directed to self-impound the vessel at its registered address until F&G can make contact with them. Direct the vessel owner / operator not to launch on any waterway until cleared by F&G. Make sure the information is entered into the live time database as an indefinite quarantine to protect other Consortium members from an unwanted repeat attempt to launch at another reservoir.

    The vessel will remain on indefinite quarantine in the live time database until released by an appropriate representative from Fish & Game, or administratively released after showing proof of decontamination and passing a full inspection.   Whoever receives the information that the boat has been released by Fish & Game or cleared by subsequent inspection will be responsible to remove the indefinite ban in the live time database; and must keep sufficient records documenting the name of the Fish & Game representative who authorized the release, or the documents proving the vessel was decontaminated and passed a full inspection.

- **As boats pull from the water after being inspected earlier in the day, offer a band and explain the benefits of banding.**

- Only consortium members with full physical inspection programs may place a band on a boat.

- Members of the consortium will recognize an intact band from other Consortium members.

- A vessel entering a vessel inspection station with an intact band will not need to submit to a full inspection. Instead the inspector shall inspect the band, insure that it is intact, untampered, and is a valid band from a member of the Consortium.

- If a band is lost or broken during transport, the vessel is subject to inspection and any applicable inspection fee.

- If there are obvious signs that the band has been subject to tampering, the vessel owner / operator will be given a 30-day quarantine, a notice on how to properly clean and dry the boat, and the information will be entered into the live time database.

1. Special Operational Issues

a. Consistency of Forms

Using a similar form insures that consistent, pertinent information is being collected and promotes efforts of the Consortium. Sample forms can be found in appendices.

b. Vessel Operator Refuses To Sign Initial Affidavit

The initial affidavit contains two important aspects, a consent clause to the search which provides legal authority to take further law enforcement action if contraband is found during the inspection. The operator is also certifying that the vessel has not been launched in an impermissible area under penalty of perjury. If the operator refuses to sign the affidavit, the inspection can not be properly completed. A failure notice can not be issued because an inspection has not occurred. The vessel may not launch and is simply turned away.

c. Vessel Owner/Operator Refuses Inspection

An operator may refuse to submit to an inspection, refuse to unlock an internal compartment, or refuse to allow the inspector to enter the boat without taking off their shoes. Each refusal precludes a full inspection. If a full inspection can not be completed, the inspector must fail the boat for a 5-day period.

d. What Constitutes Clean And Dry?

- All areas of the boat are free from standing water, and the vessel is dry.
- The exterior of the boat, trailer, and tow vehicle are free from mud, vegetation and debris.
- The drain plug has been pulled.
- The lower outboard motor has been flushed and drained.
- When the motor is lowered, water does not flow out.
- Live bait wells or bait buckets are completely dry.

e. Grounds For Vessel Failure or Refusal To Launch

- Mud or plant debris is found on any part of the vessel, trailer, or rear of an attached tow vehicle.
- Standing water is found in live wells, bait wells, bilge areas, or any other portion of the vessel.
- Water drains out of an engine when the outboard motor or out-drive is lowered into the vertical position.
- The vessel has been used in any body of water on the current banned county or banned waterway list.
- The vessel is registered out-of-state.
- The vessel has been commercially hauled.
- The vessel is found to have mussels attached.
- The vessel operator fails to comply with any aspect of the inspection.
- The band is from a non-Consortium member, or is a valid band that has evidence of tampering.

f. Banding Procedures

Vessel operators may elect to have their vessel banded upon departure from a Consortium waterway that operates a physical inspection program. A band will allow vessel operators to re-enter any reservoir in the Consortium without having to be re-inspected or pay an inspection fee.

Band Design

All bands used by members of the Consortium will be made of a similar tamper-proof, water-proof material identifying the agency that placed the band. Samples of current agency bands shall be made available to other jurisdiction inspectors to prevent fraudulent use of bands.

Band Placement

Towed Vessel	The band will be placed between the winch hook and eye attachments.
Kayaks / Car Tops	The inspector will attempt to place the band in a location that will break if the vessel is launched on a waterway. However, some vessel / transport configurations preclude the proper placement of a band. In this event the vessel will need to be re-inspected upon re-entry and will be required to pay any requisite inspection fee.
Missing / Broken	If a band is missing or broken, the vessel must be re-inspected regardless of the reason the operator provides. Associated re-inspection fees will apply.

Tampered or Fraudulent Bands

If a band has obviously been altered, taped, or fabricated in an effort to bypass inspection procedures, the vessel should be failed, and placed on quarantine for 30 days, and may be subject to citation based on the local jurisdiction’s enforcement authority.

g. Wet Weather Inspections

During wet weather, it is not possible to safely conclude whether the source of the water on the boat is from rain, or from a previous launch.

- If the boat arrives banded, but wet, the boat will be permitted to launch.

- If the boat arrives covered and fully dry on the inside, and only exhibits wetness on the exterior parts of the boat from road splash or rain, the boat will be permitted to launch after passing all other portions of the inspection.

- If the boat arrives wet on the inside, the boat will be failed and quarantined for 5-days.

h. How A Vessel Gets Released From Quarantine

Once a vessel has been quarantined, the operator will be given a failure notice indicating the period of quarantine and the reason for quarantine; and information on how to properly clean and dry the vessel (Appendix E). At the expiration of the quarantine period, the vessel operator will be required to pass a new inspection.

Information given to operators of failed boats shall include the following:

- Review the *Vessel Failure Notice* . Tell the owner / operator how long the vessel has been quarantined.

- Advise the owner / operator not attempt to launch the quarantined vessel on any reservoir in any part of the State until the quarantine period has expired.

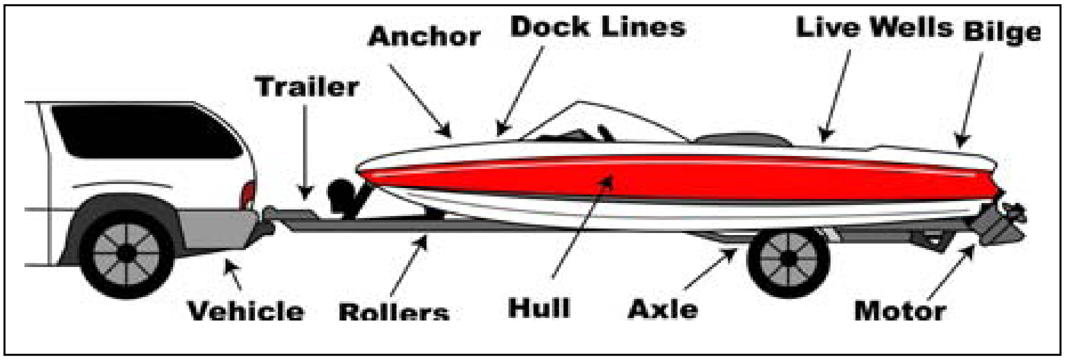
- Give the owner / operator a notice on how to properly clean and dry the vessel as recommended by the California Department of Fish & Game (see Appendix E):

  - Thoroughly wash the hull of the vessel, trailer and rear end of the vehicle used to launch the vessel.

  - Use hot water from a high-pressure hose when possible during all cleaning operations.

  - Physically inspect all exposed surfaces. All rough surfaces must be cleaned until they are smooth to the touch.

  - Remove all aquatic plants from the boat, motor and trailer and rear end of vehicle. Place aquatic plants in the trash.



- Check and clean all underwater fittings, such as rollers, axle, bilge and trailer, and above water equipment, such as anchors, live wells, and docks.
- Drain water from all equipment including the motor, bilges, live wells, bait buckets, and coolers. Ensure all areas are completely dried.
- Ensure the watercraft's lower outboard unit is drained and dry.
- Pull the boat plug, and leave out until the next inspection.
- Dispose of all live bait in the garbage. Do not use live bait on the next visit.
- For personal watercraft, impeller areas can contain water. While on the trailer, run the engine for 5 to 10 seconds to blow out excess water.
- Once the vessel has been properly cleaned and dried, the owner must let it sit for the entire quarantine period.

- Advise the owner / operator that they will be required to pass a new inspection after the quarantine period expires.
  - NOTE: Certain jurisdictions have special ordinances related to storm water run-off. Advise the owner / operator to select vessel washing methods that comply with their local storm water run-off ordinances. These ordinances are not consistent amongst Consortium members, so the owner / operator will need to consult local websites for further information to insure compliance with local ordinances.

i. Vessel Inspection Training Standards

Vessel Inspectors shall receive vessel inspection training, following the current guidelines set forth by the Department of Fish and Game. Consortium members will keep records of all training.

j. Limited Inspector Discretion

To limit confusion and promote consistency amongst program operators, inspectors shall follow these guidelines with limited discretion to deviate. Deviation confuses the public, causes complaints and undermines the credibility of the program.

k. Consistency In Signage

To promote an identifiable message, members of the Consortium will use similar signage in communicating their vessel inspection program to the public. Vessel Inspection Program sign samples are provided in Appendix H.

l. Suspected Mussels on Inspected Vessel

All suspected mussel contaminations must be immediately reported to the Department of Fish & Game. The issued failure notice should indicate that failure is indefinite until the Department of Fish & Game has cleared the vessel for launch in State Waters. Members of the Consortium shall immediately enter the failure in the live time database, so other Consortium members can protect their water ways. If F & G can not immediately respond to verify the suspected infestation, and the vessel owner / operator is permitted to leave the site, advise the owner / operator that their vessel is self-quarantined at the address on the registration papers until Fish & Game has inspected and released the vessel.

A vessel under indefinite quarantine for suspected mussel contamination will not be permitted to launch on any consortium reservoir unless released by the Department of Fish & Game.

m. Wake Board Bladders and Boats with Ballast Tanks

Wake Board Bladders are not permitted as they can not be adequately inspected.

Ballast Tanks must be completely dry, or the vessel will be failed. If the ballast tank design precludes proper inspection, the vessel must be failed.

n. Bass Tournaments and Special Events

Each consortium member will evaluate requests to hold Bass Tournaments and / or special events for potential risk to the reservoir; and make determinations to allow or disallow the event consistent with the policies and procedures outlined in this prevention plan.

B. Live Bait – Shoreline Fishing

Wet live bait is a potential source of introduction of zebra and quagga mussels. All wet live bait, like minnows, shall be banned from the vessel Dry live bait, like worms and night crawlers, may still be used.

Consortium members agree to take steps to preclude use of shoreline bait along their shores by creating applicable ordinances, posting signage, and implementing education and enforcement efforts.

C. Fish Plants

Fish plants are a potential source of introduction of dreissenid mussels. Unless the provider of the fish plant can verify that they are a registered California Fish & Game aqua culturist, and are willing to sign a declaration that they are complying with the terms of their registration agreement with Fish & Game, the fish plant should be refused (see Appendix G – Draft Guidelines to Reduce the Risk of Quagga/Zebra Mussels in California Aquaculture)..

Consortium member's will inquire where the last plant occurred, if the any portion of the vehicle touched the previous waterway, and if so, what steps the operator of the vehicle took to clean and / or decontaminate the rear of the vehicle used to plant the fish. If necessary, the rear of the fish plant truck will be inspected to insure it is clean and dry.

D. Importation of Water

Importation of water is a potential source of introduction of zebra and quagga mussels. All risks should be considered by an importing water agency and any suspected or known exposures should be communicated to Consortium members to mitigate risk to other bodies of water in the Consortium.

E. Dredging and Infrastructure Repair Equipment

Occasionally, a water agency may contract with various companies for dredging, drilling or infrastructure repair. When the work requires equipment to enter the water, the contracting agency should fully screen the operator related to where the equipment was last used, and consider whether the equipment should be properly de-contaminated and / or cleaned before entering the waterway, to prevent risk of exposure to other Consortium members.

IX. PUBLIC EDUCATION AND OUTREACH

Each member will develop a public education and outreach program that will include the following elements:

- Post signage at all reservoirs related to the existence of the Vessel Inspection Program.

- Distribution of brochures and / or leaflets to park visitors related to the risk that quagga and zebra mussels pose, and how visitors can help mitigate that risk.

- Post information on the agencies website with cross-links to the websites of consortium members, the California Department of Fish & Game, and any other site deemed relevant related to quagga and zebra mussel prevention.

X. RESERVOIR MONITORING

This section provides instruction and information for executing the zebra and quagga mussel monitoring program at consortium reservoirs. At minimum, either surface water samples will be collected and analyzed for veliger phase zebra and quagga mussels; or, biological substrate samplers will be deployed and monitored for early adult settlement stage mussels, at least one time each month. Optionally, surface surveys, dive surveys, and ROV inspections may be performed on an ad hoc basis. The shared objective of mussel monitoring is as follows:

- To provide early warning detection of zebra and quagga mussels in reservoirs that provide boating, fishing and aquatic recreation;

- To prevent adverse impact of mussel infestation and growth in recreation reservoirs;

- To prevent the spread of mussels into other water bodies;

- To control and treat mussel populations in surface waters.

The consortium members are encouraged to coordinate with Fish & Game for recommendations related to the best monitoring practices at various waterways in their jurisdiction. Each agency will strive to implement these recommendations where possible after considering budgeting, staffing and other resource constraints.

A. Quagga and Zebra Mussel Identification

<u>Veliger Monitoring</u>

Mussel veligers are identified by laboratory analysis. The parameters monitored and the detection limits are as follows:

Cross polarized light microscopy (CPLM)	presence/absence/density
Polymerase chain reaction (PCR)	presence/absence

<u>Artificial Substrate Monitoring</u>

Early stage adults are identified in the field by visual or tactile inspection, or by laboratory microscopic inspection. The parameters monitored and the detection limits are as follows:

Visual identification settlement	presence/absence

<u>Surface Survey</u>

Mussel adults are identified in the field by visual inspection. The parameters monitored and the detection limits are as follows:

Visual identification adult settlement	presence/absence

B. Reservoir Priority

All reservoirs that permit recreational boating <u>must</u> be monitored for adult and veliger mussels at least one time each month. Water bodies that do not permit recreational boating, but are open to the public, and permit fishing, body contact, or receive raw water transfers from the source water distribution system, or areas downstream of the reservoirs <u>should be</u> monitored once a month for mussels at the agency's discretion, as they are also at risk for mussel contamination and facilitate the spread of mussels to nearby water bodies.

C. Sampling / Testing Methods

There are two basic types of mussel monitoring:

1) sampling the water column for veligers (larval forms); and
2) the detection of adults attached onto various surfaces.

Four monitoring methods are available to detect the occurrence of both the veliger and adult life stages of mussels: veliger plankton sampling and analysis; early settlement; surface survey; and dive survey. General monitoring protocols developed by the California Department of Fish and Games (DFG) are included in the Appendices I, J, and K for reference.

Veliger Sampling (VS) – Veliger sampling with a plankton tow net provides the greatest chance of early detection. Samples are analyzed using either the polymerase chain reaction (PCR) or cross polarized light microscopy (CPLM) methods. (See Appendix A)

Artificial Substrate Monitoring (AS) – Artificial substrate samplers provide the simplest detection monitoring approach. Sampling consists of suspending substrate material (i.e. sections of ABS or PVC pipe, Plexiglas or plastic plates, concrete bricks, etc.) in the water column at various depths. Settling stage invasive mussels can be detected when attached to the sampler. (See Appendix B)

Surface Survey (SS) – Surface surveys are conducted in shallow streams and shorelines depending on changing water surface elevations, where appropriate hard surfaces are safely accessible. Surfaces are inspected visually and by touch for adult mussels. (See Appendix C)

Dive Survey (DS) - Dive surveys are useful for surveying relatively small and high risk areas such as marinas and intakes. They are most useful in response to a newly discovered infestation or to find an adult population that has been indicated by veliger or artificial substrate samples. Divers search for mussels on the surfaces of boats, docks, retaining walls, and other submerged structures (especially concrete).

For veliger sampling, individual nets and dedicated sampling gear will be used for each reservoir and facility location to prevent cross-contamination, OR the nets and sampling gear will be decontaminated between monitoring sites per DFG decontamination protocols. Collected samples will be preserved in the field with 20-25% ethyl alcohol and analyzed by laboratory staff using CPLM. If CPLM reveals the presence of veligers, confirmation samples will be taken and sent to the Scripps Laboratory for PCR analysis. A list of analytical laboratories performing mussel CPLM and PCR analyses is listed in Subsection I. Agency Information.

Scheduling

At least one method of mussel monitoring as presented in this prevention plan will be conducted on a monthly basis at reservoirs that permit recreational boating. Confirmation analysis and surface/dive surveys may be conducted on an ad hoc basis. The next sampling event at a specific location using the dedicated gear will not be conducted until laboratory analytical results determine that the previous sample was veliger (mussel) free.

D. Monitoring Protocols

Veliger Surveys

Zebra and quagga mussels have a planktonic, larval life stage (microscopic, free-swimming in water column) and in this stage are referred to as veligers. Veligers range in size from 70-200 microns (µm). Veligers are sampled using vertical plankton tow field procedure, using a 63-µm plankton tow net (maximum mesh size).

To optimize the likelihood of capturing veligers if they are present, several tow transects should be made at various locations within a lake/waterbody. Sample at a variety of areas, including near boat ramps, open water, near water outflows and inflows, downwind areas, and eddies, or areas where plankton collects (i.e., behind islands, etc). Tows may be horizontal or vertical through the water column. To do this, lower the net to 1 meter above the bottom and pull up to the surface. Individual waterbodies (size, depth, productivity, suspended solids, etc.) and equipment (net diameter, mesh size) will vary, so adjust sampling accordingly. Discrete samples from individual tows from the same lake/waterbody can be composited into a single sample container for laboratory analysis.

To perform a tow along a dock or bridge, attach tow rope to the mouth of the net, and lower the net into the water to the desired depth. Slowly retrieve the net by pulling back the rope in a steady, hand-over-hand motion at about 0.5 m/s (e.g., if the tow distance is 20 m, retrieval should take 40 seconds). Pulling too fast will cause a pressure wave in front of the net that pushes water and plankton away from the mouth of the net, and does not effectively sample the desired volume of water. Record the distance of each tow on the field log data sheet. Rinse net contents into sample bottle between each tow using a squirt bottle of DI water and washing down the sides of the net into the collection cup. Transfer the rinsate in the collection cup to a sample bottle and add ethyl alcohol to sample to ensure preservation at 20-25% ethyl alcohol. (i.e. 105 ml 95% Ethanol added to 395 ml rinsate) for CPLM analyses.

For PCR analyses, samples must be kept chilled, shipped overnight on ice, and be processed within days. Label the outside of the sample container with the lake/waterbody, date, time, analysis (i.e. mussel veliger CPLM) and sampler.

Contact laboratory for CPLM or PCR analyses to process the samples Preserve plankton per laboratory specifications. Depending on your lab and the method of sample analysis, preservation method may vary. Know your lab's protocol prior to collecting samples. When making several tows keep sample on ice between tows and add alcohol after tows are combined. Dilutions for final solutions and different alcohol percentages can be calculated at the following website:

http://www.restrictionmapper.org/dilutioncalc9.htm .

Maintain a field log of plankton tows, and complete a laboratory Chain of Custody for each analytical sample. For the field log, record the date, location, and time each tow sample was collected. For individual transects, record the net diameter, mesh size, and distance (i.e., depth) of each tow, and calculate the actual water volume sampled. An example of a field log data sheet for plankton tows is available in the Zebra and Quagga Mussel Veliger Sampling Protocol Vertical Tow in the appendix.

Artificial Substrate Monitoring

Artificial substrate samplers include plates, pipes, concrete blocks, or any material placed in the water for mussel settlement. In addition, buoys, docks, or other structures placed in the waterbody can be routinely monitored for mussel settlement. A description of the construction and assembly settlement plates sampler is presented in the Mussel Artificial Substrate Monitoring Protocol in Appendix J.

Ideal sites for placement of substrate samplers are areas with high boat traffic such as docks, ramps, and marinas with as much protection from vandalism as possible. Other sites include water quality monitoring stations or towers and government agency boathouses.

The deployment and inspection of the artificial substrate is described in Appendix J. One to two substrates are deployed per site. Depending on water clarity and depth, the artificial substrate is set at a depth of at least 6 feet, and at least two few feet above the bottom for shallow areas. At deeper sites, a second substrate is installed at a depth to 15 meters (50 feet).

A visual and tactile examination of the artificial substrate should be conducted every month for attached zebra and quagga mussels. At early settlement stage, mussels first feel like sand paper. In 1 to 2 months a mussel grows large enough (1/4 inch) to be seen upon close inspection and feels like a small pebble or sunflower seed. Visually inspect each plate (top, bottom, and sides), the spacers, the cable and the weight, and gently feel any attached organism. If no mussels are detected, lower the substrate back into the water.

Suspected substrates are collected and taken to the laboratory for microscopic analyses. To aid identification, first take a close-up digital photograph of each specimen. Next, collect the specimen(s) and place in a vial preserved with 20% to 25% ethanol. Label the vial with location, date, and name of collector. Place the artificial substrate in a large ziplock bag or small garbage bag and keep it in a cooler with ice while in the field, and store the substrate in the freezer until "overnight delivery" on ice to the laboratory. Replace the substrate in the field with a new one.

Never transfer substrates from one site to another, or from one water body to another, to prevent any possibility of contamination between monitoring sites (should mussels be present and not yet detected).

Record the inspection of the substrate on field datasheet even if no mussels are found; absence data is as important to document as presence data. An example of the artificial substrate field datasheet is presented in the Zebra and Quagga Mussel Artificial Substrate Monitoring Protocol in Appendix J.

Surface Surveys

Each agency may also conduct a visual and tactile search for mussels over hard and soft substrates in a wade-able area, by gently running fingers over smooth surfaces, and checking for gritty, sandpaper feeling. Areas to include in the surface survey include:

- Dock floatation, buoys, and mooring lines.
- Cables, rocks, concrete, logs/drift wood, vegetation, and anything that has been in the water for a long time.
- Pull up and inspect any substrate that is under water.
- Trap lines and any line or cable hanging in water.

Visually inspect both hard and soft substrates, and gently stir up silted areas to expose mussels. Inspect dark areas (dark substrates and low light/shaded areas); quagga and zebra mussels prefer dark substrates and low light/dark areas. Search areas at or near boat ramps, docks, marina, all concrete structures, and low flow areas. The minimum linear feet to be searched per substrate type are as follows:

- Boat ramp bottom – 100ft if the ramp is at a marina, 200ft if the ramp is the only structure at the survey location.
- Shoreline - 100ft if at a marina, 200ft if at a survey location with only a boat ramp
- Dock - 200ft
- Mooring/dock lines (portion hanging in water) - 200ft
- Anchor/dock cable or chain (portion under water) - 100ft
- Concrete structures - 100ft
- Logs and woody debris – 100ft
- All accessible buoys

The survey is complete before meeting the minimum linear feet if mussels are found in 3 or more areas within the survey location, or if all available substrate has been searched.

If mussels are present, record the water body, the lat/long or GPS coordinates of the mussels' location(s) and sketch/describe location(s) (e.g. nearest landmark, etc.) on the datasheet. An example of surface survey datasheet is available at the DWR website provided in the Zebra and Quagga Mussel Surface Survey Protocol in Appendix K.

Record the type of substrate(s) the mussel(s) was found on (for example, concrete, plastic, rope, chain, buoy, etc). Make counts of mussels at up to 3 locations within the survey site. If more locations are found, make a note in the "Comments" section. At each of the 3 mussel locations, take density estimates using one or both methods:

- **Petri Dish:** place Petri dish over surface. Count all mussels within circle.

- **Ruler:** place ruler adjacent to mussels. Count all mussels within one inch of ruler.

If you cannot see the mussels, count the mussels using touch. If entire ruler cannot be placed on surface, record length of ruler used. Collect 5 density estimates per mussel location.

Collect 4 to 5 specimens, and place in ziploc bag with sample label indicating location, lat/long or GPS, date, and name of collector. Seal dry and put in freezer. If other species of clams or mussels are found, collect 1 or 2 specimens. Preserve the specimens in ethanol, rubbing alcohol, a freezer, or allow to air dry.

E. Cleaning and Storing Sampling Equipment

Dedicated sampling gear will be used to prevent cross-contamination and reduce the risk of spreading zebra and quagga mussels. One set including a plankton net, rope, bucket, wash bottle, etc., will be used per site. The sampling gear is not used again until an 'absent' result is received from the analytical laboratory indicating that mussels are not present.

After a positive sample for adult or veliger mussels is received from the analytical laboratory or observed in the field, any field equipment and sampling gear that came in contact with the water must be decontaminated. Equipment decontamination procedures using vinegar or bleach solutions or thermal washing are described in the veliger sampling protocols in Appendix I.

If trailering a boat from a different water body, decontaminate the boat, trailer, vehicle, and equipment before transporting. Vessel decontamination procedures using thermal washing is presented in the veliger sampling protocols in Appendix I.

F. Data Recording and Reporting

If mussels are found, immediately contact the appropriate DFG regional mussel contact, see Appendix A – Consortium and Agency Contact List.

Every time a survey is made the data must be recorded on a datasheet before leaving the field. Send datasheets, or modified summary data to the appropriate DFG regional contact as requested. All data should be entered into the agencies' data reporting system, and the datasheets should be retained on-site.

Examples of field datasheets are available at the DWR Environmental Services web site:

http://www.des.water.ca.gov/docs/datasheet%20%20surface%20survey.pdf

G. Monitoring Reports / Record Keeping

Veliger Sample Results

Sample results will be sent by the laboratory with a standard turn-around-time of 2 weeks for non-detects (Absence). The lab will verbally notify the agency immediately for positive results (Presence). If veliger sample is positive, immediately schedule a follow-up sampling event in order to collect confirmation samples with rush turn around, and verbal notifications.

If Artificial Substrate sample is positive, immediately send plate to the laboratory for microscopic identification of adults, and to DWR and/or DFG for expert confirmation. Immediately schedule a follow-up sampling event in order to collect confirmation samples with rush turn around, and verbal notifications.

Veliger Confirmation Samples

Follow the sampling steps for veliger monitoring as presented above. However do not preserve confirmation samples in ethyl alcohol. Immediately place the sample on ice and freeze to preserve sample. Send the confirmation samples to Scripps Laboratory for PCR analysis (Presence/Absence) with rush turn around and verbal notifications.

Artificial Substrate Confirmation Samples

Follow the sampling steps for artificial substrate monitoring as presented above. However Do not preserve confirmation samples in ethyl alcohol. Immediately place the sample plate on ice and freeze. Send the confirmation sample plate to Scripps Laboratory for PCR analysis (Presence/Absence) with rush turn around and verbal notifications.

H. Local and Regional Notification

Each agency should have a communication response plan as an integral part of their mussel monitoring plan that includes personnel roles and responsibilities, and including agency notification guidelines for reporting suspected or confirmed presence of mussels to external agencies, media and the public. Each agency is responsible for implementing their communication plan and notifying regulatory authorities.

For this plan, each consortium partner agency will identify a contact responsible for communicating monitoring results between the other partner agencies. see Appendix A – Regional Consortium Member Contact List.

For the regional consortium reporting, two levels of reporting exist for 'suspected presence of mussels' and 'confirmed presence of mussels'. It is assumed that mussels are not present in the waterbodies monitored by the consortium agencies until a suspected or confirmed presence is detected. If veliger or adult mussels are suspected from monitoring results, the reporting agency will immediately notify the consortium partner contact of the suspected presence of mussels. If veliger or adult mussels are determined to be present in the confirmation sample, the reporting agency will immediately notify the consortium partner contact of the confirmed presence of mussels. The notification will consist of the reporting agency, the level of reporting (i.e. suspected or confirmed presence of mussels), waterbody name, date, type of monitoring, and analytical method. Each consortium partner agency will determine the level of response for accepting or banning boaters from the reporting agency's waterbody or jurisdiction (i.e. quarantine guidelines, honoring inspection bands, etc).

This information must be reported to those agencies that control the recreational boating on the reservoir if different from the water agency.

XII. APPENDICES

Appendix A – Consortium and Various Agency Contact List

Appendix B – Vessel Inspection Flow Chart

Appendix C - Sample Vessel Inspection Intake Form

Appendix D – Sample Vessel Inspection Failure Form

Appendix E - How To Properly Clean and Dry A Boat Flyer

Appendix F - Don't Move A Mussel Flyer

Appendix G - Draft Guideline To Reduce The Risk of Quagga/Zebra Mussels in California Aquaculture

Appendix H – Sign Samples

Appendix I- Zebra and Quagga Mussel Veliger Sampling Protocol Vertical Tow California Department of Fish and Game

Appendix J - Zebra and Quagga Mussel Artificial Substrate Monitoring Protocol California Department of Fish and Game

Appendix K- Zebra and Quagga Mussel Surface Survey Monitoring Protocol California Department of Fish and Game

Appendix E: San Justo Reservoir Eradication Project Monitoring Plan

Zebra Mussel Monitoring Plan for San Justo Reservoir and the Hollister Conduit and Distribution System

PREPARED FOR: San Benito County Water District

PREPARED BY: CH2M HILL

DATE: January 31, 2011

Introduction

Zebra mussels were first observed in San Justo Reservoir (SJR) in January 2008, and subsequently in the Hollister Conduit (HC) in January 2009. Since January 2008, zebra mussel infestation levels have increased dramatically in SJR. This potentially destructive mollusk is also presumed to be present in parts of the Distribution System (DS) that is connected to the HC via ten turnouts to provide Central Valley Project (CVP) water to agricultural and urban customers. SJR and HC are owned by the United States Bureau of Reclamation (USBR) and the San Benito County Water District (SBCWD) operates and maintains both these systems. SBCWD is currently working with the USBR on a plan to eradicate zebra mussels in SJR, HC and the DS.

The rationale and details of the plan for the eradication of zebra mussels from the SJR, HC and DS are being developed in SBCWD's Notice of Proposed Mitigated Negative Declaration for CEQA compliance (SBCWD 2011). To summarize, this eradication plan is two-fold and involves: (1) the treatment of San Justo Reservoir using 'muriate of potash' (potash or potassium chloride); and (2) the treatment of the Hollister Conduit in combination with District-owned water delivery conveyances (pipeline system) using potash. This two-fold eradication will be implemented concurrently, as eradicating zebra mussels in the reservoir without eradicating them in the HC and DS, and vice versa, would allow re-infestation of both appurtenant infrastructures.

For eradication treatment, the preliminary plans are to draw down SJR to a water surface elevation of between 455 and 470 feet, (personal communication with SBCWD staff), close the valve connecting SJR to the HC and DS, and treat the water in SJR, HC and DS with potash (typically beginning in November, when there is no water demand by agricultural customers) to achieve a potassium "kill" target concentration of 100 parts per million (ppm). Treatment of the HC and DS will require either treating SJR with potash and then opening the valve to charge the HC and DS, or treating HC and DS concurrently, but independently, using chemical feed stations. The reservoir drawdown has two purposes: (1) it exposes zebra mussels near the surface elevations to the air and causes desiccation-related mortality, and (2) it reduces the pool of water that needs to be treated with potash to kill the remaining mussels in the reservoir. Based on the results of a previous pilot study on desiccation of zebra mussels conducted at SJR by USBR (Chapman and Greunhagen 2010) and additional information provided by SBCWD, the length of drawdown-related desiccation and contact time with the kill concentration of potash in the reservoir, HC and DS is assumed to be between 2-3 months (Treatment Period).

The purpose of this technical memorandum is to develop an implementable monitoring plan for confirming the eradication of zebra mussels from SJR, HC and DS during, and following the Treatment Period. Specifically, the purpose of the monitoring plan is to provide the monitoring methods needed to:

1. Confirm that eradication of mussels is occurring during the Treatment Period and that mussels have been eradicated immediately following the Treatment Period, and,
2. Verify the continued non-presence of zebra mussels in the longer-term after the Treatment Period.

Monitoring Plan for San Justo Reservoir

A multi-pronged monitoring and testing approach, that builds upon previous monitoring plans for mussels in SJR, and that targets various life stages of the mussels including veligers, newly-settled mussels and adult mussels, is recommended for a comprehensive assessment of the efficacy of the eradication treatment. The monitoring will be conducted for:

- Evaluation of mussel mortality along the shoreline exposed by the reservoir drawdown (desiccation-related mortality) and for,
- Mussels within the water body contained by the reservoir (mortality caused by potash treatment).

The monitoring will be supplemented concurrently by bioassays for the potash treatment to track mortality in a more controlled set of mussels exposed to similar treatment conditions.

Exposed Shoreline Survey for Desiccation Treatment

The reservoir drawdown will expose a significant portion of the SJR shoreline. Zebra mussels that have settled in this portion of the shoreline will be exposed to the air, and over time will be subjected to desiccation. The shoreline surveys will monitor for dead mussels in a variety of locations along the exposed SJR shoreline, including those areas where the pilot desiccation study (desiccation bioassay) was conducted by USBR in 2010 (Figure 1, Chapman and Greunhagen 2010).

The purpose of the USBR desiccation bioassay study was to assess the length of time the reservoir needed to be kept low during the cool and wet winter months (conditions that favor mussel survival) to ensure that the aerially-exposed populations of mussels were fully desiccated. Tests were conducted by exposing three size classes of zebra mussels (< 5 mm, 5-15 mm, > 15 mm) to a range of conditions (sheltered, unsheltered – to simulate shading and wind protection) at various locations along the SJR shoreline that typified various substrate habitats (Figure 1). Observations for mussel mortality were conducted at 1, 10, 20 and 40 day intervals and results indicated that some mussels appeared to be alive at 20 days, but following desiccation for 40 days, most mussels were dead. However, a small fraction of the mussels (especially small mussels) observed at 40 days had flesh inside a tightly closed shell and it was uncertain whether these mussels would have revived if re-submerged. Based on these observations, it was recommended that the reservoir should be kept low for a period between at least 2-3 months, if possible, to maximize mussel eradication via desiccation.

Figure 1. Aerial image of the shoreline of San Justo Reservoir and locations (red numbered markers) where USBR conducted the desiccation bioassay study in 2010. The locations represent various habitat characteristics: (1) Dike Face with Large Boulders, (2) Geo-membrane Underlain Area with Small Rocks, (3) Point Area with Mid-Sized Rocks, (4) Muddy Area, (5) Reed Area, (6) Dam Face with Large Boulders. Adapted from: Chapman and Greunhagen (2010).

Shoreline Monitoring Protocol

- Shoreline surveys are conducted by walking as much of the exposed SJR shoreline as possible, close to the treatment water elevation, and will also include areas where the 2010 USBR desiccation bioassay study was conducted (Figure 1).
- Initial shoreline monitoring will commence one week after start of the potash treatment in the reservoir, following which monitoring will occur every two weeks.
- During these surveys, the exposed reservoir perimeter will be checked for any visibly-exposed mussels and for the presence of mussels on a variety of substrates

and "micro-habitats" including exposed crevices, pools of water, under exposed overhanging rock ledges, on and under loose rocks, attached to exposed vegetation on exposed mud surfaces, and any other exposed substrates that are encountered.

- When pools of water are encountered, their locations will be marked and recorded by GPS for closer examination in subsequent surveys. Small pools will be monitored for drying in subsequent surveys. Larger pools may be targeted for additional treatment (e.g., treated with kill concentration of 100 ppm potash, drained or pumped dry).
- Mussels detected during these surveys will first be quickly checked on-site for obvious signs of stress and/or mortality such as gaping and unresponsiveness to prodding of the exposed mantle with a dull probe, visible signs of desiccated tissue.
- At a particular location, when the numbers of detected mussels are relatively small (approximately < 100 mussels), all mussels are collected, placed in aquaria containing untreated reservoir water on-site and checked daily until they either recover (responsive to prodding) or show unmistakable signs of mortality.
- When the number of detected mussels at a location is large (> 100 mussels), the GPS location is noted and up to 100 mussels representing a range of mussel sizes (if possible) are collected, placed in aquaria and checked daily for either recovery or unmistakable mortality, as described above.
- Continue monitoring the exposed shoreline once every 2 weeks until two consecutive surveys find no live mussels, or up to the time when water level in the reservoir needs to be raised again.

Bioassay (for Shoreline Dessication Treatment)??

Complements the Pilot Test conducted by USBR in 2010; allows a more controlled assessment of mortality over time under a variety of aerial exposure conditions.

Reservoir Surveys for Potash Treatment

A key component of the reservoir surveys is the use of various monitoring and sampling techniques that target different life stages of the zebra mussel (veligers, newly-settled, and adult mussels) – this approach, used concurrently with a potash treatment bioassay in the reservoir, will allow for a robust assessment of whether, and how well the potash treatment is working to eradicate mussels from the reservoir.

Reservoir Monitoring Using Substrate Samplers

This monitoring method relies on deploying clean substrate samplers, or settling plates (Figure 2) to periodically check for newly settled mussels in the reservoir. If a new settlement of mussels is detected, it indicates the presence of viable mussels in the reservoir, and in particular, the presence of pre-settlement stages of veligers in the water column. Settlement of zebra mussels in San Justo Reservoir occurs mostly between June and October, with little settlement occurring between November and May (Veldhuizen and Janik 2010; based on 2009-2010 data). During monitoring, caution therefore needs to be exercised in the interpretation of no new settlement detections during November to May as representative of eradication effectiveness. Long term monitoring, that includes the summer period when mussel settlement is known to peak, will be essential.

Figure 2. Substrate sampler used for monitoring zebra mussels. Photo Source: CDFG and CA DWR

Construction, assembly and deployment instructions for the substrate sampler, including an example datasheet for recording settlement information, are provided by the California Department of Fish and Game (CDFG 2011).

Protocol for Monitoring with Substrate Samplers

Short-Term – During Eradication Treatment

- One week after start of the potash treatment in the reservoir, deploy the substrate samplers at various locations in the reservoir (Figure 3), following which monitoring will occur once every two weeks.
- At each location (Figure 3), deploy two sets of substrate samplers, one at 5 ft. below the water level and the other adjacent to it, at 15 ft. below the water level. These depths are based on recent data from SJR indicating that mussel settlement in the reservoir peaks between 5 ft. and 15 ft. (Veldhuizen and Janik 2010). If the bottom of the reservoir at a certain location is at less than 15 ft depth, then deploy the sampler 1-2 ft. above the bottom, and record the actual sampling depth.

- After initial deployment of the samplers, monitor the samplers for mussel attachment once every two weeks. To check for newly settled mussels, carefully lift the sampler out of the water, taking precaution to not dislodge or crush any attached mussels. Carefully perform a visual inspection of each plate (top, bottom, and sides), the spacers, the cable and the weight. Note and record any attached zebra mussels if they are clearly visible (a field magnifying glass may prove to be helpful as newly attached mussels are very small).
- Along with the visual examination, perform a tactile examination of the sampling substrate, taking care not to press down too hard. This is necessary because when mussels first attach, they are very small, practically invisible and are easily crushed. A single mussel may feel like a grain of sand. If many mussels cover a surface, the surface feels gritty like sandpaper. Based on the visual and tactile examinations of the substrate sampler, it may be necessary to scape all suspected mussels off the samplers into a bag or vial for closer examination under a dissecting microscope to positively confirm the presence of newly settled zebra mussels. Record the presence (or suspected presence) of any mussels on the substrate samplers. Redeploy the cleaned sampler at the appropriate depth.
- If no mussels are detected, lower the sampler back into the water and check again during the next monitoring period. Zebra mussels are more likely to attach to a substrate that has some algal growth. If the substrate however becomes too heavily coated with algae, it may be unsuitable for mussel settlement. As necessary, gently remove heavy accumulations of algae to maintain suitable conditions for settlement.
- Monitoring will continue until two consecutive surveys find no live mussels, and the reservoir bioassay (see below) records 100% mortality.

Long-Term Post-Eradication Treatment Monitoring

- The post-eradication monitoring period begins after the 2-3 month treatment period when the reservoir water level is lowered and the potash is applied.
- The long-term monitoring specifically targets the warm summer period (June – October) when newly settled mussels are abundant in SJR (Veldhuizen and Janik 2010).
- Monitoring with substrate samplers will occur at the same depths and general locations, and as per the protocol for short-term monitoring, recognizing that sampler locations will have to be moved to deploy the samplers at 5 ft and 15 ft when the reservoir levels are raised.
- Monitoring will occur once every month, during June to October (5 separate sampling periods) in the same year as the eradication treatment is completed, and once every month during June to October (5 separate sampling periods) the following year. For example, if the 3 month treatment period ends in February 2012, the long term monitoring period for newly settled mussels will span a period of approximately 20 months, during which monitoring will occur on 10 separate occasions over 2 consecutive summers.

- Eradication measures are considered to be successful if no new settlements of mussels are detected after post-eradication monitoring over 2 consecutive summers.

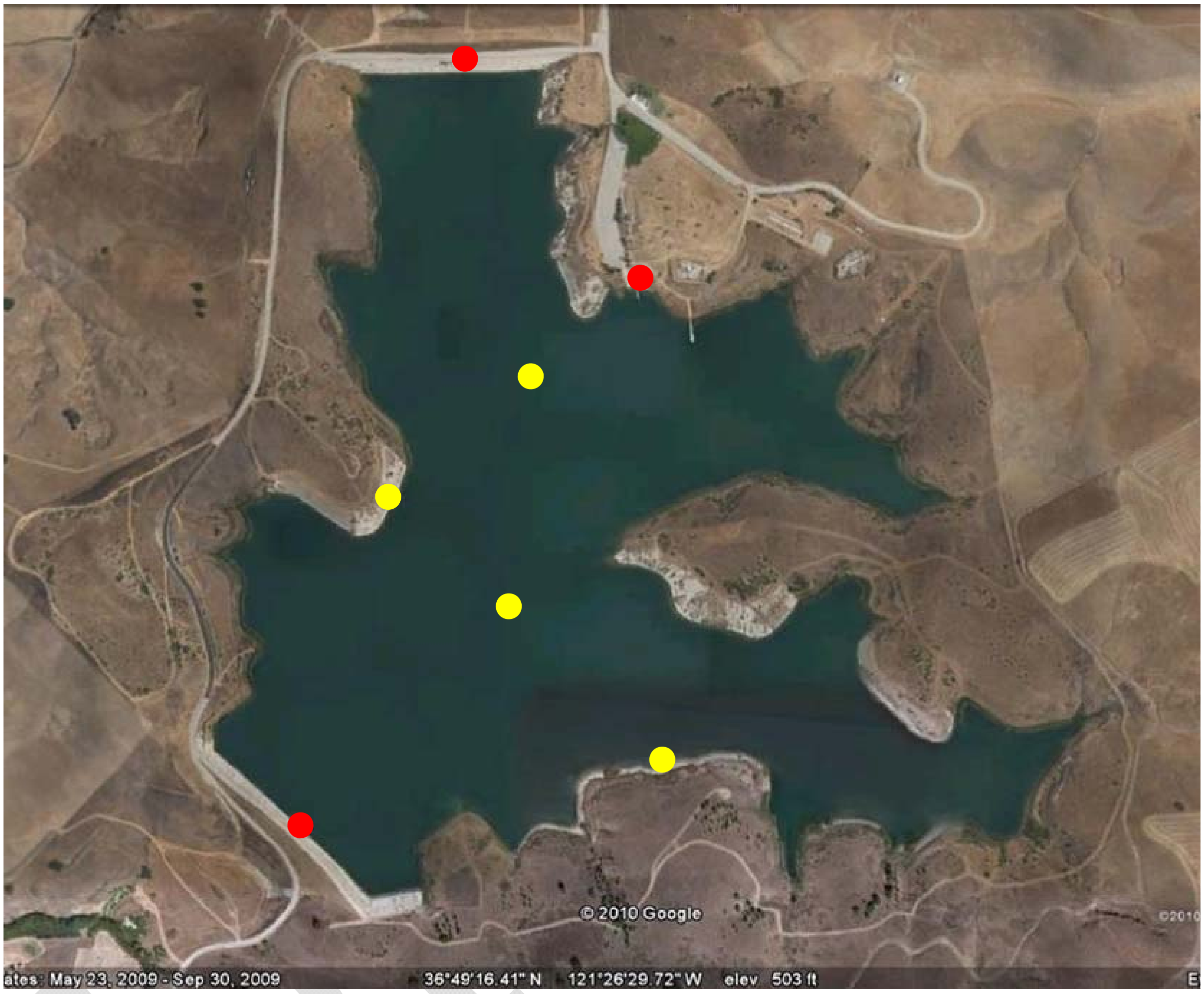


Figure 3. Proposed approximate locations for deployment of the substrate samplers for monitoring newly settled mussels in SJR. Red dots indicate obvious general locations such as the dike, dam, boat ramp and jetty areas from where substrate samplers can be easily deployed. Yellow dots depict other proposed locations that can be explored for sampler deployment. The two locations in the middle of the reservoir will require a float and anchor line to which the substrate samplers can be tethered at the required depths. If any of the proposed locations turn out to unsuitable for deployment, other locations can be explored.

Reservoir Monitoring Using Veliger Tows (Plankton Tows)

Plankton tows will be conducted to detect the presence of veligers in the SJR water column, which in turn is an indicator of the presence of viable and reproducing mussels in the reservoir. Based on data collected by the California Department of Water Resources (DWR) during June 2008- July 2010, veliger abundance peaks in May and June in SJR, drops of in July/August, with very few to no veligers present in the water column from September to April (Veldhuizen and Janik 2010). During monitoring, caution therefore needs to be exercised in the interpretation of no veliger detections during September to April as being representative of eradication effectiveness, and in the longer term, veliger monitoring must incorporate the warmer peak summer period to adequately test for eradication.

This monitoring method uses a 63-µm plankton net (maximum mesh size) attached to a length of rope (that can be towed from a boat either vertically or horizontally through the water column (Figure 4).

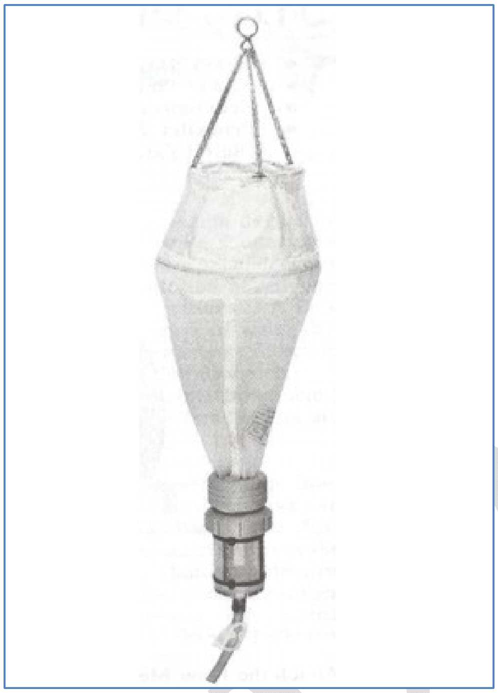


Figure 4. Plankton net for horizontal and vertical veliger tows. Photo Source: Wildco.

Horizontal tows sample for veligers present near the water surface, while vertical tows provide a depth-integrated sample of veligers that may be present in the water column at a certain location in the reservoir. In SJR, veliger abundance during the peak months of May and June was typically higher in the horizontal (surface) tow samples than in the vertical tow samples (Veldhuizen and Janik 2010), but the depths that veligers may be found may vary from year to year. Therefore, vertical tows are recommended for monitoring veligers in SJR at each proposed location.

Details on the plankton net and procedures for conducting the vertical tows, and preservation of samples for analysis, are provided by the Mussel Monitoring Program of the 100th Meridian Intiative (2009).

Protocol for Monitoring Veligers

Short-Term – During Eradication Treatment

- One week after start of the potash treatment in the reservoir, conduct vertical tows for sampling veligers at various locations in the reservoir (Figure 5), following which monitoring will occur once every two weeks.

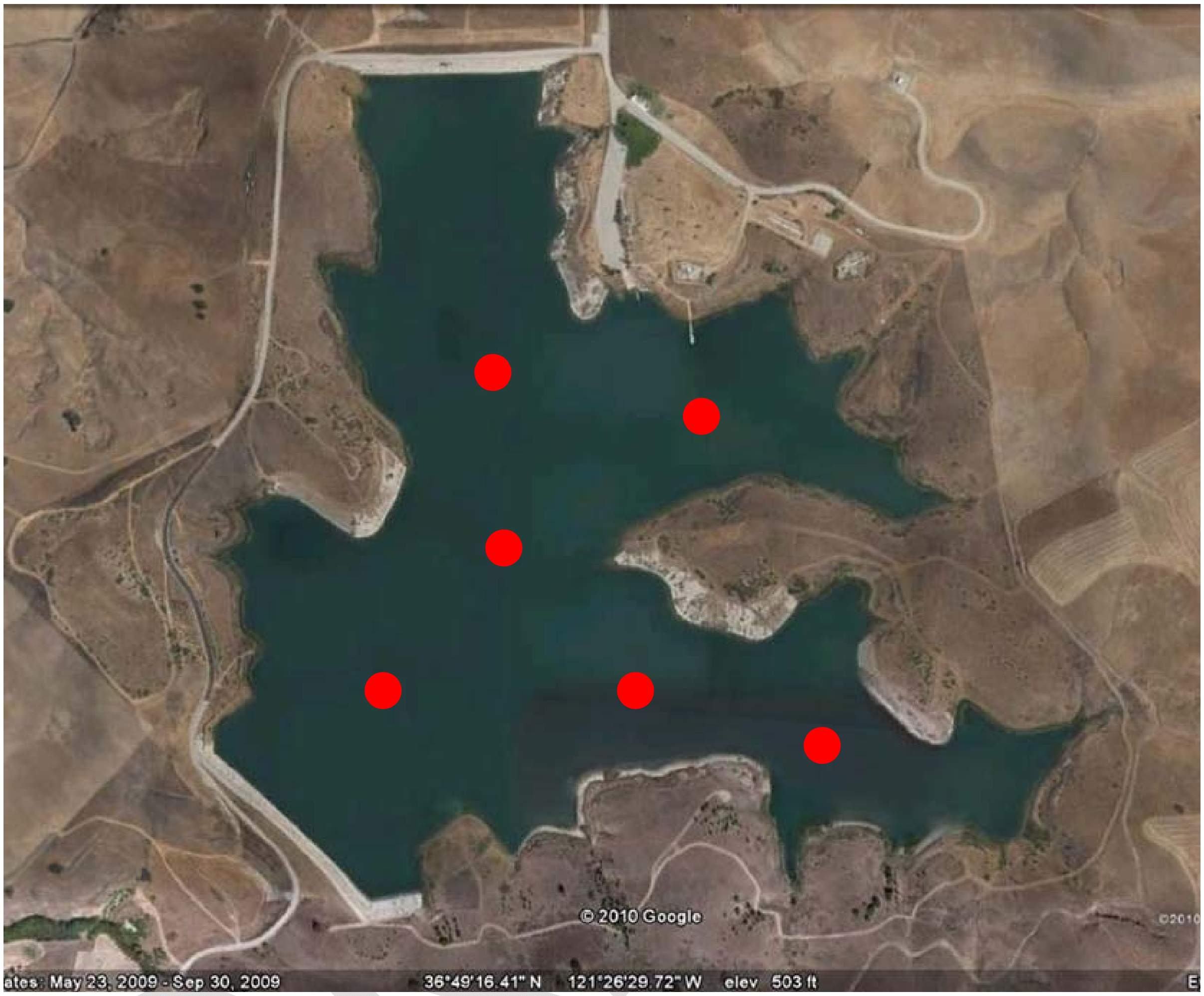


Figure 5. Proposed general locations of vertical plankton tows for monitoring veligers in SJR

- At each location (Figure 5), note the GPS coordinate, and conduct a vertical tow by lowering the plankton net to a depth of 20 m below the water surface, or to 1 m above the reservoir bottom, (whichever is deeper), and then slowly and steadily retrieving the net at a rate of 0.5 m/sec. Rinse the net, collect and preserve the veliger sample as per the referenced protocol (100th Meridian Intiative , 2009). Veligers in the samples are later detected using a Cross-Polarized Light Microscope (CPLM). With a CPLM, zebra mussels veligers can be easily distinguished from other plankton by the cross-hatch pattern they exhibit (Figure 6).
- Monitoring will continue until two consecutive surveys find no veligers, and the reservoir bioassay records 100% mortality.

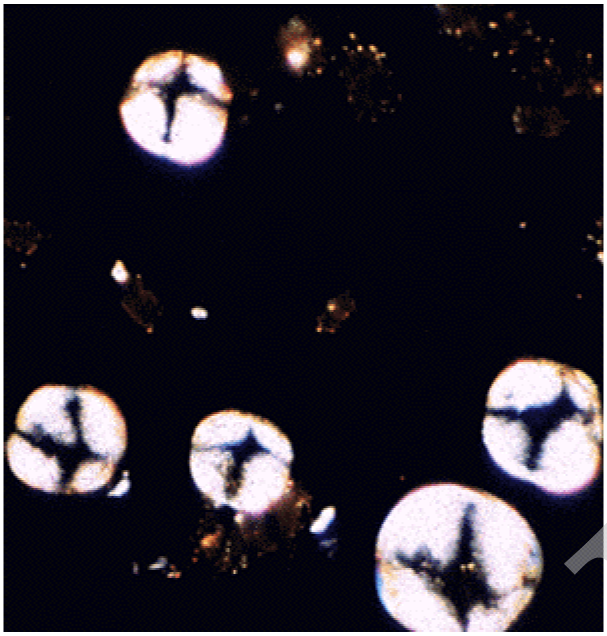


Figure 6. Zebra mussel veligers with the characteristic cross-hatch pattern observed with a Cross Polarized Light Microscope

Long-Term - Post-Eradication Treatment Monitoring

- The post-eradication monitoring period for veligers begins after the presumed 2-3 month treatment period when the reservoir water level is lowered and the potash is applied.
- The long-term monitoring specifically targets the warm summer period (May – August) when mussel veligers are relatively abundant in SJR (Veldhuizen and Janik 2010).
- Veliger monitoring will occur at the same GPS-marked locations, and as per the protocol for short-term monitoring.
- Veliger monitoring will occur once every month, during May to August (4 separate sampling periods) in the same year as the eradication treatment, and once every month during May to August (4 separate sampling periods) the following year. For example, if the 3 month treatment period ends in February 2012, the long term monitoring period for veligers will span a period of approximately 18 months, during which monitoring will occur on 8 separate occasions over 2 consecutive summers.
- Eradication measures are considered to be successful if no veligers are detected after post-eradication monitoring over 2 consecutive summers.

Reservoir Bioassay (for Potash Treatment)

A bioassay that allows for an assessment of post-treatment mortality of juvenile and adult zebra mussels placed at various depths and locations in the reservoir will be conducted. As such, this bioassay will allow for a more controlled tracking of the effectiveness of the potash treatment in the reservoir. The bioassay will compare mortality of bagged mussels immersed in the reservoir immediately after potash application is completed (desired potash concentration is achieved), to mortality of mussels in control aquaria (at on-site facilities) with no potash treatment.

Reservoir Bioassay Protocol

- Just prior to reservoir drawdown and subsequent potash treatment, collect at least 20,000 – 25,000 zebra mussels (stock set of mussels) from San Justo Reservoir and place these mussels in aquaria (300 gallon aquaria) maintained in on-site facilities. Out of this stock set of mussels, a total of 9,900 viable mussels of various sizes will be needed for the reservoir bioassay test (9,000 mussels) and the control test (900 mussels), and an additional 3,600 viable mussels for the pipeline bioassay test. Sufficient mussels should be left over in the stock set to allow for natural mortality and other contingencies (e.g., disproportionate numbers belonging to one size class).

- During potash application to the reservoir, monitor the reservoir for potassium concentration at various locations and depths. When the concentration of potassium in the reservoir reaches the target concentration (100 ppm), sort the mussels (as described below) that were collected into 3 size classes (based on mussel length measured with calipers); < 5 mm, 5-15 mm, and > 15 mm length. While sorting into size-classes, check for the viability of these mussels; reject any gaping mussels that do not close when the mantle is prodded with a dull probe. Mussels will be sorted into 2 testing groups, one for the Reservoir Bioassay Test, and the other group for the Control Test.

- Reservoir Bioassay Test Mussels: Sort 100 viable mussels of each size class into mesh bags (1-2 mm nylon mesh material) that are marked to denote which mussel sizes and group (test) they contain. Prepare a total of 90 test bags; 30 bags for each size class (90 bags x 100 mussels per bag = a total of 9,000 viable mussels).

- Control Test Mussels: Sort 100 viable mussels of each size class into mesh bags that are marked to denote which mussel sizes and group (control) they contain. Prepare a total of 9 control bags; 3 bags for each size class (9 bags x 100 mussels per bag = a total of 900 viable mussels).

- The Reservoir Bioassay Test bags will be deployed at 3 different depths (below surface; middle of water column; just above reservoir bottom) at 10 different locations in the SJR (Figure 7), some in close proximity to the shoreline or structures such as docks, dikes, dams, ramps, and others towards the middle of the reservoir (hung from buoys). Bags will be tethered to an appropriate length of rope which will be tied to a shoreline structure (e.g., dock), or to a buoy, depending on location. At each location and at each depth, 3 bags will be deployed, each containing a different mussel size class (3 bags near the surface, 3 bags in the middle, and 3 bags near the bottom = 9 bags total at each location). Location will be marked (with a GPS if necessary) for repeated monitoring and retrieval of the bags.

- Control test bags will be suspended in an aquarium on site (3 bags, each of a different size class, near the surface, 3 bags in the middle, and 3 bags near the bottom) that contains untreated reservoir water, or water with 4 mg/l of potassium or less (approximately the background levels in San Justo Reservoir).

- On the day of the deployment of the bags in the reservoir and control aquaria, 100% of the mussels are assumed to be viable, based on the viability checks. After deployment, all bags (reservoir bioassay test and control test) will be inspected every other day (i.e., day 0 = deployment, then monitor on day 2, 4, 6, etc.) until all reservoir test bags indicate 100% mussel mortality. Also note the water temperature and potassium concentration, every time the mussels are monitored. During the monitoring, all gaping and unresponsive mussels will be immersed in recovery aquaria containing untreated water and checked for continued non-responsiveness (by prodding the mantle with a probe) after a 48-h period. Non-responsive mussels after 48-h will be marked as dead, and mortality counts will be noted.

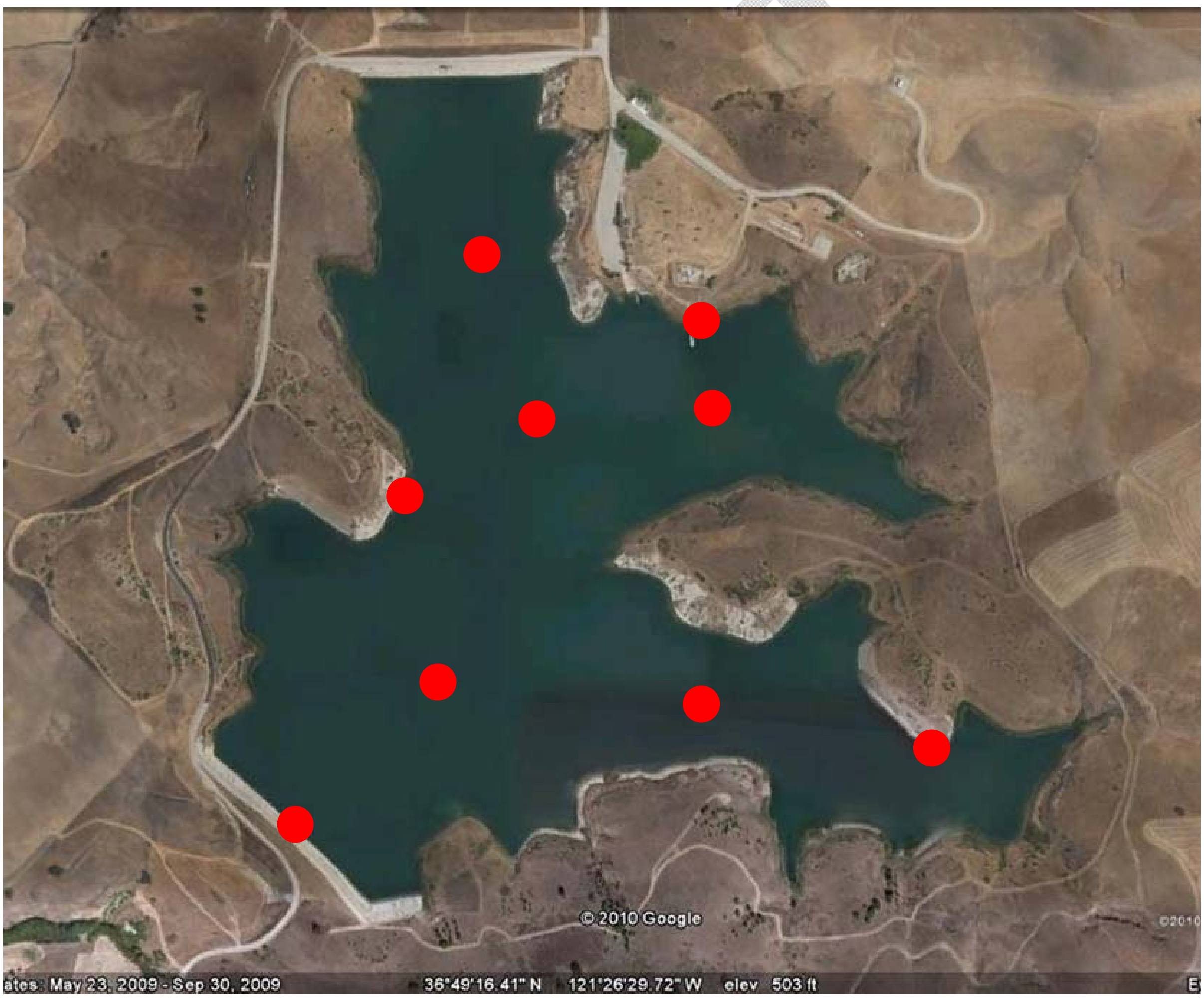


Figure 7. Proposed approximate locations for deployment of the Reservoir Bioassay Test Bags.

Divers/ROVs

Large areas of the reservoir bottom and underwater structures can be surveyed for mussel mortality with the use of divers and/or underwater Remotely Operated Vehicles (ROVs) (USGS 2010). Groups of mussels potentially representing many size classes in a variety of locations and conditions in the reservoir can be checked in this manner for gaping and/or unresponsiveness, which are indicators of potential mortality. The use of divers has an advantage over ROVs because divers can perform both visual (gaping) and tactile (unresponsiveness to prodding) checks, and bring back groups of unresponsive gaping mussels to on-site aquaria containing untreated water to check for continued unresponsiveness. In contrast, ROVs can only offer a visual depiction of potential mortality (gaping mussels), but can also cover areas that may not necessarily to accessible to divers.

Protocol for Divers/ROV

- Inspections of the reservoir with divers and/or ROV can be conducted one month following the completion of potash addition to the reservoir.
- Inspections can focus on areas where large masses of mussels are known to exist, such as indicated by previous sampling and surveys of the reservoir, and/or by observations of populations of stranded mussels along the shoreline exposed by lowering of the reservoir water level.
- Note the locations where the surveys are conducted. Note if 100% of the mussels observed show a gaping response, and if not, estimate roughly what proportion are showing gaping response. Also note, in general, if the majority of gaping shells contain tissue or not. If divers are used, check for unresponsiveness (by poking them?) and bring back samples of mussels for viability testing in aquaria containing untreated water.
- During the surveys, if some mussels have closed shells, note it. Subsequent surveys (weekly) may be required if a good proportion of the mussel shells are observed to be closed, or if some mussels are active and responsive.
- Monitoring will continue until two consecutive surveys find no live mussels, and the reservoir bioassay records 100% mortality.

Monitoring Plan for the Hollister Conduit (HC) & Distribution System (DS)

Treatment Plan Summary for HC and DS

Chemical eradication of zebra mussels in the Hollister Conduit and pipeline distribution system (Figure 8) will be implemented simultaneously with eradication measures in San Justo Reservoir. The eradication will involve dosing the Hollister Conduit and Distribution System with potash. Potash feed system(s) may be established at the Pacheco Bifurcation, and at various points in the distribution pipeline as appropriate, in the event that there is not enough hydraulic grade-line from San Justo Reservoir through the pipeline DS to move potash laden waters from SJR into the outer reaches of the DS. In such a case, said chemical feed system would likely consist of potash solution storage tanks and chemical feed pumps placed within temporary spill containment. Similar to treatment in the reservoir, the objective of the potash treatment will be to deliver and maintain a potassium concentration of 100 ppm (by volume) throughout the entire pipeline system.

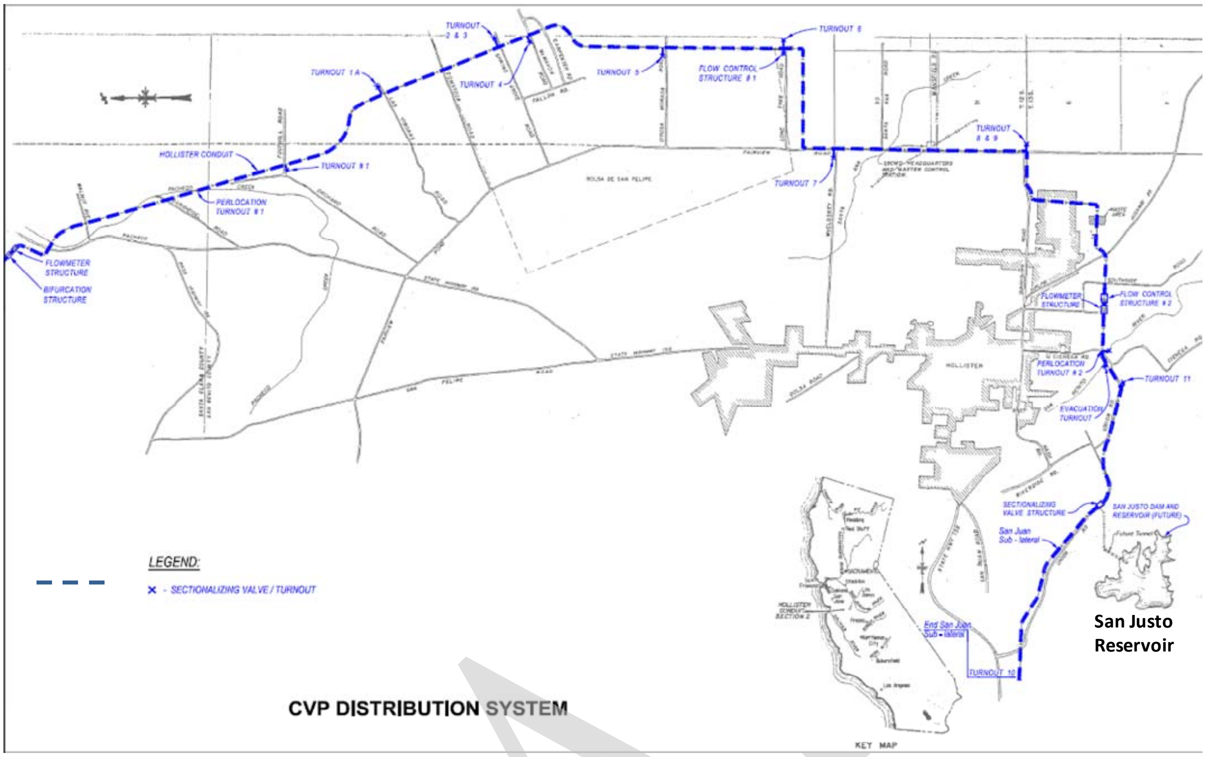


Figure 8. Schematic of the Hollister Conduit and its Distribution System showing locations of the 4 bioboxes (1-4) being used to monitor for zebra mussels. Bioboxes are located at, (1) the Valve House, (2) Sectionalizing Valve Structure, (3) Turnout 9L, and (4) Turnout 1.

Monitoring with Biobox

Four bioboxes were installed at various locations (Figure 8) in the HC in August 2009 and are being monitored for newly settled zebra mussels every one to three weeks since installation. It is recommended that these bioboxes continue to be used to monitor for conduit treatment effectiveness. To date, no mussels settlements have been observed in Bioboxes 2-4. In addition, Biobox 1 in the Valve House was seeded with live zebra mussels to test for the effectiveness of seasonal (summer-fall) hypoxia treatments (after the reservoir stratifies, pumping hypolimnetic water that is low in dissolved oxygen from the SJR) – therefore, this biobox is the only one that currently contains zebra mussels.

Biobox Monitoring Protocol – Short-term, During Treatment

- Prior to treating the HC and DS with potash, the bioboxes should be taken offline and thoroughly cleaned.
- Immediately following the treatment of the HC and DS with potash, the bioboxes are brought on line.
- Monitor the bioboxes at each location once every week for new mussel settlements. KCl concentrations and water temperature should also be recorded each time the biobox is monitored.

- Note any new mussels that are positively identified and that have settled and attached to the plates/sides of the biobox.
- After recording the findings, remove all mussels from the biobox, clean the plates/sides, replace plates in the biobox for subsequent monitoring the following week.
- Monitor on a weekly basis throughout the entire period that the HC and DC is treated with kill concentrations of potash.

Biobox Monitoring Protocol – Long-Term

- Veliger densities and new mussel settlement in SJR tends to peak in the warm summer months (Veldhuizen and Janik 2010). The long-term biobox monitoring should target the summer period (May to October) when new mussel settlements are most likely to be detected in the bioboxes.
- Monitor for new mussel settlements in the bioboxes on a bi-monthly basis during the first summer period (May to October) following treatment using the protocol established for short term biobox monitoring (during potash treatment), and again during the second summer period following treatment. (e.g., if treatment occurs in November 2011, then bioboxes will be monitored in the summers of 2012 and 2013).
- Bioboxes can also be kept on line (except when maintenance is needed) and monitored on a monthly basis from November to April, although new mussel settlements (if some mussels are still alive).
- No mussels settlements in the bioboxes for 2 years after the treatment will indicate that eradication measures were successful.

Pipeline Bioassay

- When the concentration of potassium in the pipeline system reaches the target concentration (100 ppm), sort the mussels from the bioassay stock set (see reservoir bioassay section) into 3 size classes (based on mussel length measured with calipers); < 5 mm, 5-15 mm, and > 15 mm length. While sorting into size-classes, check for the viability of these mussels; reject any gaping mussels that do not close when the mantle is prodded with a dull probe. These mussels will be used for the pipeline treatment bioassay.
- <u>Pipeline Bioassay Test Mussels:</u> Sort 100 viable mussels of each size class into mesh bags that are marked to denote which mussel sizes they contain. Prepare a total of 36 test bags; 12 bags for each size class (12 bags x 3 mussel size classes x 100 mussels per bag = a total of 3,600 viable mussels).
- <u>Control Test Mussels:</u> The control test described in the Reservoir Bioassay section above will apply to both the reservoir bioassay and the pipeline bioassay.
- The Pipeline Bioassay Test bags will be deployed at 3 different depths (below surface; middle of water column; just above the pipeline bottom) at 4 different locations in the pipeline system. Bags will be tethered to an appropriate length of

rope which will be tied to an appropriate structure at the access point of the pipeline. At each location and at each depth, 3 bags will be deployed, each containing a different mussel size class (3 bags near the surface, 3 bags in the middle, and 3 bags near the bottom = 9 bags total at each location). Location will be marked for repeated monitoring and retrieval of the bags.

- The results of the control test for the reservoir bioassay will also apply to the pipeline bioassay. There, the pipeline bioassay should be set up and occur concurrently with the reservoir (and control) bioassay.
- On the day of the deployment of the bags in the pipeline, 100% of the mussels are assumed to be viable, based on the viability checks conducted before they were bagged. After deployment, all bags (pipeline bioassay test and control test) will be inspected every other day (i.e., day 0 = deployment, then monitor on day 2, 4, 6, etc.) until all pipeline test bags indicate 100% mussel mortality. Also note the water temperature and potassium concentration, every time the mussels are monitored. During the monitoring, all gaping and unresponsive mussels will be immersed in recovery aquaria containing untreated water and checked for continued non-responsiveness (by prodding the mantle with a probe) after a 48-h period. Non-responsive mussels after 48-h will be marked as dead, and mortality counts will be noted.

Monitoring with ROV

- Inspections of parts of the HC and DC can be conducted with a ROV one month after completion of potash addition to the reservoir.
- Inspections can focus on areas where mussels are known to exist in the pipeline system such as indicated by previous visual inspections and information available about the presence of mussels in the pipeline system. Alternatively, an ROV inspection conducted before treatment begins would also point to areas with mussels where post-treatment inspections could be focused.
- During the ROV surveys, note if 100% of the mussels observed show a gaping response. Also note, in general, if the majority of gaping shells contain tissue or not.
- During the surveys, if some mussels have closed shells, note it. Subsequent surveys (weekly or bi-monthly) may be required if a good proportion of the mussel shells are observed to be closed, or if some mussels are active and responsive.
- Monitoring will continue until two consecutive surveys find no live mussels, and the pipeline bioassay records 100% mortality.

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Appendix F: Summary of previous Mussel Eradication Efforts

Publication Source	Year of Publication	Year of Experiment	Type of Study	Trade Name	Active Ingredient Used	Concentration Used (e.g., ppm etc.)	Mechanism Used	Mortality Rate (RESULT)	Link to Publication
U.S. National Library of Medicine	2019	2019	EPA Ecotoxicity	Potash	Potassium Chloride	>100 ppm	N/A	Potassium Chloride is non-toxic to Water flea and Water diatom.	https://pubchem.ncbi.nlm.nih.gov/compound/Potassium-chloride
Taylor and Francis Group	2017	2016	Field	Potash	Potassium Chloride	89.3-106.5 ppm, with a 10 day application, with a treatment area of 41,278 m^2	During application, concentrations were measured to ensure that target concentrations were achieved to kill zebra mussels and these concentrations were maintained via bump treatments. All products were applied in Christmas Lake by a state-certified pesticide applicator. Products were mixed in tanks and injected under ice. Potassium (K^+), chloride (Cl^-), and conductivity were monitored during and after treatment for 14 d to ensure target concentrations were being met.	For aquarium trials, 100% mortality was observed by Day 7–19 in these initial trials (data not shown), in which water temperatures ranged from 16 to 17 C in the tanks, considerably warmer than in-lake temperatures. Aquarium trials were then repeated with cold water (maintained at 1 C average across tanks). These cold-water tanks were treated at the same concentrations (50 ppm and 100 ppm K+) as in the 16–17 C trials. In these colder 1 C trials, 100% mortality was achieved by Day 9.	https://www.maisrc.umn.edu/sites/maisrc.umn.edu/files/zebra_mussel_dreissena_polymorpha_eradication_efforts_in_christmas_lake_mn_0.pdf
U.S. National Library of Medicine	2019	2019	EPA Ecotoxicity	Copper Sulfate	Copper Sulfate	0.030ppm-100ppm	N/A	Copper Sulfate is toxic to Rainbow trout, Goldfish, Fathead minnow, Green sunfish, and Bluegill sunfish, after 96 hours of exposure.	https://pubchem.ncbi.nlm.nih.gov/compound/Copper-sulfate
RNT Consulting	2014	2012	Experiment	Copper Sulfate	Copper Sulfate	**High Copper concentration:** 0.52ppm, **Low Copper concentration:** 0.26ppm	Groups of about 100 zebra adult mussels were placed into individual mesh bags. The bags containing adults were placed in aerated lake water to acclimate to laboratory conditions over 48 hours. Natural clumps of mussels were kept as intact as possible to minimize the stress on the adults and to evaluate if algaecides would cause de-clumping. Five 50 gallon drums in the laboratory were filled with water from San Justo Reservoir and allowed to stabilize over 24 hours. Algaecides were added to the drums, following the mixing process, the drip valves installed on the bottom of each drum were opened and the solution from each drum flowed into individual coolers. When coolers were filled to approximately 50%, 3 mesh bags containing about 100 adults each were placed in each cooler. The drip valves continuously passed solution from the drum into the associated 40 L cooler over a period of 96 hours at a rate of approximately 2 L/hour. Every 12 hours each mesh bag was examined and dead mussels were counted and removed and placed back into cooler up to 96 hours. The mesh bags were then placed in a recovery chamber and monitored for mortality post exposure up to 52 hours.	**High Copper concentration:** 25.0% average mortality after 96 hours of exposure, 70 % average mortality up to 52 hours of post exposure. **Low Copper concentration:** 0.8% average mortality after 96 hours of exposure, 6.7% average mortality up to 52 hours of post exposure.	https://cdn2.cloud1.cemah.net/wp-content/uploads/sites/36/2017/03/Claudi-et-al.-2014d.pdf
RNT Consulting	2014	2012	Experiment	Copper Sulfate	Copper Sulfate	**High Copper concentration:** 0.52ppm, **Low Copper concentration:** 0.26ppm	Groups of about 100 quagga adult mussels were placed into individual mesh bags. The bags containing adults were placed in aerated lake water to acclimate to laboratory conditions over 48 hours. Natural clumps of mussels were kept as intact as possible to minimize the stress on the adults and to evaluate if algaecides would cause de-clumping. Five 50 gallon drums in the laboratory were filled with raw water from the Colorado River and allowed to stabilize over 24 hours. Algaecides were added to the drums, following the mixing process, the drip valves installed on the bottom of the drum were opened and the solution from each drum flowed into individual coolers. When coolers were filled to approximately 50%, 3 mesh bags containing about 100 adults each were placed in each cooler. The drip valves continuously passed solution from the drum into the associated 40 L cooler over a period of 96 hours at a rate of approximately 2 L/hour. Every 12 hours each mesh bag was examined and dead mussels were counted and removed and placed back into cooler up to 96 hours. The mesh bags were then placed in a recovery chamber and monitored for mortality post exposure up to 60 hours.	**High Copper concentration results:** mortality varied from 96.2% to 96.5% after 96 hours of exposure, mortality varied from 98.3% to 100% up to 60 hours of post exposure. **Low Copper concentration results:** mortality varied from 58% to 74% after 96 hours of exposure, mortality varied from 84.5% to 95.6% up to 60 hours of post exposure.	https://cdn2.cloud1.cemah.net/wp-content/uploads/sites/36/2017/03/Claudi-et-al.-2014d.pdf
RNT Consulting	2014	2012	Experiment	Copper Sulfate	Copper Sulfate	**High Copper concentration:** 0.52ppm, **Low Copper concentration:** 0.26ppm	Groups of about 100 zebra adult mussels were placed into individual mesh bags. The bags containing adults were placed in aerated lake water to acclimate to laboratory conditions over 48 hours. Natural clumps of mussels were kept as intact as possible to minimize the stress on the adults and to evaluate if algaecides would cause de-clumping. Five 50 gallon drums in the laboratory were filled with water from the San Justo Reservoir and allowed to stabilize over 24 hours. Algaecides were added to the drums, following the mixing process, the drip valves installed on the bottom of the drum were opened and the solution from each drum flowed into individual coolers. When coolers were filled to approximately 50%, 3 mesh bags containing about 100 adults each were placed in each cooler. The drip valves continuously passed solution from the drum into the associated 40 L cooler over a period of 96 hours at a rate of approximately 2 L/hour. Every 12 hours each mesh bag was examined and dead mussels were counted and removed and placed back into cooler up to 96 hours. The mesh bags were then placed in a recovery chamber and monitored for mortality post exposure up to 60 hours.	**High Copper concentration results:** mortality varied from 29% to 47% after 96 hours of exposure, mortality varied from 40% to 70% up to 60 hours of post exposure. **Low Copper concentration results:** mortality varied from 4.5% to 23% after 96 hours of exposure, mortality varied from 5.26% to 31% up to 60 hours of post exposure.	https://cdn2.cloud1.cemah.net/wp-content/uploads/sites/36/2017/03/Claudi-et-al.-2014d.pdf
U.S. National Library of Medicine	2019	2019	EPA Ecotoxicity	Copper Sulfate Pentahydrate	Copper Sulfate Pentahydrate	0.054ppm-31.4ppm	N/A	Copper Sulfate Pentahydrate is toxic to Shore shrimp, Blue crab, Water flea, Eastern Oyster, Scud, Pink shrimp, Bluegill sunfish Rainbow trout, Pompano, Marine diatom, Freshwater diatom, and Fathead minnow, after 96 hours of exposure.	https://pubchem.ncbi.nlm.nih.gov/compound/Copper-sulfate-pentahydrate
RNT Consulting	2014	2012	Experiment	EarthTec	Copper Sulfate Pentahydrate (cupric ion [Cu^{++}])	**High Copper concentration:** 1.0ppm, **Low Copper concentration:** 0.5ppm	Groups of about 100 zebra adult mussels were placed into individual mesh bags. The bags containing adults were placed in aerated lake water to acclimate to laboratory conditions over 48 hours. Natural clumps of mussels were kept as intact as possible to minimize the stress on the adults and to evaluate if algaecides would cause de-clumping. Five 50 gallon drums in the laboratory were filled with raw water from the Colorado River and allowed to stabilize over 24 hours. Algaecides were added to the drums, following the mixing process, the drip valves installed on the bottom of the drum were opened and the solution from each drum flowed into individual coolers. When coolers were filled to approximately 50%, 3 mesh bags containing about 100 adults each were placed in each cooler. The drip valves continuously passed solution from the drum into the associated 40 L cooler over a period of 96 hours at a rate of approximately 2 L/hour. Every 12 hours each mesh bag was examined and dead mussels were counted and removed and placed back into cooler up to 84 hours.	**High Copper concentration:** 100% mortality after 72 hours of exposure. **Low Copper concentration:** 100% mortality after 84 hours of exposure.	https://cdn2.cloud1.cemah.net/wp-content/uploads/sites/36/2017/03/Claudi-et-al.-2014d.pdf

RNT Consulting	2014	2012	Experiment	EarthTec	Copper Sulfate Pentahydrate (cupric ion [Cu^{++}])	**High Copper concentration:** 1.0ppm, **Low Copper concentration:** 0.5ppm	Groups of about 100 quagga adult mussels were placed into individual mesh bags. The bags containing adults were placed in aerated lake water to acclimate to laboratory conditions over 48 hours. Natural clumps of mussels were kept as intact as possible to minimize the stress on the adults and to evaluate if algaecides would cause de-clumping. Five 50 gallon drums in the laboratory were filled with raw water from the Colorado River and allowed to stabilize over 24 hours. Algaecides were added to the drums, following the mixing process, the drip valves installed on the bottom of the drum were opened and the solution from each drum flowed into individual coolers. When coolers were filled to approximately 50%, 3 mesh bags containing about 100 adults each were placed in each cooler. The drip valves continuously passed solution from the drum into the associated 40 L cooler over a period of 96 hours at a rate of approximately 2 L/hour. Every 12 hours each mesh bag was examined and dead mussels were counted and removed and placed back into cooler up to 84 hours.	**High Copper concentration:** 99% moratility after 72 hours of exposure. **Low Copper concentration:** 97% mortaility after 84 hours of exposure.	https://cdn2.cloud1.cemah.net/wp-content/uploads/sites/36/2017/03/Claudi-et-al.-2014d.pdf
Taylor and Francis Group	2017	2014	Field	EarthTec QZ	Copper Sulfate Pentahydrate(cupric ion [Cu^{++}])	About 1 ppm,with a 14 day application (with bump treatments every 2 to 4 days), with a treatment area of 3035 m^2	During application, concentrations were measured to ensure that target concentrations were achieved to kill zebra mussels and these concentrations were maintained via bump treatments. All products were applied in Christmas Lake by a state-certified pesticide applicator.Products were mixed in tanks and injected at the water surface. Following treatment, monitoring occurred every 1–2 d for 14 d post-treatment. Monitoring consisted of collecting surface water samples at various locations inside the treatment area. Four cages of about 50–100 mussels per cage were placed within the treatment area. Cages were constructed of plastic canvas mesh sheets (1–2 mm openings), anchored to the lake bottom. Live, gaping, and dead zebra mussels were recorded daily until all mussels were dead or until no additional mussels died over 3 consecutive days. Laboratory product efficacy testing was conducted in tandem with in-lake applications for Zequanox, EarthTec QZ, and potash. Zebra mussel mortality was assessed via aquarium bioassays. A comprehensive search of the entire shoreline was conducted by 18 surveyors using both SCUBA and snorkel gear. In addition to active searches, settlement samplers were suspended from docks and buoys at several locations around the lake perimeter.	100% mortality within 6-8 days with dose of 0.6-0.9 ppm. 100% mortality by day 7 with 0.5 ppm and 1.0 ppm both were in achieved in laboratory because desired copper concentrations were not achieved due to ice formation.	https://www.maisrc.umn.edu/sites/maisrc.umn.edu/files/zebra_mussel_dreissena_polymorpha_eradication_efforts_in_christmas_lake_mn_0.pdf
Invasives Net	2019	2017	Field	EarthTec QZ	Copper Sulfate Pentahydrate (cupric ion [Cu^{++}])	0.2ppm	Product was applied to 50% of lake's surface acreage around the perimeter and allowed to disperse towards the center without mechanical assistance. Mortality was observed from cages placed throughout the lake at different water depths and copper concentrations were determined by means of the porphyrin test method, the bicinchoninate test method, and a DR900 spectrophotometer.	100% mortality in the top 6m body of water was achieved in 10 days. At all depths of water cages an average 90% of mussels died at 22 days with the last mussel to die at 40 days after treatment.	https://www.reabic.net/journals/mbi/2019/Accepted/MBI_2019_Hammond_Ferris_correctedproof.pdf
U.S. National Library of Medicine	2019	2019	EPA Ecotoxicity	Copper Ethanolamine Complex	Copper Ethanolamine Complex	0.82ppm-4.2 ppm	N/A	Copper Ethanolamine is toxic to Rainbow trout and Green sunfish, after 96 hours of exposure.	https://pubchem.ncbi.nlm.nih.gov/compound/Copper-ethanolamine-complex
U.S. National Library of Medicine	2019	2019	EPA Ecotoxicity	Copper Triethanolamine Complex	Copper Triethanolamine Complex	0.026ppm-1.3 ppm	N/A	Copper Triethanolamine is toxic to Rainbow trout, Bluegill sunfish, and water flea, after 96 hours of exposure.	https://pubchem.ncbi.nlm.nih.gov/compound/Copper-triethanolamine-complex
RNT Consulting	2014	2012	Experiment	Captain	Copper Triethanolamine Complex, Copper Monoethanolamine	**High Copper concentration:** 1.0 ppm, **Low Copper concentration:** 0.5 ppm	Groups of about 100 quagga adult mussels were placed into individual mesh bags. The bags containing adults were placed in aerated lake water to acclimate to laboratory conditions over 48 hours. Natural clumps of mussels were kept as intact as possible to minimize the stress on the adults and to evaluate if algaecides would cause de-clumping. Five 50 gallon drums in the laboratory were filled with raw water from the Colorado River and allowed to stabilize over 24 hours. Algaecides were added to the drums, following the mixing process, the drip valves installed on the bottom of the drum were opened and the solution from each drum flowed into individual coolers. When coolers were filled to approximately 50%, 3 mesh bags containing about 100 adults each were placed in each cooler. The drip valves continuously passed solution from the drum into the associated 40 L cooler over a period of 96 hours at a rate of approximately 2 L/hour. Every 12 hours each mesh bag was examined and dead mussels were counted and removed and placed back into cooler up to 96 hours. The mesh bags were then placed in a recovery chamber and monitored for mortaility post exposure up to 60 hours.	**High Copper concentration:** mortality varied from 91.0% to 96.0 % after 96 hours of exposure **Low Copper concentration:** mortaility varied from 92.0% to 95.0% after 96 hours of exposure.	https://cdn2.cloud1.cemah.net/wp-content/uploads/sites/36/2017/03/Claudi-et-al.-2014d.pdf
RNT Consulting	2014	2012	Experiment	Captain	Copper Triethanolamine Complex, Copper Monoethanolamine	**High Copper concentration:** 1.0ppm, **Low Copper concentration:** 0.5ppm	Groups of about 100 zebra adult mussels were placed into individual mesh bags. The bags containing adults were placed in aerated lake water to acclimate to laboratory conditions over 48 hours. Natural clumps of mussels were kept as intact as possible to minimize the stress on the adults and to evaluate if algaecides would cause de-clumping. Five 50 gallon drums in the laboratory were filled with raw water from the Colorado River and allowed to stabilize over 24 hours. Algaecides were added to the drums, following the mixing process, the drip valves installed on the bottom of the drum were opened and the solution from each drum flowed into individual coolers. When coolers were filled to approximately 50%, 3 mesh bags containing about 100 adults each were placed in each cooler. The drip valves continuously passed solution from the drum into the associated 40 L cooler over a period of 96 hours at a rate of approximately 2 L/hour. Every 12 hours each mesh bag was examined and dead mussels were counted and removed and placed back into cooler up to 96 hours. The mesh bags were then placed in a recovery chamber and monitored for mortaility post exposure up to 60 hours.	**High Copper concentration:** mortaility varied from 66.2% to 78.3 % after 96 hours of exposure, mortaility varied from 80.28% to 95.3% up to 60 hours of post exposure. **Low Copper concentration:** mortaility varied from 20.3% to 32.7% after 96 hours of exposure, mortaility varied from 31.8% to 55.8% up to 60 hours of post exposure.	https://cdn2.cloud1.cemah.net/wp-content/uploads/sites/36/2017/03/Claudi-et-al.-2014d.pdf
RNT Consulting	2014	2012	Experiment	Natrix	Copper Triethanolamine Complex, Copper Monoethanolamine	**High Copper concentration:** 1.0ppm, **Low Copper concentration:** 0.5ppm	Groups of about 100 zebra adult mussels were placed into individual mesh bags. The bags containing adults were placed in aerated lake water to acclimate to laboratory conditions over 48 hours. Natural clumps of mussels were kept as intact as possible to minimize the stress on the adults and to evaluate if algaecides would cause de-clumping. Five 50 gallon drums in the laboratory were filled with raw water from the Colorado River and allowed to stabilize over 24 hours. Algaecides were added to the drums, following the mixing process, the drip valves installed on the bottom of the drum were opened and the solution from each drum flowed into individual coolers. When coolers were filled to approximately 50%, 3 mesh bags containing about 100 adults each were placed in each cooler. The drip valves continuously passed solution from the drum into the associated 40 L cooler over a period of 96 hours at a rate of approximately 2 L/hour. Every 12 hours each mesh bag was examined and dead mussels were counted and removed and placed back into cooler up to 96 hours. The mesh bags were then placed in a recovery chamber and monitored for mortaility post exposure up to 52 hours.	**High Copper concentration:** 63.0% average mortaility after 96 hours of exposure, 97.2 % average mortaility up to 52 hours of post exposure. **Low Copper concentration:** 16.2% average mortaility after 96 hours of exposure, 62.3% average mortaility up to 52 hours of post exposure.	https://cdn2.cloud1.cemah.net/wp-content/uploads/sites/36/2017/03/Claudi-et-al.-2014d.pdf

RNT Consulting	2014	2012	Experiment	Natrix	Copper Triethanolamine Complex, Copper Monoethanolamine	**High Copper concentration:** 1.0ppm, **Low Copper concentration:** 0.5ppm	Groups of about 100 quagga adult mussels were placed into individual mesh bags. The bags containing adults were placed in aerated lake water to acclimate to laboratory conditions over 48 hours. Natural clumps of mussels were kept as intact as possible to minimize the stress on the adults and to evaluate if algaecides would cause de-clumping. Five 50 gallon drums in the laboratory were filled with raw water from the Colorado River and allowed to stabilize over 24 hours. Algaecides were added to the drums, following the mixing process, the drip valves installed on the bottom of the drum were opened and the solution from each drum flowed into individual coolers. When coolers were filled to approximately 50%, 3 mesh bags containing about 100 adults each were placed in each cooler. The drip valves continuously passed solution from the drum into the associated 40 L cooler over a period of 96 hours at a rate of approximately 2 L/hour. Every 12 hours each mesh bag was examined and dead mussels were counted and removed and placed back into cooler up to 96 hours. The mesh bags were then placed in a recovery chamber and monitored for mortality post exposure up to 48 hours.	**High Copper concentration:** 100 % morality after 96 hours of exposure. **Low Copper concentration:** mortality varied from 92.2% to 93.9% after 96 hours of exposure, mortality varied from 98.9% to 100% up to 48 hours of post exposure.	https://cdn2.cloud1.cemah.net/wp-content/uploads/sites/36/2017/03/Claudi-et-al.-2014d.pdf
RNT Consulting	2014	2012	Experiment	Natrix	Copper Triethanolamine Complex, Copper Monoethanolamine	**High Copper concentration:** 1.0ppm, **Low Copper concentration:** 0.5ppm	Groups of about 100 zebra adult mussels were placed into individual mesh bags. The bags containing adults were placed in aerated lake water to acclimate to laboratory conditions over 48 hours. Natural clumps of mussels were kept as intact as possible to minimize the stress on the adults and to evaluate if algaecides would cause de-clumping. Five 50 gallon drums in the laboratory were filled with raw water from the Colorado River and allowed to stabilize over 24 hours. Algaecides were added to the drums, following the mixing process, the drip valves installed on the bottom of the drum were opened and the solution from each drum flowed into individual coolers. When coolers were filled to approximately 50%, 3 mesh bags containing about 100 adults each were placed in each cooler. The drip valves continuously passed solution from the drum into the associated 40 L cooler over a period of 96 hours at a rate of approximately 2 L/hour. Every 12 hours each mesh bag was examined and dead mussels were counted and removed and placed back into cooler up to 96 hours. The mesh bags were then placed in a recovery chamber and monitored for mortality post exposure up to 60 hours.	**High Copper concentration:** moratility varied from 56.4% to 80 % after 96 hours of exposure, mortality varied from 73.2% to 93.9% up to 60 hours of post exposure. **Low Copper concentration:** mortality varied from 49.6% to 63.8% after 96 hours of exposure, mortality varied from 58.7% to 72.4% up to 60 hours of post exposure.	https://cdn2.cloud1.cemah.net/wp-content/uploads/sites/36/2017/03/Claudi-et-al.-2014d.pdf
RNT Consulting	2014	2012	Experiment	Green Clean Sodium Carbonate Peroxyhydrate Powder	27.6 % Hydrogen Dioxide	90 lbs/acre-foot	Groups of about 100 adults were placed into individual mesh bags. The bags containing adults were placed in aerated lake water to acclimate to laboratory conditions over 48 hours. Natural clumps of mussels were kept as intact as possible to minimize the stress on the adults and to evaluate if the Green Clean Sodium Carbonate Peroxyhydrate Powder would cause de-clumping. Five 50 gallon drums in the laboratory were filled with raw water from the Colorado River and allowed to stabilize over 24 hours. The maximum strength of Green Clean Powder was added to the drums, following the mixing process, the drip valves installed on the bottom of each drum were opened and the solution from each drum started flowed into individual coolers. When coolers were filled to approximately 50%, three bags of approximately 100 mussels were placed in each drum for 12 hours, then removed and evaluated for mortality.	0%	https://cdn2.cloud1.cemah.net/wp-content/uploads/sites/36/2017/03/Claudi-et-al.-2014d.pdf
RNT Consulting	2014	2012	Experiment	Green Clean Liquid	27% Hydrogen Dioxide	30 gal/acre-foot	Groups of about 100 adults were placed into individual mesh bags. The bags containing adults were placed in aerated lake water to acclimate to laboratory conditions over 48 hours. Natural clumps of mussels were kept as intact as possible to minimize the stress on the adults and to evaluate if the Green Clean Sodium Carbonate Peroxyhydrate Liquid would cause de-clumping. Five 50 gallon drums in the laboratory were filled with raw water from the Colorado River and allowed to stabilize over 24 hours. The maximum strength of Green Clean Liquid was added to the drums, following the mixing process, the drip valves installed on the bottom of each drum were opened and the solution from each drum started flowed into individual coolers. When coolers were filled to approximately 50%, three bags of approximately 100 mussels were placed in each drum for 12 hours, then removed and evaluated for mortality.	0%	https://cdn2.cloud1.cemah.net/wp-content/uploads/sites/36/2017/03/Claudi-et-al.-2014d.pdf
Taylor and Francis Group	2017	2014	Field	Zequanox	Pseudomonas fluorescens, strain CL145 A	100 ppm, with a 11 day application, with a treatment area of 243 m^2	During application, concentrations were measured to ensure that target concentrations were achieved to kill zebra mussels and these concentrations were maintained via bump treatments. All products were applied in Christmas Lake by a state-certified pesticide applicator. Products were mixed in tanks and injected at the water surface. Following treatment, monitoring occurred every 1–2 d for 14 d post-treatment. Monitoring consisted of collecting surface water samples at various locations inside the treatment area. During the Zequanox application, concentrations were estimated, using turbidity measurement, on the first and last day of treatment application. Four cages of about 50–100 mussels per cage were placed within the treatment area. Cages were constructed of plastic canvas mesh sheets (1–2 mm openings), anchored to the lake bottom. Live, gaping, and dead zebra mussels were recorded daily until all mussels were dead or until no additional mussels died over 3 consecutive days. Laboratory product efficacy testing was conducted in tandem with in-lake applications for Zequanox, EarthTec QZ, and potash. Zebra mussel mortality was assessed via aquarium bioassays. A comprehensive search of the entire shoreline was conducted by 18 surveyors using both SCUBA and snorkel gear. In addition to active searches, settlement samplers were suspended from docks and buoys at several locations around the lake perimeter.	Based on estimates from cage and aquarium bioassays 100% mortality was achieved by Day 11. Additional searching following treatment found 25 additional zebra mussels 9–18 m outside the treatment area.	https://www.maisrc.umn.edu/sites/maisrc.umn.edu/files/zebra_mussel_dreissena_polymorpha_eradication_efforts_in_christmas_lake_mn_0.pdf
Plos One	2015	2015	Experiment	UV-C	Radiation	26.2 mJ/cm^2 and 79.6 mJ/cm^2	50 watt UV-C amalgam lamp that generates 19 watts of emitted UV-C at 254 nm. UV-C exposure in a laboratory setting, with quagga mussel larvae from all stages	About 50 % mortality with a dose of 26.2 mJ/cm^2 after 4 days of exposure, about 80% mortality with a dose of 79.6 mJ/cm^2 after 4 days of exposure.	https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0133039

Appendix G: Reclamation's Cultural Resources Determination

Healer, Rain L

From: Williams, Scott A
Sent: Monday, June 27, 2011 9:41 AM
To: Healer, Rain L
Cc: Overly, Stephen A; Goodsell, Joanne E; Dunay, Amy L; Barnes, Amy J; Fogerty, John A; Nickels, Adam M; Perry, Laureen (Laurie) M; Bruce, Brandee E; Soule, William E
Subject: 11-SCAO-196, Zebra Mussel Eradication

11-SCAO-196
Zebra Mussel Eradication

Dear Rain Healer,

Reclamation finds that the Zebra Mussel Eradication Project at San Justo Reservoir has no potential to cause effects to historic properties pursuant to 36 CFR Part 800.3(a)(1). As the proposed action has no potential to cause effects to historic properties, no additional consideration under Section 106 of the National Historic Preservation Act is required.

San Justo Reservoir, completed in January 1986, serves as an offstream storage facility. Water from Hollister Conduit is stored in the reservoir and is released during the winter months. San Justo Dam and a dike are the primary features this facility. The dam is a zoned earth and rockfill dam, 151 feet high, with a crest 1,116 feet long. The reservoir`s capacity is 9,785 acre-feet. The dike is a zoned earth structure, 79 feet high, with a crest 1,296 feet long. To control seepage, Reclamation installed a 40-millimeter-thick, high-density, polyethylene membrane liner in the reservoir which was covered with earthfill to protect it against damage.

Reclamation and San Bernardino County Water District (SBCWD) need to prevent further spread of zebra mussels and impacts to San Justo Reservoir, the Hollister Conduit and SBCWD's water distribution system. The purpose of the Proposed Action is to eradicate zebra mussels in the San Justo Reservoir, Hollister Conduit, and the SBCWD. The Proposed Action area is located in northern San Benito County and includes San Justo Reservoir, the Hollister Conduit, the SBCWD water distribution system and the lands served by that system, and the northwestern portion of the SBCWD service area.

Prior to treatment, San Justo Reservoir would be drawn down to a surface elevation between 455 and 470 feet. In some reservoirs, lowering water levels below normal operating levels may have the potential for effect, due to increased wave action; however, the San Justo Reservoir is lined with a 40-millimeter-thick, high-density, polyethylene membrane liner which is covered with earthen fill, eliminating erosion concerns.

Treatment of the reservoir would consist of infusing the remaining water with a potash solution pumped from land-based storage tanks to floating supply lines attached to work boats in the reservoir outfitted with diffuser assemblies. Staging areas for treatment and monitoring of the reservoir would be within the existing paved parking area at the reservoir (Figure 2-1). Any staging needed for treatment of the water distribution system would be done within existing, previously disturbed, access roads. No ground disturbing activities would occur under the Proposed Action.

Reclamation finds that the Zebra Mussel Eradication Project at San Justo Reservoir has no potential to cause effects to historic properties pursuant to 36 CFR Part 800.3(a)(1). This concludes the Section 106 review process. Please retain a copy of this e-mail with the administrative record for this action. If the project activities change or circumstances are altered after this review, there may be additional Section 106 review responsibilities up to and including consultation with the California State Historic Preservation Officer.

Sincerely.

Scott A. Williams, M.A. Archaeologist
Bureau of Reclamation, Mid-Pacific Region
2800 Cottage Way, MP-153

Sacramento, CA 95825
916-978-5042

Appendix H: U.S. Fish and Wildlife Concurrence

United States Department of the Interior

FISH AND WILDLIFE SERVICE
Ventura Fish and Wildlife Office
2493 Portola Road, Suite B
Ventura, California 93003

IN REPLY REFER TO:
2009-SL-0399

June 29, 2016

Memorandum

To: Chief, Resource Management Division, Bureau of Reclamation, Fresno, California

From: Assistant Field Supervisor, Ventura Fish and Wildlife Office, U.S. Fish and Wildlife Service, Ventura, California

Subject: Zebra Mussel Eradication Project, San Justo Reservoir, San Benito County, California (File No. SCC-423-ENV-7.00 San Felipe)

We are responding to the Bureau of Reclamation's (Reclamation) electronic mail request, received in our office on December 10, 2015, requesting our concurrence that actions associated with the subject project may affect, but are not likely to adversely affect, the federally threatened California red-legged frog (*Rana draytonii*) and the federally endangered California least tern (*Sterna antillarum browni*) and San Joaquin kit fox (*Vulpes macrotis mutica*). On March 2, 2016, Dr. Ned Gruenhagen, of your staff, requested via electronic mail that we also include the federally threatened California tiger salamander (*Ambystoma californiense*) in this informal consultation. You have made the determination that the proposed project may affect, but is not likely to adversely affect the California tiger salamander. A small portion of the subject project, adjacent to the water distribution system, would take place within designated critical habitat for the California red-legged frog and California tiger salamander, but no habitat for either species would be affected by the project. As such, you have determined that the subject project will have no effect on designated critical habitat for the California red-legged frog and California tiger salamander. We agree with this determination, therefore we will not discuss designated critical habitat for these species further.

Information contained in this memorandum was obtained from Reclamation's Biological Evaluation (Reclamation 2015) unless otherwise noted. San Justo Reservoir (reservoir) was constructed in 1986, and serves as an offstream storage facility for the San Felipe Division of the Central Valley Project. In 2008, zebra mussels (*Dreissena polymorpha*) were discovered in the reservoir; the reservoir was subsequently closed to public recreational access. The San Benito County Water District's water distribution system has since been examined for the presence of mussels and they were confirmed in the San Benito Conduit and in a pond at the Ridgemark Golf and Country Club Golf Course.

Zebra mussels are an invasive freshwater mollusk that attach to infrastructure, clog water systems and cause changes in food web dynamics. These mussels commonly attach to boats or other watercraft or contaminate bilge water and are carried to new waterways where they become established. They can float in the currents of a water body for weeks as microscopic free-floating larval mussels, called veligers, before attaching to substrates at water levels down to 180 feet. Adults may spawn multiple times in a year and have the potential to produce millions of offspring during a single breeding season.

In 2008, Reclamation, California Department of Fish and Wildlife, San Benito County, and independent technical experts formed a working group to evaluate methods for eradicating zebra mussels within the reservoir, the Hollister Conduit, and San Benito's water distribution system. Several methods were evaluated and it was determined that the zebra mussel eradication project at Millbrook Quarry (Virginia) was, and continues to be, the most preferred method for mussel eradication at the reservoir. In 2002, zebra mussels were confirmed in the Millbrook Quarry which was the first reported presence in Virginia. The quarry was treated with potassium chloride (potash) which included the pumping of 174,000 kilograms of potassium chloride solution through a diffuser assembly from a work boat over a three week period in 2006. To ensure lethal concentrations of potassium, a target dose of 100 parts per million (ppm) throughout the water column was established. The quarry was subsequently sampled through various methods following treatment in which no mussels were found alive. There were no observed non-molluscan aquatic wildlife, vegetation, or terrestrial wildlife harmed during or after treatment at the quarry.

In this proposed project, prior to treatment, the reservoir would be drawn down from 485 feet to between 430 to 470 feet. Once the desired drawdown elevation is reached, the inlet/outlet valve connecting the reservoir to the water distribution system would be closed to isolate the reservoir. Treatment of the reservoir would consist of infusing the remaining water with a potash solution from land based storage tanks to floating supply lines attached to work boats that have been outfitted with diffuser assemblies. Injection and monitoring would be completed within different zones at different depths within the reservoir to ensure the entire water column reaches the desired minimum concentration for a minimum of 30 days. Sampling would be conducted during the treatment period to verify that concentrations of potassium chloride in the water are maintained at approximately 100 ppm. Once the desired concentration is achieved, treated water would be sent into the closed water distribution system to eradicate mussels throughout the system. Treatment of the reservoir and water distribution system would be done over a two to three month period during the late summer.

Equipment and storage tank staging would be located within existing paved areas at the reservoir. No ground disturbing activities would occur. All equipment utilized during the eradication project that comes into contact with water from the reservoir or distribution system would be required to undergo decontamination. Short and long term (two to three years) monitoring for mussels would be conducted to ensure efficacy of the project.

The Environmental Protection Agency (EPA) does not have an established drinking water maximum contaminate level (MCL) for potassium, but does have a secondary drinking water MCL for chloride of 250 ppm. Chloride levels during treatment are anticipated at 194 ppm and would decrease over time. A maximum treatment dose of 115 ppm potassium would pose no human health risks from ingestion or contact, nor is it anticipated to harm any non-bivalve aquatic wildlife, vegetation, or terrestrial wildlife.

California red-legged frog
The California red-legged frog occurs at several locations within 3.0 miles of the reservoir (CDFW 2016). The species is not known and not anticipated to utilize the reservoir for breeding due to the presence of predatory fish species. California red-legged frogs and bullfrogs (*Rana catesbeiana*) are known to utilize a pond just below San Justo Dam, for breeding and non-breeding purposes. The pond is supplied with water diverted from a sump that collects water from the San Justo Dam toe drains. The planned reservoir water level draw down that is part of the treatment may reduce or curtail flow to the toe drains. The Service anticipates that potential drying of the pond due to low reservoir levels during the project (late summer) would likely have beneficial effects to California red-legged frogs as it may result in the eradication of bullfrog larvae if present in the pond. Unlike bullfrogs (which typically require two seasons to achieve metamorphosis), the potential slow loss of water levels in the pond (during the late summer, as proposed) would allow any late season California red-legged frog larvae ample time to achieve metamorphosis and exit the pond on their own. Although the project may result in a loss of water within the pond, non-breeding aquatic and upland habitat in and around the pond should continue to provide foraging and refuge habitat for the California red-legged frog.

As mentioned above, California red-legged frogs are not expected to occur in the reservoir due to the presence of predatory fish species, but they may be subjected to potassium chloride from flow into the pond from the toe drains, although this is unlikely. Available data indicate that proposed potassium chloride concentrations would likely be below concentrations that would affect Californian red-legged frog. The potassium chloride LC50 (lethal concentration that would kill half of a sample size) for the ornate narrow mouthed frog is less than 10 percent of the proposed application concentration; similarly, mortality of bullfrogs did not begin to occur until 10 times the project concentration. Although there is no data available for California red-legged frog, based on these surrogate species, we do not believe the species would be adversely affected at treatment levels. Further, Reclamation will notify the Service immediately if any injured or dead California red-legged frogs are detected in the pond or reservoir.

California tiger salamander
The California tiger salamander is known to occur at several locations within 3.0 miles of the reservoir (CDFW 2016). The species is not known or anticipated to utilize the reservoir for breeding due to the abundance of predatory fish. Upland habitat surrounding the reservoir is suitable for the species as small mammal burrows are present throughout. Previous surveys have not observed the species utilizing the pond below San Justo Dam for breeding or non-breeding purposes. The project does not incorporate any ground disturbing activities and staging areas

would be located in existing paved areas; although, California tiger salamanders may disperse across access routes during migration events.

San Joaquin kit fox
The San Joaquin kit fox has been recorded approximately four miles east of the reservoir (CDFW 2016). The most recent occurrence of the species was in 1992. Several surveys in the area since 1992 have resulted in no observations of the species. The project site provides suitable upland habitat for denning, foraging, and dispersal, although the species is not anticipated to occur in the project area.

California least tern
The California least tern has not been recorded at San Justo Reservoir. Unconfirmed sightings of the species have been reported at water bodies approximately 10 miles north (San Felipe Lake) and 10 miles southeast (Paicines Reservoir) of the project site. The project site does not provide suitable nesting habitat; although, it does contain suitable foraging habitat. There is a low probability that migrating California least terns may occur within the project area for foraging purposes.

Avoidance Measures

1) A qualified biologist will provide training to all individuals working at the site on the California red-legged frog, California tiger salamander, San Joaquin kit fox and California least tern. The training will incorporate identification of the subject species, the protections afforded to them under the Endangered Species Act, and the procedures to follow if one is observed in an area to be impacted.

2) Prior to work in terrestrial areas, a qualified biologist will conduct a survey for the California red-legged frog, California tiger salamander, San Joaquin kit fox, and California least tern. If work extends into the winter season (October 1 through May 1), terrestrial areas will be surveyed by a biological monitor, who has undergone the training above, prior to work each morning. Surveys will include all areas where individuals and equipment would be working including under vehicles and equipment that are staged overnight.

3) Staging of equipment for treatment of the reservoir and injection points will occur on existing paved ground. If construction fencing is required the installation of such fencing will avoid small mammal burrows.

4) All piping, tubing, and similar materials that are stored in the project area will be capped or stored above ground in a manner that precludes access by the California red-legged frog, California tiger salamander and San Joaquin kit fox.

5) Project-related vehicles will observe a speed limit of 20 miles per hour throughout the project site, except on public roadways with a posted speed limit.

6) Periodic monitoring for potassium chloride at the pond below the dam will be conducted. A qualified biologist will periodically monitor the pond below the dam to survey for California red-legged frogs and California tiger salamanders.

7) Nighttime activities would be minimized or avoided to the maximum extent feasible.

8) If an individual California red-legged frog, California tiger salamander, San Joaquin kit fox, or California least tern is observed in the project area and may be adversely affected by project activities, work potentially affecting that individual will cease and the Service will be contacted immediately.

In conclusion, we concur with your determination that the proposed project may affect, but is not likely to adversely affect the California red-legged frog, California tiger salamander, San Joaquin kit fox and California least tern. We believe that potential adverse effects to the California red-legged frog and California tiger salamander due to water quality are not anticipated to occur. We anticipate that periodic monitoring of the frog pond in combination with the additional proposed protection measures will reduce and/or eliminate potential adverse effects to the subject amphibian species. We believe that daily monitoring of the project area and ceasing work if an individual of the subject species is observed in an area to be impacted will reduce and/or eliminate potential adverse effects to the subject species.

This concludes informal consultation on the San Justo Reservoir Zebra Mussel Eradication Project pursuant to section 7(a)(2) of the Act. If the proposed action changes in any manner or if new information reveals that listed species in the project area may be adversely affected by the proposed action, Reclamation should contact us immediately and suspend all activities that may affect listed species until the appropriate level of consultation is completed. If you have any questions regarding this memorandum, please contact Chad Mitcham of my staff at (831) 768-7794, or at chad_mitcham@fws.gov.

LITERATURE CITED

[Reclamation] Bureau of Reclamation. 2015. Biological Evaluation. Zebra Mussel Eradication Project for San Justo Reservoir, Hollister Conduit and San Benito County Water Distribution System. EA-09-010.

[CDFW] California Department of Fish and Wildlife. 2016. California Natural Diversity Database Sacramento, Electronic Form.

Appendix I: Comment Letters and Reclamation’s Response to Comments

State of California – Natural Resources Agency
DEPARTMENT OF FISH AND WILDLIFE
Central Region
1234 East Shaw Avenue
Fresno, CA 93710
(559) 243-4005
www.wildlife.ca.gov

EDMUND G. BROWN JR., Governor
CHARLTON H. BONHAM, Director

April 15, 2015

Rain L. Emerson, M.S.
Supervisory Natural Resources Specialist
Bureau of Reclamation
South-Central California Area Office
1243 N Street
Fresno, California 93721

Subject: Draft Finding of No Significant Impact and Draft Environmental Assessment Zebra Mussel Eradication Project for San Justo Reservoir, Hollister Conduit, and San Benito County Water Distribution System FONSI-09-010

Dear Ms. Emerson:

The California Department of Fish and Wildlife (Department) has reviewed the Draft Finding of No Significant Impact and Draft Environmental Assessment (EA) for the Zebra Mussel Eradication Project for San Justo Reservoir, Hollister Conduit, and San Benito County Water Distribution System, released for public review April 2015. The proposed Project involves a concurrent treatment approach that includes 1) the treatment of San Justo Reservoir using 'muriate of potash' (potash or potassium chloride); and 2) the treatment of the Hollister Conduit in combination with San Benito County Water District Distribution System to eradicate zebra mussels (*Dreissena polymorpha*). Our specific comments are included in the attached table.

Thank you for the opportunity to review the Draft Finding of No Significant Impact and Draft EA for the Zebra Mussel Eradication Project for San Justo Reservoir, Hollister Conduit, and San Benito County Water Distribution System. We look forward to continuing our working relationship with Bureau of Reclamation staff. If you have further questions, please contact Kelley Aubushon, Environmental Scientist, at (559) 243-4017 extension 285 or Kelley.Aubushon@wildlife.ca.gov.

Sincerely,

Jeffrey R. Single, Ph.D.
Regional Manager

Attachment

ec: See Page 2

ec: Department of Fish and Wildlife
Jennifer LaBay
Brian Beal
Margaret Paul
Brandon Sanderson
Kelley Aubushon

	Chapter, Section, Comment #	Line, Figure, Page or Table No.	Comments
	General Comments referring to both documents		
CDFW-1	General Comment, Comment #1		No reference was made to the potential economic impact of reservoir closure to recreational opportunities and to the local related businesses.
CDFW-2	General Comment, Comment #2		Drought related impacts and future allocation restrictions should be taken into consideration. For example, according to the EA, taking San Justo Reservoir out of service for treatment in non-peak demand months would likely have no adverse impact on water users. Is this still accurate with the drought?
CDFW-3	General Comment, Comment #3		Who is the lead for the eradication and monitoring efforts?
CDFW-4	General Comment, Comment #4		Multiple references to the Bay Area Consortium Plan. Is the goal to join the consortium? Suggest utilizing more recent resources referenced in the plan.
CDFW-5	General Comment, Comment #5		Is there a plan to reestablish recreation at the reservoir and if so, when? It is the Department's recommendation to not allow public access during the 2-3 year monitoring post treatment. If recreation is permitted, a Prevention Program needs to be developed and implemented that is consistent with Fish and Game Code Section 2302.
	Draft Finding No Significant Impact		
CDFW-6	Proposed Action, Comment #6	Page 2	The second proposed action of eradication followed by a management program is not evaluated or described. In addition, if the eradication project is not successful, then any management activities would fall under Fish and Game Code Section 2301 and a Control Plan that complies with the Code would need to be submitted to the Department for approval.
CDFW-7	Land Use, Comment #7	Page 4	Change "mporary impacts to agricultural uses may occur..." to "Temporary".
CDFW-8	Biological Resources, Comment #8	Page 4	According to the Department's Aquatic Invasive Species Management Plan (2008), Asian clam (*Corbicula fluminea*) is classified as an invasive species. Consider changing "... the non-native Asian clam (*Corbicula fluminea*), which is also considered a pest species." to "which is also considered an invasive species."
CDFW-9	Biological Resources, Comment #9	Page 5	"If a major fish die off were to occur in the reservoir as a result of oxygen depletion, putrid smells could temporarily foul the area." Please provide a list of the fish species known to occur in San Justo Reservoir.

CDFW-10	Migratory birds, Comment #10	Page 6	"If the survey revealed nesting migratory birds to be present in the areas to be disturbed, measures would be implemented to avoid take." Please provide measures.
CDFW-11	Water Resources, Comment #11	Page 8	"All District customers irrigating their lands with CVP "blue-valve" water. . ." Please provide a description of what "blue-valve" water is.
			Draft Environmental Assessment
CDFW-12	Section 1 Introduction 1.1, Comment #12	Page 1	"Additionally, in 2012, live zebra mussels were reported in a pond at Ridgemark Golf and Country Club Golf Course." Department of Fish and Wildlife staff conducted zebra mussel surveys four times in 2012 from May-October at Ridgemark Golf and Country Club Golf Course. No mussels were found in any of the ponds or pumps. Two zebra mussels were found by Ridgemark employees in a pump (March 2012), four more zebra mussels were found by Ridgemark employees in October in the same pump. Please change "pond" to "pump".
CDFW-13	1.1.5, Comment #13	Page 7	The Department is worried about this information being misinterpreted, recommend this information either be removed from the EA or revised to capture the full story: there were several labs evaluating samples (USBR, CDFW, Scripps and MWDSC) in 2010, and all but USBR's samples were negative. In addition, all subsequent sampling by the Department has been negative.
CDFW-14	2.2, Proposed Action, Comment #14	Page 9	The EA only focuses on a one time eradication approach. The second proposed action of eradication followed by a management program is not evaluated or described. In addition, if the eradication project is not successful, then any management activities would fall under Fish and Game Code Section 2301 and a Control Plan that complies with the Code would need to be submitted to the Department for approval.
CDFW-15	2.2.1, Equipment Decontamination, Comment #15	Page 14	Suggest utilizing USBR's Inspection and Cleaning Manual for Equipment and Vehicles to Prevent the Spread of Invasive Species and the Department's Invasive Species Decontamination Protocol. Also would suggest including desiccation along with decontamination and inspection (clean, drain, dry).
CDFW-16	2.2.1 Potassium concentration Monitoring during Treatment, Comment #16	Page 14	There is no description of actions to be taken if the potassium concentration exceeds the stated maximum of 115 parts per million (ppm). In addition, the referenced Appendix does not included details on how the potassium concentrations will be monitored. The monitoring is vital to document the stated range of potassium concentration (a minimum of 100 ppm to a maximum of 115 ppm) is achieved. This detail is needed in order to determine if the monitoring proposed is adequate to, not only insure the target potassium concentration is uniformly achieved lake-wide and pipeline-wide, but also to insure the maximum concentration is not exceeded.
CDFW-17	2.2.1 Long- Term Monitoring Post-Treatment, Comment #17	Page 15	"Reclamation and San Benito would prepare a zebra mussel re-infestation prevention program that would be consistent with the Bay Area Consortium's *Zebra and Quagga Mussel Coordinated Prevention Plan* (Appendix D)." If the eradication is successful and recreation is permitted, a Prevention Program needs to be developed and implemented that is consistent with Fish and Game Code Section 2302. If the eradication is unsuccessful, a Control Plan that complies with Fish and Game Code Section 2301 would need to be submitted to the Department for approval.

CDFW-18	2.2.2 Alternative 2, Comment #18	Page 17	Language included here should be modified and incorporated into a Control Plan in the event the eradication is not successful. The EA does not address impacts from potential long-term use of potash as a control method. If the eradication is unsuccessful, how long would the dosing last? Is there any existing literature supporting the use of potash as a method of control?
CDFW-19	3.4.1, Affected Environment, Comment #19	Page 26	Clarify how the creek, private pond, and southern pond receive water from the reservoir. Has any monitoring occurred? Is there any planned treatment for these waters?
CDFW-20	3.4.2 Environmental Consequences, Comment #20	Page 32	According to the Department's California Aquatic Invasive Species Management Plan (2008), Asian clam (*Corbicula fluminea*) is classified as an invasive species. Consider changing "... the non-native Asian clam (*Corbicula fluminea*), which is also considered a pest species." to "which is also considered an invasive species."
	Appendix D: Monitoring Plan		
CDFW-21	General Comment, Comment #21		Who will be the lead for the monitoring specified in this document? When will this document be finalized? Will it be incorporated into a final document reviewed and approved by the Department per Fish and Game Code section 2301?
CDFW-22	General Comment, Comment #22		It is unclear exactly how a successful eradication will be measured. Please incorporate a section defining how a successful eradication will be measured. For example, do all long-term post-eradication treatment monitoring need to result in no veliger or zebra mussel detections over two consecutive summers?
CDFW-23	Shoreline Monitoring Protocol, Comment #23	Page 4	Please specify the protocols used for disposal of dead mussels.
CDFW-24	Bioassay, Comment #24	Page 4	"Bioassay (for Shoreline Dessication Treatment)??" Please clarify what this section refers to.
CDFW-25	Long-Term Post Eradication Treatment Monitoring, Comment #25	Page 6	Most of the monitoring outlined is based on the 2010 study conducted by Veldhuizen and Janik. To our knowledge, this study has not been published or peer reviewed. It is recommendation USBR compares current water quality and temperature to those taken during the study to support monitoring recommendations made through the document.
CDFW-26	Long-Term Post Eradication Treatment Monitoring, Comment #26	Page 6	Recommend monthly monitoring year round. Artificial substrates monthly monitoring requires little to no extra cost and minimal resources.

CDFW-27	Reservoir Monitoring Using Veliger Tows, Comment #27	Page 8	Unable to locate the protocol referenced. Recommend using an updated protocol with proven preservation methods, i.e. the Department's plankton tow protocol.
CDFW-28	Protocol for monitoring veligers, Comment #28	Page 9	Please specify which laboratory will be used to analyze veliger samples? The Department recommends sending split samples to multiple labs.
CDFW-29	Protocol for Divers/ROV, Comment #29	Page 13	"If divers are used, check for unresponsiveness (by poking them?). . ." Please remove the ?.
CDFW-30	Treatment Plan Summary for HC and DS, Comment #30	Page 14	Please make Figure 8 a full page.
CDFW-31	Biobox Monitoring Protocol – Long-Term, Comment #31	Page 15	Recommend monthly monitoring year round. Biobox monthly monitoring requires little to no extra cost and minimal resources.
CDFW-32	References, Comment #32	Page 17	The 100th Meridian Initiative Plankton Sample Collection Protocol document link does not work and we were unable to locate the document online.
CDFW-33	References, Comment #33	Page 17	The Zebra and Quagga Mussel Artificial Substrate Monitoring Protocol document referenced should be updated with the newest version of the Department's Artificial Substrate Monitoring Protocol. In addition, the link provided is broken.
CDFW-34	References, Comment #34	Page 17	The link to the 2010 Zebra Mussel Growth and Seasonal Reproductive Cycles in San Justo Reservoir document is broken. Please update with a link to the document if available.

Response to California Department of Fish and Wildlife Comment Letter, April 15, 2015

CDFW-1 As described in Section 1.2 of Environmental Assessment (EA)-09-010, the purpose of the Proposed Action is to eradicate zebra mussels within San Justo Reservoir, the Hollister Conduit and San Benito Water District's reservoir and associated appurtenances in order to help prevent future infestation and maintain the operation of the facilities. Closure of the reservoir was initiated by the County of San Benito in coordination with Reclamation when zebra mussels were first discovered in the reservoir in 2008. Closure of the reservoir is part of the baseline conditions for the County and is not part of the Proposed Action analyzed in EA-09-010.

CDFW-2 As noted in Section 3.6.2 of EA-09-010, San Benito County Water District's water users have groundwater resources that would be sufficient to meet demand during the treatment period (Pers. Comm. Dale Rosskamp 2011). This would be true whether during low Central Valley Project (CVP) allocations or drought conditions.

CDFW-3 San Benito County Water District is Reclamation's non-federal operating entity that operates and maintains San Justo Reservoir and related federal facilities pursuant to their Operation and Maintenance agreement. They will be taking the lead, in coordination with Reclamation, in implementing and monitoring the eradication project.

CDFW-4 There is only one reference to the Bay Area Consortium's plan in EA-09-010 in reference to equipment decontamination (see page 15 in EA-09-010). The reference is specific to the decontamination methods described in the plan that would be implemented for the proposed eradication project. Reclamation has no intention of joining the Consortium.

CDFW-5 See Response to CDFW-1. Re-opening the reservoir to recreation is not part of the Proposed Action analyzed in EA-09-010 and Reclamation does not intend to allow recreation within San Justo during the eradication program or the 2-3 year monitoring period. If the County of San Benito proposes to re-open the reservoir to recreation in the future, they would need to coordinate with Reclamation and San Benito County Water District and comply with all State and Federal laws, including development of a prevention program consistent with Fish and Game Code Section 2302.

CDFW-6 Alternative 2: Mussel Population Management Program is described in Section 2.2.2 (see page 15-16) in EA-09-010. As stated in Section 2.2.2, "The Mussel Population Management Program would include provision for a treatment regimen based upon either periodic scheduled treatments or treatments based on observed mussel populations and distribution, as required to maintain the efficient function of the San Justo Reservoir, the Hollister Conduit, and the San Benito Distribution Systems. The treatment would be conducted as a scaled back version of the eradication process, but with periodic dosing. Potash would continue to be used as a control agent and the existing structures placed into the water delivery system for the eradication process would be used to introduce the treatments. If other suitable materials became available for use, further environmental review prior to implementation could be required. Specific details of the plan would be developed in cooperation with the California Department of Fish and Wildlife and San Benito." Should this alternative need to be implemented, a control plan would be developed and submitted to CDFW consistent with Fish and Game Code Section 2301.

CDFW-7 Text has been revised in the FONSI.

CDFW-8 Text has been revised in the FONSI and EA.

CDFW-9 Fish within San Justo Reservoir are all non-native fish, generally Delta bottom feeders, farm trout, etc. conveyed from San Luis Reservoir. No inventories of fish species have been made in San Justo Reservoir since the reservoir was closed to the public in 2008.

CDFW-10 Because the action is likely to occur later in summer as opposed to spring or earlier in summer, most nesting activities are expected to be completed. Little nesting habitat is present for nesting birds where disturbance may occur. Regardless, if an active nest is identified where it would be disturbed, a buffer to avoid disturbance that could cause take would be implemented, if possible. If a buffer cannot be established, graduated habituation could be implemented. Birds nesting in highly disturbed areas often habituated to activities or choose to nest in such areas despite activity. Initial low levels of activity gradually increased over time, may enable required levels of activity. If needed, measured activities would be conducted in the presence of a biologist to determine acceptable boundary limits and tolerance of activity. As a last resort, activities could be delayed, such as until fledging occurs, if take could not otherwise be avoided.

CDFW-11 "Blue valve" water is CVP water that is sold for agricultural purposes.

CDFW-12 Text has been revised in the EA.

CDFW-13 Comment noted; however, Reclamation believes that the information provided in the EA describes the differences in analysis between Reclamation's Technical Service Center and the State of California (through Scripps Institute) regarding presence, or lack thereof, of quagga mussel in San Luis Reservoir. Text has been added to the EA indicating that subsequent testing by CDFW has been negative.

CDFW-14 See Response to CDFW-6.

CDFW-15 A contractor would be required to plan procedures for decontamination of equipment utilized throughout this project. Reclamation and CDFW documents would be included to support recommendation for decontamination and to prevent spread.

CDFW-16 Potassium monitoring during treatment is described in Section 2.2.1 of EA-09-010 (see pages 12-13). As described in EA-09-010, monitoring would continue throughout the treatment period to ensure that potassium levels remain at or above the minimum 100 ppm treatment level. In addition, Appendix E describes that potassium concentrations would be monitored at various locations and depths within the reservoir to ensure that the target concentration of 100 ppm is reached. It is possible that temporary exceedances may occur in localized areas; however, monitoring and dosing regime would be conducted as described to ensure even distribution. Should exceedances occur, dosing would cease until mixing brought the concentrations back into threshold range.

CDFW-17 See Responses to CDFW-5 and 6.

CDFW-18 See Response to CDFW-6.

CDFW-19 As described in Section 3.4.1, water is pumped to the "frog" pond through a small pipe that connects to a sump that collects seepage water from the dam. No direct water is delivered to the pond. The private pond has a small seep that originates from a landslide northwest of the reservoir (QLS-18). A map of the area containing these water bodies (Figure 4) was added to the EA. No monitoring of these locations has been planned at this time.

CDFW-20 Text has been revised in the FONSI and EA.

PLEASE NOTE that the following comments refer to Appendix D of the Draft EA: *Draft Technical Memorandum: Zebra Mussel Monitoring Plan for San Justo Reservior and the Hollister Conduit and Distribution System*, prepared by CH2MHILL for San Benito County Water District. This Plan will be finalized prior to implementation of the Eradication Project. This document is now Appendix E in the Final EA.

CDFW-21 San Benito County Water District is Reclamation's non-federal operating entity that operates and maintains San Justo Reservoir and related Federal facilities pursuant to their Operation and Maintenance agreement. They will be taking the lead, in coordination with Reclamation, in implementing and monitoring the eradication project. The monitoring plan will be finalized prior to putting the project up for bid. When funding is available to complete the project and finalize a monitoring plan, this final plan will be submitted to the CDFW for review and approval per Fish and Game Code 2301.

CDFW-22 As described on page 7 of Appendix D (which is now E, see above), eradication measures are considered to be successful if no new settlements of mussels are detected after post-eradication monitoring over 2 consecutive summers.

CDFW-23 Given the current operational strategy, the mass of mussels is insignificant, so the method of disposal is through natural processes.

CDFW-24 This refers to an assessment of the success of lowering the water level in the reservoir to kill the mussels at the water/shoreline interface.

CDFW-25 Recommendation noted.

CDFW-26 Recommendation noted.

CDFW-27 The protocol referenced is available by Googling "California Department of Fish and Wildlife Plankton Tow Protocol" CDFWPlanktonTowProtocol062317.pdf.

CDFW-28 Recommendation noted.

CDFW-29 The draft plan will be finalized prior to project initiation. Reclamation will request that San Benito County Water District remove the question mark.

CDFW-30 Prior to the Monitoring Plan being finalized, Reclamation will request that Figure 8 be made larger and more legible.

CDFW-31 Recommendation noted.

CDFW-32 This protocol can be found at the following link: https://www.fws.gov/fisheries/ANS/pdf_files/100thMeridian.pdf

CDFW-33 Reclamation has updated the document referenced: https://nrm.dfg.ca.gov/FileHandler.ashx?DocumentID=4953&inline

CDFW-34 Reclamation has found that the following link works: http://www.icais.org/pdf/abstracts_2010.pdf.

Marrone® Bio Innovations

April 9, 2015

Rain Emerson
Bureau of Reclamation
1243 N Street
Fresno, CA 93721

Subject: Marrone Bio Innovations Public Comment to *Draft Environmental Assessment for the Zebra Mussel Eradication Project for San Justo Reservoir, Hollister Conduit, and San Benito County Water Distribution System* (EA-09-010)

Dear Ms. Emerson,

Marrone Bio Innovations (MBI) is the commercial license holder and developer of Zequanox®, a biopesticide derived from the dead cells of the common soil bacterium *Pseudomonas fluorescens* strain CL145A and used for the control of invasive zebra and quagga mussels. We have reviewed the Draft Environmental Assessment for the Zebra Mussel Eradication Project for San Justo Reservoir, Hollister Conduit, and San Benito County Water Distribution System (EA-09-010) our comments, described in detail below, include an update of the current status of Zequanox and identification of few locations in the long-term monitoring plan that may need to be reviewed or reconsidered based on these updates.

MBI-1

Section 2.2.3 of the draft environmental assessment notes other alternatives that were considered and describes other mussel control tools, including a "Pseudomonas-derived Biocide." Upon review of this section, we have found that the information presented does not accurately reflect the current status of Zequanox. It states, "At present, the product is not commercially availability [sic], the effectiveness of the method for eradication is less than 100 percent, and information on the toxicity to non-target organisms is being developed. In addition, sufficient quantities of the product to treat San Justo Reservoir and the distribution system is not currently available…." We would like to take this opportunity to provide updated information as it relates to the underlined areas of the quoted section to Reclamation and its partners in this project.

Zequanox was registered by US EPA in March 2012 (EPA Reg. No. 84059-15) for the control of zebra and quagga mussels in enclosed and semi-enclosed systems (systems with a defined inlet/outlet), followed by state registration in California in November 2013. In addition to this, the California State Water Resources Control Board amended Order 2011-003-DWQ through Amending Order 2014-0173-DWQ to add Zequanox to its NPDES general permit. In June 2014, the US EPA registration of Zequanox was expanded to include uses in open water systems (such as lakes, reservoirs, and rivers) with registrations in many states occurring shortly thereafter. The label expansion is currently pending in California.

Zequanox has been commercially available since its registration in 2012 and large-scale treatments of infested facilities have been occurring since that time. In open water systems, treatments have been completed in Minnesota, Michigan, Wisconsin, and Illinois. These treatments have seen mussel mortality results as high as 100%.

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Marrone® Bio Innovations

A large body of non-target toxicity studies has been completed with Zequanox and its active ingredient. The non-target studies completed to date go above and beyond the requirements of the US EPA and include at least 12 species of molluscs (including at least 10 native North American mussels), 15 species of fish, and various plants, algae, waterfowl, and other aquatic invertebrates. In its Biopesticide Registration Action Document, the US EPA states "*Pseudomonas fluorescens* strain CL145A (Zequanox) has low toxicity and presents little to no risk to non-target organisms."

MBI-1 cont.

In consideration of the updated information provided above, we suggest revisions to the Mussel Population Management Program described within the draft environmental assessment. For Example, in describing the proposed action for the eradication project (Section 2.2.1), the "Permits Required" section describes plans for permit applications for the long-term management of the reservoir and distribution systems should the eradication attempt fail. This program is further described in Section 2.2.2, where potash is listed as the planned control tool. We suggest Zequanox be considered for a long-term control program as it is a registered, commercially-available biopesticide for the type of use described in the draft environmental assessment with demonstrated success as an invasive mussel control agent. Zequanox treatments of the distribution system in particular already have much of the necessary permitting and approvals in the state of California (state registration and listing on the general NPDES permit).

MBI-2

The draft Finding of No Significant Impact (FONSI-09-010) for this project cites that the proposed action (treatment with potash) would elevate chloride levels in the treated waters such that in conjunction with measured background chloride levels in San Justo Reservoir, the concentrations could cause root and foliar adsorption problems for crops. Because agricultural users represent one of the largest users of waters from San Justo Reservoir, it is important that long-term control options present minimal risk to these users. While potash is persistent in the environment once applied (for example, the cited Millbrook Quarry eradication effort estimated continued protection for ~30 years), Zequanox quickly breaks down after application. Additionally, the US EPA has ruled Zequanox as tolerance-exempt (40 CFR Part 180 § 180.1304) for residues on food commodities, making it especially appropriate for waters destined for use in agricultural irrigation. As golf-course irrigation is another known use for waters from San Justo Reservoir, it is also important to note that Zequanox has been tested on a variety of turf grass varieties both during germination and at maturity with no indication of harmful impacts.

We appreciate this opportunity to provide updated information on the availability of Zequanox for invasive mussel treatments and we appreciate further consideration by Reclamation and its partners in the project at San Justo Reservoir to evaluate up to date information on the control options available, including Zequanox, for long-term management and control.

Sincerely,

Keith Pitts
Vice President, Regulatory Affairs

1540 Drew Avenue • Davis, CA 95618 • Phone: 530-750-2800

Response to Marrone Bio Innovations (MBI) Comment Letter, April 9, 2015

MBI-1 Comment noted. As described in Section 1.2 of Environmental Assessment (EA)-09-010, the purpose of the Proposed Action is to eradicate zebra mussels within San Justo Reservoir, the Hollister Conduit and San Benito Water District's reservoir and associated appurtenances in order to help prevent future infestation and maintain the operation of the facilities. As described in Section 2.2.2, if eradication fails and long-term treatment to manage zebra mussels within San Justo Reservoir, a Mussel Population Management Program would be implemented. The Mussel Population Management Program would include provision for a treatment regimen based upon either periodic scheduled treatments or treatments based on observed mussel populations and distribution, as required to maintain the efficient function of the San Justo Reservoir, the Hollister Conduit, and the San Benito Distribution Systems. The treatment would be conducted as a scaled back version of the eradication process, but with periodic dosing. Potash would continue to be used as a control agent and the existing structures placed into the water delivery system for the eradication process would be used to introduce the treatments. However, other suitable materials, including Zequanox, would be considered for long term treatment and management of zebra mussels based on criteria such as efficacy, cost, protection of biological species and suitability for control needs. Specific details of the plan would be developed in cooperation with the California Department of Fish and Wildlife and San Benito County Water District.

MBI-2 See Response to MBI-1.

Specifically regarding the issues of effects to crop roots and foliar absorption issues that are raised: concentrations of chloride could exceed 142 ppm, there are no expected long term effects to the roots or foliage of crops.