Board Meeting Agenda

Russ Baggerly, Director
Mary Bergen, Director
Bill Hicks, Director
Pete Kaiser, Director
James Word, Director

CASITAS MUNICIPAL WATER DISTRICT
1055 Ventura Ave.
Oak View, CA 93022
Board Room
July 13, 2016
3:00 P.M.

Right to be heard: Members of the public have a right to address the Board directly on any item of interest to the public which is within the subject matter jurisdiction of the Board. The request to be heard should be made immediately before the Board's consideration of the item. No action shall be taken on any item not appearing on the agenda unless the action is otherwise authorized by subdivision (b) of ¶54954.2 of the Government Code and except that members of a legislative body or its staff may briefly respond to statements made or questions posed by persons exercising their public testimony rights under section 54954.3 of the Government Code.

1. Public Comments (items not on the agenda – three minute limit).

2. General Manager comments.

3. Board of Director comments.

4. Board of Director Verbal Reports on Meetings Attended.

5. Consent Agenda

   a. Minutes of June 22, 2016 Board Meeting.

   RECOMMENDED ACTION: Adopt Consent Agenda

6. Review of District Accounts Payable Report for the Period of 6/20/16 – 7/5/16.

   RECOMMENDED ACTION: Motion approving report.

7. Accept the Lake Casitas Vulnerability Assessment and the Prevention, Control and Management Plan for Aquatic Invasive Mussels.

RECOMMENDED ACTION: Motion to receive and file the findings of the Lake Casitas Vulnerability Assessment and the Prevention Control and Management Plan for Aquatic Invasive Mussels.

8. Authorize the General Manager to Sign an Agreement for a Waste Water handling feasibility study at Lake Casitas for a not to exceed amount of $75,000.

RECOMMENDED ACTION: Motion to authorize the General Manager to sign an Agreement.

9. Adopt Resolution awarding a contract for the Treatment Plant Electrical Upgrades to Oilfield Electric Company in the amount of $267,900.

RECOMMENDED ACTION: Adopt Resolution.

10. Fisheries Program Update.

RECOMMENDED ACTION: No action required.

11. Closed Session

Conference with Legal Counsel – Existing Litigation (Subdivision (a) of Section 54956.9, Government Code). Name of Case: Casitas Municipal Water District; and Casitas Municipal Water District Community Facilities District No. 2013-1 (Ojai) vs. Golden State Water Company, a California Corporation, and Does 1 through 50, inclusive. Case Number: 56-2016-00481628-CU-EI-VTA.

12. Information Items:

a. Water Sales (Acre Feet) in FY 2015-2016
b. CFD No. 2013-1 (Ojai) – Cost Analysis
c. Investment Report

13. Adjournment

If you require special accommodations for attendance at or participation in this meeting, please notify our office 24 hours in advance at (805) 649-2251, ext. 113. (Govt. Code Section 54954.1 and 54954.2(a).

Minutes of the Casitas Municipal Water District
Board Meeting Held
June 22, 2016

A meeting of the Board of Directors was held June 22, 2016 at the Casitas Municipal Water District located at 1055 Ventura Ave. in Oak View, California. The meeting was called to order at 3:00 p.m. Directors Kaiser, Baggerly, Word, Hicks and Bergen were present. Also present were Steve Wickstrum, General Manager, Carole A. Iles, substituting for Rebekah Vieira, Clerk of the Board, Attorney, John Mathews and Brad Milner from Milner-Villa Consulting. There were three staff members and four members of the public in attendance. President Kaiser led the group in the flag salute.

1. Public Comments (items not on the agenda – three minute limit).

None

2. General Manager comments.

The Casitas website shows the lake capacity is at 40% or 101,000 AF close to the predicted capacity date of July 1. Stage 3 becomes effective July 1. Everybody needs to make efforts for conservation.

Casitas Dam and Avenue 2 pump plant were shut down on Friday, June 17. Avenue 2 was very successfully completed by approximately 1 p.m. with very good work by the Electrical Mechanical Department, Edison, the Contractor and everyone else switching over the electrical equipment. The shutdown at Casitas Dam went very well with video taken, with the USBR, of the intake structure, pipelines underneath the floor and pipe gallery until the end of the process. While opening one of the large butterfly valves out in the pit, the worm gear shredded. Staff worked extra hours to get the valve open and will proceed either with replacing the valve or worm gear so that it can be operated. Director Baggerly asked if there was a worm gear in storage but the General Manager said that was not something that was kept on hand. Keystone, the manufacturer, had been called to see if one was available locally and Casitas is in process of acquiring one. The valve has essentially been locked in place by welding. Everything was back in service by approximately 10:30 p.m. The O&M Manager had expressed his appreciation of the very good teamwork in accomplishing the task.

Staff has filed a water supply stress test with the State Water Resources Control Board. The Board has asked everyone in the state to report on water availability with an estimated three more drought years. Casitas looks very good on the test but even though there is sufficient water for the next three years, supplies are dwindling. The state is collecting data statewide to find individuals who will be in dire straights if the drought continues. Casitas will talking to the state about grant opportunities and prospects for other projects to help weather a longer drought.

Director Baggerly asked at what point the lake starts losing head. The General Manager said that the last gate is very low in the system. The lake

would be at the 7,000 AF minimum pool before the head disappeared. The point at which Casitas needs to start pumping is a matter of what is being served and what is going through the plant. Casitas is looking at those numbers. Director Baggerly asked if Casitas needs to start looking at pumps and the General Manager reported that had been started a year and a half ago with visits up to Santa Barbara.

The pump and packer have been installed at Mira Monte Well. Casitas is waiting for Edison to make a connection and the consultant to flush and test the water and the pump to see if the packer reduces any of the production of the well. It is anticipated that Edison will get out there and the well will be operational in two weeks.

A Star Free Press article reported that drought recovery could take four years. It is a warning to us all that El Nino was not the answer for the State of California. The report said that these were the worst four years in the last 1200 years for lack of rainfall, temperature and drought conditions.

Monday was a real challenge as far as heat was concerned. Pumps operate on set temperature ranges and at over 110 degrees some shut down. So staff had to respond to pump alarms and getting the pumps back up. The SCADA system worked as did the personnel who showed up to take care of the problems. There were no water or service outages as a result of the heat.

3. Board of Director comments.

Director Hicks commented that the (Board) meeting in October conflicts with the ACWA conference in San Diego so the meeting date may need to be changed.

Director Kaiser asked the General Manager to convey the Board's appreciation to the staff for working in the heat and bringing everything to a successful conclusion.

4. Board of Director Verbal Reports on Meetings Attended.

Director Word reported that he attended the Ventura Chamber Legislative Session. Their Urban Water Management Plan was passed on June 12, 2016 and sent in. The representative for Assembly Member, Das Williams, commented that the state has money available for affordable housing for this area but the cities are not allowing any development. He also attended an AWA session on groundwater sustainability and came away with a much better appreciation for the whole issue and the need for everyone to be at the table, not necessarily on the board, but participating. Everyone negotiating is much better than the alternative which is adjudication. It was did not indicated what would happen if the goals were not met

Director Kaiser asked if there were plans for a boat that was on the shore on the east side of the lake. The General Manager said that it had probably been

stripped and abandoned and due to the potential cost of removal would probably be left for fish habitat.

5. Consent Agenda ADOPTED

a. Minutes of the June 8, 2016 Board Meeting.
b. Minutes of the June 6, 2016 Special Meeting.
c. Recommend approval of Workers' Compensation Insurance Coverage renewal with CSAC in the amount of $ 114,881 for fiscal year 2016/2017.
d. Recommend approval of the Ernst & Young Statement of Work for Fiscal Year 2016/2017 for auditing services related to the State Water Project.

Director Bergen said that her comments in Item 4 about the GSA in the June 8 minutes, as recorded, did not make it clear that the draft JPA is almost complete and there is a long way to go before the Groundwater Agency is established. Also, under Item 8, the words Green Coalition should be capitalized.

Director Baggerly said that if evidence that there is a JPA is sent to DWR, their approval of the GSA shouldn't take too long. Director Bergen said there will be time for all the agencies to approve the JPA, select the board and get the outside members, prepare a budget and complete the process.

The Consent Agenda, with the above changes, was offered by Director Baggerly, seconded by Director Hicks and adopted by the following roll call vote:

AYES:	Directors:	Kaiser, Baggerly, Word, Hicks, Bergen
NOES:	Directors:	None
ABSENT:	Directors:	None

Resolution is numbered 16-18

6. Review of District Accounts Payable Report for the Period of 6/7/16 – 6/14/16. APPROVED

Director Bergen asked about Bill #023792, $8,853.74 for Unit #111 to Coastline Equipment, commenting that it was rather high. The General Manager reported that the bill for $8,853.74 for Unit #111 to Coastline Equipment was for the John Deere Backhoe repair – approximately $2,675 parts, $5,175 labor, $391 Freight.

Director Hicks asked about the license shared with Carpinteria. The General Manager reported that it was for the new GIS system for identifying pipelines, meters, etc. The cost sharing works for both agencies.

The report was offered by Director Hicks, seconded by Director Baggerly and approved by the following roll call vote:

AYES:	Directors:	Kaiser, Baggerly, Word, Hicks, Bergen

NOES: Directors: None
ABSENT: Directors: None

7. Urban Water Management Plan/Agriculture Water Management Plan - ADOPTED

a. Public Hearing

President Kaiser stated that it was the time and date set for a public hearing to consider input regarding the proposed Urban Water Management Plan/Agriculture Water Management Plan. He asked for the names of the public who had called or submitted information regarding the proposed plan. Ms. Iles stated there were two, Bruce Kuebler and Yasi Paulson.

President Kaiser asked for the General Manager's Report. The General Manager turn the floor over to Ron Merckling.

Ron Merckling reported that the state requires the Urban Water Management Plan to be approved every 5 years. The Agriculture Water Management Plan was done as a result of a request from the State Water Resources Board to subtract ag from the monthly reporting. Monthly reporting on Casitas' water demand is now mandatory and permanent per the Governor's declaration. He thanked Brad Milner from Milner-Villa Consulting for assistance with the process and Bryan Sandoval, Casitas Water Conservation Analyst, for entering the bulk of the numbers in all 70 tables. Director Word asked if the information from Entrix was based on when the fish ladder was installed. Ron Merckling stated that the 2004 Water Demand Study was included. Since the study did include operational changes for diverting water into the lake, the safe yield number changed slightly and that was where the 20,840 number was obtained. Director Kaiser commented that the public needs to be commended for the 38% reduction in residential use. Ron Merckling added that Resale Agencies, with a significant number of residential customers, have reduced by 30% or more and ag customers using Casitas water have reduced by about 19%. More reductions are projected with the reduction in allocations and since groundwater is not available. In some cases ag customers are choosing not to plant and use additional water.

President Kaiser opened the public hearing at 3:21 p.m. and asked for any public comments. There were none.

Brad Milner stated that the report was based on previous Casitas reports but there was a lot of new information as a result of new requirements. Director Baggerly asked for Mr. Milner to briefly go over what the water availability looks like.

Mr. Milner gave a brief overview noting that the public had had an opportunity to review the draft plan on approximately May 12, 2016. The final plan has been available since June 15, 2016. Table ES-4 in the Executive Summary shows current water supplies as used over the last five years ranging from 14,000 AF to 20,000 AF. The projected safe yield number is 20,840 AF

which is a combination of surface water supply as well as 300 AF from the well. When compared with the water supply and demand the projection for a normal year precipitation, temperature and demand, is a surplus of approximately 3,300-3,600 AF. Table ES-7 shows a dry year using the conservative number of 20,840 AF safe yield and a maximum demand number which actually matched the safe yield. Currently, the demand is approximately 15-16,000 AF which is why there is a 0 in the summation of demands in a single, dry year. The same process was used in Table ES-8 for a multiple dry year basis. In state terms, multiple dry years is three consecutive years with below normal precipitation. Right now we are in a four year going on five year period and the question is what will happen to the water resources versus water demands. Using the same principles of safe yield and potential demands, projected through 2040 there is a 0 balance. Consideration has been given to a continued drought concerning water demand and evaporation and what the Ojai and County unincorporated area development plans will be. Currently, it is projected that development and population growth will be fairly steady at .5% per year.

Ron Merckling stated that it is important to note that the processes within the plan are geared toward a general process for the whole state so this is not exactly how Casitas manages its plan. Casitas has its drought contingency plans for how certain levels and stages are dealt with.

Mr. Milner said that the bottom line was that with current storage there is enough supply to exceed demands for the next three years.

Director Baggerly commented that the outlined supply and demand took him back to the way the lake was designed. Utilizing 1998 as a base line for when the lake spilled, that was 18 years of water supply which is generally how long a drought takes to develop. The lake is functioning the way it was designed.

Mr. Milner continued that the water conservation program Casitas has implemented and the response from the public will extend the supplies.

Director Hicks acknowledged that the lake is doing what it was designed to do but it wouldn't hurt to be looking at alternate water supplies. Mr. Milner concurred that consideration should be given to a contingency plan to be adequately prepared, especially considering the length of time it takes to implement any contingencies. Director Baggerly observed that cooperation with local agencies, other retailers and the Watershed Protection District is going to be paramount in formulating contingency plans.

Director Kaiser closed the public hearing at 3:47 p.m.

b. <u>Resolution adopting the 2015 Urban Water Management Plan/Agriculture Water Management Plan</u>

The resolution was offered by Director Word, seconded by Director Baggerly and passed by the following roll call vote:

AYES: Directors: Kaiser, Baggerly, Word, Hicks, Bergen
NOES: Directors: None
ABSENT: Directors: None

Resolution is numbered 16-15

8. Public Hearing for the adoption of the 2016-2017 Budget

a. Public Hearing

President Kaiser asked for the names of any public who had called or submitted information regarding the adoption of the 2016-2017 budget. Ms. Iles stated there were none.

President Kaiser asked for the General Manager's Report.

The General Manager reported that the budget process had been developed over many years with staff, Managers, General Manager and Finance Committee review. Recent additions, mainly carry over projects, were outlined in a memorandum submitted at the meeting. He stated that Casitas should proceed with a water rate hearing and recreation rate restructuring. As in the past, Casitas estimates its revenue and expenditures conservatively which has not resulted in borrowing or taking money out of reserves to balance the year end budget. Reserves are slightly over twelve million dollars.

Director Word suggested that the surplus that had been divided between storm damage and water sales categories due to the anticipated El Nino event, which did not materialize, should now all be reallocated to water sales. The General Manager said that it would be an adjustment of reserves that would be done at a later date after the CAFR.

President Kaiser opened the public hearing at 3:48 p.m. and asked for any public comments. Hearing none, he closed the public hearing at 3:54 p.m.

b. Resolution adopting the general fund budget, debt service fund and Mira Monte water assessment district fund budgets for the Fiscal Year ending June 30, 2017 ADOPTED

The resolution was offered by Director Hicks, seconded by Director Bergen and passed by the following roll call vote:

AYES: Directors: Kaiser, Baggerly, Word, Hicks, Bergen
NOES: Directors: None
ABSENT: Directors: None

Resolution is numbered 16-16.

9. Resolution fixing a tax rate for Fiscal Year 2016-2017 and authorizing the President of the Board to execute a certificate requesting the Ventura County Board of Supervisors to levy such a tax ADOPTED

The resolution was offered by Director Baggerly, seconded by Director Hicks and passed by the following roll call vote:

AYES:	Directors:	Kaiser, Baggerly, Word, Hicks, Bergen
NOES:	Directors:	None
ABSENT:	Directors:	None

Resolution is numbered 16-17.

10. Resolution to adopt, under Proposition 4, the 2016/2017 Establishment of Appropriations Limit of $12,669,524 ADOPTED

The resolution was offered by Director Baggerly, seconded by Director Hicks and passed by the following roll call vote:

AYES:	Directors:	Kaiser, Baggerly, Word, Hicks, Bergen
NOES:	Directors:	None
ABSENT:	Directors:	None

Resolution is numbered 16-18.

11. Resolution authorizing the levy of a special tax for fiscal year 2016-2017 for Community Facilities District No. 2013-1 (Ojai) ADOPTED

The General Manager briefly explained the background of the CFD expenditures. It is the initial part to finance the legal costs associated with the acquisition of the Golden State Ojai Water System. At this point, $461,178 has been collected which is in the memorandum. At the start it was made clear that there would be no cost to Casitas rate payers. Currently Casitas is owed approximately $130,000. The taxes will be collected in November and again in April. If the lawsuits escalate it may be time to look at a Series A bond so that expenses are not paid out of reserves and Casitas is not waiting for tax money. Director Baggerly observed that the Series A bond is now an option since the Supreme Court upheld Mello Roos taxes and there is no longer a cloud over that process. The maximum tax will be collected until the Series A bond is in effect at which time the tax may be reduced.

The resolution was offered by Director Baggerly, seconded by Director Bergen and passed by the following roll call vote:

AYES:	Directors:	Kaiser, Baggerly, Word, Hicks, Bergen
NOES:	Directors:	None
ABSENT:	Directors:	None

Resolution is numbered 16-17.

12. Discussion regarding Casitas representation in a panel discussion at the Ojai Film Festival on July 16, 2016

Director Baggerly volunteered to attend.

13. Recommend approval of a letter of support for the Ventura County Watershed Protection District's Prop 1 Watershed Grant Program – Matilija Dam Removal 65% Design Planning Project APPROVED

The General Manager reported that a letter had already been sent so that the Ventura County Watershed District could submit a proposal for a three million dollar grant in a timely fashion to secure obtaining initial design work on the concepts developed at the most recent meetings.

The motion was offered by Director Word, seconded by Director Hicks and passed by the following roll call vote:

AYES:	Directors:	Kaiser, Baggerly, Word, Hicks, Bergen
NOES:	Directors:	None
ABSENT:	Directors:	None

14. Information Items:

a. Executive Committee Minutes.
b. Finance Committee Minutes.
c. Investment Report.

The motion was offered by Director Word, seconded by Director Hicks and passed by the following roll call vote:

AYES:	Directors:	Kaiser, Baggerly, Word, Hicks, Bergen
NOES:	Directors:	None
ABSENT:	Directors:	None

15. Adjournment

President Kaiser adjourned the meeting at 4:12 p.m.

_____
James W. Word, Secretary

CASITAS MUNICIPAL WATER DISTRICT
Payable Fund Check Authorization
Checks Dated 6/20/16-7/5/16
Presented to the Board of Directors For Approval July 13, 2016

Check	Payee			Description	Amount
000652	Payables Fund Account	#	9759651478	Accounts Payable Batch 062316	$117,127.52
000653	Payables Fund Account	#	9759651478	Accounts Payable Batch 062916	$612,134.37
000654	Payables Fund Account	#	9759651478	Accounts Payable Batch 070516	$260,641.51
					$989,903.40
000655	Payroll Fund Account	#	9469730919	Estimated Payroll 7/21/16	$160,000.00
					$160,000.00
				Total	$1,149,903.40

Publication of check register is in compliance with Section 53065.6 of the Government Code which requires the District to disclose reimbursements to employees and/or directors.

The above numbered checks,
000652-000655
have been duly audited is hereby certified as correct.

Denise Collin 7/6/16

Denise Collin, Accounting Manager/Treasurer

Signature

Signature

Signature

A/P Fund

Publication of check register is in compliance with Section 53065.6 of the Government Code which requires the District to disclose reimbursements to employees and/or directors.

000652	A/P Checks:	023857-023875
	A/P Draft to P.E.R.S.	000000
	A/P Draft to State of CA	000000
	A/P Draft to I.R.S.	000000
	Voids:	
000653	A/P Checks:	023876-023980
	A/P Draft to P.E.R.S.	
	A/P Draft to State of CA	
	A/P Draft to I.R.S.	
	Voids:	023936-023939
000654	A/P Checks:	023982-023995
	A/P Draft to P.E.R.S.	000000
	A/P Draft to State of CA	000000
	A/P Draft to I.R.S.	000000
	Voids:	

The above numbered checks, have been duly audited are hereby certified as correct.

Denise Collin 7/6/16

Denise Collin, Accounting Manager/Treasurer

_____

Signature

_____

Signature

_____

Signature

CERTIFICATION

Payroll disbursements for the pay period ending 06/18/16
Pay Date of 06/23/16
have been duly audited and are
hereby certified as correct.

Signed: Denise Collin 6/20/16
Denise Collin

Signed: _____
Signature

Signed: _____
Signature

Signed: _____
Signature

^

CERTIFICATION

Payroll disbursements for the pay period ending 07/02/16
Pay Date of 07/07/16
have been duly audited and are
hereby certified as correct.

Signed: Denise Collin 7/5/16
Denise Collin

Signed: _____
Signature

Signed: _____
Signature

Signed: _____
Signature

Casitas Municipal Water District
Reimbursement Disclosure Report (1)
Fiscal Year 2015/16
July 1, 2015-June 30, 2016

Date paid	Board of Director/ Employee	Description	Amount Paid
7/7/2015	Neil Cole	Lodging for AWWA Conference 6/8/15-6/10/15	273.76
7/7/2015	Neil Cole	Private Vehicle Mileage AWWA Conference	113.85
7/14/2015	Scott Lewis	Airfare to CMWD 6/21/15-6/27/15	569.20
7/14/2015	Scott Lewis	Lodging CMWD 6/21/15-6/27/15	490.50
7/14/2015	Scott Lewis	Car Rental CMWD 6/21/15-6/27/15	367.60
7/23/2015	Troy Garst	Safety Boots	155.88
7/23/2015	Rebekah Vieira	Private Vehicle Mileage to SHRM Conference 6/28/15	178.83
7/28/2015	Susan McMahon	Water TP Operation Course	119.68
8/13/2015	Vincent Godinez	Safety Boots	170.00
8/13/2015	Rebekah Vieira	Private Vehicle Mileage to SHRM Conference 7/1/15	178.83
8/19/2015	Ron Yost	Damtender Property Tax Bill	557.87
8/27/2015	Lindsay Cao	CWEA Renewal	164.00
8/27/2015	Larry Harris	Coffee/Food for Water Conservation Workshop 8/8/15	155.99
9/16/2015	Scott Lewis	Airfare to CMWD 8/26/15-9/1/15	259.20
9/16/2015	Scott Lewis	Lodging CMWD 8/26/15-9/1/15	565.44
9/16/2015	Scott Lewis	Car Rental CMWD 8/26/15-9/1/15	412.17
9/16/2015	Brian Taylor	Meal for Crews Working Overtime on Leak	113.63
9/16/2015	Robert Vasquez	2 Pairs of Safety Boots	261.44
9/22/2015	Suzi Taylor	Thermal Paper for Gate	177.32
10/7/2015	Vincent Godinez	Safety Boots	147.93
10/13/2015	Willis Hand	T5 Renewal	105.00
10/21/2015	Joel Cox	Safety Boots	160.18
10/21/2015	Scott MacDonald	Advance for AWWA Fall Conference	956.00
10/21/2015	Luke Soholt	Advance for AWWA Fall Conference	586.00
10/27/2015	Scott Lewis	Airfare to CMWD 10/25/15-11/5/15	279.20
11/3/2015	Todd Evans	Safety Boots	166.61
11/3/2015	Brian Taylor	Safety Boots	170.00
11/3/2015	Rebekah Vieira	Private Vehicle Mileage to CalPelra Conference	326.03
11/12/2015	Vincent Godinez	Water System Course	115.68
11/25/2015	Scott Lewis	Lodging CMWD 10/25/15-11/5/15	869.99
11/25/2015	Scott Lewis	Car Rental CMWD 10/25/15-11/5/15	614.53
11/25/2015	Scott Lewis	Airport Parking 10/25/15-11/5/15	110.00
11/25/2015	Scott Lewis	Hotel Parking 10/25/15-11/5/15	110.00
11/25/2015	Brian Taylor	Private Vehicle Mileage to AWWA Fall Conference	397.33
11/25/2015	Brian Taylor	Hotel AWWA Fall Conference 10/26/15-10/29/15	875.84
11/25/2015	Ron Yost	Safety Boots	160.18
12/1/2015	Eric Behrendt	Water Class & Manual	115.68
12/1/2015	Susan McMahon	Lodging 11/16/15-11/21/15 NALMS Conference	703.00
12/9/2015	Ronald Merckling	Lodging 12/1/15-12/4/15 ACWA Conference	635.91
12/9/2015	John Parlee	Safety Boots	170.00
12/16/2015	Bill Hicks	Lodging 12/1/15-12/4/15 ACWA Conference	635.91
12/16/2015	Bill Hicks	Private Vehicle Mileage ACWA Conference	232.30
12/16/2015	Scott Lewis	Airfare to CMWD 12/13/15-12/17/15	416.20
12/21/2015	Gerardo Herrera	Water Class & Manual	232.90
12/21/2015	Brian Taylor	Meal for Crews Working Overtime on Leak	106.15
12/21/2015	Robert Vasquez	Water Class	138.00
12/30/2015	Eric Grabowski	Water Class	168.00
12/30/2015	Scott MacDonald	Water Class	168.00
12/30/2015	Scott MacDonald	T3 Certificate	100.00

Casitas Municipal Water District
Reimbursement Disclosure Report (1)
Fiscal Year 2015/16
July 1, 2015-June 30, 2016

1/6/2016	Joel Cox	Mapping & GIS Course	238.50
1/6/2016	Eric Grabowski	Safety Boots	170.00
1/6/2016	Steve Wickstrum	Roundtrip Personal Vehicle Mileage to ACWA Conf	235.76
1/13/2016	Scott Lewis	Lodging CMWD 12/13/15-12/17/15	355.12
1/13/2016	Scott Lewis	Car Rental CMWD 12/13/15-12/17/15	232.33
1/13/2016	Scott Lewis	Fall Term Tuition	1,822.11
1/13/2016	Luke Soholt	US History Course	168.00
1/19/2016	Henry Islas	Safety Boots	170.00
1/26/2016	Suzi Taylor	EDD Training Seminar-Suzi Taylor & Carol Belser	150.00
1/26/2016	Suzi Taylor	Title 22 Instructor Courses-Michael Chauvel, Jessica Lugotoff	220.00
2/9/2016	Scott Lewis	American Fisheries Society 2016 Membership	100.00
2/9/2016	Scott Lewis	Airfare to CMWD 2/21/16-2/26/16	315.20
2/17/2016	Lisa Kolar	Advance for CPRS Class	807.00
2/17/2016	Brian Taylor	Safety Boots	170.00
3/1/2016	Lisa Kolar	Additional Advance for CPRS Class	195.90
3/9/2016	Gonzalo Carbajal	Safety Boots	170.00
3/9/2016	Gerardo Herrera	Safety Boots	170.00
3/16/2016	Scott MacDonald	Safety Boots	170.00
3/16/2016	Luke Soholt	Safety Boots	170.00
3/23/2016	Carol Belser	Lodging for CPRS Conference 3/9/16-3/11/16	461.60
3/23/2016	Scott Lewis	Lodging CMWD 2/21/16-2/26/16	501.35
3/23/2016	Scott Lewis	Car Rental CMWD 2/21/16-2/26/16	341.42
3/23/2016	Michael Shields	T5 Renewal	105.00
3/30/2016	Joel Cox	Airfare & Hotel for Mapping & GIS Training 3/16/16-3/17/16	628.72
4/6/2016	Neil Cole	P.E. Renewal	115.00
4/14/2016	Scott Lewis	Winter Term Tuition	1,177.89
4/14/2016	Michael Shields	Lodging AWWA Conference 3/23/16-3/24/16	218.11
4/14/2016	Michael Shields	Airfare AWWA Conference 3/23/16	154.60
4/27/2016	Mitch Tull	Replace Glasses Lost in Lake	298.20
5/11/2016	James Word	Roundtrip Personal Vehicle Mileage to ACWA Conf	306.72
5/11/2016	James Word	Lodging ACWA 5/3/16-5/6/16	886.29
5/19/2016	Vincent Godinez	D2 Certification	125.00
5/19/2016	Willis Hand	Safety Boots	134.97
5/26/2016	Gerardo Herrera	Class Reimbursement	186.33
5/26/2016	Scott MacDonald	Class Reimbursement	381.81
5/26/2016	Jordan Switzer	Field Supplies for Fisheries	127.41
5/26/2016	Suzi Taylor	Reimburse Expenses	1,500.00
6/23/2016	Gerry Herrera	Class Reimbursement	280.40
6/23/2016	Dave Pope	Safety Boots	170.00
6/29/2016	Mitch Abel	Advance for Travel for Training in July	802.00
6/29/2016	Eric Grabowski	Safety Boots	170.00

Note:
1) Reimbursement Disclosure Report prepared pursuant to California Government Code 53065.5

VENDOR SET: 01 Casitas Municipal Water D
BANK: * ALL BANKS
DATE RANGE: 6/20/2016 THRU 7/05/2016

VENDOR I.D.	NAME	STATUS	CHECK DATE	INVOICE AMOUNT	DISCOUNT	CHECK NO	CHECK STATUS	CHECK AMOUNT
C-CHECK	VOID CHECK	V	6/29/2016			023936		
C-CHECK	VOID CHECK	V	6/29/2016			023937		
C-CHECK	VOID CHECK	V	6/29/2016			023938		
C-CHECK	VOID CHECK	V	6/29/2016			023939		

* * T O T A L S * *	NO			INVOICE AMOUNT	DISCOUNTS	CHECK AMOUNT
REGULAR CHECKS:	0			0.00	0.00	0.00
HAND CHECKS:	0			0.00	0.00	0.00
DRAFTS:	0			0.00	0.00	0.00
EFT:	0			0.00	0.00	0.00
NON CHECKS:	0			0.00	0.00	0.00
VOID CHECKS:	4	VOID DEBITS	0.00			
		VOID CREDITS	0.00	0.00	0.00	

TOTAL ERRORS: 0

	NO	INVOICE AMOUNT	DISCOUNTS	CHECK AMOUNT
VENDOR SET: 01 BANK: TOTALS:	4	0.00	0.00	0.00
BANK: TOTALS:	4	0.00	0.00	0.00

VENDOR SET: 01 Casitas Municipal Water D
BANK: AP ACCOUNTS PAYABLE
DATE RANGE: 6/20/2016 THRU 7/05/2016

VENDOR	I.D.	NAME	STATUS	CHECK DATE	INVOICE AMOUNT	DISCOUNT	CHECK NO	CHECK STATUS	CHECK AMOUNT
00049		STATE OF CALIFORNIA							
	I-T2 201606211111	State Withholding	D	6/23/2016	9,422.87		000000		9,422.87
00049		STATE OF CALIFORNIA							
	I-T2 201607051116	State Withholding	D	7/05/2016	9,301.50		000000		9,301.50
00128		INTERNAL REVENUE SERVICE							
	I-T1 201606211111	Federal Withholding	D	6/23/2016	28,100.78		000000		
	I-T3 201606211111	FICA Withholding	D	6/23/2016	27,683.10		000000		
	I-T4 201606211111	Medicare Withholding	D	6/23/2016	6,474.26		000000		62,258.14
00128		INTERNAL REVENUE SERVICE							
	I-T1 201607051116	Federal Withholding	D	7/05/2016	28,957.30		000000		
	I-T3 201607051116	FICA Withholding	D	7/05/2016	29,249.28		000000		
	I-T4 201607051116	Medicare Withholding	D	7/05/2016	6,840.58		000000		65,047.16
00187		CALPERS							
	I-PBB201606211111	PERS BUY BACK	D	6/23/2016	66.87		000000		
	I-PBP201606211111	PERS BUY BACK	D	6/23/2016	161.96		000000		
	I-PEB201606211111	PEPRA EMPLOYEES PORTION	D	6/23/2016	1,937.53		000000		
	I-PER201606211111	PERS EMPLOYEE PORTION	D	6/23/2016	9,134.36		000000		
	I-PRB201606211111	PEBRA EMPLOYER PORTION	D	6/23/2016	1,933.48		000000		
	I-PRR201606211111	PERS EMPLOYER PORTION	D	6/23/2016	9,508.76		000000		22,742.96
00187		CALPERS							
	I-PBB201607051116	PERS BUY BACK	D	7/05/2016	66.87		000000		
	I-PBP201607051116	PERS BUY BACK	D	7/05/2016	161.96		000000		
	I-PEB201607051116	PEPRA EMPLOYEES PORTION	D	7/05/2016	1,938.38		000000		
	I-PER201607051116	PERS EMPLOYEE PORTION	D	7/05/2016	9,175.55		000000		
	I-PRB201607051116	PEBRA EMPLOYER PORTION	D	7/05/2016	1,934.31		000000		
	I-PRR201607051116	PERS EMPLOYER PORTION	D	7/05/2016	9,550.91		000000		22,827.98
00215		SOUTHERN CALIFORNIA EDISON							
	I-060316b	Acct#2210505426	R	6/20/2016	1,522.98		023857		1,522.98
00021		AWA OF VENTURA COUNTY							
	I-061516	Waterwise Breakfast 6/16/16	R	6/23/2016	125.00		023858		125.00
00055		CASITAS BOAT RENTALS							
	I-May 16 Cafe Passes	Reimburse Cafe Passes	R	6/23/2016	2,330.76		023859		2,330.76
01186		GERARDO M HERRERA							
	I-062116	Class Reimbursement	R	6/23/2016	280.40		023860		280.40

VENDOR SET: 01 Casitas Municipal Water D
BANK: AP ACCOUNTS PAYABLE
DATE RANGE: 6/20/2016 THRU 7/05/2016

VENDOR	I.D.	NAME	STATUS	CHECK DATE	INVOICE AMOUNT	DISCOUNT	CHECK NO	CHECK STATUS	CHECK AMOUNT
00596		HOME DEPOT							
	I-9902791	Freezer for Fisheries	R	6/23/2016	160.92		023861		160.92
02658		Liebert Cassidy Whitmore							
	I-1415917	Matter#CA18200001 1/16	R	6/23/2016	32.50		023862		
	I-1415918	Matter#CA18200005 1/16	R	6/23/2016	1,597.50		023862		
	I-1418568	Matter#CA18200005 3/16	R	6/23/2016	1,986.50		023862		3,616.50
02194		Draza Mrvichin							
	I-040416	Services Received 3/23/16	R	6/23/2016	1,512.50		023863		1,512.50
00625		OfficeTeam							
	I-45916908	Admin Temp	R	6/23/2016	693.44		023864		693.44
00188		PETTY CASH							
	I-062016	Replenish Petty Cash	R	6/23/2016	231.78		023865		231.78
02637		David Pope							
	I-061516	Safety Boots	R	6/23/2016	170.00		023866		170.00
02643		Take Care by WageWorks							
	I-4438376	Reimburse Medical	R	6/23/2016	192.75		023867		
	I-4469862	Reimburse Medical	R	6/23/2016	14.03		023867		206.78
01283		Verizon Wireless							
	I-9766473437	Monthly Cell Charges, DO & TP	R	6/23/2016	844.41		023868		
	I-9766473977	Monthly Cell Charges LCRA	R	6/23/2016	457.29		023868		1,301.70
00270		Wells Fargo Bank							
	I-060816	PSP Matting for Boat Launch	R	6/23/2016	1,083.96		023869		
	I-060816a	WP Misting Tees & Nozzles	R	6/23/2016	224.75		023869		
	I-060816b	Walkie-Talkies for Waterpark	R	6/23/2016	349.95		023869		
	I-060816c	Faucet for LCRA Maint	R	6/23/2016	80.74		023869		
	I-060816d	Accountant Ad	R	6/23/2016	108.18		023869		
	I-060816e	Misc Credit Card Charges	R	6/23/2016	306.52		023869		2,154.10
00124		ICMA RETIREMENT TRUST - 457							
	I-CUI201606211111	457 CATCH UP	R	6/23/2016	461.54		023870		
	I-DCI201606211111	DEFERRED COMP FLAT	R	6/23/2016	1,859.62		023870		
	I-DI%201606211111	DEFERRED COMP PERCENT	R	6/23/2016	134.71		023870		2,455.87
01960		Moringa Community							
	I-MOR201606211111	PAYROLL CONTRIBUTIONS	R	6/23/2016	16.75		023871		16.75

VENDOR SET: 01 Casitas Municipal Water D
BANK: AP ACCOUNTS PAYABLE
DATE RANGE: 6/20/2016 THRU 7/05/2016

VENDOR	I.D.	NAME	STATUS	CHECK DATE	INVOICE AMOUNT	DISCOUNT	CHECK NO	CHECK STATUS	CHECK AMOUNT
00985		NATIONWIDE RETIREMENT SOLUTION							
	I-CUN201606211111	457 CATCH UP	R	6/23/2016	211.53		023872		
	I-DCN201606211111	DEFERRED COMP FLAT	R	6/23/2016	3,983.85		023872		
	I-DN%201606211111	DEFERRED COMP PERCENT	R	6/23/2016	319.30		023872		4,514.68
00180		S.E.I.U. - LOCAL 721							
	I-COP201606211111	SEIU 721 COPE	R	6/23/2016	9.50		023873		
	I-UND201606211111	UNION DUES	R	6/23/2016	657.75		023873		667.25
01400		STATE DISBURSEMENT UNIT							
	I-CS4201606211111	Payroll Deduction 10-D000121	R	6/23/2016	682.14		023874		682.14
00230		UNITED WAY							
	I-UWY201606211111	PAYROLL CONTRIBUTIONS	R	6/23/2016	60.00		023875		60.00
02587		A&M LAWNMOWER SHOP							
	I-42562	Generator, Saw for O&M CS	R	6/29/2016	1,717.21		023876		
	I-42563	Small Tools for O&M CS	R	6/29/2016	165.86		023876		1,883.07
02297		AAA AWNINGS INC.							
	I-8635	Awning Covers for Pump Plants	R	6/29/2016	29,390.00		023877		29,390.00
02875		Mitch Abel							
	I-062116	Advance for Travel in July	R	6/29/2016	802.00		023878		802.00
00004		ACWA JOINT POWERS INSURANCE AU							
	I-0410946	Health Insurance June 2016	R	6/29/2016	119,539.80		023879		119,539.80
00026		AERA ENERGY LLC							
	I-1800008110	Cathodic Protection License	R	6/29/2016	200.00		023880		200.00
00010		AIRGAS USA LLC							
	I-9936884696	Cylinder Rental for Pipelines	R	6/29/2016	64.20		023881		64.20
00784		AM Conservation Group, Inc.							
	I-0200716IN	Water Saving Devices	R	6/29/2016	1,001.29		023882		1,001.29
02853		American Technologies Network							
	I-354637	Night Vision Optics for LCRA	R	6/29/2016	5,536.25		023883		5,536.25
00014		AQUA-FLO SUPPLY							
	I-933299	Valves, PVC Parts for Pipeline	R	6/29/2016	62.21		023884		
	I-940048	PVC Parts for LCRA Maint	R	6/29/2016	272.90		023884		
	I-941204	Transformer for Ave 2 PP	R	6/29/2016	47.27		023884		
	I-942749	Irrigation Parts for Waterpark	R	6/29/2016	33.02		023884		415.40

VENDOR SET: 01 Casitas Municipal Water D
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DATE RANGE: 6/20/2016 THRU 7/05/2016

VENDOR	I.D.	NAME	STATUS	CHECK DATE	INVOICE AMOUNT	DISCOUNT	CHECK NO	CHECK STATUS	CHECK AMOUNT
02179		Art Street Interactive							
	I-126884	Res Sys Web Hosting/Maint	R	6/29/2016	542.15		023885		542.15
01666		AT & T							
	I-000008175055	T-1 Lines, 9391051740	R	6/29/2016	339.20		023886		
	I-000008175065	T-1 Lines 9391051750	R	6/29/2016	1,066.25		023886		
	I-000008189804 9391035542	Local, Regional, Long Distance	R	6/29/2016	1,134.58		023886		2,540.03
00018		AT & T MOBILITY							
	I-829434088X06142016	PT Wildlife Biol Monthly Cell	R	6/29/2016	11.76		023887		11.76
00020		AVENUE HARDWARE, INC							
	I-63291	Bolts for 42" Valve Shaft, TP	R	6/29/2016	6.28		023888		6.28
00030		B&R TOOL AND SUPPLY CO							
	I-1900883264	Tools for New O&M CS Truck	R	6/29/2016	975.34		023889		
	I-1900883265	Tools for New O&M CS Truck	R	6/29/2016	937.47		023889		
	I-1900883534	Combo Wrench for TP	R	6/29/2016	178.44		023889		
	I-1900883893	Replace Cutter for Pump Plants	R	6/29/2016	31.11		023889		2,122.36
02283		Mary Bergen							
	I-Feb 16	Reimburse Mileage 2/16	R	6/29/2016	15.98		023890		
	I-Jan 16	Reimburse Mileage 1/16	R	6/29/2016	27.54		023890		
	I-Mar 16	Reimburse Mileage 3/16	R	6/29/2016	19.98		023890		63.50
00463		Cal-Coast Machinery							
	I-330865	V-Belt for LCRA Maint	R	6/29/2016	70.11		023891		
	I-333639	Gear for LCRA Maint	R	6/29/2016	46.20		023891		
	I-334267	Gear for LCRA Maint	R	6/29/2016	37.85		023891		154.16
01579		CAMPER CENTER							
	I-4537	Camper Sheel, New Fish Truck	R	6/29/2016	2,177.14		023892		2,177.14
00208		CareIQ							
	I-021915	DOS 2/19/15 Claim#1519309	R	6/29/2016	275.00		023893		
	I-022415	DOS 2/24/15 Claim#1519309	R	6/29/2016	120.00		023893		
	I-030315	DOS 3/3/15 Claim#1519309	R	6/29/2016	120.00		023893		
	I-030515	DOS 3/5/15 Claim#1519309	R	6/29/2016	120.00		023893		
	I-081315	DOS 8/13/15 Claim#1519309	R	6/29/2016	120.00		023893		
	I-081815	DOS 8/18/15 Claim#1519309	R	6/29/2016	120.00		023893		
	I-082015	DOS 8/20/15 Claim#1519309	R	6/29/2016	120.00		023893		
	I-082515	DOS 8/25/15 Claim#1519309	R	6/29/2016	120.00		023893		
	I-082715	DOS 8/27/15 Claim#1519309	R	6/29/2016	120.00		023893		1,235.00

VENDOR SET: 01 Casitas Municipal Water D
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VENDOR	I.D.	NAME	STATUS	CHECK DATE	INVOICE AMOUNT	DISCOUNT	CHECK NO	CHECK STATUS	CHECK AMOUNT
00071		COMMANDER PRINTED PRODUCTS							
	I-102462	Stationary Envelopes	R	6/29/2016	417.77		023894		417.77
00061		COMPUWAVE							
	I-SB02083803	Ribbon for WP Season Passes	R	6/29/2016	158.99		023895		
	I-SB02083828	Cisco Smartnet Renewal	R	6/29/2016	740.37		023895		
	I-SB02083839	Toner Cartridges	R	6/29/2016	833.78		023895		
	I-SB02083857	Backup Software for Server	R	6/29/2016	958.00		023895		
	I-SB02083880	Toner Cartridges	R	6/29/2016	483.00		023895		3,174.14
00062		CONSOLIDATED ELECTRICAL							
	I-9009734259	SMC Heat Sink Fan Assembly E&M	R	6/29/2016	363.79		023896		
	I-9009734978	Connectors for O&M CS	R	6/29/2016	48.03		023896		411.82
01483		CORVEL CORPORATION							
	I-052716	Utilization Rvw Claim#0301792	R	6/29/2016	120.00		023897		
	I-6100849001	Bill Review	R	6/29/2016	9.50		023897		
	I-6100849891	Bill Review	R	6/29/2016	9.50		023897		
	I-6101601101	Bill Review	R	6/29/2016	9.50		023897		
	I-6101804891	Bill Review	R	6/29/2016	12.64		023897		
	I-6101931561	Bill Review	R	6/29/2016	9.50		023897		
	I-6101932031	Bill Review	R	6/29/2016	9.50		023897		
	I-6101932181	Bill Review	R	6/29/2016	9.50		023897		
	I-6102160981	Bill Review	R	6/29/2016	9.50		023897		199.14
02716		Crop Production Services							
	I-30490588	Herbicides for Dist Maint	R	6/29/2016	2,014.23		023898		
	I-30492837	Herbicide for Dist Maint	R	6/29/2016	110.70		023898		2,124.93
00873		CSAC EXCESS INSURANCE AUTHORIT							
	I-17100032	Excess Workers Comp Insurance	R	6/29/2016	114,881.00		023899		114,881.00
02480		David Taussig & Associates, In							
	I-1605133	Project #1500115 CFD 3/16-5/16	R	6/29/2016	276.04		023900		276.04
02741		Deere & Company							
	I-115351281	JD Rotary Cutter for DM	R	6/29/2016	2,753.92		023901		2,753.92
02765		Demaria Electric Motor Service							
	I-17746	Recondition Motor, Fortress PP	R	6/29/2016	2,513.88		023902		2,513.88
02511		Draper Construction							
	I-16173	Waterpark Playground Repairs	R	6/29/2016	2,262.50		023903		
	I-16174	Waterpark Paving Repairs	R	6/29/2016	1,043.00		023903		3,305.50

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VENDOR	I.D.	NAME	STATUS	CHECK DATE	INVOICE AMOUNT	DISCOUNT	CHECK NO	CHECK STATUS	CHECK AMOUNT
00086		E.J. Harrison & Sons Inc							
	I-1232	Acct#500546088	R	6/29/2016	280.00		023904		
	I-3634	Acct#1C00053370	R	6/29/2016	141.42		023904		
	I-3657	Acct#1C00054230	R	6/29/2016	2,479.00		023904		
	I-3658	Acct#1C00054240	R	6/29/2016	149.71		023904		3,050.13
00488		ELECTRONIC SYSTEMS TECHNOLOGY							
	I-31359	Scada Modem Repairs	R	6/29/2016	497.48		023905		497.48
00095		FAMCON PIPE & SUPPLY							
	I-181342	Meter Lid Lifters, O&M CS	R	6/29/2016	64.50		023906		
	I-181568	Elbows, Gaskets for TP	R	6/29/2016	179.53		023906		244.03
00013		FERGUSON ENTERPRISES INC							
	I-3443331	Waterless Urinal Cartridges	R	6/29/2016	1,268.84		023907		1,268.84
00099		FGL ENVIRONMENTAL							
	I-604899A	Lake Nutrient Monitoring 4/27	R	6/29/2016	1,328.00		023908		
	I-604902A	Manganese Monitoring 4/27	R	6/29/2016	145.00		023908		1,473.00
00104		FRED'S TIRE MAN							
	I-91896	Flat Repair, #277, Mower	R	6/29/2016	35.00		023909		
	I-91917	Flat Repair #4	R	6/29/2016	20.00		023909		55.00
00106		FRONTIER PAINT							
	I-F0215332	Paint Supplies for Waterpark	R	6/29/2016	28.10		023910		
	I-F0215357	Paint Supplies for Waterpark	R	6/29/2016	45.88		023910		73.98
01280		FRY'S ELECTRONICS, INC.							
	I-6367339	Misc Computer Items, Admin, IT	R	6/29/2016	100.59		023911		100.59
00376		GALL'S, INC.							
	I-005565739	Battery Chargers for Radar,Rec	R	6/29/2016	678.86		023912		678.86
02720		Garda CL West, Inc.							
	I-20159479	Excess Items LCRA	R	6/29/2016	2.00		023913		2.00
00216		THE GAS COMPANY							
	I-062816	Acct#00801443003	R	6/29/2016	268.49		023914		
	I-062816a	Acct#18231433006	R	6/29/2016	49.55		023914		318.04
02872		Sergio Gonzalez							
	I-052816	Waterpark Fee Refund	R	6/29/2016	13.00		023915		13.00

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VENDOR	I.D.	NAME	STATUS	CHECK DATE	INVOICE AMOUNT	DISCOUNT	CHECK NO	CHECK STATUS	CHECK AMOUNT
02158		Google, Inc.							
	I-3360365965	Monthly Google Apps for Work	R	6/29/2016	675.83		023916		675.83
01898		Eric Grabowski							
	I-062416	Safety Boot Purchase	R	6/29/2016	170.00		023917		170.00
00115		GRAINGER, INC							
	I-9139665591	Trash Bags for Dist Office	R	6/29/2016	38.25		023918		
	I-9139665609	Hard Hats for Dist Maint	R	6/29/2016	96.60		023918		134.85
00746		GREEN THUMB INTERNATIONAL							
	I-478872	Rock Mulch for Dist Ofc Garden	R	6/29/2016	162.39		023919		
	I-478875	Rock Mulch for Dist Ofc Garden	R	6/29/2016	180.75		023919		
	I-478883	Rock Mulch for Dist Ofc Garden	R	6/29/2016	162.39		023919		505.53
00121		HACH COMPANY							
	I-9957578	Reagents for Treatment Plant	R	6/29/2016	1,323.11		023920		
	I-9978283	Lab Supplies	R	6/29/2016	168.13		023920		1,491.24
01052		HARBOR FREIGHT TOOLS USA, INC							
	I-02336986	Tie Downs, PTO Pins for DM	R	6/29/2016	44.04		023921		
	I-761480	Trash Pumps for LCRA Maiint	R	6/29/2016	257.98		023921		302.02
02805		Hogan Company Inc.							
	I-47172	Rebar Stakes for Fire PitsLCRA	R	6/29/2016	271.89		023922		271.89
00596		HOME DEPOT							
	I-062016	Carboys-WH, Tool Set-DM	R	6/29/2016	63.51		023923		
	I-1772791	Windows for Store	R	6/29/2016	472.79		023923		536.30
00872		Irrisoft, Inc.							
	I-5824	Weather Station Signal Service	R	6/29/2016	79.00		023924		79.00
00131		JCI JONES CHEMICALS, INC							
	I-691687	Chlorine for TP, CM#691717	R	6/29/2016	1,770.00		023925		
	I-692390	Chlorine for TP, CM#692469	R	6/29/2016	1,770.00		023925		3,540.00
01022		KELLY CLEANING & SUPPLIES, INC							
	I-1352468	Janitorial Services, LCRA	R	6/29/2016	300.00		023926		300.00
00199		Kern Turf Supply Inc.							
	I-342253	ET Station Maintenance	R	6/29/2016	2,386.50		023927		2,386.50

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VENDOR	I.D.	NAME	STATUS	CHECK DATE	INVOICE AMOUNT	DISCOUNT	CHECK NO	CHECK STATUS	CHECK AMOUNT
02866		Lexipol, LLC							
	I-17171	Ranger Policies Manual/Module	R	6/29/2016	11,295.00		023928		11,295.00
02831		Lightbars.com							
	C-2297a	Accrue Use Tax	R	6/29/2016	83.01CR		023929		
	C-2298a	Accrue Use Tax	R	6/29/2016	476.69CR		023929		
	C-2303a	Accrue Use Tax	R	6/29/2016	45.68CR		023929		
	C-2304a	Accrue Use Tax	R	6/29/2016	239.85CR		023929		
	D-2297a	Accrue Use Tax	R	6/29/2016	83.01		023929		
	D-2298a	Accrue Use Tax	R	6/29/2016	476.69		023929		
	D-2303a	Accrue Use Tax	R	6/29/2016	45.68		023929		
	D-2304a	Accrue Use Tax	R	6/29/2016	239.85		023929		
	I-2297	Safety Lighting Eq#35, Engin	R	6/29/2016	1,106.80		023929		
	I-2298	Safety Lighting Various Truck	R	6/29/2016	6,355.80		023929		
	I-2303	Lightbar for #42, Pipeline	R	6/29/2016	609.00		023929		
	I-2304	Safety Lights #51 & Frt Liner	R	6/29/2016	3,198.00		023929		11,269.60
00328		LIGHTNING RIDGE							
	I-6021602	Shirts for Waterpark Staff	R	6/29/2016	414.22		023930		414.22
01829		MAC'S AUTO UPHOLSTERY							
	I-24293	Seat Rebuild for EQ#22 E&M	R	6/29/2016	276.88		023931		276.88
00145		MAGNUM FENCE & SECURITY, INC.							
	I-11266	Doors for Warehouse Remodel	R	6/29/2016	365.50		023932		
	I-5295	Post Clips for Barb Wire, DM	R	6/29/2016	51.60		023932		417.10
02838		Mainstreet Architects & Planne							
	I-10167	Schematic Design, DO Remodel	R	6/29/2016	1,399.50		023933		1,399.50
02870		Malwarebytes							
	I-INV00043248	3 Yr Anti-Malware Subscription	R	6/29/2016	4,377.35		023934		4,377.35
00151		MEINERS OAKS ACE HARDWARE							
	I-714058	Scrub Brush for Fisheries	R	6/29/2016	3.42		023935		
	I-720280	Transmission Fluid, Fish	R	6/29/2016	4.33		023935		
	I-721070	Batteries, Clorox Wipes, LCRA	R	6/29/2016	54.94		023935		
	I-721651	Trash Bags, Paint Pail, LCRA	R	6/29/2016	24.26		023935		
	I-721683	Plumbing Parts for LCRA Maint	R	6/29/2016	19.23		023935		
	I-721704	Latex Gloves for PL Safety	R	6/29/2016	12.00		023935		
	I-722020	Ballcock, Hinges, LCRA Maint	R	6/29/2016	65.70		023935		
	I-722134	Tire Cleaner, Grease for Dist	R	6/29/2016	24.56		023935		
	I-722305	PVC Parts for Waterpark	R	6/29/2016	13.14		023935		
	I-722315	Batteries for Locator,Pipeline	R	6/29/2016	17.59		023935		
	I-722518	Files for LCRA Maint	R	6/29/2016	9.77		023935		
	I-722589	Pipe for Irrigation at Ave 2	R	6/29/2016	52.78		023935		
	I-722598	Bug Spray for Dist Office	R	6/29/2016	23.46		023935		
	I-722632	Plumbing Parts for LCRA Maint	R	6/29/2016	8.18		023935		

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VENDOR	I.D.	NAME	STATUS	CHECK DATE	INVOICE AMOUNT	DISCOUNT	CHECK NO	CHECK STATUS	CHECK AMOUNT
	I-722633	Elbows for LCRA Maint	R	6/29/2016	0.20		023935		
	I-722644	Sockets, Hole Saws for PL	R	6/29/2016	46.04		023935		
	I-722651	PVC Adapters for LCRA Maint	R	6/29/2016	2.13		023935		
	I-722658	Parts for Ave 2 PP	R	6/29/2016	12.85		023935		
	I-722688	Twine for Waterpark	R	6/29/2016	5.28		023935		
	I-722775	Socket Set, Hex Key Set,Garage	R	6/29/2016	31.83		023935		
	I-722794	Bolts for Garage	R	6/29/2016	6.40		023935		
	I-722903	Padlocks for LCRA	R	6/29/2016	58.65		023935		
	I-723269	Tubing, Connectors, Garage	R	6/29/2016	21.47		023935		
	I-723276	Mortor, Concrete, WP	R	6/29/2016	11.69		023935		
	I-723277	Carabiner Clip for Waterpark	R	6/29/2016	4.39		023935		
	I-723357	Faucet, Litter for LCRA Maint	R	6/29/2016	44.45		023935		
	I-723476	Bulbs, Bumpers for Dist Maint	R	6/29/2016	5.40		023935		
	I-723522	Thread Rods, Bolts for Maint	R	6/29/2016	38.73		023935		
	I-723525	Bolts for LCRA Maint	R	6/29/2016	2.77		023935		
	I-723535	Grind Wheels, Tube for Maint	R	6/29/2016	15.24		023935		
	I-723727	Spray Paint. Blades for Maint	R	6/29/2016	38.10		023935		
	I-723795	Trash Cans for Wine Festival	R	6/29/2016	568.35		023935		
	I-723857	Paint Supplies, Batteries, WP	R	6/29/2016	56.09		023935		
	I-723858	Voltage Detector for WP	R	6/29/2016	16.62		023935		
	I-724169	Screws for Dist Maint	R	6/29/2016	50.50		023935		
	I-724223	Elbow, Couplings, LCRA Maint	R	6/29/2016	31.22		023935		
	I-724257	Nuts, Washers, Bolts for SCADA	R	6/29/2016	12.65		023935		
	I-724304	Armor All, Turtle Wax for Dist	R	6/29/2016	48.32		023935		
	I-724313	Sign Items for LCRA	R	6/29/2016	147.25		023935		
	I-724333	Clamps for Leak in Lab	R	6/29/2016	11.72		023935		
	I-724334	Conduit for LCRA Maint	R	6/29/2016	73.18		023935		
	I-724451	Shower Parts for LCRA Maint	R	6/29/2016	30.58		023935		
	I-724498	Shade Cloth for Telemetry	R	6/29/2016	6.54		023935		
	I-724528	Mower Cord for LCRA Maint	R	6/29/2016	2.78		023935		
	I-724589	Filter, Brush,Ave 2 PP Vacuum	R	6/29/2016	26.85		023935		
	I-724673	Shovels, Paint for LCRA Maint	R	6/29/2016	56.63		023935		1,818.26
02876		Alisa Miller							
	I-062116	Camping Fee Refund	R	6/29/2016	35.50		023940		35.50
00149		MRC Global							
	I-2125493001	SS Tubing & Fittings for TP	R	6/29/2016	448.48		023941		448.48
00163		OFFICE DEPOT							
	I-843589827001	Office Supplies	R	6/29/2016	12.89		023942		
	I-843590036001	Office Supplies	R	6/29/2016	13.72		023942		
	I-843590036002	Office Supplies	R	6/29/2016	103.19		023942		
	I-843590037001	Office Supplies	R	6/29/2016	44.69		023942		
	I-845738612001	Office Supplies	R	6/29/2016	973.28		023942		
	I-845738827001	Office Supplies	R	6/29/2016	12.14		023942		1,159.91

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VENDOR	I.D.	NAME	STATUS	CHECK DATE	INVOICE AMOUNT	DISCOUNT	CHECK NO	CHECK STATUS	CHECK AMOUNT
00625		OfficeTeam							
	I-45976346	Admin Temp	R	6/29/2016	834.30		023943		
	I-46016887	Admin Temp	R	6/29/2016	866.80		023943		1,701.10
00160		OILFIELD ELECTRIC CO, INC							
	I-9377	Upgrade Switchgear Ave 2 PP	R	6/29/2016	44,042.00		023944		44,042.00
01570		Ojai Auto Supply LLC							
	I-371014	Oil for #100 Polaris, LCRA	R	6/29/2016	28.99		023945		
	I-374772	Spark Plugs for #138, Arima	R	6/29/2016	15.01		023945		
	I-375881	Oil for #23 Truck	R	6/29/2016	12.88		023945		56.88
00912		OJAI BUSINESS CENTER, INC							
	I-11317	Shipping for Lab, LCRA	R	6/29/2016	69.90		023946		69.90
00607		OJAI ELECTRIC							
	I-072694	Electrical Work at Waterpark	R	6/29/2016	1,348.00		023947		
	I-072695	Electrical Work at Waterpark	R	6/29/2016	190.00		023947		1,538.00
00168		OJAI VALLEY NEWS							
	I-300005351	Budget Hearing Ad	R	6/29/2016	15.00		023948		
	I-300005352	UWMP Hearing AD	R	6/29/2016	20.00		023948		
	I-300005526	Budget Hearing Ad	R	6/29/2016	12.00		023948		
	I-300005527	UWMP Hearing Ad	R	6/29/2016	16.00		023948		63.00
00169		OJAI VALLEY SANITARY DISTRICT							
	I-18443 11/1/15-4/30/16	Cust#99991 Sewer Service LCRA	R	6/29/2016	10,542.30		023949		10,542.30
00383		ON DUTY UNIFORMS & EQUIPMENT							
	I-140994	2 Level IIIA Protective Vests	R	6/29/2016	1,709.25		023950		
	I-141777	1 Level IIIA Protective Vest	R	6/29/2016	854.63		023950		2,563.88
01627		OSCAR'S TREE SERVICE							
	I-12479	Tree Service, Picnic Area 13	R	6/29/2016	975.00		023951		975.00
00627		PORT SUPPLY							
	I-3237936	LED Light Bulbs for Camp H	R	6/29/2016	83.71		023952		83.71
02833		Praxair, Inc							
	I-73432295	Liquid Oxygen	R	6/29/2016	1,971.77		023953		
	I-73453178	Liquid Oxygen	R	6/29/2016	2,018.12		023953		
	I-73468101	Liquid Oxygen	R	6/29/2016	2,110.36		023953		
	I-73487596	Liquid Oxygen for TP	R	6/29/2016	2,070.58		023953		
	I-73557694	Liquid Oxygen for TP	R	6/29/2016	1,961.28		023953		10,132.11

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01439		PRECISION POWER EQUIPMENT							
	I-2656	Gasket, Bolts for Dist Maint	R	6/29/2016	37.55		023954		37.55
02735		Pro-Line Inspections, Inc							
	I-2130	Infrared Testing @ Pump Plants	R	6/29/2016	2,000.00		023955		2,000.00
02216		Purchase Power							
	I-062016	Refill Postage Meter	R	6/29/2016	2,525.00		023956		2,525.00
00788		QUINN COMPANY							
	I-PC010336805	Parking Brake Cable, #109	R	6/29/2016	159.71		023957		159.71
01618		REI CORPORATE & GROUP SALES							
	I-9414477952	Handheld GPS Units, Fisheries	R	6/29/2016	483.75		023958		483.75
02584		Rubber Neck Signs							
	I-3291	CMWD Vehicle Door Decals	R	6/29/2016	114.15		023959		114.15
01107		SAWYER PETROLEUM							
	I-S107336	Oil for Pump at Pump Plant	R	6/29/2016	98.50		023960		98.50
01345		MICHAEL SHIELDS							
	I-Jun 16	Meal for Crew Working Shutdown	R	6/29/2016	82.53		023961		82.53
00725		SMART & FINAL							
	I-062116	Breakroom Supplies, LCRA	R	6/29/2016	47.07		023962		47.07
02814		Soilworks LLC							
	I-14036	Camp H Road Stabilizer	R	6/29/2016	6,807.44		023963		6,807.44
00215		SOUTHERN CALIFORNIA EDISON							
	I-062316	Acct#2266156405	R	6/29/2016	124.48		023964		
	I-062316a	Acct#2312811532	R	6/29/2016	54.57		023964		
	I-062816	Acct#2157697889	R	6/29/2016	7,458.03		023964		7,637.08
02202		Stanley Pest Control							
	I-834656	Pest Control Waterpark	R	6/29/2016	170.00		023965		170.00
02703		Sunbelt Rentals							
	I-61298372001	Nuts, Washers for LCRA Maint	R	6/29/2016	57.22		023966		57.22
01048		VAUGHAN'S INDUSTRIAL REPAIR CO							
	I-023485	Repair Seal #2 FVPP	R	6/29/2016	858.40		023967		858.40

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02760		Los Angeles Truck Centers LLC							
	I-XP42490	Log Book, Pipelines	R	6/29/2016	20.64		023968		20.64
00737		Ventura County Reporter							
	I-348759	Summer Guide Ad, Waterpark	R	6/29/2016	645.00		023969		645.00
00774		Ventura County Sheriff's Offic							
	I-1615690	Security at LCRA 3/18-4/30	R	6/29/2016	29,484.72		023970		
	I-1615700	Security at LCRA, 5/1-5/29	R	6/29/2016	44,882.47		023970		74,367.19
00253		VENTURA HYDRAULIC & MACHINE							
	I-171395	Trencher Ram Rebuild, Maint	R	6/29/2016	328.21		023971		328.21
00258		VENTURA STEEL, INC							
	I-182411	Metal for T Dock Repair	R	6/29/2016	74.81		023972		
	I-182511	Steel for LCRA Maint	R	6/29/2016	17.20		023972		92.01
01058		VENTURA URGENT CARE							
	I-041416	DOS 4/14/16 Claim#0301792	R	6/29/2016	128.51		023973		128.51
09955		VENTURA WHOLESALE ELECTRIC							
	I-220252	Ave 2 PP Upgrade Project	R	6/29/2016	32.41		023974		32.41
02583		WageWorks							
	I-125AI0469989	FSA Monthly Admin Fee	R	6/29/2016	136.40		023975		136.40
02515		Water Quality Solutions, Inc.							
	I-222	Annual Limnological Reports	R	6/29/2016	6,067.50		023976		
	I-223	Limnological Support Services	R	6/29/2016	3,075.00		023976		9,142.50
02854		Water Works Engineers, LLC							
	I-5804	Rincon Main, Ave 1 PP Projects	R	6/29/2016	83,794.60		023977		83,794.60
00663		WAXIE SANITARY SUPPLY							
	I-76008133	Toilet Tissue for LCRA Maint	R	6/29/2016	664.38		023978		
	I-76029474	Janitorial Supplies	R	6/29/2016	100.91		023978		765.29
00439		WAYCASY CRANE SERVICE							
	I-6370	Crane to Install Motor, OVPP	R	6/29/2016	740.00		023979		740.00
00330		WHITE CAP CONSTRUCTION SUPPLY							
	I-10005325520	Digging Bar, Tape, O&M CS	R	6/29/2016	66.18		023980		
	I-10005326355	Hacksaws, Hammers, O&M CS	R	6/29/2016	69.52		023980		
	I-10005327157	Blades, Caution Tape, O&M CS	R	6/29/2016	72.73		023980		
	I-10005328828	Shovels for O&M CS	R	6/29/2016	64.46		023980		272.89

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00188		PETTY CASH							
	I-062916	Increase LCRA Petty Cash	R	6/29/2016	500.00		023981		500.00
02755		Vincent Godinez							
	I-063016	Water Distribution Course	R	7/05/2016	50.00		023982		
	I-063016a	Safety Boot Purchase	R	7/05/2016	153.87		023982		203.87
02867		Houston & Harris PCS, Inc.							
	I-1619714	Video Pipeline Inspections, TP	R	7/05/2016	2,267.50		023983		2,267.50
00126		CAROLE ILES							
	I-Jun 16	Reimburse Mileage 6/16	R	7/05/2016	41.58		023984		41.58
01270		SCOTT LEWIS							
	I-Apr 16	Reimburse Expenses 4/16	R	7/05/2016	78.08		023985		
	I-May 16	Reimburse Expenses 5/16	R	7/05/2016	335.60		023985		413.68
02724		Michael Moler							
	I-Jun 16	Reimburse Mileage 6/16	R	7/05/2016	97.20		023986		97.20
02759		The Pun Group							
	I-1600153	Audit Services for FY 15/16	R	7/05/2016	9,450.00		023987		9,450.00
00215		SOUTHERN CALIFORNIA EDISON							
	I-062916	Acct#2210507034	R	7/05/2016	12,216.79		023988		
	I-063016	Acct#2210503702	R	7/05/2016	10,494.59		023988		
	I-070216	Acct#2210502480	R	7/05/2016	85,670.84		023988		
	I-070216a	Acct#2210505426	R	7/05/2016	1,448.34		023988		
	I-070216b	Acct#2237789169	R	7/05/2016	28.03		023988		
	I-070216c	Acct#2269631768	R	7/05/2016	22.66		023988		109,881.25
00124		ICMA RETIREMENT TRUST - 457							
	I-CUI201607051116	457 CATCH UP	R	7/05/2016	461.54		023989		
	I-DCI201607051116	DEFERRED COMP FLAT	R	7/05/2016	1,859.62		023989		
	I-DI%201607051116	DEFERRED COMP PERCENT	R	7/05/2016	89.81		023989		2,410.97
01960		Moringa Community							
	I-MOR201607051116	PAYROLL CONTRIBUTIONS	R	7/05/2016	16.75		023990		16.75
00985		NATIONWIDE RETIREMENT SOLUTION							
	I-CUN201607051116	457 CATCH UP	R	7/05/2016	211.53		023991		
	I-DCN201607051116	DEFERRED COMP FLAT	R	7/05/2016	3,983.85		023991		
	I-DN%201607051116	DEFERRED COMP PERCENT	R	7/05/2016	319.30		023991		4,514.68

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00180		S.E.I.U. - LOCAL 721							
	I-COP201607051116	SEIU 721 COPE	R	7/05/2016	9.50		023992		
	I-UND201607051116	UNION DUES	R	7/05/2016	657.75		023992		667.25
01400		STATE DISBURSEMENT UNIT							
	I-CS4201607051116	Payroll Deduction 10-D000121	R	7/05/2016	682.14		023993		682.14
00230		UNITED WAY							
	I-UWY201607051116	PAYROLL CONTRIBUTIONS	R	7/05/2016	60.00		023994		60.00
00047		STATE WATER CONTRACTORS							
	I-051816	16-17 Member Dues	R	7/05/2016	32,258.00		023995		32,258.00

* * T O T A L S * *	NO			INVOICE AMOUNT	DISCOUNTS	CHECK AMOUNT
REGULAR CHECKS:	135			798,302.79	0.00	798,302.79
HAND CHECKS:	0			0.00	0.00	0.00
DRAFTS:	6			191,600.61	0.00	191,600.61
EFT:	0			0.00	0.00	0.00
NON CHECKS:	0			0.00	0.00	0.00
VOID CHECKS:	0	VOID DEBITS	0.00			
		VOID CREDITS	0.00	0.00	0.00	

TOTAL ERRORS: 0

	NO	INVOICE AMOUNT	DISCOUNTS	CHECK AMOUNT
VENDOR SET: 01 BANK: AP TOTALS:	141	989,903.40	0.00	989,903.40
BANK: AP TOTALS:	141	989,903.40	0.00	989,903.40
REPORT TOTALS:	141	989,903.40	0.00	989,903.40

CASITAS MUNICIPAL WATER DISTRICT
INTEROFFICE MEMORANDUM

TO: Steve Wickstrum, General Manager

FROM: Carol Belser, Park Services Manager

SUBJECT: **Review and Approve RNT Consulting Services Inc. Lake Casitas Vulnerability Assessment and Prevention, Control and Management Plan for Aquatic Invasive Mussels**

DATE: JULY 6, 2016

RECOMMENDATION:

It is recommended that the Board of Directors receive and file the findings presented by RNT Consulting Inc. in the Vulnerability Assessment and the Prevention, Control and Management Plan for Invasive Mussels (Dreissenid Mussels).

BACKGROUND AND DISCUSSION:

At the November 14, 2014 meeting of the Board of Directors, the Board authorized an agreement between the District and RNT Consulting Inc. (RNT) to perform a vulnerability assessment and create a control and management plan for invasive mussels in Lake Casitas.

Quagga and Zebra mussels arrived in North America from Europe in the 1980s first appearing in Lake Mead in January 2007. They were subsequently found in Lakes Mohave and Havasu on the Colorado River and in the Colorado River Aqueduct System which serves Southern California. Zebra Mussels heavily colonize hard substrates while Quaggas colonize both hard and soft substrates and both clog water intake structures such as pipelines and screens, reducing pumping capabilities for water treatment facilities. Recreation based industries and activities are affected by the mussels which take up residence on docks, buoys, boats and beaches. Casitas has had aggressive inspection and vessel tamper proof tag prevention programs in place since 2008 in response to the threat of Quagga/Zebra Mussel migration from other lakes in California and Nevada through recreational boating.

In December 2013, Lake Piru identified mollusks attached to a Lake Patrol vessel and several substrate monitoring devices. The mollusks were identified as Quagga Mussels,

or Dreissena bugensis, through DNA testing. The Quagga found in Lake Piru are the first to be found in Ventura County and the first in a California lake body that is not connected to the Colorado River system. United Water Conversation District, the agency that manages Lake Piru, has released statements that maintenance costs to deal with the infestation are in the hundreds of thousands and eradication in the millions of dollars. Maintenance costs are exponential since unless the mussel is eradicated, constant maintenance and management practices must be done to keep the infrastructure operational. Mussel transport from an infected water source to Lake Piru via recreational boating appears to be the source of the infestation.

SUMMARY:

The initial field assessment was launched by RNT in January 2015. To ensure compliance with California Department of Fish and Wildlife (CDFW) Codes 2301 and 2302, CDFW staff reviewed and commented on the reports as well as staff from the Department of Parks and Recreation, Division of Boating and Waterways (B&W) which had awarded a $40,000 grant from the 2014 Quagga and Zebra Mussel Infestation Prevention Fee Grant Program to Casitas. CDFW responded to Casitas with comments in September 2015 and B&W staff reviewed the documents giving their final approval in April 2016. Several changes were requested by staff from both the CDFW and B&W and all comments have been incorporated into the final draft presented to the Casitas Board.

The documents presented are living documents and will be updated as new information, such as new circumstances and other quagga eradication methods, become available. In April 2016, New Zealand Mud Snails (NZMS), an invasive species, was discovered and positively identified in the North Fork of Matilija Creek. According to our consultant, the CDFW has not agreed on any action for the NZMS. While Casitas is now aware of the invasive species threat to Lake Casitas, no action will be taken until the CDFW provides guidance on how to proceed.

Once the two documents have been approved by the Board, staff will file them with CDFW and B&W.

Lake Casitas

Vulnerability Assessment

for

Invasive Mussels

July 13, 2016

Prepared for Casitas Municipal Water District by

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Funding for this project has been provided in full or in part
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1. Executive Summary

In late 2013, Quagga mussels were found to be present in Lake Piru in Ventura County, Southern California. This is the first time Quagga mussels have been found in California in a lake or reservoir, which does not directly receive Colorado River Water. Casitas Municipal Water District has had a strict water vessel tagging and quarantine program at Lake Casitas since 2008. While there appears to be no indication of an infestation of Quagga/Zebra (dreissenid) mussels in Lake Casitas, the infestation of Lake Piru has prompted Casitas Municipal Water District to re-evaluate the current dreissenid mussel prevention program, assess vulnerabilities and develop an action plan, which is both preventative and proactive.

Casitas Municipal Water District contracted RNT Consulting Inc. to review the existing Quagga/Zebra mussel prevention protocols as well as the operations of Lake Casitas Reservoir to further strengthen the existing efforts to prevent an introduction of dreissenid mussels. This report deals with the vulnerabilities of the Casitas reservoir and associated facilities to dreissenid mussel infestation. Together with its companion report **"Lake Casitas Control and Management Plan for Invasive Mussels**", the two reports contain the information required for an official Rapid Response Plan.

As outlined in Lake Casitas Control and Management Plan, the water chemistry of the Lake Casitas Reservoir is well suited to support a potentially massive infestation of Quagga/Zebra mussels in upper levels of the reservoir. Below the depth of 20 to 30ft, dissolved oxygen tends to drop off rapidly during summer months making this portion of the reservoir less suitable for mussel infestation. Overall, the reservoir is at great risk of infestation by Quagga or Zebra mussels should they become introduced. **On a scale of 1 to 5, with 5 being the highest risk, Lake Casitas would qualify for risk rating of 5**.

Monitoring for Quagga and Zebra mussels is ongoing with collection of monthly plankton samples from June to October, snorkel surveys and settlement samplers. The existing protocol for presence and absence of dreissenid veligers and adult mussels is adequately robust to provide early detection should mussels arrive in the reservoir. If dreissenid mussels become established, the monitoring protocol will be modified to track breeding season of the mussels, growth rates and distribution patterns within the lake.

As boating is the primary vector by which dreissenid mussels move from one body of water to another, the existing policy on boat quarantine and good physical access control has undoubtedly helped to keep Lake Casitas free of mussels. Casitas Municipal Water District has had a strict water vessel tagging and quarantine program in place at Lake Casitas since 2008. The long quarantine period following an inspection of boats for mussels guarantees that these boats will not be a vector of introduction. The risk of introduction by this pathway is considered low – **Level 1**.

Physical access to the reservoir is via a manned entrance. The perimeter of the reservoir restricts access using fences and the features of naturally rugged terrain. There is an opportunity to launch a small water craft where Rt.150 crosses a small arm of Lake Casitas. This unauthorized access route is steep and likely to require considerable effort to gain access. This would limit entry of most water craft except perhaps a small kayak or an inflatable dinghy. Neither of these types of vessels is likely to carry an existing mussel infestation. Nevertheless signage in the area indicating launching of water craft is prohibited will be posted. The risk of introduction by this pathway is considered low – **Level 1**.

A common vector of Quagga/Zebra mussel transfer is the use of live bait in buckets which may contain water from infected areas. While there are currently very few off-site sources of live bait in the area, the presence of mussels in Lake Piru has made this mode of transfer a possibility. For example, it is illegal to transport live shad from one water body to another in California, but fisheries staff reports that anglers do fish with live shad (Per.comm.M.W.Gibson). Further, crayfish and clams can be captured in most water bodies and transported as bait. Both crayfish and clams may carry attached dreissenid mussels. To prevent this mode of transfer increased signage will be placed at the reservoir and staff will question anglers as to what they are using as bait. The risk of introduction by this pathway is considered high – **Level 4**.

Lake Casitas has not stocked fish for the last two years but stocking has resumed. At this point fish stocking is not a concern. California hatcheries only receive live fish or eggs from other California hatcheries; no out of state fish stock is brought in. A number of California hatcheries use well water, a water source which is free of dreissenid mussels. At this time, no hatchery in California has a mussel infestation and monitoring protocols for aquatic invasive species are in place at all hatcheries. In the future, if infestation of hatcheries does happen, stocking will only be done using hatcheries which will provide a certificate documenting that they are free of all life stages of dreissenid mussels and that the water in which the fish is transported is also mussel free. The risk of introduction by this pathway is considered low – **Level 1**.

Vessels from outside contractors required to enter Lake Casitas on an urgent basis, such as to treat an algae bloom, are decontaminated with thermal wash per the District's policy. The risk of introduction by this pathway is considered low – **Level 1**.

An opportunity for introduction exists if mussels become introduced into Matilija reservoir, which provides periodic flow to the Ventura River. Ventura River is an intermittent stream, running usually only in the winter month`s `wet season.` It would be at this time, when the Ventura River is flowing, that mussels if introduced into Matilija Reservoir could reach Lake Casitas. Access to Matilija Reservoir is limited by rugged terrain but people with small water crafts have been spotted at the reservoir. Transfer of mussels from Matilija to Lake Casitas by water craft is unlikely given the type of water craft used on Lake Matilija (kayak and dinghy) and the length of time these water crafts spend on Lake Matilija (one day or less) . The risk of introduction by this pathway is considered low – **Level 1**.

A small pond of water exists at the end of Santa Ana Road on the north side of HWY 150, situated on Federal Land. As this pond may pass water to Lake Casitas, periodic visual inspection of the shoreline pond and veliger sampling is planned. The risk of introduction by this pathway is considered low – **Level 1**.

The most likely vector by which mussels may reach Lake Casitas is a person carrying a bait bucket containing water from Lake Piru or adult mussels. The bucket is then emptied into Lake Casitas, unintentionally or deliberately. Although the Lake is fully fenced around the perimeter of the recreation area, gaps in the fence exist to allow for movement of wildlife. An introduction could happen by an individual coming through the main gate or walking in through a gap in the fence fishing from the shoreline and then depositing the remains of the bait bucket in the reservoir. Although such act is against Casitas Municipal Water District Ordinance 16-01 Establishing Rules and Regulations for the Public Use of the

Lake Casitas Recreation Area and against the Fish and Wildlife prohibition to transport invasive species, no practical defense exists for such an act. The risk of introduction by this pathway is considered high – **Level 4**.

Based on the evaluation of above vectors of introduction of dreissenid mussels into Lake Casitas Reservoir it is clear that all possible preventative actions have been taken to minimize the risk of introduction. The primary vector, boating, has been well controlled for some time. Controlled access and fencing around the perimeter further minimize the potential for introduction. With the planned increase in engaging the fishing public on the topic of bait buckets the overall risk of introduction is perceived as low – **Level 1**.

If dreissenid mussels reach Lake Casitas reservoir, downstream spread of the mussels through water releases is not likely unless water spills over the dam when the lake is full. Lake Casitas has filled over capacity eight times in the last 50 years, and the spilled water flows into catch basin and into the original site of Coyote Creek. Potential for downstream dispersal of mussels will depend on the volume of the water spilled. The water would have to travel approximately 2 miles to reach Ventura River. The risk of dispersing Quagga/Zebra mussels by this pathway is considered low – **Level 1**.

The primary water withdrawal is via the drinking water plant. Water is withdrawn from Lake Casitas in the southern end of the lake through a submerged intake, which has openings at different depths covered by removable hatches. When open, the hatches are covered by a coarse mesh which would provide ideal substrate for settlement and growth of mussels. The mesh will have to be maintained and as a minimum the pipeline to the water treatment plant will have to be periodically treated, most likely with a chemical. The distribution system after the filters in the drinking water plant is fully protected by the filters themselves and by the injection of an oxidant.

Increased education and signage will be used to engage users upon entry with brochures, waterproof stickers reminding users to “CLEAN, DRAIN and DRY” and “Stop Aquatic Hitchhikers!”, explaining the potential of transferring unwanted species by bait bucket transfers. This is a useful investments in prevention of infestation not just by dreissenid mussels but also by other invasive species such as aquatic weeds.

The presence of Quagga mussels in Lake Piru continues to be a threat to Lake Casitas. Transplanting mussels from Lake Piru would be easy given the short distance to Casitas, Pyramid and Castaic Lakes. During the mussel breeding season, the water, which is being released from Lake Piru for maintenance of downstream fishery is not treated and therefore contains free floating larvae. This stream release is not easy to access but anglers and others who may not realize Quagga mussel larvae are in the water may collect water for fish transfer in this area.

2. Background Information

2.1 History of the Reservoir. Lake Casitas was created under contract between the Ventura River Municipal Water District now called Casitas Municipal Water District and the United States under contract 14-06-200-5257 Ventura River Project. The Lake Casitas Recreation Area was also developed under that contract to accommodate the visiting public. All lands related to Lake Casitas being under, around, and the watershed are federally owned by the Bureau of Reclamation. The water is owned by Casitas Municipal Water District.

Lake Casitas is an artificial lake formed by the construction of the Casitas Dam in 1958 on the on Coyote Creek, two miles (3 km) before it joins the Ventura River. Santa Ana Creek and North Fork Coyote Creek also flow into the lake as does water from the Ventura River through the Robles diversion canal. The annual average flow of the Ventura River is 13,600 acre-feet. Ventura River is an intermittent stream, running usually only in the winter month`s “wet season”.

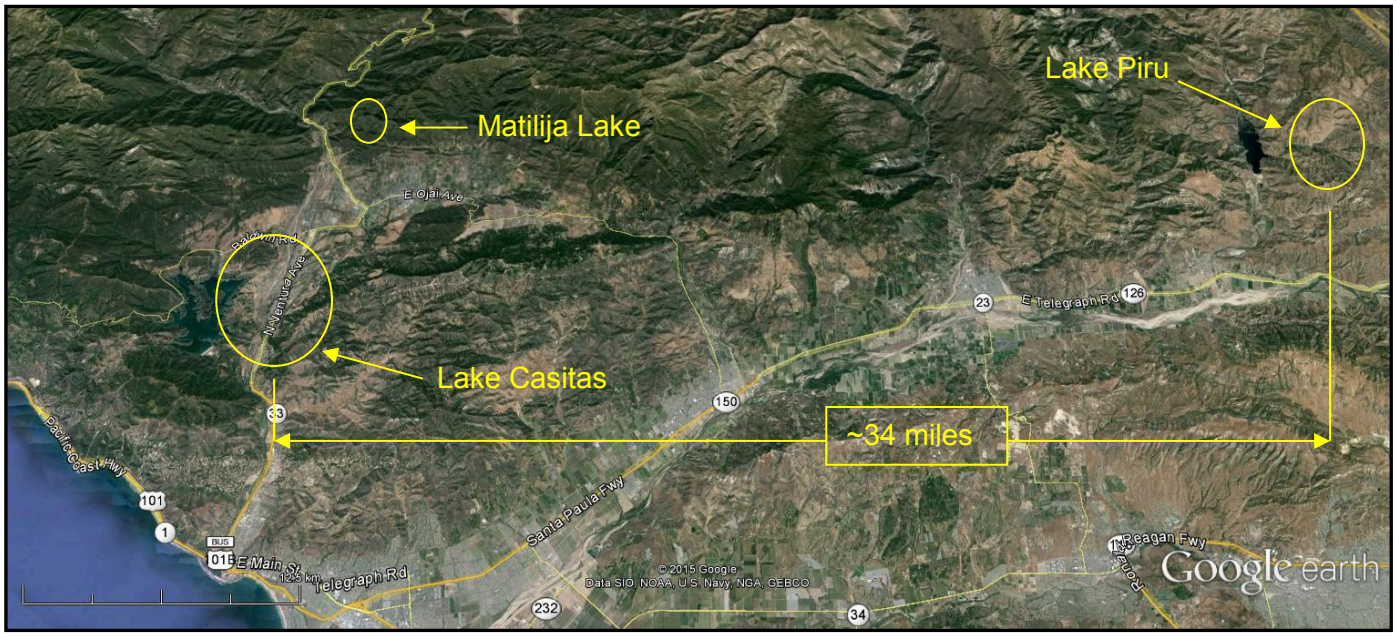

Figure 2.0 - Position of Lake Casitas and other water bodies of interest

The dam was constructed of earth-fill and was completed in 1959. It is 279 feet (85 m) tall and was built by the U.S. Bureau of Reclamation. The lake has a capacity of 254,000 acre-feet (313,000,000 m^3). The dam was built as part of the Ventura River Project and was strengthened in Jun-Dec 2000 as a seismic improvement to help withstand earthquakes greater than 6.5 magnitude. The underlying rock is thought to be limestone, as is the case with much of this geographical area.

Due to various meteorological events the lake was not fully filled and functional until 1978. Generally, the only outflow from the lake is the water withdrawn from Lake Casitas in the southern end through a submerged intake of the water treatment plant. The Casitas Municipal Water District supplies water from Lake Casitas to 60-70,000 people in Western Ventura County and to hundreds of farms through an extensive network of concrete and steel pipes. Generally the only outflow from the lake is the water withdrawn from Lake Casitas in the southern end through a submerged intake to supply drinking and irrigation water to Ventura County. The only other water release occurs when Lake Casitas has filled over

capacity and water was spilled over the dam. The spilled water flows into catch basin and the into the original site of Coyote Creek. This situation has occurred eight times in the last 50 years.

The Lake Casitas Recreation Area encompasses the northern end of Lake Casitas (**Figure 2.1**) and is a very popular destination site with over 650,000 visitors each year. While camping draws the most attendance, boating and fishing activities have always been popular. Lake Casitas has a robust boat inspection and tagging protocol in place. As Lake Casitas is a drinking water reservoir, no body contact such as swimming, wading, or water skiing is allowed.

Due to the persistent drought in Southern California, Lake Casitas is only partially filled and much of the lake bottom is visible as a "sandy" beach. The substrate appears quite firm with boat trailers able to partially drive in without sinking.

There are Asian clams (*Corbicula fulminea)* present in the sediments of the reservoir. Asian clams were introduced to North America in 1938. The first collection of *C. fluminea* in the United States occurred along the banks of the Columbia River near Knappton, Washington (Counts 1986). Since this first introduction, the Asian clam is now found in 38 states and the District of Columbia. *C. fluminea* is thought to have entered the United States as a food item used by Chinese immigrants. Alternatively, it may have come in with the importation of the Giant Pacific oyster, also from Asia. Human-mediated transport is the primary agent of dispersal. Methods of introduction include bait bucket introductions and accidental introductions associated with imported aquaculture species (Counts 1986). Bait bucket introduction is the most likely vectors by which Asian clams have reached Lake Casitas as the only other significant dispersal agent is thought to be passive movement via water currents; fish and birds are not considered to be significant distribution vectors (Counts 1986, Isom 1986).

Lake Casitas has an average calcium level of 57mg/L (S. McMahon pers. comm.). This level of calcium can support a massive infestation by dreissenid mussels (Mackie and Claudi 2010). It does have low level of dissolved oxygen below 30 foot depth for most of the summer. This lack of oxygen may limit the development of dreissenid population in this zone of the lake.

Lake Casitas is a reservoir with a dendritic pattern and considerable shoreline complexity characterized by a rugged coastline within numerous bays (**Figure 2.1**). Shore line shape (D_L) is important because it reflects the potential for development of littoral communities. High values of D_L reflects increased shoreline area for productivity, including that of invasive species. D_L is calculated by dividing the lake's shoreline length (SL) by $2 \cdot \sqrt{(\pi \cdot A_o)}$, A_o being the surface area of the lake. For Casitas Lake the shoreline development is 6.97 (using: SL = 32.4 mi; A_o = 1100 acres; π = 3.14). Circular lakes have a D_L near 1. What this means is that Quagga mussels in Lake Casitas have about seven times more opportunities to settle than in a circular lake such as Crater Lake, Oregon.

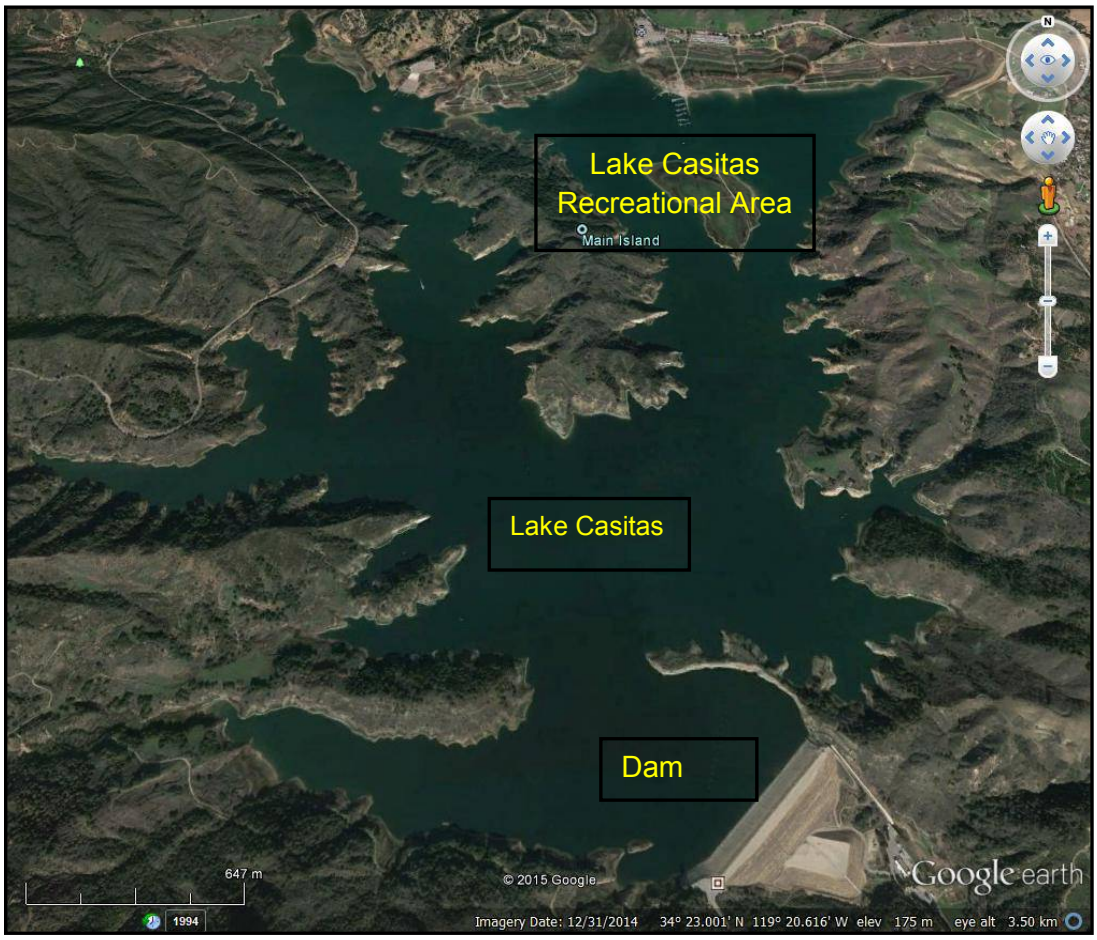

Figure 2.1 - Lake Casitas showing location of dam, recreation area and the rugged shoreline development.

There are no water releases from Lake Casitas beyond the withdrawal of water through the dam that supplies the drinking water plant unless water spills through the spillway of the dam during high water levels. Lake Casitas has filled to over capacity eight times in the last 50 years, and the spilled water flows into catch basin and the into the original site of Coyote Creek.

2.2 Environmental Preferences and Impacts of Zebra and Quagga Mussels

2.2.1 Environmental Parameter Ranges. Though dreissenids have a distinct set of environmental preferences, they can survive in many subpar conditions, often successfully facing starvation, desiccation, extreme variances in temperature and variable oxygen levels. They can survive in static lakes and reservoirs and in the fast currents of pipelines in both nutrient poor and nutrient rich lakes. Though a freshwater species, they can survive for some time in brackish areas, and are capable of tolerating a certain degree of pollution. If intolerable conditions are present, the mussel can close its shell for up to 2 weeks before reopening. Details on the biology of Quagga/Zebra mussels are found in **Appendix E**.

The following: **Table 2.1** was derived from the values reported by various authors in North America and Europe and gives the ranges of values for each of the environmental parameters as they relate to success of dreissenid mussel populations.

Parameter	Adults do not survive long-term	Uncertainty of veliger survival	Moderate Infestation Level	High Infestation Level
Calcium mg/L	<8 to <10	<15	16-24	≥24
Alkalinity mg CaCO3/L	< 30	30-55	45-100	>90
Total Hardness mg CaCO3/L	<30	30-55	45-100	≥90
pH	<7.0 or >9.5	7.1-7.5/ 9.0-9.5	7.5-8.0 or 8.8-9.0	8.2-8.8
Dissolved Oxygen mg/L (% saturation)	<3 (25%)	5-7 (25-50%)	7-8 (50-75%)	≥8 (>75%)
Chlorophyll a µg/L	<2.5 or >25	2.0-2.5 or 20-25	8-20	2.5-8
Total phosphorous µg/L	<5 or >50	5-10 or 30-50	15-25	25-35
Secchi depth m	<0.1 >8	0.1-0.2 or >2.5	0.2-0.4	0.4-2.5
Mean Summer Temperature °C	<2(36°F) >30(88°F)	2-10(36-50°F) or >28 (82° F)	10-16 (50 – 61°F) or 24-28 (75- 82°F)	16-24 (61 - 75°F)
Conductivity µS/cm	<30	<30-60	60-110	≥100
Salinity g/L (ppt)	>10	8-10 (<0.01)	5-10 (0.005-0.01)	<5 (<0.005)

Table 2.1 - Criteria used in determining levels of infestation by dreissenids in temperate zone of eastern portion of North America and Europe (after Mackie and Claudi 2010).

The primary way of reaching unconnected bodies of water is with human assistance, including networks of canals, such as in Europe where the network of inland waterways is made up of >28,000 km of navigable rivers and canals, connecting 37 countries. They can be unknowingly transported on the hulls of ships and boats, in ballast water or bait buckets of sport fishermen.

2.3 Potential Size of Dreissenid Population in Lake Casitas based on Raw Water Chemistry. The success of an invasion by dreissenids depends on the quality of water, lake morphology, and the health of the receiving ecosystem.The quality of water in a lake depends in part on the chemistry of the water that supplies the lake. Every lake has its own watershed, and the chemistry of the soil and bedrock in the watershed will largely (but not entirely) dictate the chemistry of the water flowing through it and over it. The chemistry may change over time. The rate and amount of change depends on factors such as type and amount of bedrock, climate and the weathering processes which naturally and continually take place.

Lake morphology, including depth and surface area plays a role in the susceptibility of a lake to invasion by aquatic invasive species. Shoreline complexity is a key morphological trait that enhances the probability of species establishment by offering more bays and inlets for settlement. Lake Casitas not only has a dendritic pattern, which offers several large bays typical of many impoundments, but also many smaller bays and inlets that resemble a serrated shoreline (**Figure 2.1**) This pattern not only enhances chances of establishment, but makes delineations of infestations and monitoring of growth more complex.

The success of an invasion by an aquatic species depends on the health (physiological and ecological requirements and tolerances) of the species. Thus, a species' potential for invasion into a body of water not only depends on its dispersal potential and the shoreline pattern, but on the ability of the body of water to support a viable population. Detailed analysis of the environmental variable data is included in 0.

As seen in **Table 2.2,** the environment of Lake Casitas, with some exceptions, is likely to support a massive population of Quagga/Zebra mussels should they become introduced. Therefore, the risk of establishment of a massive population upon introduction,1 (being low) to 5 (being high) is 5. For more details of the environmental variables found in Lake Casitas see **Appendix C.**

Parameter	Adults do not survive long-term	Uncertainty of veliger survival	Moderate Infestation Level	High Infestation Level	Lake Casitas
Calcium mg/L	<8 to <10	<15	16-24	≥24	57
Alkalinity mg CaCO3/L	< 30	30-55	45-100	>90	
Total Hardness mg CaCO3/L	<30	30-55	45-100	≥90	
pH	<7.0 or >9.5	7.1-7.5/ 9.0-9.5	7.5-8.0 or 8.8-9.0	8.2-8.8	7.2- 8.4
Dissolved Oxygen mg/L (% saturation)	<3 (25%)	5-7 (25-50%)	7-8 (50-75%)	≥8 (>75%)	0 to > 100%)
Chlorophyll a µg/L	<2.5 or >25	2.0-2.5 or 20-25	8-20	2.5-8	0 to 15
Total phosphorous µg/L	<5 or >50	5-10 or 30-50	15-25	25-35	
Secchi depth m	<0.1 >8	0.1-0.2 or >2.5	0.2-0.4	0.4-2.5	2 to 12
Mean Summer Temperature °C	<2(36°F) >30(88°F)	2-10(36-50°F) or >28 (82° F)	10-16 (50 – 61°F) or 24-28 (75- 82°F)	16-24 (61 - 75°F)	61 -75°F
Conductivity µS/cm	<30	<30-60	60-110	≥100	
Salinity g/L (ppt)	>10	8-10 (<0.01)	5-10 (0.005-0.01)	<5 (<0.005)	

Table 2.2 - Comparison of preferred environmental variables of Zebra and Quagga mussels with the environmental factors of Lake Casitas.

3. **Vulnerability Assessment**

3.1 Possible Vectors of Introduction and Dispersal. Below is a review of the potential vectors of introduction. Dispersal mechanisms have been well studied, from those concerned mainly as primary vectors (for introductions from other continents) to those considered as secondary vectors used to spread aquatic species once introduced. The main secondary vector of introduction is overland transport of propagules; which means any life stage of the dreissenid mussel (Johnson et al. 2001, 2006). Such transport mechanisms include trailered boats and motors which may carry attached adults and juveniles, mussels and juveniles entangled in macrophytes, larvae in fish and bait wells/buckets, or on fishing gear (Johnson and Carlton 1996). Sabotage, that is intentional introductions, is of particular concern. Other potential vectors are fish stocking, and water withdrawal and transfer activities, Wildlife (e.g. waterfowl, aquatic mammals) are not considered major vectors (Johnson and Padilla 1996).

3.1.1 Sabotage. At this point-the most likely vector by which mussels may reach Lake Casitas is through deliberate introduction. A deliberate introduction could happen by an individual coming through the main gate or walking in through a gap in the fence carrying a container of adult mussels or a reasonable volume of water containing veligers. No real defense exists for such an act. The presence of Quagga mussels in Lake Piru, a short distance away, makes this vector a possibility. The risk of introduction by this pathway is considered high – **Level 5**.

3.1.2 Bait Bucket Introductions. A common vector of transfer is the use of live bait in buckets which may contain water from infected areas. While there is currently very few off-site sources of live bait in the area, the presence of mussels in Lake Piru has made this mode of transfer a possibility. For example, it is illegal to transport live shad from one water body to another in California, but fisheries staff reports that anglers do fish with live shad (Per.comm.M.W. Gibson). Further, crayfish and clams can be captured in most water bodies and transported as bait. Both crayfish and clams can carry attached dreissenid mussels. Increased signage at the reservoir and planned questions on entry by the staff as to what anglers are using as bait and where they are from will be helpful to prevent his mode of transfer. The risk of introduction by this pathway is considered high – **Level 4**.

3.1.3 Recreational Boating. Casitas Municipal Water District has a strict water vessel tagging and quarantine program in place at Lake Casitas since 2008. In 2008 the Board of Directors of the Casitas Municipal Water District adopted Resolution #08-08 restricting outside boats, including canoes, kayaks and float tubes, (those not stored or moored at the Recreation Area as of that date) from entering the Lake Casitas Recreation Area. A Tamper Proof Tag Program has been developed for vessels that pass inspection. This qualification involves a 35-Day Quarantine period. The quarantine can be completed either inside or outside the Recreation Area. The long quarantine period following an inspection of boats for mussels guarantees that these boats will not be a vector of introduction. Full description Resolution #08-08 is included in Appendix A. The risk of introduction by this pathway is considered low – **Level 1**.

There is an opportunity to launch a small water craft where Rt.150 crosses a small arm of Lake Casitas (Fig.3.1). The access route is steep and likely to require a considerable effort. This would limit any water craft to perhaps a small kayak or an inflatable dinghy. Neither of these types of vessels are likely to carry an existing mussel infestation but signage at this location would be helpful. The risk of introduction by this pathway is considered low – **Level 1**.

3.1.4 Fish Stocking. At this point fish stocking it is not a concern. California hatcheries only receive live fish or eggs from other California hatcheries, no out-of-state product is brought in. Number of California hatcheries use well water (a water source free of mussels and other undesirable species). At the time of writing, no hatchery in California has a mussel infestation and monitoring protocol for aquatic invasive species are in place at all hatcheries (**Appendix B**).

If in the future some California hatcheries become infested by dreissenid mussels, it will be important to determine where all the fish to be stocked into Lake Casitas come from, following a trail of custody such as possible trail of egg and young fish purchases. Sampling the water at the hatchery, which may raise and deliver the fish is also prudent if there is any doubt of possible contamination. Possibly, requiring a certificate from the hatchery that they are free of dreissenid mussels would put the onus on the hatchery rather than on the staff of Lake Casitas.

If there is any doubt that the hatchery is mussel free, it may be prudent to insist that the water in which fish is delivered be treated with potash and formalin. This treatment is thought to be effective in eliminating any veligers, which may be present in the water although this protocol is currently under review. Any treatment used for water with the hatchery fish should be approved by the regulator. The risk of introduction by this pathway is considered low – **Level 1**.

3.1.5 Emergency Water Withdrawal. Emergency equipment which comes to withdraw Lake Casitas water is sterilized with steam/hot water using a dedicated mobile hot water pressure machine. Steam/hot water sterilization can also be used on contractor equipment such as those coming to do an algaecide treatment in Lake Casitas. The risk of introduction by this pathway is considered low – **Level 1**.

3.1.6 Water Transfers. Another opportunity for introduction exists if mussels are accidently or deliberately introduced into Matilija reservoir, which provides periodic flow to the Ventura River (**Figure.3.1**).

Figure 3.1 - Showing the two nearest water bodies to Lake Casitas and possible launching site

Ventura River is an intermittent stream, running usually only in the winter month`s “wet season”. It would be at this time, when Ventura River is flowing, that mussels if introduced into Matilija Reservoir could reach Lake Casitas. Access to Matilija Reservoir is limited by rugged terrain but people with small water crafts have been spotted at the reservoir (**Figure 3.2**).

Figure 3.2 - Details of Matilija Lake

A small pond on Federal Land is located approximately 1.25 miles from the entrance to Lake Casitas (**Figure 3.3**). The pond is approximately 160 yard x 90 yard and has an approximate elevation of 710 feet ASL as compared to Lake Casitas at an approximate level of 560 feet ASL. There is a small dock that exists on the north side of the pond. Santa Ana Road ends approximately 1/4 mile south east of the pond and from there a private road, of unknown condition and access, proceeds to and beyond the pond. The contour of the surrounding area is such that if an overflow from the pond occurred there is a potential water path that would enter the northwest arm of Lake Casitas near a creek overpass on Rte. 150 after travelling a path of approximately 1.5 miles.

Figure 3.3 - Small pond near the entrance to Lake Casitas Reservoir

Annual visual inspection of the shorelines of both bodies of water as well as collection of water samples for plankton analysis will be done. The risk of introduction by this pathway is considered low – **Level 1**.

3.1.7 Perimeter Security. Although the Lake is fully fenced around the perimeter of the recreation area, gaps in the fence exist to allow for movement of wildlife. The gaps in the fence allow people to access the lake without going through the main gate and paying a fee. Such access is used mainly for shoreline fishing but there is an opportunity to launch a small water craft where Rte.150 crosses a small arm of Lake Casitas as discussed earlier (Fig.3.1). The risk of introduction by this pathway is considered low – **Level 1**.

In summary, based on the evaluation of above vectors of introduction of dreissenid mussels into Lake Casitas Reservoir it is clear that all possible preventative actions have been taken to minimize the risk of introduction. The primary vector, boating, has been well controlled for some time. Controlled access and fencing around the perimeter further minimize the potential for introduction. With the planned increase in engaging the fishing public on the topic of bait buckets the overall risk of introduction is perceived as low – **Level 1**.

3.2 Impact of Dreissenid Mussels to District/Area

3.2.1 Filter Feeding. The feeding behavior of dreissenid mussels directly affects ecosystems. Zebra/Quagga mussels are efficient filter feeders that process up to approximately one liter of water per mussel per day (Mackie and Claudi 2010). Microscopic plankton and algae in the water column are removed and either eaten by the mussels or wrapped in mucus and ejected as pseudofaeces. The microscopic plankton comprises the base of the food chain and serves as food for larval fish, native mussels, aquatic invertebrates and insect larvae. Large populations of dreissenid mussels can significantly decrease or eliminate the presence of these microscopic organisms thereby disrupting the food chain. Fish that the fishing recreation industry in the area relies on may be negatively affected. As Lake Casitas may be able to support a massive population of dreissenid mussels, the fishing quality may be seriously impacted.

3.2.2 Changes in Water Clarity. Mussel filter feeding also indirectly affects the aquatic environment by removing particulates from the water, thereby increasing water clarity. While clear water is attractive from an aesthetic standpoint, significant increases in water clarity can profoundly change the aquatic ecosystem. Increased clarity allows light to penetrate deeper into the water column. The increased light encourages the growth of rooted aquatic vegetation on the lake bottom. Increases in biomass and diversity of aquatic plants, along with bottom-dwelling forms of algae, can drive a change from having fish dwelling in the top layers of the lake (pelagic fish) to fish that thrive by feeding on bottom organisms.

It is estimated that over three million people fish for freshwater fish species in California and one out of every three fish specifically for bass. Lake Casitas is considered a prime largemouth bass fishing lake. Bass do not like bright light and increased water clarity will drive them deeper and alter their feeding behavior. The actual impact on the fishery is uncertain as effects tend to be very site specific (Strayer et.al. 2004).

3.2.3 Bioaccumulation of Pollutants and Toxic Metals. Zebra and Quagga mussels have the potential to accumulate various environmental contaminants because of the large volumes of water they filter and the high body-fat content in the gonads. Studies have shown that dreissenid mussels may mobilize toxic materials from the sediments back into the food chain. As mussels filter algae that have absorbed toxic materials, they ingest the toxic materials and accumulate it either in fatty tissue or in the shells. This toxic burden is then passed on to fish or ducks that prey on mussels. Alternatively, if mussels reject the algae as pseudofeces, the algae plus the toxins are deposited on the bottom of the reservoir. Amphipods that graze on the pseudofeces are then eaten by fish, thereby introducing toxins to the food chain via a new mechanism.. The release of gametes dissipates the fat stores and changes the amount of toxins in the mussels during the season. Therefore when the ingestion of mussels by other organisms occurs affects the toxic burden they receive.

Depending on the background level of pollutants in the sediments of Lake Casitas and the existing food chain, consumption restrictions and catch limits on some species or sizes of fish may be necessary.

3.2.4 Waterfowl Migrations.

Consumption of Zebra and Quagga mussels by migrating or overwintering waterfowl has been noted. Changes in waterfowl abundance and migratory patterns can occur if dreissenid mussel abundance is high enough to attract the attention of passing birds. Diving ducks (like canvasbacks, redheads, scaups

and mergansers) are most attracted to dreissenid mussels as food. Increase in waterfowl presence on Lake Casitas is not desirable as this is a drinking water reservoir and additional biological burden from water fowl feces is not desirable.

3.2.5 Botulism Outbreaks. In the Great Lakes, bacteria which causes Botulism Type E (*Clostridium botulinum*) has been found in the tissue of dreissenid mussels when outbreaks occur. Species that feed on dreissenids such as round gobies, freshwater drum and ducks such as scaup may be impacted by eating infected mussels which could result in dieoffs. The outbreaks may continue to go further up the food chain when ducks, loons, grebes, gulls and/or other fish eat the infected species and other animals such as raccoons scavenge the contaminated victims. (OFAH, 2004)

3.2.6 Potential Fishing Recreation Impacts at Lake Casitas. Lake Casitas is a popular fishing destination in Southern California. Stocking of trout has resumed in 2015 assuring a good fishing experience for anglers. It is not clear if an infestation by dreissenids would interfere with the success of stocked fish thriving thus affecting the fishing experience.

3.2.7 Positive Effects of Zebra Mussels. Many native fish, birds, and other animals have come to rely on young and adult Zebra mussels as a food source in ecosystems which have been invaded for some time. Consumption by predators does not translate to population control due to the reproductive potential of dreissenid mussels.

Increase in large aquatic plants, due to improved water clarity, can result in more nursery habitat for young fish.

3.2.8 Impact to Facilities - Intake Line for Drinking Water Plant. The Casitas Dam is an earth-filled structure stretching 2060 feet from bank to bank and stands 285 feet above the lake bed. The water is withdrawn from Lake Casitas in the southern end through a submerged sloped intake, which has 9 intake openings at different depths covered by removable hatches. When open, the hatches are covered by a semi-circular shaped basket with one inch by one inch steel mesh screen. This screen would provide ideal substrate for settlement and growth of mussels. The mesh screen is easily removable as it travels on rails located above the intake hatches. The rails extend to the crest of the dam where the intake screen can be cleaned. Cleaning of screens is usually done with pressure washers and some manual scraping. A heavy mussel infestation would likely require the screen to be cleaned every 2 months.

A transfer pipe proceeds from the intake structure to the water treatment plant. Mussels will be able to settle on the walls of the transfer pipe. It is not possible for mussels to block the large transfer pipe but if allowed to grow on the walls, mussel shells will eventually slough off and be removed by the media filters in the water treatment plant. Some increased backwashing of the filters may occur if there is a large die off of mussels on the transfer pipe walls.

Mussel veligers settle out of the water column when they are in the range of 250-400 microns in size. Smaller mussels remain free floating in the water. The free floating veligers will be removed by the multimedia filters in the water treatment plant and will not be able to enter into the water distribution system. The distribution system after the filters is protected by the filters themselves and additionally by the injection of an oxidant into the delivered water.

3.2.9 Containment. Current and pending laws or regulations that contain provisions regarding access to affected properties for containment, treatment, and control or any legal or regulatory concerns related to treatment need to be considered during the decision making.

All vectors which may result in the spread of Zebra/Quagga mussels, such as boating and bait buckets need to be evaluated if and when mussels are introduced into Lake Casitas.

Rigorous boat inspections are already in place. Should mussel be introduced into Lake Casitas the current procedures used to control boating on Lake Casitas offer a high level of assurance of containment if the inspection and decontamination of boats focuses on boats leaving the reservoir rather than entering it. This would prevent the spread of dreissenids to other water bodies in California and possibly to other states via the boating vector. Education and outreach program aimed at recreational boaters and anglers to reduce the risk of spread is critical.

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APPENDIX A

Lake Casitas Existing Policies for Prevention of Quagga/Zebra Mussel Introduction

Appendix A.1 - Policy for Decontamination

CASITAS MUNICIPAL WATER DISTRICT
POLICIES & PROCEDURES FOR VESSEL DECONTAMINATION FOR AQUATIC INVASIVE SPECIES
LAKE CASITAS RECREATION AREA

Board Approved: 8/12/15 Effective Date: 8/12/15

Park Services Manager Approval: C. Belser Date: 8/12/15

1. **POLICY**

All vessels and equipment entering the Lake Casitas shall be made free of invasive species, such as dressenid Quagga mussels. Casitas Municipal Water District (Casitas) has determined that there are operational and emergency requirements that cannot accommodate a 35-day quarantine that is specified by the Lake Casitas Recreation Area Vessel Quarantine, Re-Entry, Temporary Storage and Tamper-Proof Tag Program (Quagga Prevention Program). Casitas has determined that specific alternative decontamination methods can be applied to remove the risk of invasive species entering Lake Casitas and to lessen or remove the quarantine period.

The appropriately assigned Casitas staff are authorized under the procedures of this policy to perform inspection, alternative decontamination, and risk mitigation compliance of vessels and equipment belonging to Casitas and Casitas approved public agencies or agents that are performing under a Casitas agreement or contract.

The alternative decontamination procedures shall not be applied to recreational vessels belonging to the general public. The Lake Casitas Recreation Area Vessel Quarantine, Re-Entry, Temporary Storage and Tamper-Proof Tag Program Casitas Vessel Inspection and Tagging Program is the standard for such vessels.

Any deviation from the decontamination policy or the procedures will require a timely written submittal to the General Manager that includes, but is not limited to, a request for deviation naming the key persons in control of the vessel or equipment, evaluation of the risk posed by the vessel/equipment, supporting factual documentation, a justification for the deviation and an assessment of the risk that is associated with the deviation. A request for a deviation to the policy may not proceed without the written approval of the General Manager.

Emergency or life-threatening situations will be processed as expeditiously as possible within established decontamination protocols that are addressed in Memorandums of Understanding with Federal, State and County emergency response agencies.

2. PROCEDURES

A. **Notification**. It shall be incumbent upon the responsible Casitas Manager to:

(a) Provide a timely request to the Park Services Manager for inspection and decontamination services to be rendered by the Lake Casitas Recreation Area (LCRA) staff; and

(b) Provide correct information for the person(s) to contact and the purpose of the vessel entry.

When an emergency is deemed to be occurring and entry to Lake Casitas is required by emergency responders, the emergency response agency shall:

(c) Contact the Park Services Manager by direct telephone call to request access, state the emergency and requirements and methods to access Lake Casitas; and

(d) Comply with all pre-arranged decontamination procedures prior to accessing Lake Casitas waters.

In case of an emergency, the Park Services Manager will immediately notify the General Manager and follow up with a written report of the emergency action and measures taken to comply with this policy.

B. **Inspection and Decontamination**. In order to be consistent with policies, procedures and training, the Lake Casitas Recreation Area Vessel Decontamination Checklist will be completed on all vessel inspections and decontaminations. This document outlines the process that staff must complete before a vessel of any kind is authorized to enter the LCRA and launch in Lake Casitas. Each step in the Vessel Decontamination Checklist has specific expectations associated with it and will only be conducted by fully trained and Casitas approved staff. LCRA staff will follow a zero tolerance policy for completing the decontamination procedures following current Pacific States Marine Fisheries Commission (PSMFC) Watercraft Inspection Training II (WIT II) standards.

C. **Documents**. The Vessel Decontamination Policies and Procedures, Vessel Decontamination Procedures, Vessel Decontamination Checklist, Vessel Inspection Policies and Procedures, Vessel Inspection Checklist, Vessel Acknowledgement Forms and Casitas handouts have been developed to ensure proper inspections of vessels, trailers and vehicles to prevent Lake Casitas from becoming infested with invasive species. All documents pertaining to the Vessel Inspection and Vessel Decontamination Policies and Procedures are subject to change due to updated policies at the sole discretion of Casitas.

D. **Vessel Inspection and Decontamination Checklist**

(a) Staff will complete a Casitas Municipal Water District Clean and Dry inspection following the Policies and Procedures for Vessel Inspections for Invasive Species.

(b) Staff will write the state boating identification number and owner/operator's name and date on the Vessel Decontamination Checklist.

(c) Staff will check the Casitas generated database of vessels that have previously been denied access.

(d) Staff will request the owner/operator of the vessel to open all compartments.

(e) Staff will request the owner/operator of the vessel to remove all equipment or gear from the vessel.

(f) Should the owner/operator refuse to allow a complete inspection and decontamination, access to the LCRA and Lake Casitas shall be denied.

(g) The decontamination shall be performed at a location designated by Casitas that will not drain directly into a waterbody.

(h) Staff will decontaminate the vessel, trailer and vehicle with a hot water wash with water temperatures ranging from 120 degrees F to 140 degrees F on high and low pressures depending on the area of the vessel being washed as listed below. The hot water wash will comply with current (PSMFC WIT II) standards.

E. **Areas of Decontamination**. The following areas will be decontaminated by Staff:

(a) **Vehicle Rear**: The vehicle bumper, tailgate or spare tire may have mud, grass, weeds or other debris on it. If there are positive signs of mud, etc., the area will be decontaminated with a hot water wash using low

pressure in compliance with (PSMFC WIT II) standards as may be modified from time-to-time. An infrared thermometer will be used to confirm the appropriate temperature has been reached. (See attached for current temperature requirements.)

(b) **Trailer Structure, Railings and Spare Tire**: The trailer, railings and spare tire may have mud, grass, weeds, debris or standing water. The area will be decontaminated with a hot water wash using high pressure in compliance with current (PSMFC WIT II) standards as may be modified from time-to-time. An infrared thermometer will be used to confirm the appropriate temperature has been reached. (See attached for current temperature requirements.)

(c) **Vessel Hull**: The vessel hull will be inspected for growth and debris. Growth may be visible if the vessel has been in the water for an extended period of time. Small mussels attached to a vessel can feel like sandpaper or sesame seeds. The area will be decontaminated with a hot water wash using high pressure in compliance with current (PSMFC WIT II) standards as may be modified from time-to-time. An infrared thermometer will be used to confirm the appropriate temperature has been reached. (See attached for current temperature requirements.)

(d) **Transom**: The transom is at the back of the vessel where the engine is attached. The transom may have several items of importance for inspection that mussels can attach to including outdrive, trim tabs, transducers, bilge plug area and through hull fittings. The transom must be checked to make sure the surface is smooth and visibly clear of all debris and growth. All areas will be decontaminated with a hot water wash in compliance with current (PSMFC WIT II) standards as may be modified from time-to-time. A high pressure wash will be used on all areas other than the transducers (see below). An infrared thermometer will be used to confirm the appropriate temperature has been reached. (See attached for current temperature requirements.)

(e) **Outdrive**: The Outdrive is attached to the transom on stern drive vessels and the lower unit on outboard vessels. It has intricate parts that make it easy for mussels to attach, hide and grow. Staff will feel and look for any signs of growth, debris or texture of sandpaper. The area will be decontaminated with a hot water wash using high pressure in compliance with current (PSMFC WIT II) standards as may be modified from time-to-time. An infrared thermometer will be used to confirm the appropriate temperature has been reached. (See attached for current temperature requirements.)

(f) **Propeller/Shafts**: Mussels can attach and live on or around where the propeller attaches to the lower unit of the drive shaft. Mussels can also attach to the shaft or connecting points of the vessel. These can be hard to see and must be inspected with a flashlight to verify if any mussels, debris or water are present. The area will be decontaminated with a hot water wash using high pressure in compliance with current (PSMFC WIT II) standards as may be modified from time-to-time. An infrared thermometer will be used to confirm the appropriate temperature has been reached. (See attached for current temperature requirements.)

(g) **Trim Tabs**: Trim tabs are located on the lower portion of the transom and are usually metal plates that help stabilize the vessel while underway. Staff will feel the corners, edges and look on the underside of the trim tabs for debris and growth. The area will be decontaminated with a hot water wash using high pressure in compliance with current (PSMFC WIT II) standards as may be modified from time-to-time. An infrared thermometer will be used to confirm the appropriate temperature has been reached. (See attached for current temperature requirements.)

(h) **Transducers:** These are located on the transom or bottom of the hull near the stern of the vessel. They are used in conjunction with a computer to determine depth, speed and water temperature. Growth or debris can appear on them. The area will be decontaminated with a hot water wash using low pressure in compliance with current (PSMFC WIT II) standards as may be modified from time-to-time. An infrared thermometer will be used to confirm the appropriate temperature has been reached. (See attached for current temperature requirements.)

(i) **Bilge Plug**: If the bilge plug is pulled when the vessel arrives at the lake, there should be no fluid or debris coming from it. Staff will check to determine if debris is blocking water from exiting. If the bilge plug is not pulled, the owner/operator will be requested to pull the plug. The area will be decontaminated with a hot water wash using high pressure in compliance with current (PSMFC WIT II) standards as may be modified from time-to-time. An infrared thermometer will be used to confirm the appropriate temperature has been reached. (See attached for current temperature requirements.)

(j) **Through Hull Fittings**: Through hull fitting in all boats have the potential to store mussels in the right conditions. To check these fittings, Staff will use a flashlight to look inside and feel for irregularities. The area will be decontaminated with a hot water wash using low pressure in compliance with current (PSMFC WIT II) standards as may be modified from time-to-time. An infrared thermometer will be used to confirm the appropriate temperature has been reached. (See attached for current temperature requirements.)

(k) **Bait Tank/Live Well/Compartments**: Bait tanks, live wells and compartments should be dry and clear of all water and debris. Some compartments do not drain completely due to the way they are manufactured. Any debris in compartments is not acceptable. Common debris often found includes; fish scales, weeds, small pebbles, and trash. The area will be decontaminated with a hot water wash using low pressure in compliance with current (PSMFC WIT II) standards as may be modified from time-to-time. An infrared thermometer will be used to confirm the appropriate temperature has been reached. (See attached for current temperature requirements.)

(l) **Bilge**: The bilge is at the bottom of the inside stern of the vessel. It may not be visible in all boats due to various boat designs. The bilge should be clean from all water and debris. The area will be decontaminated with a hot water wash using low pressure in compliance with current (PSMFC WIT II) standards as may be modified from time-to-time. An infrared thermometer will be used to confirm the appropriate temperature has been reached. (See attached for current temperature requirements.)

(m) **Anchor/Fenders and Line**: Anchors can have mud or debris on them. If an anchor, fender and lines attached have been in infested water for an extended period of time then mussels and debris can attach. Staff must check these items for mud, growth and debris. The area will be decontaminated with a hot water wash using low pressure in compliance with current (PSMFC WIT II) standards as may be modified from time-to-time. An infrared thermometer will be used to confirm the appropriate temperature has been reached. (See attached for current temperature requirements.)

(n) **Trolling Motor**: Trolling motors can pick up plants and debris while being used and must be inspected. These items must be checked for mud, growth and debris. The area will be decontaminated with a hot water wash using high pressure in compliance with current (PSMFC WIT II) standards as may be modified from time-to-time. An infrared thermometer will be used to confirm the appropriate temperature has been reached. (See attached for current temperature requirements.)

(o) **Engine:** The engine will need to go through a hot water wash to insure no contaminated water or invasive species are present in the engine. The appropriate attachments will need to be connected to the engine to insure no damage is done. Cold water will need to be run through the engine while it is running until the engine is appropriately “warmed up”. Once the engine is “warmed up” the hot water wash can begin. The engine will be decontaminated with a hot water wash using low pressure in compliance with current (PSMFC WIT II) standards as may be modified from time-to-time. An infrared thermometer will be used to confirm the appropriate temperature has been reached. (See attached for current temperature requirements.)

F. **Compliance**

(a) If for any reason the decontamination is unable to be completed or there is good reason that Casitas staff believes that a risk still exists, the vessel will be denied entry into the LCRA and launching into Lake Casitas pending further review of the vessel’s condition and determination of a remedy. Staff will provide to the Park Services Manager and General Manager, in a timely manner by written report, all reasons and concerns that staff has identified, remedies staff recommends for decontamination, or reasons that decontamination cannot be attained by the alternate decontamination method. If the vessel is denied entry due to an incomplete decontamination, the General Manager’s direction must be obtained prior to any subsequent decontamination.

(b) Upon successful completion of the inspection and decontamination process, the vessel will be secured until the time the vessel is launched into Lake Casitas. Securing a vessel may include, but not be limited to, vessel cabling and tagging in accordance with the Casitas Quagga Prevention Program, or temporarily storing the vessel in a Casitas approved secure area at either the LCRA or Casitas Dam. If the removal of the cable-tag or removal of the vessel from the secured area causes Casitas to determine that the vessel decontamination has been compromised, re-inspection and decontamination will be required. Such a determination shall be immediately

reported to the General Manager prior to proceeding with launching the vessel. The Vessel shall be denied entry into Lake Casitas until full disclosure is provided and a clearance for re-inspection and decontamination is given by the General Manager.

G. **Decontamination of Field Equipment**. This protocol applies to all dive gear used in all water bodies, not just water thought to be infested. Decontamination of field equipment shall occur prior to conducting field work in Matilija Canyon, upstream of Matilija Dam, Coyote Creek upstream of Casitas Dam, Santa Ana Creek upstream of Casitas Dam, and Lake Casitas.

Field equipment requiring inspection and decontamination includes equipment associated with wading, scuba, snorkeling and surface supplied air (SSA) activities. The alternative decontamination protocols adopted are specified in Attachment B hereto - Bureau of Reclamation Technical Memorandum No. 86-68220-07-05, entitled "Inspection and Cleaning Manual for Equipment and Vehicles to Prevent the Spread of Invasive Species" (2012 Edition).

Field staff may also apply 100% vinegar in a 20 minute dip bath or apply a 200 ppm chlorine bleach solution with a 10 minute contact time to achieve the decontamination of field equipment. The field personnel are cautioned, with the application of vinegar or chlorine, to thoroughly flush the field equipment with clean water. Residual vinegar or chlorine is unhealthful to breathe.

Waders and wading boots are a likely vector for transmission of invasive species, extra precautions are to be taken with boots. In addition to cleaning and washing, waders and wading boots are to be soaked in a saltwater bath for a minimum of 30 minutes. After soaking, the waders and wading boots are to be rinsed with freshwater. Snorkel gear is generally used one day per month to conduct surveys. All snorkel gear is to be cleaned with a mild detergent and rinsed with tap water. Generally this gear is dried for 35 days or more before the next survey.

A California Department of Fish and Wildlife (CDFW) study, Hosea and Finlayson 2005, found that bleach had deleterious effects on waders and wading boots. In addition, CDFW found bleach is ineffective for decontamination of New Zealand Mud Snail. NZMS has been observed in the Santa Clara River and in several streams in the Santa Monica Mountains. NZMS has been found to have a negative impact on trout.

Field staff shall document the application of the alternative decontamination protocol for each field equipment, date and location of field equipment use and date of decontamination being performed. The decontamination documentation shall be formally recorded and controlled by the Casitas Manager who is responsible for the field staff. The documentation shall be readily available for review at any time by the General Manager.

PACIFIC STATES MARINE FISHERIES COMMISSION (PSMFC)

WATERCRAFT INSPECTION TRAINING II (WITII) STANDARDS

AS OF MAY 2015

Area	Pressure	Temperature to Reach Degrees Fahrenheit	Confirm with Infrared Thermometer
Vehicle Rear	Low	120˚	Yes
Trailer Structure, Railings & Spare Tire	High	140˚	Yes
Vessel Hull	High	140˚	Yes
Transom	High	140˚	Yes
Outdrive	High	140˚	Yes
Propeller/Shafts	High	140˚	Yes
Trim Tabs	High	140˚	Yes
Transducers	Low	120˚	Yes
Bilge Plug	High	140˚	Yes
Through Hull Fittings	Low	120˚	Yes
Bait Tank/Live Well/Compartments	Low	120˚	Yes
Bilge	Low	120˚	Yes
Anchor/Fenders & Line	Low	120˚	Yes
Trolling Motor	High	140˚	Yes
Engine	Low	140˚	Yes

Expert from USBR: ATTACHMENT B

Technical Memorandum No. 86-68220-07-05
Inspection and Cleaning Manual for Equipment and Vehicles to Prevent the Spread of Invasive Species
2012 Edition

Page B26 through B29

Inspection and Decontamination Standards for Dive Gear and Related Equipment

In compliance with State and Federal laws, under no circumstances shall Zebra or Quagga mussels (including veliger) be transported away from an infested site. Therefore, all gear exposed to diving water must be treated onsite after the completion of the dive activities. Dive gear is often used in Zebra or Quagga mussel infested waters; therefore, it is vital that the equipment be properly treated using inspection and decontamination standards. Because dive gear is not exposed to Zebra or Quagga mussel infested waters over a long term, adult mussel infestation of dive gear is less of a concern. However, there is higher probability that mussel veliger could become trapped in or attached to dive gear during normal duration dives. Veliger would be invisible to the unaided human eye during visual inspection. Any adult mussels found on dive gear would be easily spotted and must be removed during visual inspection.

Exposed dive gear requiring inspection and decontamination includes equipment associated with scuba, remotely operated vehicle (ROV), and surface supplied air (SSA) activities. This protocol applies to all dive gear used in all water bodies, not just waters thought to be infested.

Do not assume any diving water is uninfested.

When making dives at multiple sites, the known (or most likely) infested site should be the last dive of a multiple dive operation.

Drain water from all equipment before leaving the dive site. Remove all mud and vegetation from your equipment.

Visually inspect all gear for adult mussels attached to or trapped in equipment.

Feel surfaces by hand for rough spots that may indicate attached juvenile mussels.

Four suggested dive gear decontamination methods are listed below for veliger decontamination.

Dive Gear Decontamination Methods

Saltwater Treatment

Use saltwater (sodium chloride) as described below. Of these methods, perhaps the most challenging for dive team members to use involves a saltwater decontamination solution. While a saltwater solution is widely accepted in the literature as being very effective in killing Zebra and Quagga mussel veliger, and the solution is easy to prepare and use, disposal of the spent saltwater solution may be complicated by variable disposal requirements from State to State and among local governments.

What might be an acceptable disposal technique for the spent saltwater solution in one locale may not be acceptable in another. Therefore, it is not possible for the manual to discuss every saltwater disposal requirement that divers might encounter. If the saltwater decontamination method is selected, the dive team coordinator is advised to contact the environmental staff at the responsible field or area office. Advance contact with the environmental staff is highly recommended since discussion with other agencies may become necessary. It is preferable, when possible and if allowed by the local treatment plant authority, that the saltwater decontamination solution be disposed of into a domestic sewer drain. In remote locations with no reasonable access to domestic sewer drains, dispose of the spent saltwater solution on the ground near to the infested water body, or to another ground location recommended by the environmental staff or local facility manager.

Dedicated Equipment

The dive team would purchase and use a separate set of dive equipment dedicated for work in known infested water bodies only. Instead of purchasing extra dive equipment for all divers on the team, the dive

team would select a limited number of divers with experience in performing Zebra and Quagga mussel inspection.

Quarantine

All exposed dive equipment must be contained (kept separated from other dive gear in bags, etc.) and then thoroughly dried in storage before using again. This would prohibit diving with possibly contaminated dive equipment for a minimum quarantine period of time based on storage humidity. This is more easily accomplished when a separate dedicated set of dive gear is purchased for the diving in infested waters only.

Cold Temperature

Freezing is a possible option in some places because many Reclamation facility locations are at high altitude and dive operations are conducted year round. When outdoor air temperature is below freezing, drain excess water from dive equipment and leave it outside overnight, or use a refrigerated freezer system, allowing equipment to freeze. Freezing is appropriate for dive equipment that does not contain water and does not break, such as dive suits, fins and gloves, etc. Ensure that freeze time is adequate for a complete freeze. Use caution with dive gear that could hold water, such as valves or hoses, because expanding water may damage equipment. Make sure all components are completely free of water before freezing, or use a different treatment method.

Notes on Saltwater Decontamination Treatment: Except for ROV, SSA, and other equipment as noted, the decontamination protocol below uses a desirable decontamination water temperature of 104 F for greater efficacy. However, heated water may not be available at remote locations when decontamination of dive gear is necessary. Therefore, decontamination of dive gear in the field using a cold saltwater solution is the recommended minimum treatment option. Zebra and Quagga mussel veliger are far more susceptible to salinity than adult mussels. Kilgour and Keppel (1993) recorded acute toxicity for Zebra mussel veliger at 4.5 parts per thousand (ppt) (or 0.45 percent) salinity. Mixing the saltwater decontamination solution at the rate of ½ cup of table salt per gallon of water approximates the salinity of seawater at 35 ppt (or 3.5 percent) salinity. The salinity of this solution is almost eight times more concentrated than the acute toxicity of 4.5 ppt noted.

Do not use a chlorine decontamination solution. Chlorine is not safe for dive gear decontamination due to a risk of residual chlorine gas inhalation through the regulator. It is also possible that chlorine could damage glue and other materials associated with diving gear from repeated chlorine washing. Equipment failure during diving may be hazardous to the diver. The use of normal chlorinated tap water (e.g., drinking water) to prepare the saline decontamination solution does not pose a chlorine risk to the diver.

Notes on Desiccation and Drying Time: Drying dive gear between dives is important, but the Reclamation dive team is often tasked to dive multiple locations over several days, making equipment drying difficult. Follow an accepted decontamination method and, whenever possible, allow dive gear to dry completely between dives. When used alone, drying is capable of killing mussels, but drying time effectiveness varies widely according to the mussel life stage, month of the year, location, and relative humidity; therefore, no single drying time estimate can ensure a complete kill for all situations, unless a set maximum time is used. Zebra and Quagga mussel veliger are far more sensitive to desiccation than are adults. Although developed for adult mussels, as a guide, refer to the 100th Meridian *Quarantine Estimator* drying schedule at the following Web site: http://www.100thmeridian.org/Emersion.asp (100th Meridian Initiative, 2011).

Inspection and Saltwater Decontamination Protocol for Dive Gear

Flashlights, weight belt, mask, snorkel, fins, notepad, hood, gloves, regulator, buoyancy control device (BCD), etc.

1. Visually inspect inside of pockets. Scrub all surfaces with a brush as required to remove foreign material.

2. Carefully inspect the inside of BCD.

3. Soak all dive gear in saltwater. If available onsite, use hot water (104 F) to prepare the decontamination saline solution. Note that water temperatures greater than 104 F may shorten the life of dive gear due to

glue or plastic failure. A failure in the equipment, at the seams of a wet suit for example, may be hazardous to the diver. Use a salt concentration of ½ cup commercial table salt per gallon of water.

4. Soak gear ½ hour, rinse with non-infested fresh water. Allow gear to dry completely prior to next use.

For Dry Suit:
1. Visually inspect inside of pockets and bottom of boots.

2. Close off valve, wrist, and neck openings of dry suit. Prepare and use the saltwater solution as described above. Immerse in saltwater for ½ hour.

3. Rinse with non-infested fresh water. Carefully inspect valves and zippers to prevent salt corrosion.

4. Allow to dry completely prior to next use.

Appendix A.2 - Tamperproof Tag Policy

CASITAS MUNICIPAL WATER DISTRICT
LAKE CASITAS RECREATION AREA
VESSEL QUARANTINE, RE-ENTRY, TEMPORARY STORAGE AND
TAMPER-PROOF TAG PROGRAMS

Date Issued: 4/3/08 Effective Date: 4/3/08

Park Services Officer Approval: Brent Doan Date: 4/3/08

Revision #1 Effective 12/17/08 PSO Approval: Brent Doan

Revision #2 Effective 2/12/14 Manager Approval: Carol Belser

THESE PROGRAMS ARE NOT AVAILABLE FOR
SKI BOATS WITH INTERNAL BLADDERS OR FLOAT TUBES.

Programs have been developed for quarantine procedures, tamper-proof cables and tags and provision for existing trailer storage and boat slip customers to remove their vessels from the park for servicing and return at a later date, and accommodate customers who do not have trailer storage spaces or boat slips.

A. **INSPECTION**

1. The customer must schedule a boat inspection appointment with either a Park Services Officer (PSO) or an Associate Park Services Officer (APSO). No other staff are authorized to conduct vessel inspections.

2. The customer must be informed that if temporary, long-term storage (other than in the Trailer Storage Area) is being requested, the customer will be required to sign a Self-Service Storage Facility Rental Agreement & Addendum and must provide current copies of the vessel and trailer registrations and driver's license.

3. The inspection will be conducted by a PSO or APSO only in accordance with the attached policy entitled "Policies & Procedures for Vessel Inspection for Quagga Mussels". If the vessel passes inspection the vessel will continue with the 35-Day Quarantine Process described in B below. If the vessel does not pass, the customer's name and state boating identification number will be placed on the 7-day wait list. The vessel may be re-inspected at the end of the 7-day wait period, i.e. the same weekday of the following calendar week, and if it passes will be subject to the 35-day quarantine process described below before being allowed to launch.

B. **35-DAY QUARANTINE PROCESS**

1. If the customer has been assigned a dry storage space (Trailer Storage Area):

   (a) Verify that the vessel has a current annual boat permit.
   (b) Enter release date in log book.
   (c) Escort the customer to his/her assigned space.
   (d) Secure vessel by using one (1) or more of the following methods:
      (i) Place tongue lock or cuff (boot) provided by Casitas over the tongue of the trailer.
      (ii) Affix a customer or Casitas owned Tamper-Proof cable on the vessel and secure with a Casitas provided lock.
      (iii) Affix a Casitas provided lock to secure canoe/kayak to rack or trailer as applicable.
   (e) Advise customer to retain a copy of the Vessel Acknowledgement sheet containing the quarantine expiration date.

2. If the customer has an assigned Boat Rental slip:

(a) Verify that the vessel has a current annual boat permit.
(b) Enter release date in log book.
(c) Escort the customer to his/her designated quarantine space.
(d) Secure vessel by using one (1) or more of the following methods:
(i) Place tongue lock or cuff (boot) provided by Casitas over the tongue of the trailer.
(ii) Affix a Tamper-Proof cable and lock and secure with a Casitas provided lock.
(iii) Affix a Casitas provided lock to secure canoe/kayak to rack or trailer as applicable.
(e) Advise customer to retain a copy of the Vessel Acknowledgement sheet containing the quarantine expiration date.

3. If the customer **declines** to participate in the Tamper-Proof Tag Program and is completing the 35-Day Quarantine period inside the park:

(a) Direct the customer's attention to the disclaimer for temporary quarantine parking on the signed Vessel Survey.

(b) Enter release date in log book.

(c) Escort the customer to the designated space.

(d) Secure vessel by using one (1) or more of the following methods:

(i) Place tongue lock or cuff (boot) provided by Casitas over the tongue of the trailer.
(ii) Affix a Tamper-Proof cable and lock and secure with a Casitas provided lock.

(e) Advise customer to retain a copy of the inspection sheet containing the quarantine expiration date.

(f) Upon completion of the thirty-five (35) day quarantine collect applicable fees (e.g. day use or overnight boat, etc.).

4. The customer may complete the 35-Day Quarantine Process out of the park by participating in the applicable sections of the Tamper-Proof Tag Program described in B below.

5. At the end of the quarantine period, staff will remove the lock or cuff (boot). It is the responsibility of customers to immediately remove their vessels from the quarantine area. Any vessel left in the quarantine area longer than fifteen (15) days after release will be removed by Casitas and stored at the owner's sole cost and expense.

C. TAMPER-PROOF TAG PROGRAM

The purpose of this policy and procedure is to guarantee that vessels that enter and leave periodically have not been in any infected waters. This will be accomplished by installing a tamper-proof cable, padlock, and a tamper-proof security tag. The tamper-proof cable must be attached to both the vessel and the trailer. The connection points must be in a location that prevents a part of the vessel or trailer from being removed without damaging the cable or tamper-proof security tag.

1. All vessels are subject to a 35-day Quarantine period which may be completed inside or outside the park.

2. The customer will schedule an appointment with a Park Services Officer or Assistant Park Services Officer in order to be considered for the Tamper-Proof Tag Program. If eligible for the program, a boat inspection will be performed.

3. The inspection will be conducted by a Park Services Officer or Associate Park Services Officer only in accordance with the attached policy.

(a) If the vessel passes inspection it will continue with the Tamper-Proof Tag Program Process. Advise the customer to retain a copy of the Vessel Acknowledgement sheet containing the quarantine expiration date.

(b) If the vessel does not pass, the customer's name will be placed on the 7-day wait list. The vessel will not be eligible for re-inspection for a minimum of seven (7) days i.e. the same weekday of the following calendar week.

4. For Vessels Completing the Thirty-Five (35)-Day Quarantine Period Outside the Park

(a) Inform the vessel owner/operator that a security kit must be purchased. Inform the vessel owner/operator that the kit consists of a weatherproof tamper-proof steel cable, weather resistant padlock and a tamper-proof tag. Review the connection point areas with the vessel owner/operator and explain why these locations have been chosen.

(b) The vessel owner/operator shall install the equipment as needed. The connection points must be verified and relocated by the owner/operator if necessary.

(c) Install the tamper-proof security seal as required and fill out the Tamper Proof Tag Program Log. Make sure the vessel owner/operator verifies the tamper-proof security number and cable number and signs the Tamper Proof Tag Program Log. Explain to the vessel owner/operator that if the weatherproof tamper-proof steel cable and tamper-proof security tag are not in place or damaged in any way upon his/her return, a new inspection and thirty-five (35) day Quarantine period will be required.

(d) Instruct the vessel owner/operator that the vessel has been placed on a 35-Day Quarantine list. Tell them that they may leave the park and return after the 35-day Quarantine period has been completed.

(e) Vessels returning to the park after completing the Tamper-Proof Tag Program will have the weatherproof tamper-proof steel cable and tamper-proof security tag inspected by Staff and the cable and tag numbers verified with the entries in the Log. As long as the tamper-proof security cable and tag are not missing or damaged, the tamper-proof security tag can be removed by specifically designated or authorized Staff and the vessel will be allowed to enter the park and launch. **Special Note: A "Clean & Dry Inspection", will not be required because the vessel and trailer will not have been in any other body of water**. If there is **any** evidence that the weatherproof tamper-proof steel cable or tamper-proof security tag have been compromised, Staff must obtain a second opinion before the vessel is rejected.

(f) If repairs have been made to a vessel and the weatherproof tamper-proof steel cable or tamper-proof security tag have been damaged or removed, the vessel will **start the program over again**.

5. For Vessels Completing the 35-Day Quarantine Period Inside the Park Without Participating in the Tamper-Proof Tag Program

Any vessel returning to the park without participating in the Tamper-Proof Tag Program will start the inspection and 35-Day Quarantine period over again.

Appendix A.3 - Vessel Inspection Form

CASITAS MUNICIPAL WATER DISTRICT
POLICIES & PROCEDURES FOR VESSEL INSPECTION FOR INVASIVE SPECIES
LAKE CASITAS RECREATION AREA

Date Issued: __February 1, 2008_____ Effective Date: ____February 1, 2008_____

Park Services Manager Approval:_____B. Roney_____ Date: ____2/1/08_____

Revision #1 Effective ___2/12/14___ Manager Approval: _____Carol Belser_____

1. **Policies & Procedures**

The policies and procedures in this document are for inspection criteria for vessels entering the Lake Casitas Recreation Area. These policies and procedures are to ensure that invasive species do not enter Lake Casitas and impact treatment infrastructure and threaten the lake's ecosystem.

In order to be consistent with policies, procedures and training, the Lake Casitas Recreation Area Vessel Inspection Checklist will be used on all vessel inspections. This document outlines the process that staff must complete before a vessel of any kind is authorized to enter the Lake Casitas Recreation Area. The Vessel Inspection Checklist is a check off sheet outlining aspects of this policies and procedures document. Each step in the Vessel Inspection Checklist has specific expectations associated with it and will only be conducted by fully trained staff.

Lake Casitas Recreation Area staff will follow a zero tolerance policy for inspection criteria. If at any time during an inspection a vessel fails a step on the Vessel Inspection Checklist, the vessel will fail the inspection process and a re-inspection will need to be scheduled. The re-inspection will be scheduled no sooner than seven (7) days, i.e. the same weekday of the following calendar week. Upon passing a re-inspection, the vessel will be quarantined for thirty-five (35) days.

At the discretion of Casitas Municipal Water District, vessels may be subject to random bilge water test that will examine water microscopically.

Vessel Inspection Checklist

(a) The owner/operator is to be informed that an inspection will be performed and that Casitas has a zero tolerance policy for any water, including condensation, debris, or growth found on any vessel, trailer or towing vehicle due to possible transportation of invasive species by vessels and trailers.

(b) Staff will write the state boating identification number and owner/operator's name and date on the Vessel Inspection Checklist.

(c) Staff will check the Casitas generated database of vessels that have previously been denied access due to inspection issues. A re-inspection cannot be performed until the due date.

(d) Customer will fill out and sign the "Vessel Quarantine, Re-Entry, Temporary Storage and Tamper-Proof Tag Acknowledgement" (Acknowledgement) in staff's presence. Customer is voluntarily signing the Vessel Acknowledgement under penalty of perjury. After the customer signs the Vessel Acknowledgement, he/she will be given the bottom yellow carbon copy of the Vessel Acknowledgement form.

(e) Staff has been directed to provide educational materials to the boating community and general public. Two handouts are given to each vessel operator/owner upon first entry to the park and in general as new information becomes available as follows:

(1) Casitas flyer entitled "Take Action to Save Our Lakes from Quagga Mussels".
(2) Department of Fish & Wildlife flyer entitled "Don't Move A Mussel".

(f) Staff will request the owner/operator of the vessel to open all compartments.

(g) The vessel, trailer and vehicle inspection will include looking for moisture, water, debris including but not limited to: mud, weeds, sand/pebbles or growth on or in any inspected area. Surfaces will also be touched to see if growth or mussels may be attached. The inspection will be completed the same way each time starting at one side of the vehicle, vessel and trailer and ending at the other side. Checking the "Yes" box indicates that the inspected material is dry and clear of debris. If the "No" box is checked the vessel has failed, will be placed on the Casitas 7-day wait list and will not be eligible for re-inspection for seven (7) days.

2. **Areas of Inspection**

The following areas will be inspected by Staff:

(a) **Vehicle Rear**: The vehicle bumper, tailgate or spare tire may have mud, grass, weeds or other debris on it. If there are positive signs of mud, etc., the inspection cannot continue. The vessel may return at a later date for re-inspection, towed by a different vehicle.

(b) **Trailer Structure, Railings and Spare Tire**: The trailer, railings and spare tire may have mud, grass, weeds, debris or standing water. If there are positive signs of mud, etc., the inspection cannot continue. The vessel may return at a later date for re-inspection or on a different trailer that is clean and dry.

(c) **Vessel Hull**: The vessel hull will be inspected for growth and debris. Growth may be visible if ~~it~~ the vessel has been in the water for an extended period of time. Small mussels attached to a vessel can feel like sandpaper or sesame seeds. If a vessel's hull has any type of growth or debris, the vessel will not be eligible for re-inspection for a minimum of seven (7) days and will be placed on the Casitas 7-day wait list.

(d) **Transom**: The transom is at the back of the vessel where the engine is attached. The transom may have several items of importance for inspection that mussels can attach to including the out drive, trim tabs, transducers, bilge plug area and through hull fittings. The transom must be checked to make sure the surface is smooth and visibly clear of all debris and growth. If there are positive signs of growth, etc. the vessel will not be eligible for re-inspection for a minimum of seven (7) days and will be placed on the Casitas 7-day wait list.

(e) **Outdrive**: The outdrive is attached to the transom on stern drive vessels and the lower unit on outboard vessels. It has intricate parts that make it easy for mussels to attach, hide and grow. Staff will feel and look for any signs of growth, debris or texture of sandpaper. If there are positive signs of growth, debris or texture of sandpaper, etc. the vessel will not be eligible for re-inspection for a minimum of seven (7) days and will be placed on the Casitas 7-day wait list.

(f) **Propeller/Shafts**: Mussels can attach and live on or around where the propeller attaches to the lower unit of the drive shaft. Mussels can also attach to the shaft or connecting points of the vessel. These can be hard to see and must be inspected with a flashlight to verify if any mussels, debris or water are present. If there are positive signs of mussels, etc. the vessel will not be eligible for re-inspection for a minimum of seven (7) days and will be placed on the Casitas 7-day wait list.

(g) **Trim Tabs**: Trim tabs are located on the lower portion of the transom and are usually metal plates that help stabilize the vessel while underway. Staff will feel the corners, edges and look on the underside of the trim tabs for debris and growth. If there are positive signs of growth, etc. the vessel will not be eligible for re-inspection for a minimum of seven (7) days and will be placed on the Casitas 7-day wait list.

(h) **Transducers:** These are located on the transom or bottom of the hull near the stern of the vessel. They are used in conjunction with a computer to determine depth, speed and water temperature. Growth or debris can appear on them. If there are positive signs of growth, etc. the vessel will not be eligible for re-inspection for a minimum of seven (7) days and will be placed on the Casitas 7-day wait list.

(i) **Bilge Plug**: If the bilge plug is pulled when the vessel arrives at the lake, there should be no fluid or debris coming from it. Staff will carefully insert fingers in the plug hole to determine if debris is blocking water from exiting. If the bilge plug is not pulled, the owner/operator will be requested to pull the plug. If water exits, the plug

will be reinstalled to prevent additional water from being released. If there are positive signs of growth, etc. the vessel will not be eligible for re-inspection for a minimum of seven (7) days and will be placed on the Casitas 7-day wait list.

(j) **Through Hull Fittings**: Through hull fitting in all boats have the potential to store mussels in the right conditions. To check these fittings, Staff will use a flashlight to look inside and feel for irregularities. If water or debris is observed or felt, the vessel will be eligible for re-inspection for a minimum of seven (7) days and will be placed on the Casitas 7-day wait list.

(k) **Bait Tank/Live Well/Compartments**: Bait tanks, live wells and compartments should be dry and clear of all water and debris. Some compartments do not drain completely due to the way they are manufactured. Any debris in compartments is not acceptable. Common debris often found includes; fish scales, weeds, small pebbles and trash. If it does have positive signs of fish, etc., the vessel will not be eligible for re-inspection for a minimum of seven (7) days and will be placed on the Casitas 7-day wait list.

(l) **Bilge**: The bilge is at the bottom of the inside stern of the vessel. It may not be visible in all boats due to various boat designs. The bilge should be clean from all water and debris. If there are positive signs of water, etc. the vessel will not be eligible for re-inspection for a minimum of seven (7) days and will be placed on the Casitas 7-day wait list.

(m) **Anchor/Fenders and Line**: Anchors can have mud or debris on them. If an anchor, fender and lines attached have been in infested water for an extended period of time then mussels and debris can attach. Staff must check these items for mud, growth and debris. If there are positive signs of mud, etc. the vessel will not be eligible for re-inspection for a minimum of seven (7) days and will be placed on the Casitas 7-day wait list.

(n) **Trolling Motor**: Trolling motors can pick up plants and debris while being used and must be inspected. These items must be checked for mud, growth and debris. If there are positive signs of mud, etc., the vessel will not be eligible for re-inspection for a minimum of seven (7) days and will be placed on the Casitas 7-day wait list.

Denying a customer access to his/her favorite fishing lake can be very frustrating for both customer and staff. The following statement has been developed to help staff inform the customer of the results of his/her vessel's failure of the inspection.

"Your vessel has not cleared the inspection due to water and/or debris in one or more areas. Your vessel will be placed on the 7-day wait list as of today and may return for re-inspection at the end of the 7 days. This zero tolerance policy has been established to protect the reservoir water quality, water distribution system and its ecosystem. Thank you for your cooperation."

The Vessel Inspection Procedures, Vessel Inspection Checklist, Vessel Acknowledgement Forms and Casitas handouts have been developed to ensure proper inspections of vessels, trailers and vehicles to prevent Lake Casitas from becoming infested with invasive species. All documents pertaining to the Vessel Inspection Procedures are subject to change due to updated policies at the sole discretion of the District.

Appendix A.4 - Decontamination Checklist

LAKE CASITAS RECREATION AREA

DECONTAMINATION CHECKLIST

CF #: _____ Owner/Operator (Print Name) _____

- ☐ Computer check to see if vessel has been previously denied entry.
- ☐ Completed Vessel Acknowledgement. Have owner/operator complete and sign form.
- ☐ Remove all equipment from the vessel to insure easy access for decontamination.
- ☐ Request vessel owner to open all compartments and have the bilge plug pulled.
- ☐ Select an appropriate location to insure waste water from decontamination does not drain into watershed.

Vessel Decontamination: Decontaminate Vessel to current WIT standards using hot water wash.

Hot Water Wash Vessel Locations at the Following Temperatures: Check appropriate box below.

Yes	No	
☐	☐	Any equipment making contact with waterway (120˚ F with low pressure).
☐	☐	Trailer structure, railings, spare tire (140˚ F with low to high pressure).
☐	☐	Vessel hull (140˚ F on low to high pressure).
☐	☐	Transom (140˚ F on low to high pressure).
☐	☐	Outdrive (140˚ F on low to high pressure).
☐	☐	Prop/shafts (propeller on the engine) (140˚ F on low to high pressure).
☐	☐	Trim tabs (140˚ F on low to high pressure).
☐	☐	Transducers (140˚ F on low pressure).
☐	☐	Bilge plug pulled (120˚ on low pressure).
☐	☐	Through hull fittings (120˚ on low pressure).
☐	☐	Bait tank/live wells/compartments (120˚ on low pressure).
☐	☐	Bilge (may not be visible) (120˚ on low pressure).
☐	☐	Anchor/fenders and line (120˚ on low pressure).
☐	☐	Trolling Motor (120˚ on low pressure).

☐ Your vessel has not cleared the Decontamination process due to inability to remove ANS. A zero tolerance policy has been established to ensure the safety of Lake Casitas water quality and its ecosystem. Thank you for understanding in this matter.

☐ You may enter the Lake Casitas Recreation Area on the date indicated on the Vessel Acknowledgement. Thank you for your cooperation.

Appendix A.5 - Vessel Decontamination Checklist

LAKE CASITAS RECREATION AREA - VESSEL INSPECTION CHECKLIST

CF #: _____ Owner/Operator (Print Name) _____

- ☐ Computer check to see if vessel has been previously denied entry.
- ☐ Completed Vessel Acknowledgement. Have owner/operator complete and sign form.
- ☐ Informational handouts "Take Action to Save Our Lakes" and "Don't Move a Mussel" flyers given.
- ☐ Request vessel owner to open all compartments and have the bilge plug pulled.
- ☐ Inform owner/operator that Casitas has a no tolerance policy for any water, debris or growth found on any vessel due to possible transportation of invasive species by vessels and trailers.

Vessel Inspection: Check for **WATER, DEBRIS** or **GROWTH** and check all smooth surfaces for **"SANDPAPER"** feel.

Clear of Water, Debris and/or Growth: Check appropriate box below.

Yes	**No**	
☐	☐	Vehicle rear
☐	☐	Trailer structure, railings, spare tire
☐	☐	Vessel hull
☐	☐	Transom
☐	☐	Outdrive
☐	☐	Prop/shafts (propeller on the engine)
☐	☐	Trim tabs (located on back of hull near engine. Not all vessels have them)
☐	☐	Transducers
☐	☐	Bilge plug pulled – no fluid or debris
☐	☐	Through hull fittings
☐	☐	Bait tank/live wells/compartments
☐	☐	Bilge (may not be visible)
☐	☐	Anchor/fenders and line
☐	☐	Trolling Motor

☐ Your vessel has not cleared the inspection due to water and or debris in one or more areas. A re-inspection will need to be scheduled with staff. The re-inspection will be scheduled no sooner than seven (7) days, meaning the same weekday of today's date next calendar week. This zero tolerance has been established to ensure the safety of Lake Casitas water quality and its ecosystem. Thank you for understanding in this matter.

☐ You may enter the Lake Casitas Recreation Area on the date indicated on the Vessel Acknowledgement. Thank you for your cooperation.

APPENDIX B

Mussel Control Options for Fish Stocking

Aquatic Invasive Species Monitoring at CDFW Hatcheries
California Department of Fish and Game - October 2014

1. Invasive Species

"Invasive species" are defined as plants or animals that cause environmental or economic harm, or harm to human health. Invasive species tend to be adaptable to new environments and multiply quickly. It is difficult to predict where an invasion will occur, which species may invade, or the consequences of their invasion; therefore, to protect facilities and the environment it is necessary to monitor for invasive species so that if an invasion does occur, efforts can be made quickly to prevent their spread within an area and to adjacent areas.

Invasive species threaten the diversity and abundance of native and desirable non- native species through competition for resources, predation, parasitism, hybridization, transmission of diseases, and/or causing physical or chemical changes to the environment. Invasive species also threaten man-made systems and structures, including water delivery and flood protection systems, agriculture, and developed lands.

Invasive species are commonly introduced into new areas as a result of human activities. Natural barriers, such as mountains, oceans, etc., historically confined species to their native range. Commerce and the advent of travel between remote locations has circumvented natural barriers, and trains, planes, ships, and vehicles are capable of transporting organisms great distances, often unknowingly and unintentionally. Hatchery activities have the potential to spread invasive species to new waterbodies, as well as between waterbodies, when stocking fish.

Invasive species in hatcheries pose a number of concerns. First, they may become established within a hatchery and impact operations, including clogging pipes, aeration devices, screens, and encrusting equipment, necessitating added maintenance. Second, they may be spread to other hatcheries and/or into the environment along with transferred or planted fish. Alternatively, invasive species may not directly impact operations at a hatchery, and thus go unnoticed, or pass through a hatchery in its source water. Both of these situations present the opportunity for hatchery activities to move invasive species to new environments in transport water, and therefore must also be addressed.

This protocol is limited to monitoring for aquatic invasive species (AIS); however, it is recommended that precautions to prevent the spread of terrestrial invasive species also be taken. This protocol does not address fish health issues or disease prevention. Monitoring for AIS is a component of a comprehensive Hazard Analysis- Critical Control Point (HACCP) Plan, which identifies pathways and preventatives for the introduction of AIS into a hatchery, the spread of AIS within a hatchery, and the release of AIS from a hatchery.

2. Sources of Aquatic Invasive Species

Many hatcheries use surface water for operation. Surface waters are susceptible to AIS contamination, particularly if accessible for recreation (boating, fishing, etc.).
Most of CDFW's anadromous mitigation hatcheries are located below dams and use water directly from an impounded reservoir that allows recreational access. Other hatcheries are located further down-river from reservoirs, or on rivers where recreation occurs, and are also at risk of AIS contamination. Well water pumped directly into a hatchery is at very low risk of being contaminated with AIS.

Other potential pathways for the introduction of AIS into a hatchery include the importation of eggs or fish, or by picking up an AIS on equipment or vehicles in the course of planting fish. These pathways, and all others, should be addressed in a comprehensive HACCP Plan.

3. Aquatic Invasive Species of Concern and Aids to Their Identification

AIS believed to pose the greatest threat to California's hatcheries and the environment are Quagga mussel, Zebra mussel, and New Zealand mudsnail, and the monitoring methods described herein are specific for these three species. Other AIS of concern, including channeled apple snail, Brazilian waterweed, Eurasian watermilfoil, Hydrilla, and the algae Didymosphenia geminata (also known as didymo or rock snot), are described on page 52 and should be reported if found. Refer to page 52 for species descriptions, suitable environmental conditions, known range, and photos to assist in their identification.

(a) Quagga Mussel and Zebra Mussel – (Dreissena bugensis and Dreissena polymorpha)

Quagga and Zebra mussels are separate species, but look very similar. The following description applies to both species. These freshwater mussels produce microscopic, free-floating larvae. The larvae eventually settle on surfaces and turn into the shelled adult form.

(1) Species Description

Body form – Juveniles and adults are 2-shelled (bivalve); may have dark colored "threads" on one edge. Larval life-stage is microscopic and cannot be seen by the unaided eye.

Size – Range in size from microscopic to up to 2" long; free-floating (planktonic) larvae are microscopic.

Color – Shells usually have alternating light and dark brown stripes, but can also be solid light brown to dark brown.

(2) Suitable Environmental Conditions

Temperature – Survives in water temperatures between 32° F and 88° F.

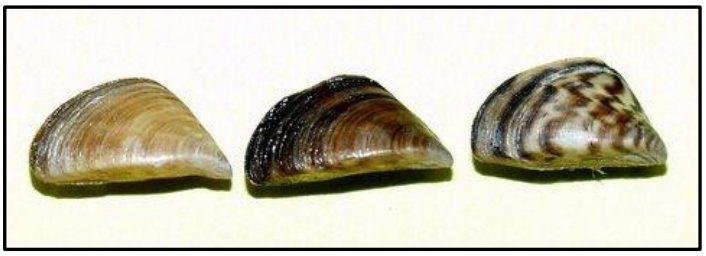
Moisture – Aquatic, but can survive out of water for weeks under suitable conditions (longest at low temperatures and high humidity).

Substrate – Usually attached to soft and hard surfaces, including aquatic plants, but also known to detach from surfaces and crawl or be carried by water. Small, newly settled mussels feel like gritty sandpaper when attached to a smooth surface. Larger mussels may feel coarser, like a small pebble or sunflower seed. Mussels often adhere to surfaces firmly and when lightly touched may rock back and forth.

Known occurrences in California – San Bernardino, Riverside, San Diego, Imperial, Orange, and San Benito Counties. For current known locations visit http://nas.er.usgs.gov/taxgroup/mollusks/zebramussel/maps/CaliforniaDreissenaMap.jpg.

(3) Key Features for Identification

Quagga and Zebra mussels are not the only freshwater bivalve found in California, however they are the only freshwater bivalves that attach to surfaces. In the absence of attachment, a combination of characteristics including their alternating bands of color and evidence of "threads" can be used to identify.



Size and color variation in mussels

Quagga mussel showing 'threads'

(b) New Zealand Mudsnail – (*Potamopyrgus antipodarum)*

Small, fresh to brackish water aquatic snail that can be easily overlooked because it often blends in with its surroundings. New Zealand mudsnails are self-reproducing and give birth to live offspring, therefore a single snail can create a population.

(1) Species Description

Body form – Single shell that is elongated and spiraled, when fully grown having 5-7 spirals.
Size – From microscopic up to ¼" long. Color – Variable; light to dark brown in color.

(2) Suitable Environmental Conditions

Temperature – Survives in waters between 32° F and 83° F.
Moisture – Aquatic, but can survive for weeks under suitable temperatures and humidity.
Substrate – Soft (mud, silt, plants, etc.) and hard substrates. Also capable of detaching and floating in the water.
Known occurrences in California – For current known locations visit http://nas.er.usgs.gov/queries/collectioninfo.aspx?SpeciesID=1008.

(3) Key Features for Identification

A key feature of live New Zealand mudsnails is the presence of an operculum (flap covering the shell opening). New Zealand mudsnails require expertise to accurately identify. Any snail ¼" or less should be forwarded for identification (see page 46).

Dead New Zealand mudsnail on metric ruler (5 millimeters =~¼") Operculum often absent in dead specimens.

Live New Zealand mudsnail showing operculum and spirals, numbered 1-5.

Dense colony of New Zealand mudsnails attached to the underside of a rock

4. Monitoring for Quagga and Zebra Mussels and New Zealand Mudsnail

(a) General Guidelines

Early detection monitoring concentrates efforts on areas where AIS are most likely to be found, rather than by randomly sampling. Attention should be directed to protected areas, such as crevasses, corners, and edges.

Hatchery personnel should always be on the look-out for unfamiliar plants and animals during daily operations. Current maintenance-intensive hatchery operations provide considerable opportunity to watch for AIS. Intensive maintenance could, however, inhibit the detection of AIS. Routine cleaning may prevent organisms from attaching to surfaces, becoming established, growing large enough to detect, or keep them at such low densities that they remain undetected.

In addition to watching for AIS during routine operations, hatcheries must inspect their facilities quarterly for AIS. Inspections provide only a snapshot in time, and do not guarantee that a facility is AIS-free. Increasing the frequency of inspections and using a variety of methods will improve the likelihood that an AIS is detected. In addition, monitoring may be useful in identifying the point of AIS introduction, should an infestation occur.

Because each AIS is different, no one method is effective for detecting all species. A combination of methods, including specialized sampling devices and examination of existing surfaces, is necessary. Monitoring methods and specific directions, as well as procedures for documenting and reporting monitoring, are provided below.

(b) Monitoring Source Water and Outflow

A means for continuous monitoring of non-well water entering the hatchery is necessary. Detecting AIS in water coming into a hatchery can exclude hatchery activities as the source of an AIS infestation. A portion of the inflow is routed into a flow-through system, referred to as a "biobox", designed to provide a suitable

environment for some AIS species, making their detection possible. In addition, hatchery staff should examine debris, including plants, entrained on intake screens and trash-racks for AIS. If it is not feasible to use a biobox at the inflow, then artificial substrates must be deployed near the water intake.

Because hatchery water is released into the environment untreated, AIS may be released as well. Monitoring hatchery outflow samples all the water passing through the hatchery, and is the final opportunity to detect AIS. Outflow monitoring can be achieved using either a biobox, artificial substrates and surface survey for depths three feet and greater, or surface survey for depths less than three feet.

Bioboxes

This method is suitable for detection of Quagga mussels, Zebra mussels and New Zealand Mudsnails

Bioboxes are flow-through aquaria, designed specifically to sample for the larval/settlement stage of Quagga mussels, Zebra mussels and New Zealand mudsnails. Microscopic larvae are suspended in the water, and upon reaching settlement stage, attach to surfaces. The biobox provides suitable conditions (surface and flow) for this to occur. Flow rates greater than 5 feet/sec inhibit mussel and mudsnail settlement, so a flow-through system must not exceed this velocity.

(1) Location(s) - If using bioboxes, one will be installed where raw water enters the facility and, if feasible, at each (if more than one) hatchery outflow, prior to discharge. Bioboxes are not needed on water drawn directly from a well. Bioboxes should be placed on a stable surface adequate to support its weight. If the water temperature inside the biobox is more than 2° F above the hatchery water temperature then the biobox must be shaded. Bioboxes should be located in areas that will not be damaged by water if the box were to overflow. Individual hatcheries may need to modify the Biobox during installment to adequately meet all flow and temperature requirements. There may also be infrastructure modifications needed to connect the Biobox to individual hatcheries inflow and outflow water supply.

(2) Monitoring Frequency - Bioboxes should be checked as needed to ensure they are operating correctly and maintaining the appropriate flow rate. A visual and tactile (touch) examination is conducted quarterly.

(3) Requirements for Biobox Design

- Minimum internal volume of 12 gallons
- Flow rate of 1.32 gallons/minute

The following design specifications meet the biobox requirements, above.

Biobox Construction and Assembly (Figure 1)
(Designed by Jody Rightmier, CDFW Yreka Screen Shop)

Biobox Materials Parts Listing (Material To Cover Single Box)

1” PVC ball valve female threaded ends, quarter turn design	1 each
Nipple TBE SCH 80 1” x close PVC	1 each
1” PVC 90 degree elbow slip x slip SCH 40	1 each
1” pipe x MIPT PVC insert male adapter	2 each
1’ PVC tank adapter SOCXFPT NPRN gasket	2 each
1’ x 2” (length) SCH 40 PVC pipe	1 each
22 x 17 x 12” grey bins and divider box	1 each
Snap F/DC3000 bins & divider box cover	1 each
Short divider F/DC3080 (sold in 6 pack). Bins & divider box	3 each/box
ER308L 3/32 x 36” TIG welding rod	1 each
1/2 " bolt size medium flat washer 18-8 stainless/steel	6 each

The plates slide down into “channel guides” on either side of the interior walls of the box (Figure 2) and water flows over and under the plates as it passes through the box. Plates are kept submerged with stainless steel wire and washers that allow for removal when inspecting the plates. Flow into the box is regulated by a valve on the incoming water line. The outlet is an overflow pipe that ensures the water level in the box remains at a constant level. All interior surfaces and plates are roughed up with fine (150-180 grit) sandpaper to maximize suitability for settlement.

Figure 2. Interior view of biobox plates that provide suitable surfaces for mussel and mudsnail settlement.

(4) Monitoring Procedure - To inspect biobox, begin by closing the inflow valve. One at a time, carefully remove each plate. Do not set the plates down as small or delicate organisms could be crushed. Hold the plate over a separate container to catch any dislodged organisms, and visually inspect it. Use a magnifying glass if necessary. Next, gently run fingers over the plates to feel for any organisms. Very small Quagga or Zebra mussels may be more easily felt than seen. Do not leave the plates out of the water so long that they dry; examine and return to the water immediately if no suspect organisms are found. When finished with the first plate, reinsert it and inspect the remaining plates the same way. Also examine the inner walls of the biobox. If walls are transparent, look in from the outside. If not, view from above. Next, gently run fingers over the walls as with the plates. When finished, open the valve to resume appropriate flow.

Artificial Substrates

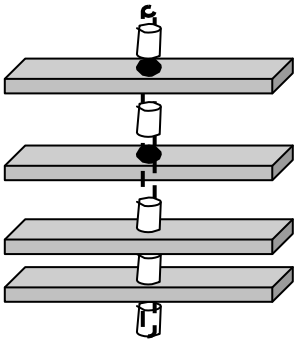
This method is suitable for detection of Quagga and Zebra mussels

If it is not feasible to use a biobox at the inflow or outflow, then artificial substrates must be deployed.

1.2 ARTIFICIAL SUBSTRATE MATERIALS PARTS LISTING: material to cover single substrate

6" x 6" x 0.25" black/grey PVC with 1" hole through center 4
1.5" x 1.375" (35mm) exterior diameter PVC or ABS tube..... 5
8.5" x 0.8125" (21 mm) exterior diameter PVC or ABS tube.....1
~25 feet plastic coated cable or rope
Some form of attachment to keep plates from floating up
Weight
Laminated label with your contact information

To assemble the substrate, run the cable or rope through the 8.5" tube and secure at one end. From the loose end of the rope string on the remaining pieces, alternating between the short segments of tube and the plates, beginning and ending with the short tubes (see figure). Secure the top tube to the rope to prevent the pieces from floating up. If necessary, attach a weight to the bottom of the assembly. Attach the label to the cable where the cable is secured to the structure.



California Department of Fish and Game

Biological Research

PLEASE DO NOT DISTURB

(1) Deployment of the Artificial Substrates - Depending on water clarity and depth, the artificial substrate should be set below the euphotic zone (below the depth of light penetration) or 6 feet, whichever is deeper, and at least two few feet above the bottom. One to two substrates are deployed per site. If the site is shallower than 2 m, then raise the substrate about 0.5 m (2 feet) off of the bottom. Record the actual sampling depth. At sites that are deep and have little vertical mixing, a second substrate is installed at a depth of approximately 15 meters (50 feet) below the surface (or 1 meter off the bottom if the depth is less than 15 meters).

(2) Monitoring Procedure - To check an artificial substrate, first carefully lift it out of the water and place it in a large plastic tub (the tub will capture any mussels that fall off). Avoid knocking the substrate as you pull it out of the water because you may dislodge or crush any attached mussels. First visually inspect each plate (top, bottom, and sides), the spacers, the cable and the weight. Use a magnifying glass if necessary. Next, gently run fingers over the plates to feel for any organisms. Very small Quagga or Zebra mussels may be more easily felt than seen. After looking closely, attempt to gently push any attached organism that might be a mussel. Freshwater limpets and snails easily move or slide across the plate. Zebra and Quagga mussels stick in place or are more securely attached. In all cases, if in doubt, bag it.

If no mussels are detected, lower the substrate back into the water. Zebra and Quagga mussels are more likely to attach to a substrate that has some algal growth, however if the substrate becomes too heavily coated it may be unsuitable for mussel settlement. As necessary, gently remove heavy accumulations of algae to maintain suitable conditions for settlement.

Monitoring In-Hatchery and Outflow

In addition to monitoring at the inflow and outflows, surface surveys must be conducted within the hatchery facilities and outflows if a biobox is not used.

Surface Surveys

This method is suitable for detection of Quagga and Zebra Mussels and New Zealand Mudsnail

When areas are dewatered during hatchery operations, surfaces must be inspected for AIS. Many AIS blend in with their surroundings and prefer sheltered areas, so close inspection is necessary and most easily conducted when dewatered. In addition, surfaces and structures within the hatchery must be inspected quarterly.
Specific instruction on how to inspect surfaces is provided below.

(1) Locations and Frequency - Inspect 5% of dewatered surfaces as dewatering occurs. In addition, inspect 5% of surfaces throughout the facility each quarter. For example, if there are ten raceways, inspect the safely accessible surfaces equivalent to one-half of a raceway (10 raceways x 0.05 = 0.5 raceways), divided among the ten raceways. Spreading the 5% over all of the raceways increases the chance of finding an AIS if it is in the facility.

The 5% applies to surfaces, outflow settling ponds (if applicable) as well as equipment such as screens, tubing, lines, etc. As with all forms of early detection monitoring, the more you look, the more likely you are to find something if it is there. Always err on exceeding the minimum sampling requirement, rather than just meeting it.

If monitoring is conducted outside of secured areas of the hatchery there is greater potential that they are infested with invasive species. Do not allow gear that will be returned to the hatchery (including, but not limited to boots, waders, nets, etc.) to contact the settling ponds. In these cases gear dedicated to this purpose should be used and prominently labeled, and stored separately from other gear. If dedicated gear is not feasible, then gear must be decontaminated after monitoring outside of the hatchery according to the following protocols:

http://www.dfg.ca.gov/invasives/quaggamussel/

(2) Monitoring Procedure - Carefully examine surfaces both visually and tactilely by running fingers over them, with particular attention given to protected areas such as crevasses, corners, and edges, and areas where fish are excluded from. If needed, use a magnifying glass, flashlight, or other aides to thoroughly examine.

Summary of Monitoring Methods and Minimum Monitoring Frequencies

	Biobox	**Surface Survey**	**Artificial Substrates**
Inflow	Quarterly (January, April, July,	N/A	N/A
In hatchery	N/A	Dewatering and 5% Quarterly (January, April, July,	N/A
Outflow	Quarterly (January, April, July,	5% Quarterly (January, April, July,	Quarterly (January, April, July,

(3) Specimen Identification and Collection - If a suspect AIS is detected either during daily operations or monitoring, immediately contact your CDFW Regional AIS Scientist (page 12). To aid their identification, first take a close-up digital photograph of the organism next to a ruler so that there is a size reference. Next, collect the specimen(s) and place in a container where it will not be crushed and add enough 70% ethanol to cover it. Label the sample with hatchery name, location within the hatchery, date, suspected species, and the name of who collected it. If the entire substrate needs to be retained, place the entire unit in a plastic bag. E-mail the photos to the CDFW Regional AIS Scientist and they will try to identify the specimens from the photographs. If they are unable to identify the species from photographs, they may request the specimen(s) or substrate.

(4) Data Recording and Reporting - Quarterly monitoring is to be conducted during the months of January, April, July, and October. Quarterly monitoring datasheets must be completed to document monitoring, and are to be submitted by the end of the month of monitoring. Absence data is as important to document as presence, so complete and submit a datasheet (electronic form provided) even if no AIS are found. Hatcheries are to send an electronic copy of the datasheet to their respective regional Senior Hatchery Supervisor, Regional AIS Scientist, to the Fisheries Branch Fish Production Program Manager and Hatchery Coordinator via email, and retain the originals on-site. All data will be entered into a centralized monitoring database maintained by the Habitat Conservation Planning Branch AIS Program.

5. CDFW Regional Office Contacts for AIS Monitoring

Contact information subject to change. For the most up to date information refer to: http://www.nrm.dfg.ca.gov/FileHandler.ashx?DocumentID=4955.

Region 1 – Northern Region
Counties: Del Norte, Humboldt, Lassen, Mendocino, Modoc, Shasta, Siskiyou, Tehama, and Trinity
601 Locust Street, Redding, CA 96001
L. Breck McAlexander Louis.McAlexander@wildlife.ca.gov Office: (530) 225-2317
Fax: (530) 225-2381

Region 2 – North Central Region
Counties: Alpine, Amador, Butte, Calaveras, Colusa, El Dorado, Glenn, Lake, Nevada, Placer, Plumas, Sacramento, San Joaquin, Sierra, Sutter, Yolo and Yuba
1701 Nimbus Road, Rancho Cordova, CA 95670 Angie Montalvo
Angie.Montalvo@wildlife.ca.gov
Office: (916) 358-2895
Fax: (916) 358-2912

Region 3 – Bay Delta Region
Counties: Alameda, Contra Costa, Marin, Napa, Sacramento, San Mateo, Santa Clara, Santa Cruz, San Francisco, San Joaquin, Solano, Sonoma, and Yolo
7329 Silverado Trail, Napa, CA 94558
Catherine Mandella Catherine.Mandella@wildlife.ca.gov Mobile: (831) 588-1463
Fax: (707) 944-5563

Region 4 – Central Region
Counties: Fresno, Kern, Kings, Madera, Mariposa, Merced, Monterey, San Benito, San Luis Obispo, Stanislaus, Tulare and Tuolumne
1234 E. Shaw Avenue, Fresno, CA 93710
Kelley Aubushon
Kelley.Aubushon@wildlife.ca.gov
Office: (559) 243-4017 X-285
Fax: (559) 243-4004

Region 5 – South Coast Region
Counties: Los Angeles, Orange, San Diego, Santa Barbara and Ventura 4665 Lampson Avenue, Los Alamitos, CA 90720
Eloise Tavares Eloise.Tavares@wildlife.ca.gov
Office: (562) 342-7155
Fax: (562) 342-7153

Region 6 – Inland Deserts Region
Counties: Imperial, Inyo, Mono, Riverside and San Bernardino
P.O. Box 2160, Blythe, CA 92226 David
Vigil David.Vigil@wildlife.ca.gov Office:
(760) 922-4928
Fax: (760) 922-5638

6. Other Aquatic Invasive Species of Concern

The following species are known to occur in California and should be reported if found. Additional species accounts may be added as warranted.

Animals
Channeled apple snail

Plants and algae
Eurasian watermilfoil
Brazilian waterweed or Brazilian elodea Hydrilla
Rock snot or didymo

(a) Channeled Apple Snail – (*Pomacea canaliculata)*

Freshwater aquatic snail. Channeled apple snails leave the water to lay eggs and eat terrestrial vegetation. Eggs hatch and juvenile snails return to the water. Reproduction is dependent on food availability and water temperature, but usually occurs in the early spring and early fall.

(1) Species Description

Body form – Single shell with compact spirals that are deeply indented, hence the common name "channeled". Eggs are reddish in color, and loosely attached to each other in masses of 200-600.
Size – Adult shells can reach up to 3" long, individual eggs are 0.09-0.14" in diameter.
Color – Shell color is yellowish to brown.

(2) Suitable Environmental Conditions

Temperature – Survives in water between 65° F and 90° F.
Moisture – Aquatic, but commonly leaves water to lay eggs and eat. Can survive out of water for several months by closing the opening of its shell and bedding in the soil.
Substrate – Soft (mud, silt, plants, etc.) and hard surfaces.

Known occurrences in California – Lake Miramar, San Diego County, Norton Simon Museum pond, Los Angeles County, and Riverside County near the Salton Sea.

(3) Key Features for Identification

The large size of adult channeled apple snails and their egg masses is unique. Smaller specimens may be identifiable by their round, deeply indented shell.

Adult channeled apple snail shells

Egg masses

Newly hatched (5 day) channeled apple snail.

(b) Eurasian Watermilfoil – (*Myriophyllum spicatum)*

(1) Species Description

Plant – Reddish-brown or whitish-pink
Stems – Branched and 20-30" long, reddish-brown or whitish-pink.
Leaves – Olive green and occasionally reddish tinted and arranged circularly around the stem in groups of 3-6 (usually 4). Each leaf is less than 2" long, soft, and feather-like. Each leaf has a rib and 14-24 or so slender segments on each side of the rib.
Flowers – Individual flowers are reddish, very small, and many together form spikes several inches long that are held above the water.
Roots – Fibrous, often developed on small pieces broken off larger plant.

(2) Suitable Environmental Conditions

Temperature – Able to overwinter in frozen lakes and ponds in northern states and Canada; also able to grow in shallow, over-heated bays.
Moisture – Underwater; often found in water 1½" to 12' deep, and up to 30' in very clear water. Prefer lakes, ponds and slow-moving rivers and streams but can also grow in fast-moving water. Tolerates a wide range of water conditions, including spring water and even brackish water of tidal creeks and bays with salinity of up to 10 parts per thousand.
Substrate – Root in all types of substrates, and broken pieces float freely.

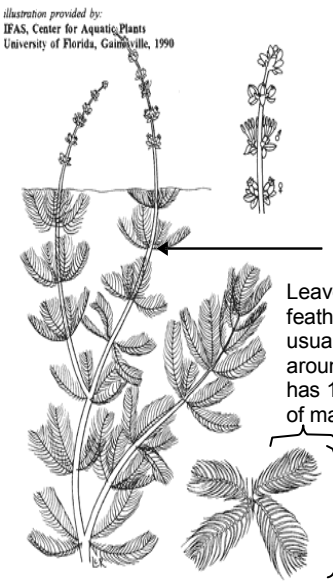
Known occurrences in California – Sacramento-San Joaquin Delta, San Francisco Bay Area and Central Valley ditches and lakes; margins of Southern California's south-east border.

(3) Key Features for Identification

Finely divided, feather-like leaves ½ to 2" long.

Color variation of Eurasian

Species Monitoring at CDFW Hatcheries



Node: Each point where a leaf (or leaves) attaches to the stem.

Leaves less than 2" long, feathery and number 3-6, usually 4 (as shown here) around the stem. Each leaf has 14-24 leaflets per side of main rib.

Whorl: Circular arrangement of leaves (when viewed from above) around the stem. Usually number Aquatic Invasive 3-6, usually 4 (as shown here).

(c) Brazilian Waterweed Or Brazilian Elodea – (*Egeria densa)*

(1) Species Description

Plant – Green
Stems – Highly branched and can reach 25' or more in length.
Leaf attachment to stem (nodes) – Densely spaced at growing tip and indistinguishable. Points of attachment are more widely spaced near the main stem and stems deeper in the water. Double nodes bear branches and flowers.
Leaves – Thin, ¾ – 1½" in length and 1/16 – 1/8" wide, arranged circularly around the stems when viewed from above (whorls) of 3-6 leaves. Spear- shaped leaves have tiny teeth that may require a magnifying glass to see. The number of leaves doubles or triples (up to 12 leaves per whorl) every 8-12 whorls.
Flowers – Three white petals and are about ¾" across on 1" stems above the surface of the water.
Roots – Thin

(2) Suitable Environmental Conditions

Temperature – Survives in water between 40°F and 90°F.
Moisture – Underwater, in both flowing and shallow and standing water.
Substrate – Roots in all types of substrates; broken pieces float freely.

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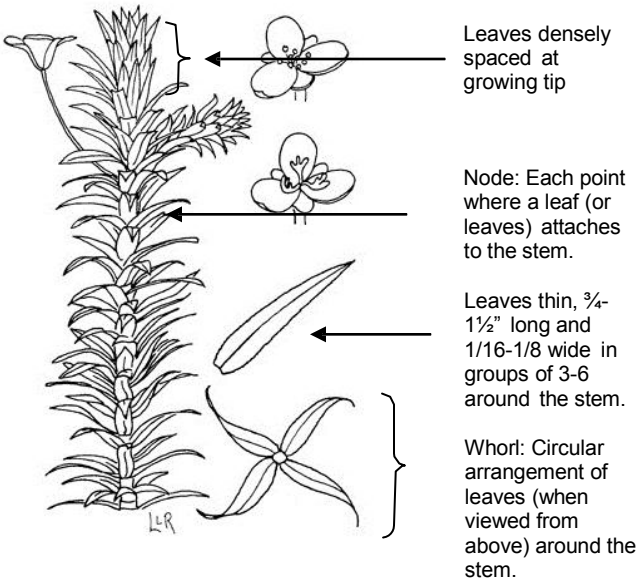
Known occurrences in California – Throughout the Sacramento-San Joaquin Bay-Delta.

(3) Key Features for Identification

Robust 1-inch leaves closely spaced in whorls of 3-6 around the stem.



Aquatic Invasive Species Monitoring at CDFW Hatcheries

(d) Hydrilla – (Hydrilla verticillata)

(1) Species Description

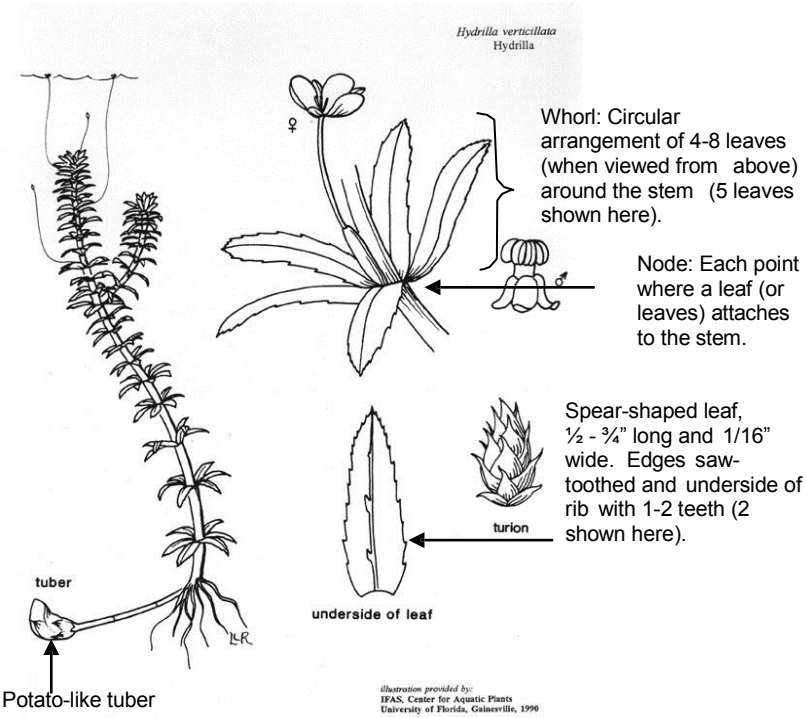
Plant – Green, up to 25' long.
Stems – Slender, branched.
Leaves – Spear-shaped, ½ - ¾" long and 1/16" wide arranged in groups of 4-8 leaves around the stem. Leaf margins distinctly saw-toothed. Often 1-2 sharp teeth along the underside of the leaf rib.
Flowers – Tiny, white flowers born on long stalks at the surface of the water.
Roots – Roots are white and may have yellowish, potato-like structures ½" long and ½" wide at the tips of the roots.

(2) Suitable Environmental Conditions

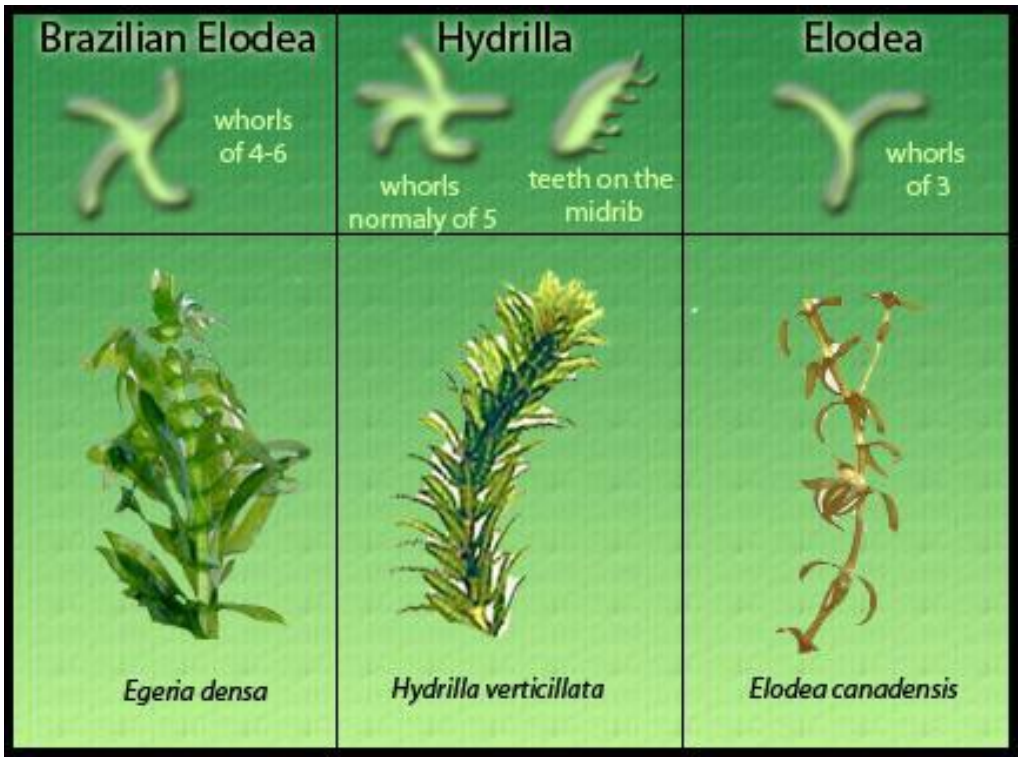
Temperature – Somewhat winter-hardy; its optimum water temperature is 68^{O}F – 81^{O}F; its maximum temperature is 86^{O}F.
Moisture – Underwater, from a few inches deep to more than 20'.
Substrate – May be found in all types of water bodies including springs, lakes, ponds, marshes, ditches, canals, rivers, tidal zones. Broken pieces float freely.
Known occurrences in California – As of 2012, hydrilla is currently being eradicated from 9 locations in Calaveras, Imperial, Lake, Nevada, Shasta, Tulare, and Yuba counties.

(3) Key Features for Identification

Hydrilla has distinctly saw-toothed leaf edges and teeth on the leaf underside. In addition, potato-like tubers on roots are diagnostic. Also refer to page 7 for a comparison with similar species.



Side-by-side comparison of two invasive aquatic plants, *Egeria densa* and *Hydrilla verticullata*, to that of the common native *Elodea canadensis*.



INVASIVE	INVASIVE	NOT INVASIVE

(e) Rock Snot Or Didymo – (*Didymosphenia geminate)*

Rock out of water, Colonized with rock snot

(1) Species Description

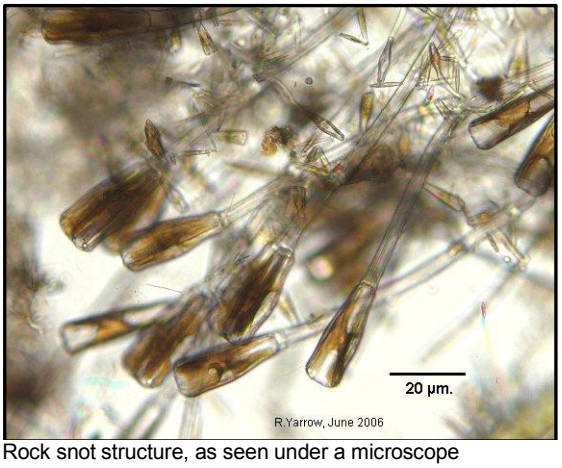
Growth form – Single-celled algae that forms thick mats.
Size – Starts as small clumps and can spread to cover entire wetted areas.
Color – Pale yellowish-brown to white.

(2) Suitable Environmental Conditions

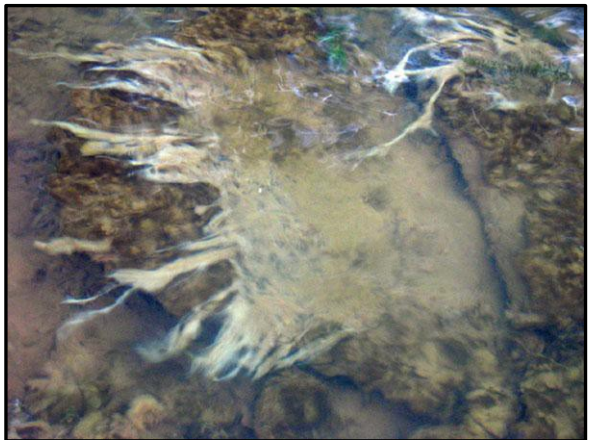
Temperature – 32° F - 72° F
Moisture – Under water.
Substrate – Attaches to hard and soft substrates at depths of 4" to 6½'. Fragments float freely
Known occurrences in California – South Fork of the American River, Sierra Nevada.

(3) Key Features for Identification

Looks like slimy blobs attached to rocks or wet toilet paper trailing from rocks and aquatic plants in streams, and as mats in slow moving water. Appears slimy but feels coarse, like damp wool.



Rock snot structure, as seen under a microscope



Rock snot in flowing water

Appendix C
Post Invasion Monitoring Plan

Zebra and Quagga Mussel Artificial Substrate Monitoring Protocol*
California Department of Fish and Wildlife

*This protocol was adapted from the California Department of Water Resources *Monitoring Instructions for Zebra/Quagga Mussel Plate Samplers,* April 2, 2008.

Description of Zebra and Quagga Mussels

The zebra mussel, *Dreissena polymorpha*, and the quagga mussel, *Dreissena bugensis*, are small mussels found only in freshwater. They look very similar to each other. They commonly have alternating light and dark brown stripes, but can also be solid light brown or dark brown. They have 2 smooth shells that are shaped a little bit like the letter "D". These mussels are usually less than 2 inches in length. In new populations, most mussels are young and therefore very small (under ¼ -inch long).

Quagga Mussel *Dreissena bugensis*	**Zebra Mussel** *Dreissena polymorpha*
	
• Shell: D-shaped and triangular; thin, fragile; smooth or shallowly ridged; solid light to dark brown or dark concentric rings; paler near hinge • Attaches to hard and soft surfaces	• Shell: D-shaped and triangular; thin, fragile; smooth or shallowly ridged; solid light to dark brown or striped • Attaches to hard surfaces

Color variation in zebra and quagga mussels

Quagga and zebra mussels are freshwater mussels that can physically attach onto hard substrates. Like the mussels found clinging to the rocks along the California coastline, zebra and quagga mussels attach onto hard surfaces (e.g. pipes, screens, rock, logs, boats, etc.). They form colonies made up of many individuals attached onto an object and even onto each other. Small newly settled mussels feel like gritty sandpaper when attached to a smooth surface. Larger mussels will feel coarser (like a small pebble or sunflower seed) or be visually apparent.

Other Organisms Mistaken for Zebra/Quagga Mussels

Asian clam, Corbicula fluminea

People often mistake the very common Asian clam (also introduced) for zebra or quagga mussels. The Asian clam is widespread and abundant in California. It is brown and has ridges in concentric rings on its shells. The shells of older clams or of dead clams are white at the hinge (where the two shells join together). These clams do not attach onto surfaces. They live in mud or sand.


Asian clam

Snails and Freshwater Limpets

Small snails and freshwater limpets cling to hard substrates and can be mistaken for small juvenile mussels. They are similar in color and size to small zebra and quagga mussels. Snails have a spiral shape. Limpets have one shell and are flat. Zebra and quagga mussels attach on the edge of their shell and stick up and away from the surface.


Snail


Snails


Limpets

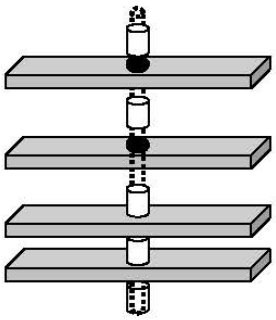
Artificial Substrate Construction and Assembly

To construct the artificial substrate you will need the following materials cut to size:

(4) 6" x 6" x 0.25" black/grey PVC with 1" hole through center
(5) 1.5" x 1.375" (35mm) exterior diameter PVC or ABS tube
(1) 8.5" x 0.8125" (21 mm) exterior diameter PVC or ABS tube

~25 ft plastic coated cable or rope
Some form of attachment to keep plates from floating up
Weight
Laminated label with your contact information

To assemble the substrate, run the cable or rope through the 8.5" tube and secure at one end. From the loose end of the rope string on the remaining pieces, alternating between the short segments of tube and the plates, beginning and ending with the short tubes (see figure). Secure the top tube to the rope to prevent the pieces from floating up. If necessary, attach a weight to the bottom of the assembly. Attach the label to the cable where the cable is secured to the structure.



California Department of Fish and Wildlife
Biological Research

PLEASE DO NOT DISTURB

For information about this study please contact:
Bob Smith, Environmental Scientist
(XXX) XXX-XXXX

Example of a label

Selection of Monitoring Site

Zebra and quagga mussels are transported between waterbodies by watercraft (boats, wave runners, etc), water diversions, and the natural downstream flow of a river system. Monitoring sites are selected with these factors in mind. Prime sites are areas with high boat traffic and downstream of source water. If you are sampling at a waterbody that allows boating, select a site that has a lot of boat traffic. Examples are boat ramps, gas docks or dockside marina stores. Then find a location with low flow and protection from vandalism. Marinas often offer all of these features. Within a marina, find a location with restricted public access. Avoid placing the artificial substrate at unsupervised boat ramps because of tampering by the general public and entanglement with the dock cabling system when the water level changes or the ramp is moved. If these types of structures are not available, find a site downstream of the boat traffic that offers as much protection from vandalism as possible. Examples include water quality monitoring

stations or towers and government agency boathouses. Always ask for permission before attaching artificial substrates to structures. Again, find a location that offers protection from vandalism and has low flow.

Deployment and Inspection of the Artificial Substrate

Depending on water clarity and depth, the artificial substrate should be set below the euphotic zone (below the depth of light penetration) or 6 feet, whichever is deeper, and at least two few feet above the bottom. One to two substrates are deployed per site. If the site is shallower than 2 m, then raise the substrate about 0.5 m (2 ft) off of the bottom. Record the actual sampling depth. At sites that are deep and have little vertical mixing, a second substrate is installed at a depth of approximately 15 meters (50 feet) below the surface (or 1 meter off the bottom if the depth is less than 15 meters).

A visual and tactile examination of the artificial substrate is conducted every month for attached zebra and quagga mussels. When mussels first attach they are very small (invisible to the naked eye) and are very delicate (shells are thin and easily crushed). A single mussel may feel like a grain of sand. If many mussels cover a surface, the surface feels gritty like sandpaper. In approximately 1 to 2 months a mussel grows large enough (1/4 inch) to be seen upon close inspection, but the shell is still very delicate. At this size it feels like a small pebble or sunflower seed.

To check an artificial substrate, first carefully lift it out of the water and place it in a large plastic tub (the tub will capture any mussels that fall off). Avoid knocking the substrate as you pull it out of the water because you may dislodge or crush any attached mussels. First visually inspect each plate (top, bottom, and sides), the spacers, the cable and the weight. After looking closely, attempt to gently push any attached organism that might be a mussel. Freshwater limpets and snails easily move or slide across the plate. Zebra and quagga mussels stick in place or are more securely attached. In all cases, if in doubt, bag it.

If no mussels are detected, lower the substrate back into the water and check again in a month. Zebra and quagga mussels are more likely to attach to a substrate that has some algal growth, however if the substrate becomes too heavily coated it may be unsuitable for mussel settlement. As necessary, gently remove heavy accumulations of algae to maintain suitable conditions for settlement.

Specimen Collection

If you suspect you have found a mussel immediately contact the appropriate CDFW regional mussel contact (list attached). To aid identification, first take a close-up digital photograph of each specimen. Next, collect the specimen(s) and place in a vial with 70% ethanol. Label the vial with location, date, and name of collector. If ethanol is not available, place the sample in a rigid container (to prevent crushing) without water, label, and refrigerate. E-mail the photos to the CDFW contact and they will try to

identify the specimens from the photographs, and may request the actual specimen(s) to make a positive identification.
If the entire artificial substrate needs to be retained for laboratory processing, place the entire unit in a large Ziplock bag or small garbage bag and keep it in a cooler with ice while in the field. Store the substrate in the freezer until ready to mail. Mail it "overnight delivery" on ice.

Replacement of Artificial Substrate

Replace a missing or broken artificial substrate with a new one. If the substrate is repeatedly lost or damaged look for a new deployment site that offers more protection. Report any incidents and the action(s) taken.

To prevent any possibility of contamination between monitoring sites (should mussels be present and not yet detected), never take a substrate from one site and place it at a different site (even within a single waterbody).

Data Recording and Reporting

Every time an artificial substrate is checked the data must be recorded on a datasheet before leaving the field. Absence data is as important to document as presence, so complete and submit a datasheet even if no mussels were found. Send datasheets to the appropriate CDFW regional contact. All data will be entered into a data reporting system and the datasheets will be retained on-site.

Artificial Substrate Datasheet

California Department of Fish and Wildlife

(One datasheet for each artificial substrate)

Collection Information		
Date:		
Waterbody:		
Substrate location (GPS or site description):		
Substrate depth (meters):		
Collector(s):	Affiliation:	
Contact information (email or phone # if not CDFW):		
Substrate		
Substrate (circle one): Present	Missing	
Condition (circle one): Intact	Damaged	
Comments:		
Mussels		
Mussels (circle one): Present Absent	Species (circle one): Quagga Zebra Unknown	
Where (circle all that apply): Plate surface Plate edge Spacers Rope (depth _____) Other (_____)	Total # of mussels on each part of substrate _____ _____ _____ _____ _____	
Plate dimensions (units): ____ x ____ (__)	Plate area (multiply plate dimensions):	
Plates:	Number of mussels	Density (# of mussels ÷ area)
Side 1 (top side of top plate)		
Side 2 (bottom side of top plate)		
Side 3 (top side of second plate)		
Side 4 (bottom side of second plate)		
Side 5 (top side of third plate)		
Side 6 (bottom side of third plate)		
Side 7 (top side of bottom plate)		
Side 8 (bottom side of bottom plate)		
Additional Information		
Other organisms present:		
Comments:		

Return completed datasheets to the appropriate California Department of Fish and Wildlife Regional office.

CDFW Regional Office Contacts for Quagga Mussel Monitoring

Region 1 – Northern Region
Counties: Del Norte, Humboldt, Lassen, Mendocino, Modoc, Shasta, Siskiyou, Tehama, and Trinity
601 Locust Street, Redding, CA 96001
L. Breck McAlexander
Louis.McAlexander@wildlife.ca.gov
Office: (530) 225-2317
Fax: (530) 225-2381

Region 2 – North Central Region
Counties: Alpine, Amador, Butte, Calaveras, Colusa, El Dorado, Glenn, Lake, Nevada, Placer, Plumas, Sacramento, San Joaquin, Sierra, Sutter, Yolo and Yuba
1701 Nimbus Road, Rancho Cordova, CA 95670
Angie Montalvo
Angie.Montalvo@wildlife.ca.gov
Office: (916) 358-2895
Fax: (916) 358-2912

Region 3 – Bay Delta Region
Counties: Alameda, Contra Costa, Marin, Napa, Sacramento, San Mateo, Santa Clara, Santa Cruz, San Francisco, San Joaquin, Solano, Sonoma, and Yolo
7329 Silverado Trail, Napa, CA 94558
Catherine Mandella
Catherine.Mandella@wildlife.ca.gov
Mobile: (831) 588-1463
Fax: (707) 944-5563

Region 4 – Central Region
Counties: Fresno, Kern, Kings, Madera, Mariposa, Merced, Monterey, San Benito, San Luis Obispo, Stanislaus, Tulare and Tuolumne
1234 E. Shaw Avenue, Fresno, CA 93710
Kelley Aubushon
Kelley.Aubushon@wildlife.ca.gov
Office: (559) 243-4017 X-285
Fax: (559) 243-4004

Region 5 – South Coast Region
Counties: San Diego
3883 Ruffin Road, San Diego, CA 92123
Russell Black
Duane.Black@wildlife.ca.gov
Office: (858) 467-4262
Fax: (858) 467-4299

Counties: Los Angeles, Orange, Santa Barbara and Ventura
4665 Lampson Avenue, Los Alamitos, CA 90720
Eloise Tavares
Eloise.Tavares@wildlife.ca.gov
Office: (562) 342-7155
Fax: (562) 342-7153

Region 6 – Inland Deserts Region
Counties: Imperial, Inyo, Mono, Riverside and San Bernardino
P.O. Box 2160, Blythe, CA 92226
David Vigil
David.Vigil@wildlife.ca.gov
Office: (760) 922-4928
Fax: (760) 922-5638

Zebra and Quagga Mussel Artificial Substrate Monitoring Protocol*

California Department of Fish and Wildlife

*This protocol was adapted from the California Department of Water Resources *Monitoring Instructions for Zebra/Quagga Mussel Plate Samplers,* April 2, 2008.

Description of Zebra and Quagga Mussels

The zebra mussel, *Dreissena polymorpha*, and the quagga mussel, *Dreissena bugensis*, are small mussels found only in freshwater. They look very similar to each other. They commonly have alternating light and dark brown stripes, but can also be solid light brown or dark brown. They have 2 smooth shells that are shaped a little bit like the letter "D". These mussels are usually less than 2 inches in length. In new populations, most mussels are young and therefore very small (under ¼ -inch long).

Quagga Mussel *Dreissena bugensis*	**Zebra Mussel** *Dreissena polymorpha*
	
• Shell: D-shaped and triangular; thin, fragile; smooth or shallowly ridged; solid light to dark brown or dark concentric rings; paler near hinge • Attaches to hard and soft surfaces	• Shell: D-shaped and triangular; thin, fragile; smooth or shallowly ridged; solid light to dark brown or striped • Attaches to hard surfaces

Color variation in zebra and quagga mussels

Quagga and zebra mussels are freshwater mussels that can physically attach onto hard substrates. Like the mussels found clinging to the rocks along the California coastline, zebra and quagga mussels attach onto hard surfaces (e.g. pipes, screens, rock, logs, boats, etc.). They form colonies made up of many individuals attached onto an object and even onto each other. Small newly settled mussels feel like gritty sandpaper when attached to a smooth surface. Larger mussels will feel coarser (like a small pebble or sunflower seed) or be visually apparent.

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Snails


Limpets

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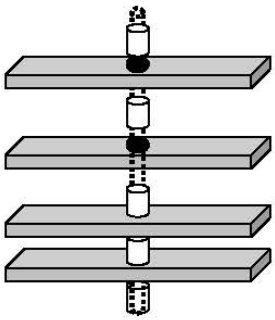

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For information about this study please contact:
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Example of a label

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Artificial Substrate Datasheet

California Department of Fish and Wildlife

(One datasheet for each artificial substrate)

Collection Information		
Date:		
Waterbody:		
Substrate location (GPS or site description):		
Substrate depth (meters):		
Collector(s):	Affiliation:	
Contact information (email or phone # if not CDFW):		
Substrate		
Substrate (circle one): Present	Missing	
Condition (circle one): Intact	Damaged	
Comments:		
Mussels		
Mussels (circle one): Present Absent	Species (circle one): Quagga Zebra Unknown	
Where (circle all that apply): Plate surface Plate edge Spacers Rope (depth _____) Other (_____)	Total # of mussels on each part of substrate _____ _____ _____ _____ _____	
Plate dimensions (units): ____ x ____ (__)	Plate area (multiply plate dimensions):	
Plates:	Number of mussels	Density (# of mussels ÷ area)
Side 1 (top side of top plate)		
Side 2 (bottom side of top plate)		
Side 3 (top side of second plate)		
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Additional Information		
Other organisms present:		
Comments:		

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Office: (530) 225-2317
Fax: (530) 225-2381

Region 2 – North Central Region
Counties: Alpine, Amador, Butte, Calaveras, Colusa, El Dorado, Glenn, Lake, Nevada, Placer, Plumas, Sacramento, San Joaquin, Sierra, Sutter, Yolo and Yuba
1701 Nimbus Road, Rancho Cordova, CA 95670
Angie Montalvo
Angie.Montalvo@wildlife.ca.gov
Office: (916) 358-2895
Fax: (916) 358-2912

Region 3 – Bay Delta Region
Counties: Alameda, Contra Costa, Marin, Napa, Sacramento, San Mateo, Santa Clara, Santa Cruz, San Francisco, San Joaquin, Solano, Sonoma, and Yolo
7329 Silverado Trail, Napa, CA 94558
Catherine Mandella
Catherine.Mandella@wildlife.ca.gov
Mobile: (831) 588-1463
Fax: (707) 944-5563

Region 4 – Central Region
Counties: Fresno, Kern, Kings, Madera, Mariposa, Merced, Monterey, San Benito, San Luis Obispo, Stanislaus, Tulare and Tuolumne
1234 E. Shaw Avenue, Fresno, CA 93710
Kelley Aubushon
Kelley.Aubushon@wildlife.ca.gov
Office: (559) 243-4017 X-285
Fax: (559) 243-4004

Region 5 – South Coast Region
Counties: San Diego
3883 Ruffin Road, San Diego, CA 92123
Russell Black
Duane.Black@wildlife.ca.gov
Office: (858) 467-4262
Fax: (858) 467-4299

Counties: Los Angeles, Orange, Santa Barbara and Ventura
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Eloise Tavares
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Office: (562) 342-7155
Fax: (562) 342-7153

Region 6 – Inland Deserts Region
Counties: Imperial, Inyo, Mono, Riverside and San Bernardino
P.O. Box 2160, Blythe, CA 92226
David Vigil
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Office: (760) 922-4928
Fax: (760) 922-5638

CASITAS MUNICIPAL WATER DISTRICT

Mussel Veliger Quagga Vertical Plankton Tow Sampling Protocol (From CA Department of Fish and Game* and USBR Protocol**)

- 63-µm plankton tow net (maximum mesh size)
- Rope, 50 meters
- Sample bottles (250 mL – 1L)
- Sample labels
- Sharpie pen
- Alcohol (ethanol or isopropyl, depending on your lab's specifications)
- Plankton Sample Log (on waterproof paper)
- Plankton Sample Datasheet (on waterproof paper)
- Ice chest with crushed ice/blue ice
- Wash bottle(s) filled with tap water
- 5-gal bucket ("wash down" bucket)
- White vinegar, 100% solution (3 to 5 gal or enough to submerge plankton net and tow rope)
- 5-gal bucket with lid ("vinegar decontamination bucket")
- Chlorine solution, 10% bleach (16 to 32 oz or enough to fill spray bottle)
- Spray bottle for chlorine solution (16 to 32 oz)

1. **Field Procedures**

To optimize the likelihood of capturing veligers if they are present, tows should be made at various locations within a lake/waterbody. **It is recommended that 8 to 16 separate tows (depending on the size of the waterbody), of at least 8 meters(26 feet) each in length be made.** 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.). You may also want to sample the entire depth of your water column as vertical distribution of veligers may be variable. 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. Individual tows from the same lake/waterbody can be combined into a single sample jar for laboratory analysis.

To perform a tow, attach rope to the "bridle" (the rope system fixed to the mouth of the net). Gently lower the net into the water to the desired depth. To retrieve, pull rope back in a steady, unhurried, hand-over-hand motion. Note: Do not pull faster than 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 as such, does not effectively sample the desired volume of water. Record the distance of each tow on the Plankton Sample Datasheet. Rinse net contents into sample bottle (described below) between each tow.

2. **Sample Collection**

- At the end of each tow, lift the net so that the net opening is above the water surface. Next, lower the net back into the water (keeping the opening above the water surface) and then quickly pull the net straight up; this action will move the collected plankton into the cod-end piece. Repeat this procedure as needed. Note: If sampling from shore, use a 5-gal bucket of water to wash the contents down into the cod-end. Carefully lower the net into the bucket and lift out quickly to wash the organisms down (again, keep the opening of the net out of the water). Repeat as necessary.

- Depending on the configuration of your net, carefully transfer the net contents to the labeled sample jar. Use the wash bottle to gently rinse down any remaining contents into the jar. Try to minimize the amount of rinse water collected in the sample jar so that subsequent tows from the same lake/waterbody can be added.
- Reattach the cod-end piece to the net and repeat the tow.
- Combine the samples for all the tows into one jar, if possible, leaving sufficient room for alcohol.

3. **Sample Preservation**

DFG Method:

Depending on your lab and the method of sample analysis, preservation method may vary. Know your lab's protocol prior to collecting samples.

Portland State University analyzes plankton samples using microscopic examination, and requests samples to be preserved in a 70% final alcohol solution. Alcohol can be either 95% non-denatured ethanol or isopropyl (over-the-counter isopropyl is usually 70% alcohol). If using 95% ethanol, samples should be approximately one-quarter plankton/water, and three-quarters alcohol to get a solution that is approximately 70% alcohol. If using 70% isopropyl, you will need a greater proportion of alcohol to water - approximately 85% alcohol to 15% plankton/water. When making several tows keep sample on ice between tows and add alcohol after tows are combined. Samples preserved in this manner can be held and shipped at room temperature and have a shelf life of at least 3 months.

The Bureau of Reclamation lab requires samples for PCR analysis to be preserved in a final solution of 25% non-denatured ethanol. With less alcohol, samples must be kept chilled, shipped overnight on ice, and be processed within days.

Dilutions for final solutions and different alcohol percentages can be calculated at http://www.restrictionmapper.org/dilutioncalc9.htm .

USBR Method:

Samples with a pH below 7 degrade the veliger shell making the shell undetectable by CPLM (cross polarized light microscopy). Raw water will become acidic over time, due to the addition of alcohol that euthanizes and preserves the sample. Buffering the sample with baking soda stabilizes the pH and preserves the veliger shell for easier detection by microscopy.

1. Preserve sample by adding 20 % alcohol to raw water sample volume.
2. Add 0.2 gram of baking soda per 199 mL of raw water sample.

4. **Shipping Samples**

Ethanol (ethyl alcohol) and isopropyl alcohol are class 3 hazardous material. They may be shipped via ground transportation in limited quantities when proper packed and labeled. Consult you carrier for guidance.

5. **Data Recording**

Complete a datasheet for each sample (Plankton Sample Datasheet). Fill datasheets out while sampling to ensure accuracy. Record the date, location, and time each sample was collected. Record the distance (depth or length) of each tow; this information is used to calculate the actual water volume sampled.

6. **Cleaning and Storing Equipment**

If there is a need to decontaminate the equipment, the sampling gear (including net, rope, wash bottles, buckets, etc.) that came into contact with the water should be soaked in vinegar for 24 hours (an absolute minimum of 4 hours), and rinsed. As an additional precaution, equipment can be sprayed with or soaked in chlorine solution for 5 minutes, and then thoroughly rinsed with clean tap water (the bleach is corrosive so rinse thoroughly with clean tap water). Vinegar can be reused. Dispose of the contaminated rinse water away from the waterbody. The vinegar solution can be reused multiple times. The chlorine solution should be discarded after 24 hours.

Vinegar Solution

100% white table vinegar (5% acetic acid solution).

Chlorine Solution: 10% solution of household bleach (5.25% sodium hypochlorite). To make the bleach solution, add 1.5 cups of household bleach to 1 gal of water. The bleach solution must be fresh (less than 24 hours old)

Disassemble net and hang to dry. Routinely inspect the net for damage or wear and repair or replace if necessary.

*This protocol was adapted from the California Department of Water Resources Zebra and Quagga Mussel Veliger Sampling Protocol for the State Water Project, April 29, 2008

**USBR Technical Memorandum No. 86-68220-13-02, Lab Protocol: Preparation and Analysis of Dreissenid Veliger Water Samples.

Notes:

Metric calculation

50 cm diameter net =500 mm net = 0.5m = 20" net
16.4 feet tow length = 1000 L (264 gallons) of sample volume
$V=\pi r^2 d$ x 1000L/m^3
1000 L=3.14 (0.5/2meter) 2 x distance (meters) x 1000L/m^3
1000 L sample volume = 5 m = 16 feet
20L per 1 m tow

Standard Calculation
$V=\pi r^2 d$ x 7.48 L/ft^3
264 gal = 3.14 (1.67/2 feet)^2 x distance (feet) x 7.48 gal/ft^3
264 gal sample volume = 16 feet = 5 m
16.5 gal per 1 feet tow

Optimal tow plan

2 @ sides of harbor entrance (25 feet each)
1 @ 100 yards outside harbor entrance (50 feet)
1 @ Coyote Ramp (25 feet)
Total towing distance = 125 feet or 38.1 m
125 feet tow = 2063 gallons or 7809 L

Quagga/plankton Tow Field Data Sheet- Casitas Municipal Water District				
Date:				Time:
Sample Collector(s): Ken Grinnell				
Preservatives used in field:				pH:
Net				
Mesh Size: 63 um				
Net Diameter: 0.5 m (20 inches)				
Tows				
Location Description	# of Tows	Feet/tow	Total Feet	Gallons Per Tow Area*
East side of harbor entrance (25')				
West side of harbor entrance (25')				
100 yards outside of harbor entrance (50')				
Coyote Ramp area (25')				
	Total Gallons*			
Microscopic Analysis				
Date Analyzed:				
Sample Settling Time:				
mls of Sample Analyzed				
# of Possible Veligers Observed				
Comments:				

* **Gallons Calculation**

$V=\pi r^2 d$ x 7.48 L/ft^3

264 gal = 3.14 (1.67/2 feet)^2 x distance (feet) x 7.48 gal/ft^3

264 gal sample volume = 16 feet = 5 m

16.5 gal per 1 feet tow

Zebra/Quagga Mussel Surface Survey Protocol*
California Department of Fish and Wildlife

*This protocol was adapted from the California Department of Water Resources *Zebra/Quagga Mussel Surface Survey Protocol*.

Description of Zebra and Quagga Mussels

The zebra mussel, *Dreissena polymorpha*, and the quagga mussel, *Dreissena bugensis*, are small mussels found only in freshwater. They look very similar to each other. They commonly have alternating light and dark brown stripes, but can also be solid light brown or dark brown. They have 2 smooth shells that are shaped a little bit like the letter "D". These mussels are usually less than 2 inches in length. In new populations, most mussels are young and therefore very small (under ¼ inch long).

Quagga Mussel *Dreissena bugensis*	**Zebra Mussel** *Dreissena polymorpha*
	
• Shell: D-shaped and triangular; thin, fragile; smooth or shallowly ridged; solid light to dark brown or dark concentric rings; paler near hinge • Attaches to hard and soft surfaces	• Shell: D-shaped and triangular; thin, fragile; smooth or shallowly ridged; solid light to dark brown or striped • Attaches to hard surfaces

Color variation in zebra and quagga mussels

Quagga and zebra mussels are freshwater mussels that can physically attach onto hard substrates. Like the mussels found clinging to the rocks along the California coastline, zebra and quagga mussels attach onto hard surfaces (e.g. pipes, screens, rock, logs, boats, etc.). They form colonies made up of many individuals attached onto an object and even onto each other. Small newly settled mussels feel like gritty sandpaper when attached to a smooth surface. Larger mussels will feel coarser (like a small pebble or sunflower seed) or be visually apparent.

Other Organisms Mistaken for Zebra/Quagga Mussels

Asian clam, Corbicula fluminea

People often mistake the very common Asian clam (also introduced) for zebra or quagga mussels. The Asian clam is widespread and abundant in California. It is brown and has ridges in concentric rings on its shells. The shells of older clams or of dead clams are white at the hinge (where the two shells join together). These clams do not attach onto surfaces. They live in mud or sand.


Asian clam

Snails and Freshwater Limpets

Small snails and freshwater limpets cling to hard substrates and can be mistaken for small juvenile mussels. They are similar in color and size to small zebra and quagga mussels. Snails have a spiral shape. Limpets have one shell and are flat. Zebra and quagga mussels attach on the edge of their shell and stick up and away from the surface.


Snail


Snails


Limpets

Visual and Tactile Search for Zebra and Quagga Mussels

Gently run fingers over smooth surfaces, checking for gritty feeling or small "seed-like" or "pebble-like" objects. Areas likely to harbor mussels, if they are present, include:

- Dock floatation, buoys, mooring line, 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 all hard and soft substrates. Fan areas covered with silt to expose mussels.

Inspect dark areas (dark substrates and low light/shaded areas). Do not disturb private vessels or property.

Prime Areas to Search

Quagga and zebra mussels prefer dark substrates and low light/dark areas. They prefer concrete over other substrates. Search areas at or near boat ramps, gas dock, dock near marina store, other docks in high traffic areas, all concrete structures, and low flow areas.

Minimum Sample Size

The minimum number of linear feet to be searched per substrate is defined below. You can stop before meeting the minimum linear feet if quagga/zebra mussels are found in 3 or more locations within the survey location, or if all available substrate has been searched.

- 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

Make a notation in "Comments" section if minimum sample size requirements could not be met.

If Mussels are Found

Record the lat/long (in decimal degrees and use WSG 84) of the mussels' location(s) and mark/describe location(s) on the back of the datasheet. 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 specimens (4-5). Place in Ziploc bag with label. Label should include location, lat/long, date, and name of collector. Seal and keep dry or put in freezer. Do not put water in the bag.

If other species of clams or mussels are found, collect specimens (1-2) and place in bag with collection label. Seal and keep dry or put in freezer. Do not put water in the bag.

Data Recording and Reporting

Datasheets are available at:
https://nrm.dfg.ca.gov/FileHandler.ashx?DocumentID=4949

If mussels are found, immediately contact the appropriate CDFW regional mussel contact.

Every time a survey is made the data must be recorded on a datasheet before leaving the field. Absence information is as important to document as presence, so complete and submit a datasheet even if no mussels were found. Send datasheets to the appropriate CDFW regional contact. All data will be entered into a data reporting system and the datasheets will be retained on-site.

CDFW Regional Office Contacts for Quagga Mussel Monitoring

Region 1 – Northern Region
Counties: Del Norte, Humboldt, Lassen, Mendocino, Modoc, Shasta, Siskiyou, Tehama, and Trinity
601 Locust Street, Redding, CA 96001
L. Breck McAlexander
Louis.McAlexander@wildlife.ca.gov
Office: (530) 225-2317
Fax: (530) 225-2381

Region 2 – North Central Region
Counties: Alpine, Amador, Butte, Calaveras, Colusa, El Dorado, Glenn, Lake, Nevada, Placer, Plumas, Sacramento, San Joaquin, Sierra, Sutter, Yolo and Yuba
1701 Nimbus Road, Rancho Cordova, CA 95670
Angie Montalvo
Angie.Montalvo@wildlife.ca.gov
Office: (916) 358-2895
Fax: (916) 358-2912

Region 3 – Bay Delta Region
Counties: Alameda, Contra Costa, Marin, Napa, Sacramento, San Mateo, Santa Clara, Santa Cruz, San Francisco, San Joaquin, Solano, Sonoma, and Yolo
7329 Silverado Trail, Napa, CA 94558
Catherine Mandella
Catherine.Mandella@wildlife.ca.gov
Mobile: (831) 588-1463
Fax: (707) 944-5563

Region 4 – Central Region
Counties: Fresno, Kern, Kings, Madera, Mariposa, Merced, Monterey, San Benito, San Luis Obispo, Stanislaus, Tulare and Tuolumne
1234 E. Shaw Avenue, Fresno, CA 93710
Kelley Aubushon
Kelley.Aubushon@wildlife.ca.gov
Office: (559) 243-4017 X-285
Fax: (559) 243-4004

Region 5 – South Coast Region
Counties: San Diego
3883 Ruffin Road, San Diego, CA 92123
Russell Black
Duane.Black@wildlife.ca.gov
Office: (858) 467-4262
Fax: (858) 467-4299

Counties: Los Angeles, Orange, Santa Barbara and Ventura
4665 Lampson Avenue, Los Alamitos, CA 90720
Eloise Tavares
Eloise.Tavares@wildlife.ca.gov
Office: (562) 342-7155
Fax: (562) 342-7153

Region 6 – Inland Deserts Region
Counties: Imperial, Inyo, Mono, Riverside and San Bernardino
P.O. Box 2160, Blythe, CA 92226
David Vigil
David.Vigil@wildlife.ca.gov
Office: (760) 922-4928
Fax: (760) 922-5638

Zebra/Quagga Surface Survey Data

(Use Pencil Only)

Waterbody _____ **Date** __ __ / __ __ / __ __

Location _____ **Crew** _____

GPS _____ **(Decimal Degrees, WSG 84)**

Secchi Depth ☐☐☐ **Wave Chop** ☐

 # Linear Meters of:

Boat Ramp Bottom (30 m at marina, 60 m at ramp only) ☐☐☐

Shoreline (30 m at marina, 60 m at ramp only) ☐☐☐

Dock (60 m) ☐☐☐

Concrete Structures (30 m) ☐☐☐

Mooring Line (60 m) ☐☐☐

Logs/Woody Debris (30 m) ☐☐☐

Anchor/Dock Cable (30 m) ☐☐☐

Other _____ ☐☐☐

% of Dock/Marina/Boat Ramp Searched ☐

Zebra/Quagga Mussels Present? Y / N **Specimens Collected?** Y / N

	Exact GPS Location (if isolated occurrences):	**Mussel Density** (# of mussels):	**Method** (circle one):
1	☐	☐ ☐ ☐ ☐ ☐	Ruler / Petri
	Ruler Length (if < 0.5 m)	____ ____ ____ ____ ____	
	Substrate Type	☐	
2	☐	☐ ☐ ☐ ☐ ☐	Ruler / Petri
	Ruler Length (if < 0.5 m)	____ ____ ____ ____ ____	
	Substrate Type	☐	
3	☐	☐ ☐ ☐ ☐ ☐	Ruler / Petri
	Ruler Length (if < 0.5 m)	____ ____ ____ ____ ____	
	Substrate Type	☐	

Corbicula Clams Present? Y / N **Snails Present?** Y / N

Other Mussel/Clam Species Present? Y / N **Specimens Collected?** Y / N

Quagga Mussel
Dreissena rostriformis bugensis

• Shell: D-shaped and triangular; thin, fragile; smooth or shallowly ridged; solid light to dark brown or dark concentric rings; paler near hinge
• Attaches to hard and soft surfaces

Zebra Mussel
Dreissena polymorpha

• Shell: D-shaped and triangular; thin, fragile; smooth or shallowly ridged; solid light to dark brown or striped
• Attaches to hard surfaces

Asian Clam
Corbicula fluminea

• Shell: fan-shaped and symmetrical; thick, hard; deep ridges; solid light to dark brown; may have a white patch near hinge
• Burrows into sand or mud; never attaches to structures
• Dead shells often found along shoreline

Map of sampling location:

Place empty circles (○) in areas that were surveyed but no mussels were found. Place circles with plus sign (⊕) where mussels were found, and number 1, 2, or 3 to correspond to GPS coordinates.

Did weather conditions negatively affect sampling conditions? Y / N

Comments _____

_____

_____

Appendix D

Budget Proposal for Dreissenid Eradication in Lake Casitas

Two methods of eradication are offered for consideration with a pricing confidence suitable for budgeting. The methods are both chemical treatments; method one is potash treatment and method two is copper based treatment using the Earthtec –QZ product.

Potash Treatment

Appendix D.1 – Background

Zebra and Quagga mussels (*Dreissena polymorpha and D. bugensis*) (mussels) have been present in North American waters for nearly three decades. As a result industries and other raw water users along affected waterways have had to implement costly control programs to ensure that water supply to their facilities remains unobstructed.

ASI Group Ltd has worked extensively in this field since 1989 and has conducted or been involved in many of the initial experimental treatment programs which are ultimately used for mussel control today.

ASI Group Ltd conducted experiments on the effectiveness of potassium, in the form of muriate of potash, as a method of controlling Zebra mussel infestation in the early to mid-nineties. Through research with Niagara Mohawk and Ontario Power Generation, it was concluded that at 100 ppm potassium was acutely lethal to mussels. More importantly it was determined, through lab toxicity testing, that LC_{50} values for key non-target lab organisms such as Water Fleas *(Daphnia magna and Ceriodaphia dubia),* Rainbow Trout and Fathead Minnows were well below Potassium concentrations employed to control zebra mussels. As a result new treatment techniques for controlling adult mussels in semi-static systems, such as fire protection systems were developed and since 1996 have been used regularly throughout industry.

During the same period ASI conducted experiments to determine the long term effects of Potassium on adult mussels. Research demonstrated that adult mussels could be controlled through chronic exposure to lower Potassium concentrations which range from 20 ppm to 40 ppm under varying treatment durations.

In 2006 ASI was retained by the Virginia Department of Game and Inland Fisheries to perform the first North American open water treatment for mussel colonization through exposure to Potassium. Using a Muriate of Potash ASI introduced approximately 131 tonnes of dry product mixed into a 20% solution achieving a 100 ppm target concentration throughout Millbrook Quarry, located in Haymarket, Virginia. The treatment was 100% successful with complete eradication occurring within 60 days under cold water conditions. ($<5^{o}C$) We are confident our treatment process can be scaled up to meet the challenges posed by Lake Casitas.

Appendix D.2 - Methodology

Appendix D.2.1 – Process. Aquatic Sciences' proposed treatment methodology for eradicating mussels will be extended exposure to potassium; in the form of agriculture grade potash (fertilizer), at a

level toxic (40 ppm) to adult mussels. Understanding the toxicity of potassium; while maintaining focus on sensitivities to the surrounding environment, ASI Group Ltd has designed a method that incorporates specialized equipment and operational protocol for controlling the introduction of potassium into the quarry.

ASI will use a two-step conceptual approach to introduce potassium into Lake Casitas, incorporating both shore and water based operations.

A shore based staging area will be situated in close proximity to the Lake and will be used throughout the duration of the project. It will include two mixing / replenishment stations to ensure a constant supply of stock solution. A stock solution of approximately 12% potassium will be mixed on a daily basis where it will be kept in solution by an electric tank mixer. A reversible centrifugal pump system will be used to draw water from the Lake and supply the batch mixing tanks. When reversed, the pump system will draw stock solution from the batch tanks and supply a floating work platform with stock solution.

An inventory of dry 98% muriate of potash (MOP) will be stored onsite in two steel sea containers. The lockable and watertight containers will protect the MOP from the elements, ensure product security and prevent accidental release of the product to the environment. It is estimated that 14,000 tonnes of 98% MOP will be required to treat Lake Casitas at the current water level.

Water based operations will utilize our 22 ft. Sealander work boat outfitted with a specially designed diffuser assembly. Stock solution from the shore based storage tanks will continuously feed the diffuser through a floating 1.5 in. diameter supply line and shore based centrifugal pump transfer system.

Stock solution from the shore based mixing / replenishment tanks will be transferred to the work platform using the shore based centrifugal pump transfer system. Proper diffusion of potassium; opposed to batch dumping, is a critical element of what ASI considers to be an advantageous treatment methodology. This will ensure the shortest period of time required for uniform mixing throughout the water column and more importantly minimize impacts to non-target organisms, as there will be less chance for high concentration “slugs” of potassium-rich water to build up.

Treatment will proceed on a systematic basis by separating the Lake into segments or treatment zones being characterized by depth, length, width and location. This will be accomplished using the automated hydrographic survey system including HYPACK MAX software described above and being mounted on the work platform. A contour map resulting from the hydrographic survey will be uploaded into HYPACK and used to pre-plan survey lines that run contiguous with contours (e.g. 5’, 10’,...100’, etc.). Using HYPACK with a helmsman’s display, the work platform will be precisely navigated along pre-planned survey lines while the 12% potassium solution is being introduced through the diffuser assembly. The work platform based retractable 10 ft. by 4 ft. diffuser assembly will consist of ten perforated vertical flexible hoses having capped and weighted ends and being attached to the 10 ft. horizontal section. This will allow for an enlarged mixing zone to be achieved while the flexible hose will reduce damage due to submerged obstacles. An echo sounder will be used to monitor water depth along with the depth of the submerged diffuser assembly in order to maintain an optimum height above the quarry bottom. This system will also reduce the risk of entangling the diffuser assembly on bottom features.

It is estimated that it will take 12 weeks to charge the entire Lake with potassium. Water samples will be collected during the charging phase to ensure that all areas are within the target concentration range of 40 ppm. If during operations it is determined that the potassium concentrations are not within the 40 ppm target then the dosing strategy will be modified to ensure the target concentration is achieved.

Once the target concentration of potassium has been achieved, bioassays using live adult dreissenid mussels will be placed in the Lake at varying depths with 100% mortality of mussels expected within 25 days, at water temperatures greater than 60˚ F.

Appendix D.2.2 - Measures of Effectiveness. To ensure the potassium diffusion system is operating efficiently and is attaining target potassium concentrations throughout the treatment zone, daily potassium monitoring will be completed following the initial treatment. Daily monitoring will provide ASI personnel with information on how quickly and how well the MOP is dispersing through the treatment zone. This information can be used to modify the treatment protocol, either by increasing the dosing rate to achieve the target concentration, or by reducing the dosing rate if the potassium levels are significantly exceeding targets. The target concentration of 40 ppm is optimum as the mussels will die within a three to four week period, depending on water temperatures.

Following the “charge” activities, and prior to bioassay initiation, a final sampling exercise will be conducted throughout the entire quarry to characterize potassium concentrations at various depth profiles at selected points on predetermined transects throughout the Lake to confirm that target levels have been achieved. Areas which do not contain adequate concentrations, will be re-charged and re-sampled to ensure that the target has been achieved.

Monitoring points along each transect will be spaced 250 feet apart depending on the width of the Lake at each transect location. Approximately 3 to 5 sites will be monitored along each transect to ensure feasible and maximum monitoring coverage of the treated transect area. Duplicate samples will be collected and analyzed for every tenth sample for QA/QC purposes.

To determine the potassium concentrations, water samples will be obtained by two different methodologies. Surface grabs will be conducted where water depths are less than six feet, and will be collected at least 0.5 feet below the surface. A peristaltic pump or Kemmerer bottle will be used to collect samples at depths greater than six feet. This methodology will enable ASI to determine if proper mixing is occurring and to ensure target concentrations are achieved throughout the entire water column.

Sample identification, location, depth, date, GPS coordinates for each monitoring point and other pertinent information will be recorded in the field logbook and on reporting log sheets. The field instruments will be calibrated prior to use every day with standards of known value.

Appendix D.2.3 - Mortality Monitoring (Bioassay). In situ bioassays will be utilized to determine the effectiveness of MOP at eradicating adult mussels within the Lake. The purpose of a bioassay is to provide an indication of when mussels succumb to the MOP treatment.

Bioassays involve placing 100 healthy adult mussels into a mesh basket, and then exposing the mussels to the potassium-charged water. The mussels are inspected at pre-determined intervals for mortality. Once complete (100%) mortality has been achieved in all bioassays, the treatment is considered effective.

Adult mussels will be provided by ASI for the bioassays. Adult mussels will be sorted into bioassay baskets, placed into untreated water and aerated in a climate-controlled site trailer. Prior to being seeded at the bioassay locations, checks for background mortality to confirm the health of the mussels will be completed.

Once charge activities have been completed, bioassay baskets, each containing 100 adult mussels, will be seeded in various locations throughout the Lake. These locations will be determined based on potassium analysis results, and will target areas and depths where potassium concentrations fluctuate. Bioassay locations will also target areas where mussels were most prolific prior to the treatment

In addition to the bioassays seeded in the Lake, a control bioassay will be conducted by monitoring 100 adult mussels contained in fresh, untreated water in a climate-controlled site trailer to mimic Lake water conditions. These mussels will be aerated and the water will be exchanged daily to avoid the build-up of waste products and to provide a continuous source of food. The control mussels will monitor the health of the population during the bioassay to ensure the reliability of the mortality results.

The exact mode of action which causes the mortality is unknown; however, evidence suggests that potassium kills mussels by interfering with the organisms' ability to transfer oxygen across gill tissue, resulting in asphyxia. Within approximately 48 hours of potassium intoxication, the mussels will suffocate, resulting in mortality. Since dead and intoxicated mussels appear similar (as both are gaped open and non-responsive to probing), it is necessary to provide a recovery chamber where the mussels' ability to recuperate in untreated water can be monitored. Recovery chambers will be located in the climate-controlled site trailer and used to determine when the mussels have succumbed to the treatment.

Forty eight hours after the mussels are seeded in the Lake; groups of ten potentially dead mussels exhibiting potassium intoxication will be removed ("pulled") from each bioassay basket and placed into a recovery chamber that contain untreated water for a period of 48 hours. It can take up to 48 hours for mussels to recover from potassium-induced intoxication. Therefore, it is necessary to allow the mussels 48 hours to recuperate from the exposure. Mussels will be inspected for latent mortality after 24 hours in recovery and again at 48 hours for actual mortality. Studies have indicated that mussels that have not recovered by 48 hours will not recover.

Mussels will continue to be "pulled" from each bioassay basket at 24 hour intervals and placed in recovery chambers until complete actual mortality is observed in mussels that were in the recovery chamber for 48 hours.

Appendix D.2.4 – Pricing. **ASI Group Ltd. (ASI) can provide the following "turnkey" Potash treatment of Lake Casitas at an estimated cost of $4 million** (net 30 days, taxes extra). Detailed budget can be developed if dreissenid mussels invade Lake Casitas. The project cost may decrease if the water level of the lake could be lowered.

Service provided for this project charge include:

Project Support:

- Mobilization/Demobilization

- System installation
- System commissioning and operation
- Provision of chemical metering system with tanks; bioassay apparatus, application and sample vessels (boats), chemical hose and diffuser assembly, barrier membranes, test organisms, and Zebra mussel monitoring plates.
- Final Report

Operations Support:

- Project Management
- Operating Personnel
- ASI site vehicle supplied as required
- Bulk chemicals are based on a maximum system target K^+ concentration of 40 mg/L, and total Lake volume of 5.5 Billion USG.
- Use of ASI owned analytical equipment as required

This proposal is subject to the following terms and conditions:

Project Term

The project term is based on, mobilization, installation, commissioning and ramp-up of equipment, daily treatment operations, demobilization, and final report production.

Scheduling

Quotation assumes project schedule is established at least six weeks prior to mobilization. Once scheduled, additional charges may apply to any delay or deviation from the scheduled treatment caused by factors outside ASI's standard rates. Incremental material and equipment costs will be billed at cost +20%.

Other

- Quotation is for budgeting purposes only. A firm cost estimate can only be provided following a detailed site inspection.
- Please reference ASI Group Proposal MU14-006 on all correspondence.
- A service charge of 1.5% per month (19.5% per annum) may be charged on past due balances.

Earth Science Laboratories, Inc. **Phone 800.257.9283**
113 S.E. 22nd St., Suite 1 Fax 479.271.7693
Bentonville, Arkansas 72712 www.earthsciencelabs.com

Lake Casitas Mussel Control Initiative

Pre-Proposal - March 2015

Disclaimer: This "pre-proposal" has been prepared with minimal background information about Lake Casitas, its water characteristics, management procedures, and stakeholder priorities. It is a "good faith" estimate of the measures and costs required to achieve the lake managers' mussel-control objectives, as we understand them. If there is sufficient interest, Earth Science Labs will prepare a more detailed proposal in cooperation with managers and stakeholders at Lake Casitas, or their agents.

Objective - To apply EarthTec QZ at the minimum concentration required to achieve 100% mortality of the dreissenid (Quagga and/or Zebra) mussels present in Lake Casitas, Ventura County, California. Earth Science Laboratories, manufacturer of EarthTec QZ, anticipates this will require 2-4 separate applications, separated by days or weeks.

Background - EarthTec is a copper-based algaecide/bactericide with a record 20+ years of safe and effective use throughout the U.S. EarthTec is applied in a wide variety of sites, including treatment of potable water reservoirs, lakes, pipelines, canals, aqueducts, and even within water treatment plants. Although most frequently applied for control of algae and cyanobacteria, some water districts use EarthTec to reduce geosmin and other compounds that cause taste and odor problems in drinking water. It is also approved for agriculture, including irrigation lines (e.g., keeping drip irrigation lines and their emitters free from algae and bacteria) and rice fields (control of tadpole shrimp) At doses recommended for control of mollusks and most algae it is safe for fish, as evidenced by its popularity among aquaculture farmers, especially those who culture catfish.

EarthTec is NSF-approved for drinking water and is frequently applied in potable water lakes, reservoirs and at the intake of water treatment plants.

EarthTec's unique formulation maintains the copper in the cupric ion form (Cu++) – the biologically active form of copper – and this formulation is the reason EarthTec performs well at a significantly lower copper dose than other copper-based products. This cupric ion remains in solution until it is consumed by a cell, so there is virtually no waste or loss to precipitation or settling, and for that reason we believe EarthTec is the most environmentally safe and responsible way to apply copper for pest control.

In August of 2013, EarthTec was granted federal EPA approval for use against Zebra and Quagga mussels. Studies by widely respected authorities on mussels indicate that EarthTec QZ is one of the most effective and practical products currently available for mussel control. State labels have been granted in all 27 states that have dreissenid mussels, including California.

Advantages of EarchTec:

- It is a liquid formulation and is self-dispersing, thus greatly reducing time and labor for application.
- The copper is formulated in the biologically-active form (as cupric ion, Cu++), and stays in solution until it encounters a cell wall to bind to and penetrate, so virtually 100% of the copper applied is effective, with no waste or copper precipitating into bottom sediments.
- EarthTec is NSF-certified for drinking water, reservoirs, lakes, irrigation canals, and even (under another brand name and label) for swimming pools & spas. It's also approved for raw water intakes and sedimentation basins within water treatment plants.
- Does not contain precursors of disinfection by-products like THMs and HAA5s
- Greatly reduces taste and odor, and the organisms that cause them.
- Long history of effective use with no negative impacts on fish and other non-targets.

Project Goals:

- Treat Lake Casitas with the minimum dose or doses required to achieve 100% mortality of dreissenid mussel adults, juveniles, and larvae.

- Minimize collateral damage to non-target species such as fish, amphibians and native mollusks.

Proposed Method: Based on existing information, our proposed approach is to:

- Dose with sufficient EarthTec QZ to achieve 0.24 mg/L (ppm) copper equivalent in Lake Casitas.
- Monitor copper concentrations beginning the day prior to application and then every 24 hours at key spots around the lake.

- For the 6 days following the initial treatment, apply additional “bump” treatments as necessary to maintain a free copper concentration at or above 0.12 mg/L for at least 120 hours (6 days).

- Beginning on Day 3, check adults every few days for any survival and monitor for any living veligers using plankton tows.

- If any adults are still living after 6 days, apply supplementary doses of EarthTec QZ as necessary to maintain 0.12 mg/L free copper during the subsequent 5 days.

- Interface with local agents who regularly monitor veliger presence using plankton tows and settlement plates for the subsequent 6 months.

Preliminary Cost Estimate:

Assumptions:

- Lake at 30% of full capacity = 76,000 acre-feet of water = 24.8 billion gallons
- Treat 100% of lake volume*.
- Initial dose at 0.24 mg/L, as copper = 100,000 gallons of EarthTec QZ.
- 2 supplemental doses at 0.12 mg/L, as copper.
- Discounted bulk pricing.
- Application will be done by a licensed, private, third-party contractor at competitive market rates.

* *A Special Local Needs permit will be required.*

Cost Estimate: $2.0 million in chemical cost for three treatments expected to achieve 100% control. Any further treatments, if required, will be handled through a cost-sharing arrangement with the customer. The cost of an applicator's service is expected to be in the range of $100,000 to $200,000.

More precise cost estimates will be possible as further details of the situation become available.

Next Steps:

On-Site Survey - A site visit by reps of Earth Science Labs will verify conditions in the field.

Small-Scale Trial - A field trial would serve as proof of concept to stakeholders and funding sources, and a way to answer site-specific questions you may have regarding efficacy, effects on non-targets, persistence of copper in the water, etc.

Regulatory - Gauge the response and potential for support from agencies such as Fish & Wildlife, NOAA, Bureau of Reclamation, etc.

Stakeholder Engagement - Sport fishermen and other recreational users may have concerns about the collateral impacts of an eradication effort, for example on game fish; ESL emphasizes that our goal is zero "take" (by-kill) of fish and we believe this is achievable. Regardless, we can't lose sight of the fact that dreissenids are highly destructive invasive species that completely alter an ecosystem through their effects on fish, bivalves, phytoplankton, zooplankton, etc. Dreissenids were first detected in Lake St Clair, Ontario, which at that time was the area of highest mollusk biodiversity in all of Canada, yet in the 5 years following their appearance in North America at least 12 species of native mussels were driven to extinction.

We look forward to a meeting during which we can discuss in greater detail the particulars of the situation at Lake Casitas and how best to meet your needs.

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Appendix E

Biology of Zebra and Quagga Mussels

Quagga and Zebra mussels are members of the dreissenid family of bi-valves. These non-native, invasive mussels are an environmental and economic nuisance across North America and Europe. An understanding of the biology of the dreissenid mussels, especially their differences to native aquatic species, is essential for control of these invaders. A basic description of mussel characteristics follows in the subsequent paragraphs.

Dreissenid mussels are bivalve mollusks that have:

- Two equal sized shells, also referred to as valves.
- Unequal adductor muscles - the main muscular system that opens and closes the two valves. All freshwater bivalve mollusks have two adductor muscles, one anterior and one posterior. The muscles are strong enough to enable the animal to close its valves tightly when necessary, such as when the bivalve is exposed to the air during low water levels, when attacked by a predator or exposed to a noxious chemical.
- They are filter feeders, using an inhalant siphon to bring in food, sieving small particles from the water using cilia on the gills, and exhaling the sieved water and waste through the exhalant siphon. Any material not digestible is wrapped in mucous and expelled as “pseudofeces” through the inhalant siphon.

There are four main species of freshwater bivalves in North America:

Native Bivalves

- The Sphaeriidae or Fingernail Clams (named for their shape).
- The Unionidae, or Pearly Mussels (named for the mother-of-pearl layer on the interior of their shell).
- All native bivalves are burrowers and because they spend most of their time within the substrate they are referred to as “infaunal” mollusks.

Introduced/Exotic Bivalves

- The Corbiculidae, or Asiatic or Asian Clam (named for their Asiatic origin).
- The Dreissenidae, Zebra and Quagga Mussels (named for the zebra-stripe pattern on their shells) and Conrad’s false mussel are the only fresh water mussels in North America that possess a byssus - a bundle of strong filaments secreted by the foot of the animal to attach themselves to surfaces (**Figure E.1**).
- The Asian clams are infaunal mollusks, like the sphaeriids and unionids.
- The dreissenids spend most of their lives attached to the surfaces on the substrate, like rocks, concrete, native mussels, plants, piers, etc., Because they spend most of their time on surfaces they are referred to as epibenthic (epi = upon, benthic = substrate) mollusks.

Figure E.1 - Zebra mussel with a byssus

Appendix E.1 - External Biology.

The shell of the Zebra mussel is distinct, taking its name from its zebra-like stripes on the exterior of its shell. Its scientific name (*Dreissena polymorpha*) refers to the many variances (or morphs) that occur in the shell's color pattern, which can include albino, black and brown. The Quaggas have an equally variable pattern to their shell, but the bottoms of their shells are more rounded than those of Zebra mussels. Usually the way to tell Zebra and Quagga mussels apart is to place each shell on its ventral side; the Quagga mussel will topple over due to its rounded bottom surface, while the Zebra mussel will remain upright (**Figure E.2**).

Figure E.2 Zebra mussel on the left, Quagga mussel on the right

Occasionally, Zebra and Quagga mussels are confused with a third species – *Mytilopsis leucophaeta*, Conrad's false mussel. This species is distinct in that it has unique structure on the inside of the shell (an interior apophysis or septum), which is absent in Zebra and Quagga mussels and generally the shell is uniformly dark and not striped.

Most adult dreissenid shells average 1 - 2.5 cm, but may reach 4 cm on occasion. Their shells are designed to survive on hard surfaces. Their strong byssal attachment makes it difficult for predators to pry the mussels from surfaces. If cross-sectioned, the shells are tent shaped, again making it difficult for predators to grasp.

Appendix E.2 – Interior Biology. The shell's hinge has a ligament that joins the two vales dorsally. The ligament has a built-in torque that opens the valves, which is why most dead bivalves are found gaping. The pointed end of the shell has an apical septum, or myophore plate to which attaches the small anterior adductor muscle – one of two that help to close the two valves. The broad, round posterior end of the shell, houses the large posterior adductor muscle. Each of these posterior and anterior adductor muscles serves to close the valves. The ligament serves to open the valves when the adductors relax.

A thin tissue, called the mantle, envelops the internal body of the mussel. The mantle (also known by the Latin word pallium, meaning mantle, robe or cloak) is a significant part of the anatomy of mollusks: it is the internal dorsal body wall that covers the visceral mass and usually protrudes in the form of flaps ornamented with tentacles well beyond the visceral mass itself. In all mollusks the epidermis of the mantle secretes calcium carbonate to create a shell.

The mantle has two openings for the inhalant siphon (lower opening) and exhalent siphon (upper opening). Siphons are tube-like structures in which water flows in and out. The water flow is generated by gill cilia used for feeding; the gills also serve for respiration and elimination of waste. The siphons are part of the mantle. In the native bivalves the gills also serve as reproductive structures, with brood sacs in sphaeriids, and marsupia in unionids.

The inhalant siphon is the larger opening and is ringed with 80 to 100 tentacles, which assist in selecting food particles. The exhalent siphon is cone-shaped, has no tentacles and is dorsal to the inhalant siphon. Ventrally, the small foot (reduced in size due to its epibenthic habit) protrudes through the pedal gape, which occurs when the valves gape. However, there is a permanent opening that allows for the extrusion of the large byssus while the shells are closed. Dreissenids have a small muscular foot, which is used to pull the animal over the substrate (typically rock, sand or gravel). It does this by repeatedly advancing the foot, expanding the end so it serves as an anchor, and then pulling the rest of the animal forward. It also serves as a fleshy anchor when the animal is stationary.

The byssal glands are housed adjacent to the foot, and are responsible for secreting byssal threads, which allow mussels to adhere to objects. The threads are formed one at a time, branching from a central stem. In order to detach itself from an object, enzymes are secreted at the base of the byssal mass and the entire mass of byssal threads are released – the mussel then secretes new threads. Mussels 2.5 cm in length may have up to 600 threads holding it in place.

On each side of the body of dreissenid mussels are gills, which are divided into a series of water tubes by septa or filaments – these filaments make up sheets or lamellae (thin plate-like structures with space in between). Through the small openings in the lamellae, lake water is able to circulate.

The dreissenid mussels' gills are covered with small cilia, which create currents that aids in pulling water through the inhalant siphon, into the mantle cavity and over the gills. As digestible particles pass over the gills, they are removed by the cilia, and directed towards the mouth for digestion. Inedible particles are wrapped in mucous and rejected as pseudofeces.

The mouth is comprised of a pair of flaps called labial palps and is located at the anterior end of the body around the mouth. The labial palps assist in guiding and selecting digestible food into the mouth, through a

short esophagus and into a large, thin-walled stomach. Undigested food is passed by cilia from the stomach to eventually be expelled at an anal papilla located within the exhalant siphon.

Appendix E.3 - Reproduction and Life Cycle.

Zebra and Quagga mussels have separate male and female gender. Eggs and sperm begin maturing when the water temperature reaches about 12°C, but their numbers don't peak until the end of May/June when water temperatures near 15-17°C. After eggs and sperm are released by the adults, fertilization occurs externally in the water. Some females can produce up to 1 million eggs in 2 years.

In the Great Lakes the peak reproductive season is in June/July, but the larvae that are born in the spring can reach sexual maturity (at length of 8 to 10mm) by mid-summer and contribute to the production of new larvae (veligers) by the fall. Spawning may last 3-5 months though it can last longer in warmer climates. The development from fertilized egg to ready-to-settle larvae requires 3-5 weeks depending on the ambient temperature of the water.

Appendix E.4 – Larval Life Cycle.

The larval life cycle has three stages (**Figure E.3**):

Veliger Stage: After fertilization the embryos develop into free-swimming larvae in 6-20 hours. Several days after fertilization, the veliger secretes its first larval shell and continues to grow for the next 3 to 5 weeks. The next stage is D-shaped or straight hinge shape, followed by a clam shape. Up to this point all of the larval stages are capable of limited "swimming" using an apparatus called the velum. This ability makes it possible for them to maintain their position in the water column. However, it is not possible for them to swim against any current. Eventually the larvae lose their velum, acquire a foot and the name pediveliger. Unless carried by current, they fall to the bottom seeking a place to attach.

The Pediveliger: Uses its foot for crawling on surfaces. It seeks out appropriate surfaces, secretes its byssal thread and undergoes metamorphosis to become a plantigrade (a stage between pediveliger and an adult shape).

The Plantigrade: Continues to grow, acquiring the adult triangular shape. It is now called a juvenile, and with time, further growth and sexual maturity, an adult. Mussels can grow incredibly fast, as much as 0.5 - 1mm/day. Typically, adults grow 1.5-2cm/year with average daily growth rates in summer at about 0.10mm – 0.15mm/day. Depending on water temperature and food supply mussels can reach sexual maturity in as little as eight weeks. In the Great Lakes the maximum lifespan of the adult mussels appears to be 2 to 3 years.

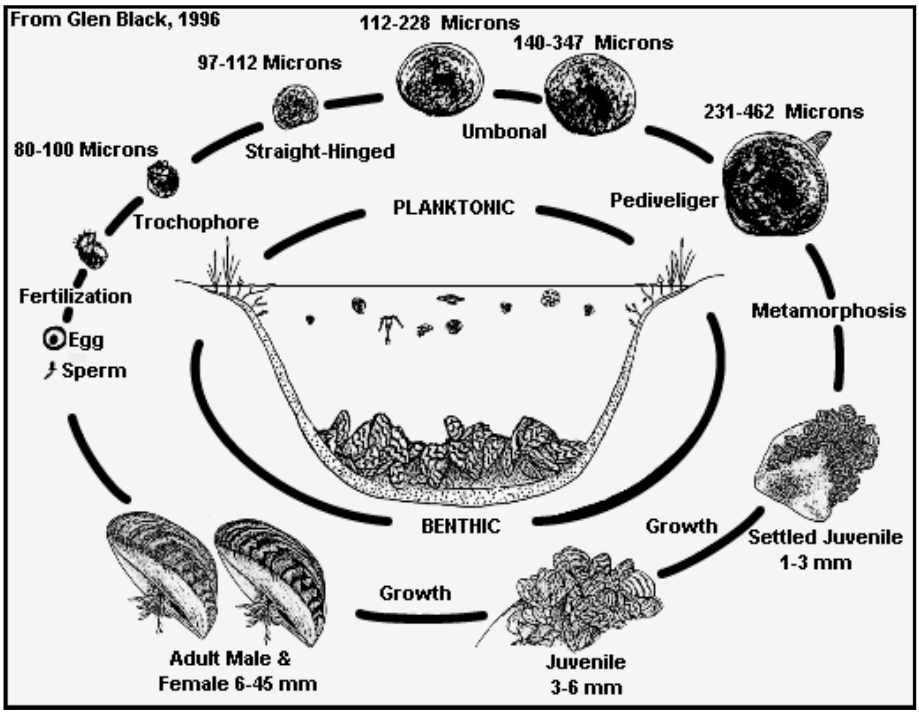


Figure E.3 - Dreissenid life cycle

Appendix E.5 – Habitat

Dreissenids are epifaunal, living upon or on top of all types of solid substrates – rocks, floating logs, break-walls, pipelines, cooling water systems, wet wells, intake structures, hulls of boats and large living invertebrates such as large unionid shells and crayfish. All other freshwater bivalves are infaunal living partially or completely buried in sediments.

Dreissenids are found at varying depths. Quagga mussels have been found as deep as 120 meters in Lake Ontario. They tend to be most numerous in the zone below ice formation and above the thermocline (1 meter to 10 meters). Densities of up to 100,000/m^2 have been recorded in many infested areas.

Young mussels will settle in internal piping where the water flow is slow (less than 1.5 – 2m/sec), allowing for easy attachment. When they first settle they increase the coefficient of friction within most pipes often causing a decrease in head pressure. Further settlement and growth will result in a decreased supply of water to vital areas, obstruction of valves, and loss of heat exchange efficiency. If mussels are allowed to infest a system and are then eliminated, a large number of byssal threads are left behind, up to 500 per mussel. This large number of byssal threads can continue to disturb the flow of water through pipelines. Byssal threads can also affect iron and steel pipelines by increasing corrosion rates under areas of attachment. Bacteria thrive underneath the mussel colonies and anaerobic respiration produces acidic compounds, which can accelerate corrosion and pitting of pipelines.

Dreissenids will attach to any non-toxic hard surface. They also attach to each other, which creates large clump-like colonies. These clumps can break off and cause downstream fouling of intake structures, pipes etc. The clumps, called druses, also act as substrate for settlement, particularly on soft substrates like sand that otherwise is inappropriate for dreissenids.

Appendix F

Mussel Control Options and Alternatives

Appendix F.1 – Use of Chemicals for Mussel Control.

The treatment of choice for most facilities tends to be one of chemical control, as it has often proven to be convenient and effective. To date, chemical control has been the common practice in both Europe and North America. The major advantage offered by chemical treatments is that they can be engineered to protect almost the entire facility, from intake to discharge. The difficulty in pursuing treatment through chemical means is in limiting the discharge of toxic materials to the environment and meeting local environmental regulations. As facilities continue to find themselves in an increasingly stringent regulatory environment, mitigation based on use of chemicals may have to be limited. The exception to this is the new biopesticide Zequanox from Marrone Bio Innovations. This product is specific to dreissenid mussels and requires no detoxification. In Canada this product has a label which allows use only in once-through cooling systems of hydraulic generating stations but less stringent labeling is currently under negotiation. When fully approved, it could be used in-once through cooling systems of any facility.

A wide variety of chemical treatment strategies are available for controlling mussel populations. One objective, however, should always be to minimize local environmental impact whenever possible and practical. It is, therefore, essential to work with the local regulators to ascertain that the chemical of interest is acceptable to them, especially when treated water is to be discharged into the local waterway. In closed systems, or under static conditions, a wider variety of chemical treatments can be used, provided there is no release to the environment.

Appendix F.1.1 – Reactive Options Using Chemical Control. Reactive chemical control strategies are used after adult mussels have become established in a raw water system. At this time, there are no reactive treatments using chemicals for fouled external structures.

Appendix F.1.2 – End-of-Season Treatment. End-of-season treatment is performed after the mussel breeding season is complete. Sufficient oxidizing or non-oxidizing chemical is applied for a long enough period to kill all adults established in the system. The end-of-season treatment pre-supposes that the pipe system in question can tolerate one season's worth of macrofouling and that the accumulated biomass and shells can be removed from the system after the treatment. Adult mussels will release from the internal walls of systems during and after the treatment. The system components must be able to tolerate the predicted mass of shell material that is released, and maintenance staff must be on hand to remove the debris. It is very hard to predict the rate at which the release of shell material will take place so it is wise to prepare for both early post-treatment release of large amounts of shells and ongoing release of shells for several weeks thereafter.

When deciding on the timing for an end-of-season treatment, operating experience in the continental northeast suggests that mussels tend to be most vulnerable just after spawning. Therefore, adults may be most easily eliminated in the fall at the end of the spawning cycle.

Appendix F.1.3 – Periodic Treatment. Periodic treatment is a variation on the end-of-season treatment. Once again, adults are targeted, but the chemical is applied more often, basically eliminating the fouling while the densities and physical size of the adult mussels remain fairly low. The

chemical concentration needed and the duration of application will be similar to that used for the end-of-season treatment. The biomass that has to be removed following the application is proportionally smaller, but the system in question still must be capable of tolerating a high degree of fouling. If implemented frequently, periodic treatment will prevent the presence of large individuals in the system.

Appendix F.1.4 – Proactive Options Using Chemical Control. The following chemical treatments are designed to be used proactively to prevent the settlement of mussels in raw water systems.

Appendix F.1.5 – Intermittent Treatment. Chemical dosing at frequent intervals (every 12-24 hours) is aimed at preventing infestations before they begin. It is generally accepted that the freshly settled post-veligers are more susceptible than adults. Therefore, the concentration of chemical used and the duration of application to control this life stage will be significantly less than if adults are targeted. Most intermittent treatments will not eliminate adults already present in the system or translocators that gain access.

Effective treatments include:

- Chlorine as sodium hypochlorite used for 30 minutes every 12 hours, at 2 mg/L to prevent freshly settled post-veligers from developing. This strategy was used at several plants belonging to Ontario Hydro for a number of years with good results.
- The addition of 5 – 8 mg/L of ozone for 5 minutes every 12 hours can prevent the development of dreissenid mussel populations.
- Chlorine dioxide applied for 15 minutes every 6 hours at a concentration of 0.25 ppm and ambient temperature of 12.8ºC, has been shown to achieve 95% reduction in new settlement.
- An intermittent strategy using the molluscicide Mexel has been developed in Europe. An addition of 6 mg/L of the Mexel chemical for 3 hours prevents infestation. More recently, the manufacturer suggests that a once per day 30-minute addition of Mexel at a level of 4 ppm to 5 ppm will control freshly settled mussels and avoid infestation of the system.

Appendix F.1.6 – Semi-Continuous Treatment. The semi-continuous treatment was developed after observing the response of Zebra mussels to a chemical irritant. Upon exposure to a noxious substance (oxidizing chemical), mussels will stop filtering and quickly close their shell. It will then take 15 to 30 minutes before they will reopen the shell and attempt to resume filtering. This means that the treatment schedule can be adjusted to 15 minutes on and 15 to 45 minutes off. This is particularly advantageous to facilities that have multiple systems to be treated. The chemical addition system will work continuously, but the chemical can be directed sequentially to the different systems to be treated. This strategy has resulted in complete control of all stages of Zebra mussels in the piping, while using significantly less chemical than if applied continuously and minimum discharge levels due to large volume of water available for dilution.

This semi-continuous strategy has been further refined under the trademark Pulse-chlorination®. Using electrodes attached to shells of mussels within a specially constructed monitor, Pulse-chlorination® determines the precise timing for semi-continuous chlorine treatment by observing if the mussels in the monitor have their shell open or closed. The system only applies chlorine when the mussels have opened their shells and discontinues the addition when the shells are closed. This technique significantly reduces the amount of chlorine required (up to 50%) for a treatment compared to a continuous application.

Appendix F.1.7 – Continuous Treatment. The continuous treatment strategy is designed to eliminate any level of settlement in the system. The incoming larvae (veligers) do not necessarily suffer 100% mortality, but the presence of a noxious substance is enough to discourage settlement. Any adults present will either succumb to the toxin (if the low level chemical addition is carried out for the entire reproductive season) or detach themselves and attempt to leave the system being treated. The concentrations of chemical needed can be quite low but the application must be continuous. Typically, continuous treatment is chosen for systems which cannot tolerate even the smallest degree of fouling. Fire protection and other safety related systems for example, often utilize this type of treatment. To date, this type of treatment has been attempted primarily with oxidizing chemicals such as chlorine or with continuous feed of copper ions. Potentially, other chemical strategies, such as depression or elevation of the pH or continuous addition of flocculants, could be used as a continuous treatment.

Appendix F.2 - Types of Chemical Options Available

If fouling organism mortality was the only consideration when designing a treatment, any number of chemicals could be successfully used to control fouling. Due to economic and environmental concerns though, only a relatively small number of chemicals are ever likely to be used in practice. When approached by a vendor of either new or existing chemical treatment for macrofouling control, it is best to direct them to the local regulatory agency for an assessment of their product. In many cases, the manufacturer will not be willing or able to provide the money, data, or empirical studies required by regulators to gain approval for use. This reality sometimes keeps promising new products from reaching the market.

Appendix F.2.1 - Oxidizing Chemicals. Oxidizing chemicals have been utilized as disinfecting agents in water supply systems for over one hundred years. In most cases, their effect on the environment is understood and well documented. Treatment with oxidizing chemicals (primarily chlorine) has been the most frequently used proactive chemical treatment to date. Oxidizing chemicals have also been used in periodic and end-of-season treatments by a number of different industries.

Chlorine - One of the most effective and popular methods of macrofouling control is chlorination, where chlorine is added as diatomic chlorine gas, liquid sodium hypochlorite, or solid calcium hypochlorite. Chlorine has been used for over one hundred years in the treatment of potable water. It is a well-known and studied chemical with well-documented use and by-products. One of the major concerns in using chlorination in surface water supplies is that it will combine with various organic compounds to form trihalomethanes (THMs), which are considered carcinogens. Many regulatory agencies permit the use of chlorine in flow through systems but have stringent limitations on the level of total residual chlorine in the discharge water. To meet these requirements, most facilities have to de-chlorinate the treated stream, or else use a storage lagoon or a large volume of diluting water. Before deciding on a chemical treatment strategy, it is wise to contact the local regulatory agency to check on their policy for chemical treatment in general and chlorine in particular.

Chlorine based mitigation can be used for all strategies discussed above. Chlorine treatment strategies and concentrations used to control Zebra mussels also successfully control Quagga mussels.

Chlorine Dioxide - Chlorine dioxide (ClO_2) has been implemented as a disinfectant in the water treatment industry for over fifty years. It acts effectively on both aerobic and anaerobic bacteria. Unlike

chlorine based treatments, chlorine dioxide does not form trihalomethane by-products and is equally effective at all pH levels. Chlorine dioxide does not react with ammonia and therefore does not form chloramines. The by-products generated in the breakdown of ClO_2 in aqueous solution consist primarily of sodium chlorite, chlorate, and chloride, all considered to be acceptable at low levels to regulatory bodies. However, the United States Environmental Protection Agency (EPA) did find that bromate and aldehyde by-products can be formed by chlorine dioxide addition to water. The by-products include propanal to decanal series, benzaldehyde, methyl glyoxal, and glyoxal which may be of some interest depending on specific facility concerns.

Chlorine dioxide can be manufactured on-site from various precursors such as sodium chlorite and hydrochloric acid, sodium chlorite and chlorine gas, sodium chlorite and sodium hypochlorite, and hydrochloric acid or sodium chlorate and hydrogen peroxide and sulphuric acid. The manufacture of chlorine dioxide requires specialized equipment, and there have been past concerns regarding worker safety. In Germany, chlorine dioxide generators are permitted for drinking water applications only if they meet the technical requirements for automatic and airtight generation on-site.

Recently, manufacturers have started producing 3000 ppm solutions of chlorine dioxide off-site and delivering these solutions to the client. Although an aqueous solution of 3000 ppm chlorine dioxide is not classified as a hazardous substance, at room temperature it will sublimate into a gaseous phase, which is extremely poisonous. If the addition equipment is not airtight and carefully controlled, this can lead to health and safety concerns. For this reason, on-site generation with state of the art equipment is recommended.

Chloramines - Chloramines are formed when free available chlorine (HOCl and OCl) reacts with nitrogen containing compounds, such as ammonium and amino acids. Chloramines are formed naturally when chlorine or sodium hypochlorite is added to lake water. The more ammonium that is present, the higher the level of chloramines formed. Chloramines can be generated in bulk by co-injection of ammonium as either ammonium gas or ammonium hydroxide and sodium hypochlorite. Although chloramines have generally been found to be a less powerful oxidant than hypochlorous acid, they have been used as disinfectants in various applications. Monochloramine (NH_2Cl) has been used as a disinfectant in drinking water, and it was also found effective in controlling veligers of the Asiatic clam. At two French power plants, monochloramine is produced on-site by mixing sodium hypochlorite and ammonium chloride, and it is used to control Zebra mussels as well as bryozoans (*Plumatella sp).* At this time, it would seem that the use of chloramines over chlorine may hold some advantages for some facilities. This is particularly true if the formation of trihalomethanes is a concern.

Ozone - Ozone is a well-known bactericidal agent in the sewage treatment and water treatment industry. The first experiments with ozone in drinking water treatment were conducted in France in the late19th century. It was first used commercially as a drinking water disinfectant at Nice in 1906. Since that time, ozone has gained increasing popularity worldwide, particularly for its viral and bacterial inactivation properties. Viruses and bacteria are completely eliminated within thirty seconds by a dissolved ozone residual of less than 0.5 mg/L. Ozone improves taste, odor, and color of drinking water, and can also be used to prevent various other forms of biofouling. Concentrations of 0.25 mg/L to 0.5 mg/L have been reported to eliminate the blue mussel (*Mytilus*) from seawater systems in some European studies. In terms of contact time at comparable residual levels, ozone outperforms other oxidizing chemicals. The most significant negative aspect to an ozone based mitigation strategy is the high initial capital cost of the equipment and the difficulties involved in maintaining it. Additionally, one of the main characteristics of

ozone that make it attractive for use in once-through systems also turns out to be a major drawback. The relatively unstable ozone molecule dissipates quickly in water depending on a number of factors including temperature, pH, and organic matter concentration.

In practical applications ozone has performed remarkably well in controlling dreissenid infestations. In Canada, ozone treatment is currently being used in an electricity generating station on Lake Ontario to prevent biofouling of once-through service water systems. The ozone generating equipment was installed in the spring of 2000 and put into immediate use. Ozone is injected at the start of the system at 0.5 mg/L to 0.3 mg/L continuously throughout the mussel breeding season. At this location, ozone has provided excellent control of all biofouling, including the prevention of Zebra mussel settlement. It has also eliminated any adults which had previously settled in the system prior to the installation of the ozone generator. This elimination took place within the first six months of the initiation of the treatment system. Caged fish fingerlings placed in the discharge stream of the generating station did not suffer any mortality, upholding ozone's reputation as an ecologically friendly treatment option. The Lake Ontario data mirrors the experience in Belgium at a power plant on the river Meuse. At this installation, ozone was injected at the level of 0.3 mg/L to 0.5 mg/L. This treatment achieved complete control of Asian clams and Zebra mussels, as well as bacteria and algae in the secondary cooling system. The discharge into the river had less than 10 ppb of residual ozone. Significant mortality of adults was observed after 20 days of exposure, with complete mortality achieved in 48 days.

A fish hatchery in New England currently utilizes an ozone treatment system. The facility is relatively small, using approximately 11 MGD of raw water. The mussel-control regime involves continuous application of ozone at a concentration of 0.3 mg/L. The system is designed to treat a 2,500 ft. long pipeline, inactivating the Zebra mussel veligers in order to limit infestation in the hatchery raceways. The ozone injection at the intake is followed by removal of ozone at the hatchery using ultraviolet light.

Hydrogen Peroxide - Hydrogen peroxide has the reputation of being a benign oxidizing agent, dissociating into hydrogen and oxygen and leaving no detrimental environmental by-products. While this may not be completely true, it is frequently used as an algaecide or biocide in small, contained systems such as spent fuel bays in nuclear generating stations.

Several trials on both adult Zebra mussels and veligers have shown that relatively high doses of hydrogen peroxide are required to induce mortality. A concentration of 12 mg/L was required for adults and 6 mg/L was needed for veligers. Ninety percent mortality of adult Zebra mussels in 21 days of exposure to hydrogen peroxide was achieved at a concentration of 5.4 mg/L. The duration of the treatment decreased with increasing hydrogen peroxide concentration. Total mortality was achieved after 7.8, 4.8, and 3.0 days at concentrations of 10, 20, and 40 mg/L, respectively. In the same study, Asiatic clams were observed to be less sensitive to hydrogen peroxide than Zebra mussels. Total mortality for the clams was observed after 13.5, 9.5, and 9 days at concentrations of 10, 20, and 40 mg/L, respectively.

As hydrogen peroxide is quite expensive when compared to sodium hypochlorite, it would not seem economically practical to treat large volume, flow-through systems using this chemical.

Potassium Permanganate - Potassium permanganate is another oxidizing chemical commonly used in municipal facilities for water purification. It is widely utilized to protect against oxidation of iron and manganese, and for control of taste and odor problems. Effective control of adults has been achieved at a concentration of 2.0 mg/L and veliger settlement was prevented using a concentration of 1.0 mg/L. These

results suggest that potassium permanganate may prevent the settlement of mussels, but that it is not acutely toxic to either veligers or adults.

The Paul M. Neil Water Treatment Facility has employed the use of potassium permanganate at the intake structure on Lake Michigan, successfully preventing mussel settlement in the 2 miles of piping leading to the treatment facility for several years. Utilizing potassium permanganate as a mitigation strategy seems most applicable in potable water treatment facilities, especially considering that many already utilize this chemical for sanitation purposes or to eliminate trihalomethanes already in solution.

Appendix F.2.2 - Non-oxidizing Chemicals. A number of non-oxidizing chemicals have been developed for bacterial disinfection, algae control, and as molluscicides. Some of these chemicals have regulatory registration for use in once-through cooling systems. With few exceptions, these products require detoxification upon discharge to the environment. Most of these products are used for end-of-season or periodic treatments.

Proprietary Molluscicides - The term molluscicide is somewhat of a misnomer as generally these formulations are toxic to a wide variety of species and not just molluscs. Many of these proprietary formulations are based either on quaternary amines (Betz-Clamtrol) or on isothiazolones (Buckman-Bulab 6002) or on other organic compounds (Bayer-Baylucide). The use of these products in closed systems is unrestricted. In once-through applications, most of the products have to be detoxified with the addition of bentonite clay slurry.

The major form of use for these chemicals is as an end-of-season or, in some cases, periodic treatment. These chemicals are not detected by mussels as noxious compounds, allowing them to continue filtering normally without closing up until death. Thus, mortality can be achieved quite quickly. Depending on the concentration used and the ambient temperature of the water, significant mortality can occur in 4 to 24 hours. Non-oxidizing chemicals have been used with good results in a number of facilities primarily as an end-of-season or periodic treatment. In some of these applications, operators have been able to set up closed loop systems where the same chemical was recirculated for the required period of time. This type of application significantly decreases the volume of chemical required, which is of both environmental and economic benefit.

There are two considerations when using non-oxidizing chemical treatments. First, when a facility uses bentonite clay for detoxification of periodic or seasonal treatments; the amount of material which will accumulate in the discharge over the period of some years needs to be considered. The active product will adhere to the clay particles and be carried to the bottom. The fate of some of these complex products in sediment is not well documented, but some products are believed to be quite persistent. Second, most of these products require relatively warm ambient temperatures to work swiftly. In temperate zones, this may mean a treatment well in advance of the end of spawning, leaving a fairly sizable population of macrofoulers in the system to grow over the winter.

One category of non-oxidizing chemicals is proprietary compounds which act as filming agents and are based on fatty amines. The Mexel® line of products belongs in this category. These products consist of filming aliphatic amines which are thought to inhibit corrosion, prevent slime, scaling, and various forms of macrofouling. The active ingredient in Mexel® is an alkyltrimethylenediamine (ATMD). Mexel ® was found to inhibit the formation of byssal threads of dreissenid mussels at concentrations of 2, 6, and

10 mg/L. Unlike other proprietary products, Mexel® can be used as an intermittent treatment. When added at the water intake point, typically once a day for 30 minutes at a level of 4-5 ppm, Mexel® has been reported to keep all treated systems free of dreissenid mussels. Unlike other proprietary products, Mexel® does not require detoxification on discharge. High concentrations of total suspended solids (TSS) or organic matter content in the water will require larger concentrations of chemical to maintain an effective residual treatment level.

Zequanox - Over the last decade, an enormous amount of work was undertaken by a team led by Dr. Dan Molloy from the New York State Museum studying the use of a common soil bacterium as a specific control agent for dreissenids. The team found that the bacterial species *Pseudomonas fluorescens*, strain CL145A, has the ability to cause mortality in adult mussels. When dreissenid mussels ingest artificially high densities of the bacteria (living or dead), a toxin within the bacterial cell destroys the mussels' digestive system. To date, no other aquatic species tested has demonstrated any susceptibility to this bacterium.

Zequanox is currently in the commercialization stage and concurrently going through the regulatory approval process in Canada. Marrone Bio Innovations is the company behind this effort. At this time the product is very expensive but with economies of scale it could potentially offer a significant alternative to all forms of chemical control.

Ammonium Nitrate - At concentrations of 400 mg/L to 500 mg/L, ammonium nitrate has been reported to cause 100% mortality of adults in 5 to 6 days when ambient water temperature was 61°F to 67°F (16.1°C to 19.4°C). Ammonia concentrations exceeding 3 mg/L have been reported to cause 100% mortality in veligers. This treatment is not feasible for once-through systems, but could be used within a closed loop and also in agricultural circumstances where chemical fertilization is already being used. Ammonium nitrate does not appear to offer any advantages over the commercial molluscicides mentioned above except perhaps economics.

Copper Ions - Dissolution of copper and aluminum anodes by electrolysis has been used to protect ship cooling systems from macrofouling for at least forty years. Based on the marine experience, a series of experiments was conducted to determine if the same technology could be used against dreissenid mussels. A continuous dose of 20 ppb of copper ions appears to limit veliger settlement in systems protected in this manner. This technology was commercialized under the trademark of MacroTech Copper Ion generator. Wisconsin Energy Corporation utilizes this copper ion technology to control dreissenid mussel infestations in its Oak Creek Power Plant service water system in west Lake Michigan. The copper ion generator does not eliminate all macrofouling in the service water system, but the level of infestation is acceptable to the plant personnel. The copper ion generator equipment has significant short-comings for use in industrial setting such as uneven release of copper ions, no built-in feedback loop, and no alarm system for low levels of copper. The discharge of copper ions into the aquatic ecosystem may not be permitted in all jurisdictions.

Copper sulphate and the copper rich algaecide, Cutrine-Ultra® and EarthTec, have been reported to eliminate adult mussels while being used for algal control in various systems at levels of 30 to 50ppb applied for a number of days (**Table F.1**).

Dose as EarthTec	Dose as element	Mortality after: 6 days	11 days	13 days	19 days	25 days
3 ppm	150 ppb	100%				
2 ppm	100 ppb	100%				
1 ppm	50 ppb	50%	100%			
0.6 ppm	30 ppb	15%	55%	70%	80%	pending

Appendix Table F.1 – Mortality of adult Zebra mussels when exposed to various levels of EarthTec under flow-through conditions.

Potassium Salts - Potassium compounds are toxic to most bivalves, including dreissenids and corbiculids. ASI Group has been using potassium chloride as an end-of-season treatment for a number of different systems. They have found that 100 mg/L for two days at an ambient temperature of 15°C resulted in 100% mortality of dreissenid adult mussels in the system treated. The length of treatment increased with decreasing temperatures. In 2006, ASI Group treated an isolated quarry in Virginia with potassium chloride in order to eradicate an infestation of Zebra mussels. A total of 131,000 kg of muriate of potash (KCl) solution was used with apparent success. Recently the Manitoba Government conducted very successful eradication of Zebra mussel in several harbors on Lake Winnipeg.

Although potassium compounds are nontoxic to higher organisms such as fish, the toxicity to native bivalves makes the approval for use of potassium salts in once-through systems unlikely. In closed loop systems, however, the use of potassium salts is an attractive option.

Sodium Metabisulfite - Dreissenid mussels are relatively intolerant of low dissolved oxygen concentrations (< 25% of full air saturation levels), which at 20°C (68°F) is approximately 2.3 mg/L at sea level or 1.8 mg/L at an elevation of 2133 m (7000 feet). Systems with less than 3 mg/L at 20°C (68°F) would have little chance of mussels surviving. Dissolved oxygen concentrations exceeding 50% saturation seem to be required for sustained, healthy populations. Depressing the dissolved oxygen level in a system infested by dreissenids could be a form of end-of-season treatment. Several dual intake water treatment plants in Wisconsin have received permission to add either chlorine or sodium bisulphite to the intake they wish to take out of service. The chemical is added just before the intake is capped and kept static for four to ten weeks. At the end of the lay-up period, all Zebra mussels will be dead either from the effects of chlorine or from anoxia caused by sodium bisulphite removing all available oxygen.

The use of sodium metabisulfite as a dechlorinating and oxygen stripping agent prompted speculation if this chemical could be used effectively as a treatment for Zebra mussels. Sodium metabisulfite by itself is not very toxic to Zebra mussels. A minimum concentration of about 177 mg/L of sodium metabisulfite would be required to kill all adult mussels in closed systems. Below this level, toxic effects are absent. Anoxia caused by the addition of sodium metabisulfite will contribute to mussel mortality on prolonged exposure as sodium metabisulfite is an effective oxygen stripper. Depending on facility-specific conditions, anoxic conditions combined with higher water temperatures will increase dreissenid mortality more than the effects of either alone.

Sodium metabisulfite is not considered to be a practically feasible chemical to kill Zebra mussels in pipelines or conduits because enormous amounts of the compound are required for treatment where water is renewed continuously. However, it may be practical for use in closed systems, such as fire protection systems, which hold water for long periods of time. The potential for unacceptable growth of sulphate-reducing bacteria should be evaluated before using this method as the bacteria can cause serious corrosion problems in the system.

pH Adjustment - Dreissenid mussels have a range of pH values within which they flourish and outside of which they do not survive for prolonged periods of time. Given the relatively narrow range of pH tolerance, water systems which draw water with pH near the limit for successful survival of dreissenid veligers may be protected if the pH is either further depressed below 7.0 or raised above 9.5 at the raw water intake. This could create a hostile environment which would preclude dreissenid settlement.

Recent research suggests that, at pH 6.9 and pH 9.6, new settlement by veligers is essentially prevented. Furthermore, a pH of 3 as well as a pH of 12 will cause adult mussel mortality in approximately 140 hours.

If practical, pH adjustment would act as a continuous chemical treatment preventing all settlement and growth. The lowering of pH can be particularly useful for drinking water facilities which adjust the pH of the incoming water before processing it. If the point of pH adjustment could be moved to the intake of a facility, it would protect all subsequent structures and systems.

Increasing the pH to 9.6 will not only prevent mussel settlement but it may also inhibit bio-film formation in the system treated. However, if the raw water has a high calcium saturation index, precipitation of calcium carbonate may occur when pH is increased. In such water bodies, high pH treatment will not be a viable option.

Chemical Cleaning - Chemical cleaning is an option to be used in the event that small diameter piping or perhaps heat exchangers become plugged by mussels and mechanical cleaning is difficult or impossible at that location. Several products exist on the market, mostly proprietary inorganic acid mixtures (e.g. phosphoric acid mixtures), which will rapidly dissolve mussel shells. The chemicals will often remove accumulated corrosion products as well. The suitability of the pipe material of construction needs to be checked to ensure the pipe will not be degraded beyond acceptable limits. The vendor generally assists in delivering the product in a suitable container. The chemical product is circulated through the piping in a closed loop manner for three to four hours and then removed for recycling by the vendor. The system is then flushed and, if found satisfactory, is returned to service. This is an expedient remedy for small, neglected systems but is not appropriate for large volume systems.

Appendix F.3 – Non Chemical Mussel Control

Just as there are proactive and reactive techniques using chemicals, there are proactive and reactive non-chemical strategies for macrofouling control.

Appendix F.3.1 - Non-Chemical Proactive Techniques

Infiltration Galleries and Sand Filters - Infiltration galleries and sand filters are capable of removing all stages of all mollusc macrofoulers and protecting all downstream systems and components. An infiltration gallery can be described as a “built-in-place” rapid or slow sand filter. Those designed as

rapid sand filters have flow rates of 7 to 15 L/min (2 to 4 gpm) per 0.1 m^2 of filter area. Others slow filter at a rate of 0.15 to 0.3 L/min (0.04 to 0.08 gpm) per 0.1 m^2. Given these projected flow rates, obtaining large amounts of filtered water would require construction of an infiltration area of substantial dimensions. Such an undertaking undoubtedly requires regulatory approval as it takes place in or near a water body and generally involves shoreline alteration. Additional engineering factors which have to be incorporated into the design process include raw water quality, proximity to sources of high turbidity, hydraulic considerations, and cleaning method and frequency.

Although infiltration galleries and sand filters offer full system protection, they are not appropriate for existing facilities using large volumes of water. The retrofit required is likely to be very expensive, difficult to implement, and may result in an unacceptable pressure drop to the system. For new intakes, an infiltration gallery could be a viable option. Currently, infiltration galleries are being considered for a number of water withdrawal applications.

Mechanical Filtration - Mechanical filtration is capable of removing all stages of all mussels if an appropriate screen size and configuration is used. Most conventional industrial strainers have strainer screen openings which will prevent some translocating mussels and most shell debris from fouling the raw water systems. None, however, will protect against the introduction of larval stage organisms. In most instances, it is not possible to retrofit existing strainers with finer screens and hope for successful mitigation. The performance of such a modified strainer or filter tends to deteriorate, excessive clogging of the screen may result in stretching and tearing of the material, the backwash system may prove to be inadequate, and the pressure drop caused by the strainer may be unacceptable.

Different types of filters, designed primarily for the removal of small particles, have been tested for dreissenid veliger control by a number of different organizations. Wedge wire slot filters have difficulty in excluding larval stages of macrofoulers. This is likely due to the fact that wedge wire type screen filters are designed to remove inorganic matter such as quartz or metal shavings, but they are not designed to stop organic matter from passing through the screen. Organic particles, due to their flexible nature, tend to “sneak through” the wedges of the screen. Excellent results were obtained by Ontario Hydro using a continuous backwash, pleated screen filter and by the New York Power Authority using a modified clean-in-place bag filter to eliminate dreissenid veligers from incoming water.

Hydro-cyclone or centrifugal separators were initially thought to be a mitigation option for facilities that already employ this technology for silt removal. Studies have shown that centrifugal separators removed at most 50% of veligers present.

Many filters are very good at removing all or most particles from the water stream, but most filters are not able to process large volumes of water efficiently. Filters which use stainless steel, square weave mesh and periodic backwash seem to have the best balance between particle removal efficiency and volume of water filtered. A number of manufacturers produce such filters and the evaluation process of individual units can be confusing. We offer the following points as aid in evaluation of filters.

Filtermesh - Some manufacturers do not distinguish between nominal and absolute size of the pores in the mesh they offer. It is important to understand the difference. There are various test methods used to establish the absolute size of pores in woven wire cloths. One such method is the Bubble Point Test. The absolute mesh size rating done using this test corresponds to the diameter of the largest, hard

spherical particle which can pass through the filter medium under steady flow conditions. Nominal value, on the other hand, is an arbitrary term generally corresponding to removal of 98% of all incident particles larger than the nominal value given. Various methods are used to determine the nominal rating and the reproducibility using these methods is poor. Therefore, it is advisable to determine the quality and the absolute mesh size rating the filter manufacturer is offering.

Smythe *et al.* (1993) reports on the performance of the Kinney Strainer (equipped with a 40-, 95-, or 142-micron mesh) and the Bromm Filter (nominal mesh size 60 µm and 100 µm). Although the Kinney Strainer (40 nominal micron mesh) and the Bromm Filter (60 micron nominal mesh) reduced the densities of ready-to-settle veligers (>250 micron) in the filtrate by up to 97%, they did not totally exclude all individuals from the system. Examination of the mesh used in each case revealed that the nominal micron ratings were not reliable indicators of the largest opening found in the mesh.

Even great quality wire weave mesh will allow some organic particles greater than the absolute micron size to pass through. This is not surprising given the test protocol which uses hard spherical particles. Soft or flexible particles of size greater than the absolute mesh pore rating will be able to pass through. During recent filter trials, it was noted that a 120-micron absolute mesh allowed some veligers of up to 200 µm through. A 57-micron absolute screen passed some veligers of up to 100 µm in size.

In order to have as much open area as possible in the mesh, the wires used to create the mesh tend to be very thin. This means that unless the mesh is properly supported, the individual pores may be distorted by pressure and the cloth may be torn by the backwash system. Strong support of the screen to prevent distortion and tearing is essential. Three to four layers of “sandwich” is recommended. The various layers should be sintered together for best support and performance.

Filter Construction - Sturdy materials of construction are essential. Plastic parts generally do not stand up to the rigors of industrial application. Excellent sealing between filter components is required to prevent water interchange between filtered and non-filtered water in different chambers.

Filter Backwash System - The more water a filter uses for its backwash, the less there is available for application use. Under normal conditions, 1 to 3 percent of the total filtered flow is required for backwash. This percentage increases as the total suspended solid (TSS) load increases. The filter should be capable of backwash cycles that are based on both time elapsed and differential pressure across the screen. The greater the differential pressure across the screen, the more likely it is that soft organic material will be forced through. A differential of no more than 3 to 5 psi is generally recommended.

In addition to removing all larval stages of macrofoulers, filters remove substantial portions of particulate matter, such as sediment. How much they remove is a question of mesh size and size distribution of the particulate matter in the water column. At one installation, it was estimated that a self-cleaning filter installed on a system carrying 4,000 L/min of water removed over 10,000 kg of silt each year. Sediment removal necessarily results in improved performance and a decrease in maintenance for most industrial systems.

Filtration systems are not appropriate for water streams with continuously high sediment load such as exist in Red River. Under such conditions, the backwash system may not be able to remove the sediment

cake which builds up on the screen. Very efficient backwash systems are capable of coping with higher sediment loads. BallastSafe® reported that a filter using a 40-micron screen continued to perform even when incoming water had 250 ppm of TSS. The filter flushed continuously, with the backwash consuming between 8% and 12% of the total flow water. Since the amount of TSS a filter is able to cope with is somewhat related to the particle size distribution in the incoming water, a small-scale, site specific trial with the filter being considered is recommended.

Filter Field Installation - Operating experiences suggest that, in critical applications, a backup system (i.e. a parallel arrangement of multiple units) is a must if filtration is to be considered as a viable control measure option. For example, two filters, each capable of filtering 100% of the flow, would represent a guarantee that only filtered water reached downstream systems. If some ingress of unfiltered water can be tolerated, a system by-pass may be installed to guarantee uninterrupted supply of water in case of filter upset.

To monitor the performance of the filter, at least one manufacturer suggests installing a small fixed filter screen downstream of the self-cleaning filter. The fixed screen should be the same or a slightly larger pore size than that used in the self-cleaning filter. If this fixed screen becomes plugged, it is an alert that the self-cleaning filter is passing particles larger than the rating would suggest.

In the United States of America (USA), the State of Vermont has successfully used a series of Amiad® automatic backwashing filters for Zebra mussel control at the Edgar Weed Fish Culture Station facility since 1996. At this installation, due to the line pressure required by the filtration unit, the filter had to be located downstream from the pump. This requirement means that the intake piping must be mechanically cleaned periodically using a “pigging” unit, and that the pump itself must be allowed to dry out biannually to allow for mussel desiccation and elimination.

In the fall of 1999, a full-scale filter experiment was set up at the Nanticoke Thermal Generating Station (TGS) by Ontario Power Generation. The self-cleaning filter, equipped with a 40-micron absolute woven mesh, was installed downstream of a self-cleaning wedge wire strainer with an approximately 3 mm gap. The designed filter capacity was 12,000 gpm but the system rarely required more than 6,000 gpm. Typically, backwashing cycles were triggered about once every hour. During a backwash cycle, the water flow would drop down to about 4,500 gpm. This represents a drop of about 15-20%. The design specifications required that a minimum 30-psi differential across the cleaning nozzles be available for the system to work effectively. This had to be increased to about 45-50 psi for the filter to cope with the incoming sediment load. The system generally ran well when total solids loading was 15 mg/L or less. The filter was able to handle a TSS loading of 60-80 mg/L, but it had to backwash almost continuously. It was concluded that the system would be unable to cope when the turbidity exceeded 80 mg/L.

In terms of efficacy, defined as the difference between veligers entering the system and those passing through the filter (dead or alive), the filter achieved between 95.9% and 100% veliger removal. In all instances where veligers did pass through the filter screen, they were dead. The downstream bio-box sampler was free of any adult settlement at the end of the experiment, while the bio-box placed just ahead of the filter had hundreds of large mussels settled on walls and sampling plates.

Recent advances in filtration technology have allowed several manufacturers to design filters capable of removing all particles greater than 25 µm from relatively large streams of water. These filters are

designed to minimize pressure drop in the system and have corrected many of the problems encountered in the above described installation. Several of these filters are currently being tested as part of ballast water treatment systems.

Note on filter construction for mussel exclusion: The shape of mussels is somewhat like a flat disc. In addition, at the age where they are ready-to-settle their shell still has some limited flexibility allowing them to be flattened beyond their normal thickness without harm. Therefore wedge wire filters are not effective at excluding mussels. The recommended filter basket material is woven wire square mesh designs. The diagram below depicts a suitable commercial mesh (**Figure F.1**).

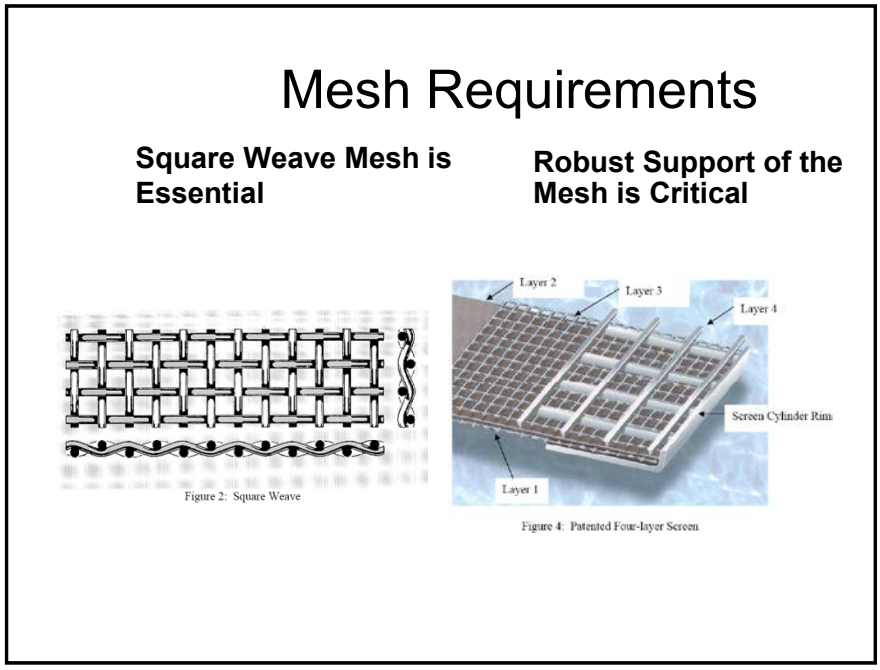


Figure F.1 - Recommended Filter Screen Construction for Mussel Exclusion

Ultraviolet Light - The use of ultraviolet (UV) radiation is appropriate for larval stages of mussels which have transparent shells. The term ultraviolet is applied to electromagnetic radiation emitted from the region of the spectrum lying beyond the visible light and before x-ray wavelength. The UV light ranges between 190-400 nm and has been subdivided into UVA, UVB, and UVC. Based on work by numerous authors in the early 1990s, UVB and UVC wavelengths were found to be most effective for dreissenid veliger control. The basis for the control is thought to be the impact of the UV light on the essential functions of the veliger, thereby inactivating the organism and preventing attachment. The most effective wavelength and the radiation dose (Dose = intensity x residence time) which the veliger must receive to experience either immediate or latent mortality have been the subject of numerous experiments.

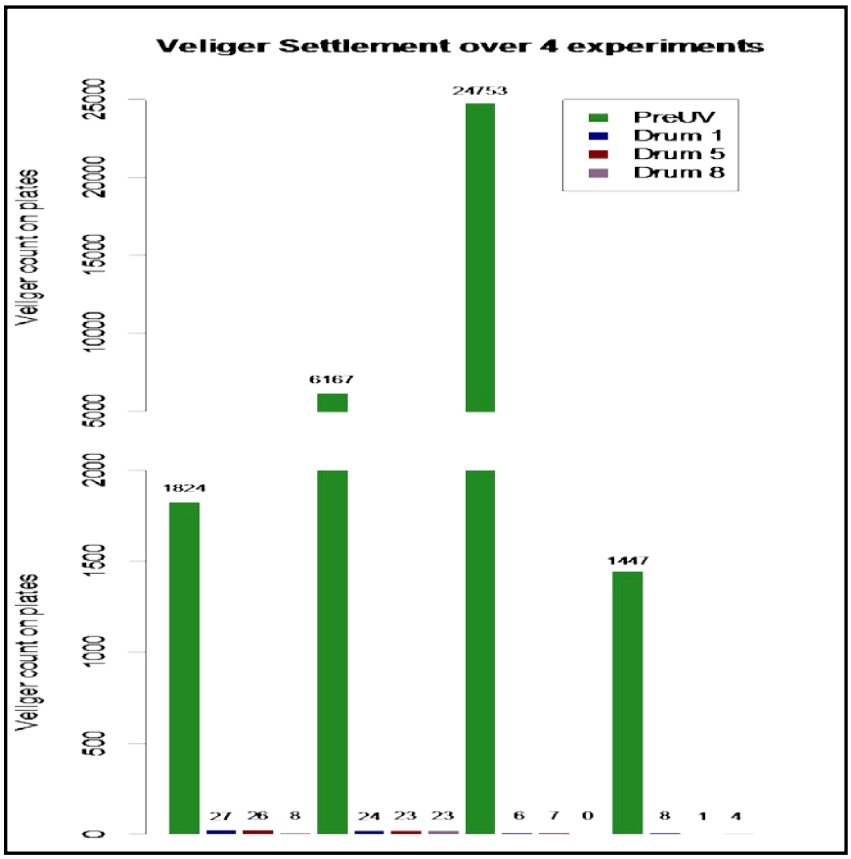
A full sized pilot UV system was installed at a power plant on Lake Huron in 1999. Twenty medium pressure lamps were arranged in four frames each containing five lamps. The total volume treated was 760 L/s (12,000 gpm). The system was sized to deliver a radiation dose of 0.07 to 0.1 Watt-seconds/cm^2 to all particles passing through. This UV system was the only means of protection for the power plant cooling system. During the operation of the UV system, lamps had to be serviced, the system

experienced numerous upsets, and, occasionally, it was even taken out of service accidentally. Despite these confounds, there was an 85% reduction in settlement in the system when compared to control.

A study aimed at treatment of ballast water in 2002 attempted to determine an effective treatment regime for ballast water systems. They found that, after the water was passed through a 50-micron filter, any remaining organisms could be eliminated by a dose of 200 mW/cm^2/s applied at a flow rate of 1000 gpm.

The effectiveness of a UV system is dependent on the characteristics of the raw water being treated. Factors such as water transmittance, presence and size of suspended solids, iron, hardness, and temperature all affect the efficacy of the UV system. Treatment systems must be designed for the worst case scenarios. This means designing for peak flows, end of lamp life intensity, minimum transmittance, and maximum suspended solids at the installation location. The aim of the system is to achieve 100% immediate or latent mortality in all ready-to-settle veligers which pass through. If an adequate dose is not delivered at this point, downstream settlement will occur as UV based systems have no residual toxicity which could impact areas outside the influence of the lamps.

In 2012 Atlantium Technologies sponsored an evaluation of Atlantium medium pressure UV system as preventative treatment for the settlement of Quagga mussel veligers. This study was carried out on the Lower Colorado River. Four separate experiments each one with a UV dose levels between 80 and 20 mW/cm^2/s were carried out. Each level provided settlement inhibition in excess of 95% (**Figure F.2**).



Appendix Figure F.2 - Overview of veliger settlement before and after UV treatments of varying strengths

In 2013 Davis Dam installed a full sized medium pressure UV system from Atlantium Technologies to protect all of the cooling water (total flow of total flow of 3550gpm) on power generating Unit 3. Davis Dam management agreed to allow the UV system to be adjusted so as to deliver various levels of UV irradiation. This in turn allowed for second evaluation of downstream Quagga veliger settlement after exposure to various UV doses using an actual industrial installation (**Table F.2**).

Cycle	UV Dose	Settlers		% Reduction
		Control	Test (after UV)	Box 1 to 2
1	50	160	8	95%
2	40	386	8	98%
3	20	223	26	90%
4	40	1445	18	99%
5	40	810	76	91%

Table F.2 – Total Settlement of mussels per square foot, including percent reductions.

For complete elimination of all settlement UV doses between 100 – 120 mW/cm^2/s are recommended.

Anti-Fouling and Foul Release Coatings - Historically, the majority of developmental work in anti-fouling paints/coatings has been directed towards prevention of barnacle growth on ships. In fresh water, anti-fouling coatings' primary use has been for the prevention of mussel attachment to structures exposed to raw lake water. Coatings do not offer any protection to the rest of a facility and therefore have to be combined with other mitigation strategies. For new facilities, appropriate selection of materials of construction may minimize the need for coatings. The following is a general substrate preference by mussels when using settling plates: copper < galvanized iron < aluminum < acrylic < PVS < teflon < vinyl < pressure treated wood < black steel < pine < polypropylene < asbestos < stainless steel. For pipes the preference is as follows: copper < brass < galvanized iron < aluminum < acrylic < black steel < polyethylene < PVC < ABS. Pipes oriented horizontally had significantly greater settlement than vertical pipes, and rough surfaces were more heavily colonized than smooth. The strength of attachment of Zebra mussels also varies with substrates. Within the substrate, the strength of attachment increases with surface roughness. Strongest attachment is to limestone and mild steel of all roughness. Attachment strength is intermediate on marine concrete, polyvinyl chloride, stainless steel, and coal tar epoxy coated mild steel. Smooth polytetrafluoroethylene, polymethylmethacrylate, and aluminum have the weakest attachment. However, most facilities have to deal with existing structures and therefore coatings present one of the best methods for minimizing the fouling on external surfaces.

The overall trend is toward the use of environmentally benign foul release coatings which form a physical barrier to attachment. The most promising coatings at this time are nontoxic silicone based paints which prevent or greatly decrease the strength of attachment. Silicone based coatings applied to the pump well

wall at a nuclear power plant were found to be effective at minimizing mussel settlement for almost ten years. The silicone based coatings usually require several different layers to be applied to a perfectly clean, white metal surface or very clean, almost dry (10% or less moisture level) concrete. This tends to make them very costly ($80 -$100/m^2). In addition, the foul release coatings tend to perform better in areas of high or moderate flow, rather than in quiescent areas.

DWR Division of Operations and Maintenance, Operations Support Office, evaluated the performance of anti-fouling coatings along with anti-corrosion coatings commonly used in the SWP. The best performing coatings were those developed by Fuji Film Company and Intersleek manufactured by International Paints.

Vendors with known successful anti-fouling coatings include:

- CPM Coatings/Chugoku Paint (Bioclean-Si)
- Kansai Paint (Biox Si)
- International Paints (Intersleek)
- GE Coatings (Exsil)
- Fuji Film Smart Surfaces

The U.S. Bureau of Reclamation (USBR) also has a coatings research program that has evaluated many of the same coatings and has published the summary report from a six year study (http://www.usbr.gov/mussels/docs/MERL2014-64Coatings.pdf).

When considering which coating to choose to protect external structures of a facility, consider the cost of coatings and the problems associated with the application (e.g. sandblasting of surfaces, exposure of personnel to toxic fumes, problems of keeping large areas dewatered, etc.) with that of mechanical cleaning and the disposal of mussel debris on a regular basis. If, after this evaluation, coating is still the appropriate strategy, carefully examine the data provided by the vendor. Make sure that the coating has been successfully used in an industrial environment for at least three years and has shown a capability to prevent settlement of mussels. Furthermore, make sure that no toxic substances are likely to either leach from this coating or be released into the environment when the "top-coat" of the coating is "reactivated" (i.e. abraded to expose fresh coating). Check with the local regulatory agency as to any possible constraints on the use of any particular product.

Speed of Flow - When the speed of flow in a raw water system exceeds 1.5 m/s (4.9 feet/s), there is minimal, if any, veliger settlement observed. However, very few systems are designed for such fast flow rates and it would involve a major expense to redesign the systems. In fact, intake structures are frequently designed to maintain as slow a rate of flow as possible to prevent entrainment of fish.

Appendix F.3.2 – Non-Chemical Reactive Techniques

Thermal Shock - Hot water has proven very effective in killing mussels (**Table F.3**). Thermal backwash appears feasible for some facilities and systems as an end-of-season or periodic treatment. The temperature and duration of the treatment can be combined in different ways. A temperature of 32°C (89.6°F) for 48 hours has caused 100% mortality in dreissenids, as has 40°C (104°F) for one hour. In between these temperatures lays a grey area where the exact temperature and time to death is dependent on several factors. One factor is the acclimation temperature of the mussels (i.e. the ambient temperature

of the water). The lower the acclimation temperature, the more susceptible the mussels are. A second factor is the rate of temperature increase. If the rate of increase is very gradual, the mussels may acclimate during the process and survive for a longer period than anticipated. The last factor is the possible genetic variation in local populations. It is possible that Zebra mussels from a particular geographic area may be more temperature tolerant than mussels many miles away.

Test Temperature	Acclimation Temperature			
	5°C	**10°C**	**20°C**	**25°C**
34°C	419	396	687	-
35°C	243	231	271	525
36°C	209	107	202	261
37°C	116	52	126	153
38°C	-	-	66	78

Table F. 3 - Resistance time (in minutes) for 100% mussel mortality in relation to temperature.

There are problems associated with using thermal shock for mussel control. Regulations governing discharge of heated water have to be considered. Plants which do not already possess the capability to recirculate hot water are likely to be unable to retrofit to do so and will only be able to apply thermal shock in small systems using an external heat source such as a steam generator. As plants have to be either taken off-line or production curtailed during thermal treatment, the cost of treatment tends to be quite high. In addition, manual cleaning of components may be required after a thermal treatment to clear away accumulated dead mussels and shells. Nevertheless, a number of facilities have used this method of treatment and achieved very good results. Commonwealth Edison heat treated one of its plants by raising the water temperature from 31.6°C to 37.2°C (89°F to 99°F) in ten hours. They then maintained this temperature for six hours, resulting in 100% mussel mortality. Plants in Italy, France, and Spain have also used thermal treatments for mussel control. It is certainly worth considering a periodic or an end-of-season heat treatment as an alternative to chemical treatment. Most regulatory authorities regard heat treatment as a more environmentally safe and benign method than chemical treatment.

Desiccation - Desiccation involves the draining of systems and subjecting the mussels to drying. Unless the process is speeded up by the use of hot air circulating in the pipes, a prolonged shutdown may be required. Adult dreissenid mussels can survive considerably more than 10 days in a cool (below 15°C), moist environment. On the other hand, at 25°C, Zebra mussels can survive for less than 150 hours regardless of relative humidity. At 35°C, death occurs in less than 40 hours particularly at high relative humidity. It appears that the inability of mussels to cool tissues through evaporation at high relative humidity accelerates mortality rates rather than the actual loss of water from the tissues.

Oxygen Deprivation - Oxygen deprivation could be accomplished by adding an oxygen scavenging chemical into a closed system or by keeping a system such as a pipeline static for a sufficient time period. Mortality due to lack of oxygen occurs faster at higher temperatures (Table F.4)

O_2 Partial Pressure (Torr)	O_2 % Saturation (%)	Temperature (°C)		
		5°C	15°C	25°C
7.9	5	*x	70	12
11.9	7.5		x	15
15.9	10		x	19
23.8	15	x	x	x

*x = mortality was observed but 100% mortality was not reached in the experimental time frame.

Table F.4 - Approximate number of days to 100% mortality for Zebra mussels at different oxygen and temperature levels

For facilities which have two intakes but only need to use one, oxygen deprivation could be an efficient method of control. One intake is capped until the other one is fouled and then the two are switched. The treatment would work best at high ambient water temperatures. A word of caution is given here; lack of oxygen frequently results in a dramatic increase of sulphate reducing bacteria which in turn are responsible for some microbially induced corrosion (MIC). Limiting the amount of oxygen in a system may exacerbate corrosion problems.

Mechanical Cleaning - Accumulated Zebra mussel populations can be removed from all external structures and some large diameter piping by a variety of manual methods. This provides a short-term solution which must be repeated at regular intervals. New tools for mechanical cleaning are being introduced at such frequent intervals that it is impossible to mention them all.

To date, all mussels removed by all types of mechanical cleaning have been disposed of in regular landfill sites or composted at site. Several tests done on these mussels did not uncover any high concentrations of toxic materials which would have forced disposal at a hazardous waste site.

Mechanical Cleaning of Large Diameter Pipes - Mechanical "pigs" or scrubbers have been used effectively to knock and scrape mussels and other debris from large-bore pipelines. Pigs are available in a wide variety of designs and they are manufactured to clean pipes up to 180 cm (70 inches) in diameter.

The pipeline is unavailable during cleaning, and the disposal of mussels dislodged can cause a problem. Drinking water plant intakes are particularly suitable for this method. However, several have expressed concern that their structures may not be able to withstand the pressure generated by the mechanical pig on the pipeline.

Underwater Cleaning Using Divers - Due to operational requirements, Ontario Hydro has concentrated on developing an efficient and economic strategy for underwater cleaning. A number of different diver-operated tools and techniques were tested during the summer and fall of 1990 on a variety of infested surfaces. A continuous flow, 6-inch hydraulic pump reduced to 3-inch (600 gpm) equipped with two scraper assemblies (two diver operation) was found to be the best available option for the cleaning of

vertical walls. Power wash was used on the pump bells with some success, but a more efficient technique is needed.

New diver-operated tools are being introduced all the time. This, as well as the development of remotely-operated tools, could make mechanical cleaning a viable option for pipelines and external structures.

High and Low Pressure Water Cleaning - Hydro-blasting, or hydro-lasing, has been used to remove corrosion products, unwanted coatings, and biofouling. The area to be cleaned is generally dewatered and then cleaned with a jet of water. It is advisable to proceed with cleaning as soon as the structure is dewatered. If the mussels are allowed to die in place, the cleaning crew will be faced with very unpleasant working conditions. At Detroit Edison, a jet at 3000 psi was adequate to remove a thick build-up of mussels on the concrete wall of the pumpwell. A variety of nozzle and hose configurations are possible as is a combination of pressure and volume. The choice will depend on the personal preference of the user. However, the integrity of the surface being cleaned has to preserved, and it is desirable to remove as much of the byssal thread and byssal pad as possible. In 2008, the U.S. Bureau of Reclamation initiated a demonstration project on the use of water jetting for removal of mussels from an underwater intake pipeline. A water jetting nozzle delivering a water stream at 10,000 psi was inserted into a 25-cm (10-inch) diameter pipe which was over 100 feet in length. The pipe was heavily fouled by adult Quagga mussels. The water jet was able to remove majority of the fouling and restore the pipe to fully operational conditions.

Design Changes - Occasionally, a system design change may be the most expeditious way to cope with mussels. If well water or municipal water is available, the fire suppression system may be connected to these mussel free water sources. Old equipment that is being upgraded such as air compressors, electricity transformers, or HVAC units may consider air cooled models as opposed to models that are cooled with raw water. If trash racks are being replaced, consider designs that are easy to remove for cleaning and painting.

Appendix G

Analysis of the Environmental Variables from Lake Casitas

Appendix G.1 – Calcium

Dreissenid mussels need calcium in order to build their shells (**Table G.1**).

Parameter	Adults do not survive long-term	Uncertainty of veliger survival	Moderate Infestation Level	High Infestation Level
Calcium mg/L	<8 to <10	<15	16-24	≥24
Alkalinity mg CaCO3/L	< 30	30-55	45-100	>90
Total Hardness mg CaCO3/L	<30	30-55	45-100	≥90
pH	<7.0 or >9.5	7.1-7.5/ 9.0-9.5	7.5-8.0 or 8.8-9.0	8.2-8.8
Dissolved Oxygen mg/L (% saturation)	<3 (25%)	5-7 (25-50%)	7-8 (50-75%)	≥8 (>75%)
Chlorophyll a µg/L	<2.5 or >25	2.0-2.5 or 20-25	8-20	2.5-8
Total phosphorous µg/L	<5 or >50	5-10 or 30-50	15-25	25-35
Secchi depth m	<0.1 >8	0.1-0.2 or >2.5	0.2-0.4	0.4-2.5
Mean Summer Temperature °C	<2(36°F) >30(88°F)	2-10(36-50°F) or >28 (82° F)	10-16 (50 – 61°F) or 24-28 (75- 82°F)	16-24 (61 - 75°F)
Conductivity µS/cm	<30	<30-60	60-110	≥100
Salinity g/L (ppt)	>10	8-10 (<0.01)	5-10 (0.005-0.01)	<5 (<0.005)

Table G.1 – Criteria used in determining levels of infestation by dreissenids in temperate zone of eastern portion of North America and Europe (after Mackie and Claudi 2010)

The larval forms of dreissenids (veligers) require higher levels of calcium in order to develop than is required by adult mussels for survival. Therefore, adult mussels if introduced into a body of water with low calcium may survive for some time, but the population may fail to reproduce and therefore will be eliminated over time. Calcium is considered the most essential environmental constituent when assessing the likelihood of long term mussel survival. The initial water quality review has determined that dreissenids would be able to survive and thrive in Lake Casitas as it has an average calcium level of 57mg/L (S. McMahon pers. Comm.)

Appendix G.2 – pH

Values of pH above 7.5 are generally required for veliger development. A pH of 7.5 is usually given as the lower limit for long term veliger survival. Higher values, up to a pH of 9.0 are suitable for mussel

development and survival. From the 2014 Lake Casitas data (**Figure G.1**) it would appear that pH falls below the critical level at depth of 60 feet or greater from roughly June to October. Survival of veligers below the depth of 60 feet is unlikely during most of the reproductive season.

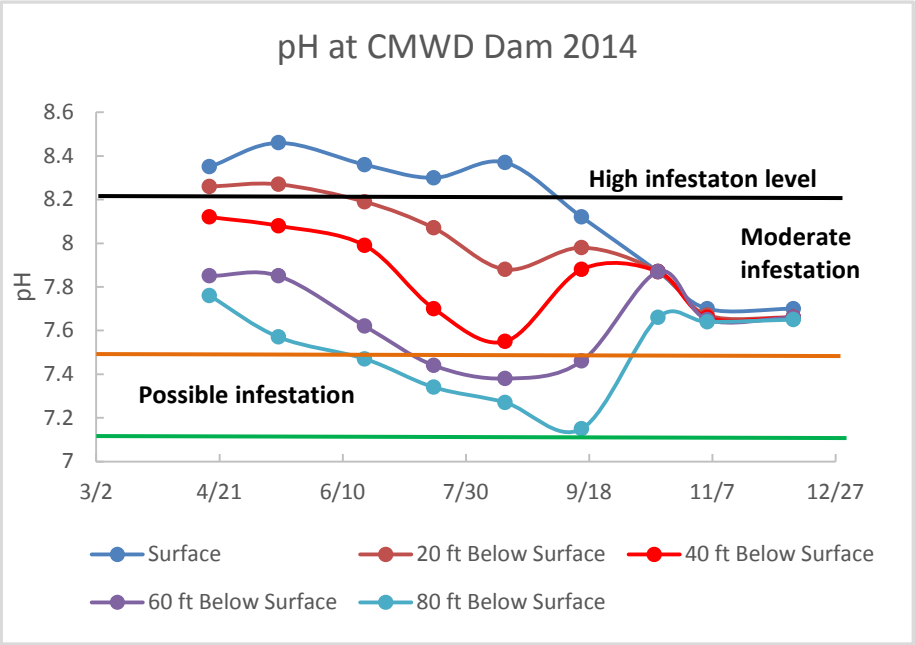


Figure G.1 - pH levels recorded in 2014 near the Lake Casitas Dam

The variations in pH with depth and season are dictated by biological processes in the lake. Surface values are affected mostly by photosynthetic processes that introduce oxygen into the water. The photosynthetic process removes carbon dioxide from the water:

$$\text{carbon dioxide + water} \xrightarrow[\text{chlorophyll}]{\text{sunlight}} \text{glucose + oxygen}$$

The removal of carbon dioxide increases the pH of the water. This process occurs down to depths where photosynthesis prevails, that is when more oxygen is produced than carbon dioxide. When production of carbon dioxide exceeds that of oxygen, reduction processes occur, CO_2 combines with water to produce carbonic acid that has a pH of 5.6. A study of dissolved oxygen saturation levels shown below helps to explain the variations in pH with depth and season (**Figure G.2**), where declines in pH begin occurring when dissolved oxygen levels begin to fall. The uniform pH levels from November to December are due to lake turnover when bottom waters mix with surface waters.

Appendix G.3 – Dissolved Oxygen

To settle, survive and grow into adults each mussel larva has to land on firm substrate. The settlement stage of larvae experience major mortality. During this settlement stage, if the dissolved oxygen levels near the bottom are less than 3 mg/L (**Table G.1**), the pediveligers are unlikely to survive and develop into adults. As shown in (**Figure G.2**), the dissolved oxygen level plummets below 40 feet in Casitas Reservoir making this area of the reservoir inhospitable to settling pediveligers. However, temperature affects the solubility of oxygen with the solubility increasing with decreasing temperature until 4°C when solubility

decreases between 0°C and 4°C. **Figure G.3** shows dissolved oxygen saturation levels at 80 feet are less than 25% during early June to mid-October and at 60 feet between mid-July and early October. At these saturation levels pediveligers are unlikely to survive and develop. Dissolved oxygen saturation levels are stressful throughout most of the year at 60 and 80 feet.

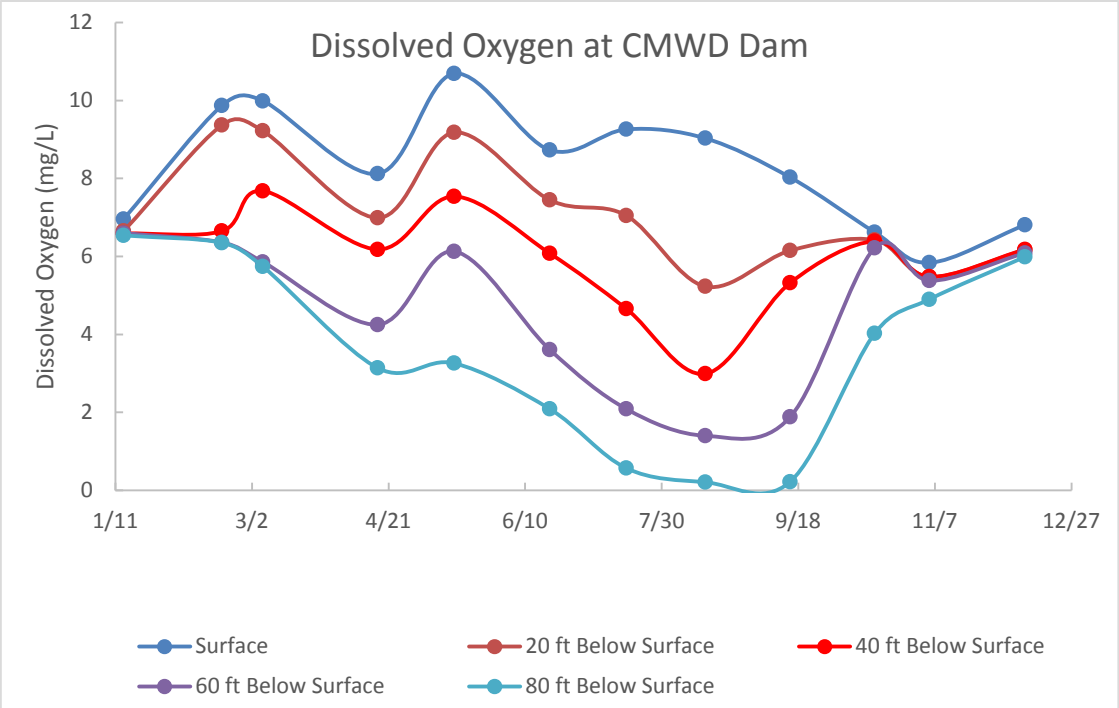


Figure G.2 - Dissolved oxygen levels (mg/L) recorded in 2014 near the Lake Casitas Dam

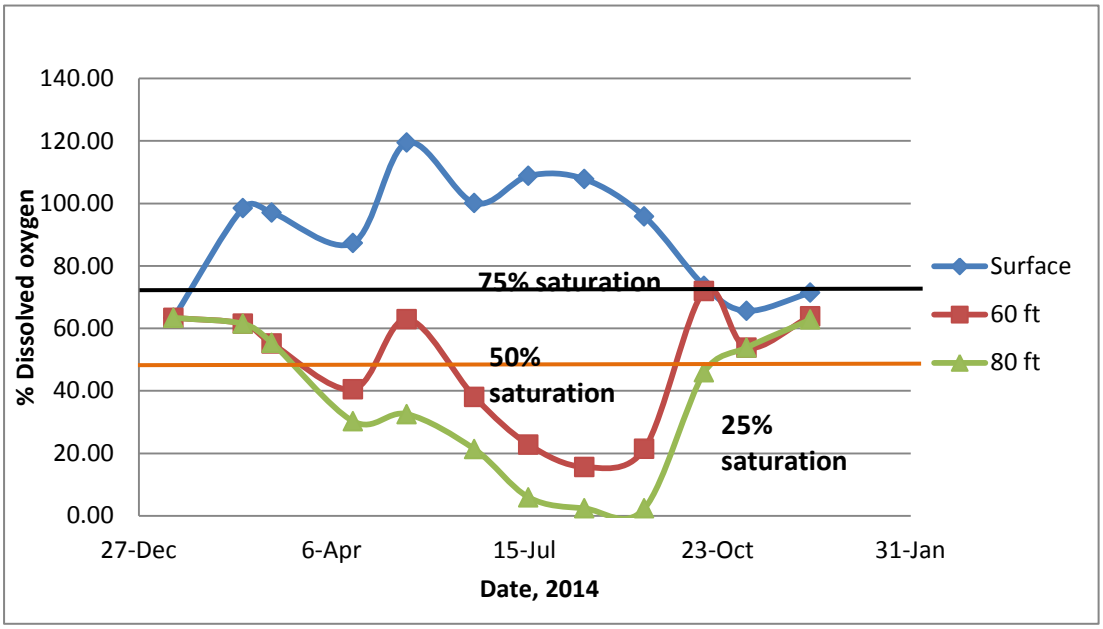


Figure G.3- Percent Dissolved Oxygen saturation levels in 2014 near Lake Casitas Dam at three depths

Oxygen levels are between 25 and 50% saturation from March to October (**Figure G.3**). Surface waters, however are pretty much above 75% saturation throughout the year, with supersaturation occurring between late May to mid-September (**Figure G.3**). It is clear that oxidation processes from winds and photosynthesis prevail throughout the year in the epilimnion but reduction processes (e.g. carbon monoxide production from decomposition of sediments) predominate in the hypolimnion. There is a distinct thermal resistance to mixing by the metalimnion from end of May to late October as evidenced by the troughs in oxygen saturation at 60 and 80 feet and the increase in oxygen saturation in the surface water over the same period.

Appendix G.4 – Temperature

Temperature is another important variable, which determines the length of the reproductive season and also the rate of growth of adults. The release of eggs and sperm and subsequent fertilization in the dreissenid mussel population occurs when the ambient water temperature reaches 54°F - 59°F (12°C to 15°C). Reproduction ceases when the water temperature falls below 54 °F (12°C) but veligers usually continue to be present in the water column for about three weeks after reproduction stops. After this time veligers generally lose their ability to swim, develop a foot and leave the water column to settle and attach to substrate.

The upper thermal limit for survival of veligers is between 82 and 89°F (28 and 32°C). Given the temperature profile recorded in 2014 (**Figure F.4**) at the Casitas dam, temperature is not likely to have moderating effect on the dreissenid population should it be introduced.

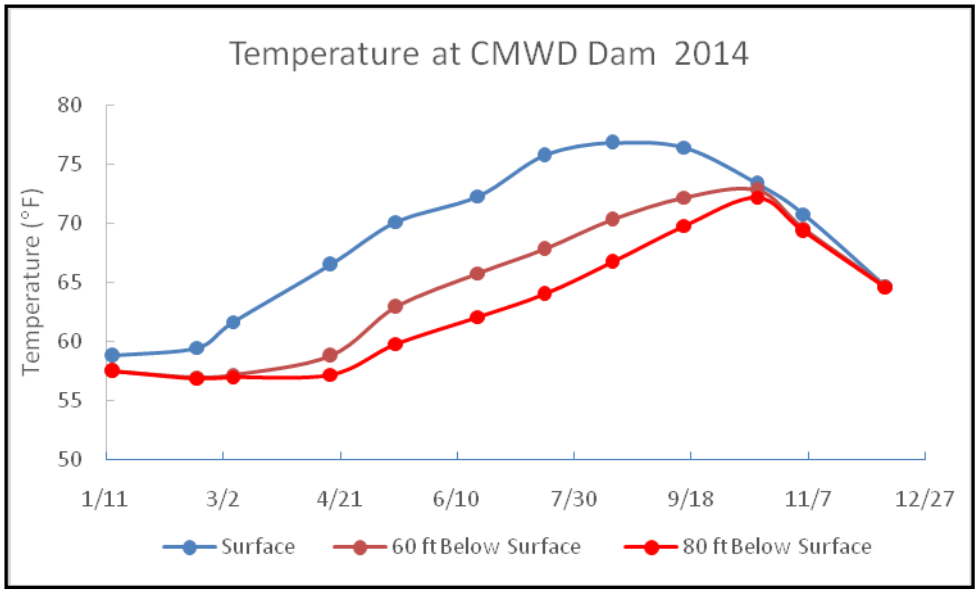


Figure G.4 - Temperature levels recorded in 2014 near the Lake Casitas Dam

Appendix G.5 – Chlorophyll "a"

Chlorophyll "*a*" is used as an indicator of the presence of green algae, which is considered the primary food source for dreissenid mussels. Levels of chlorophyll "*a*" between 2.5 and 8 µg/L are considered

optimum. Concentrations of chlorophyll "*a"* lower than these values may represent inadequate food supply to support adult dreissenid population. Concentrations greater than 25 µg/L may signify an algal bloom and high turbidity which in turn may interfere with veliger survival in the water column. The peaks in chlorophyll "*a"* on August 7 and 28, 2014 (**Figure G.6**) correspond to the supersaturation of dissolved oxygen in the surface waters at this time (**Figure G.3**).

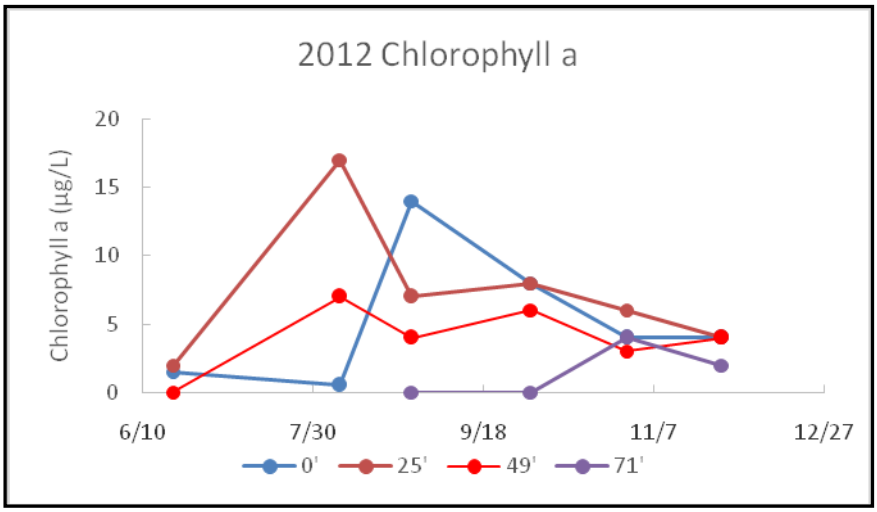


Figure G.5 - Chlorophyll "a" levels in Lake Casitas in 2012 (Susan McMahon)

From the one year of chlorophyll "*a"* data it would appear that there is more than adequate food available in Lake Casitas. Collection of additional chlorophyll data is recommended.

Appendix G.6 – Secchi Depth

Secchi depth is a measure of turbidity, the lower the Secchi depth the greater the turbidity. Turbidity consists of living (e.g. algae) and dead (e.g. moribund algae) organic material, as well as inorganic material (e.g. silt). If turbidity consists mostly of algae, one would expect an increase in oxygen saturation with a decrease in Secchi depth. The lower Secchi depths from May 15 to September 15 (**Figure G.6**) correspond to the high oxygen supersaturation values in (**Figure G.3**). It is not likely that any upwelling of moribund organic material from the hypolimnion contributed to the turbidity because of the thermal resistance to mixing during this period (see discussion of dissolved oxygen). The dramatic increase in Secchi depth on April 17 corresponds to the "dips" in dissolved oxygen saturation in (**Figure G.3**). This exceptional increase in water clarity may have occurred during the end of the turnover period prior to which oxidized bottom waters were mixing with surface waters. By May 15 the water was stratified and primary production increased leading to the gradual decline in Secchi depth. While further research is required to determine the upper turbidity limit for dreissenids, there is some documented evidence that turbidity/TSS can negatively impact metabolic function of dreissenids (Madon et.al. 1998) and that high turbidity/TSS can have a negative effect on pumping rates of individual mussels (Garton et.al. 2014). Madon et.al. (1998) reported that suspended inorganic sediment above 1mg/L greatly reduced the ability of adult Zebra mussels to feed. Schneider et.al. (1998) also concluded that conditions of high suspended inorganic sediment concentrations in turbid rivers represent difficult growth environment for Zebra mussels. Alexander et.al. (1994) concluded that periodic turbidity between 10 and 20 NTU affects the

metabolic rate of Zebra mussels, particularly at high ambient temperatures (25 °C). The Missouri River, with turbidity variations between 10 to 1,000 NTU (average levels between 25 to 54 NTUs) has remained essentially free of dreissenid infestation to this date.

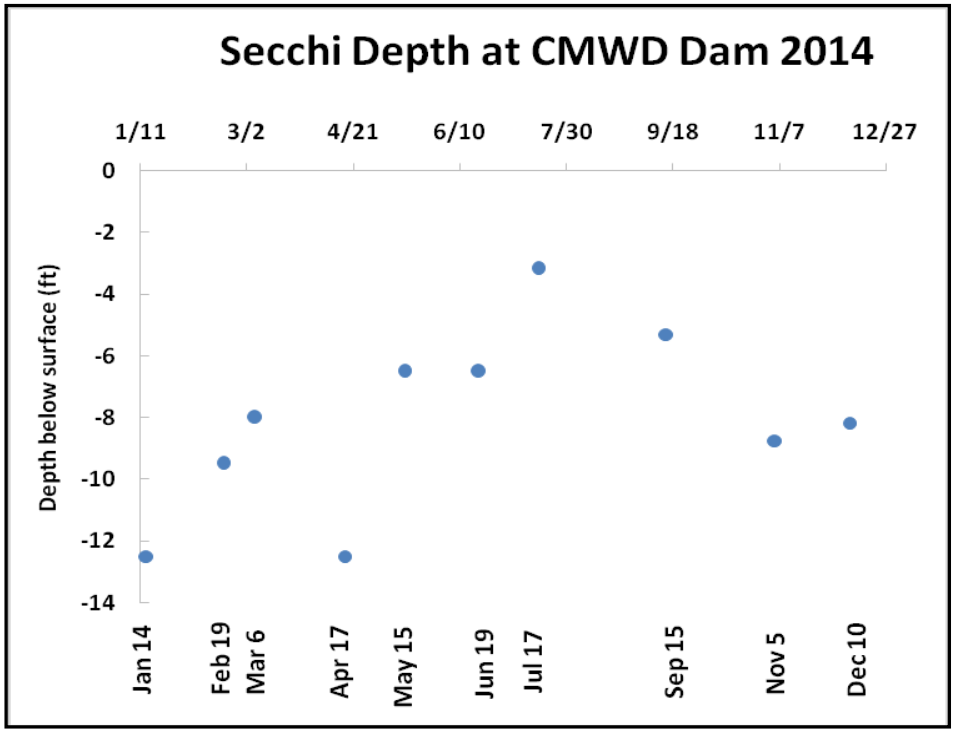


Figure G.6 - Secchi depth recorded in 2014 near the Lake Casitas Dam

The impact of turbidity on survival of dreissenid veligers is unknown, but likely to be even more profound than the impact on adults, particularly if the algal community consists mostly of filamentous species.

The Secchi depth recorded in 2014 suggests turbidity in the optimum range for dreissenids to thrive, 6 to 12ft. (Mackie and Claudi 2010).

In summary, with the exception of the low dissolved oxygen levels in the deeper parts of Lake Casitas there are no mitigating environmental factors which would prevent the development of a massive dreissenid population should they become introduced. As seen in Table 2.-2, the environment of Lake Casitas, with some exceptions, is likely to support a massive population of Zebra or Quagga mussels should they become introduced. The risk of establishment for 1 (being low) to 5 (being high) is 5.

A small pond on private property is located approximately 1.25 miles from the entrance to Lake Casitas. The pond is approximately 160 yard x 90 yard and has an approximate elevation of 710 feet ASL as compared to Lake Casitas at an approximate level of 560 feet ASL. There is a small dock that exists on the north side of the pond. Santa Ana Road ends approximately 1/4 mile south east of the pond and from there a private road of unknown condition and access proceeds to and beyond the pond. The contour of the surrounding area is such that if an overflow from the pond occurred there is a potential water path that would enter the northwest arm of Lake Casitas near a creek overpass on Highway 150 after travelling a path of approximately 1.5 miles.

Lake Casitas Prevention, Control and Management Plan

for

Invasive Mussels

July 13, 2016

Prepared for Casitas Municipal Water District by

Renata Claudi MSc., Gerry Mackie PHd., T.H. Prescott MASc., PEng.

Funding for this project has been provided in full or in part
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Dated January 14, 2016

Table of Contents

1. Executive Summary

In late 2013, Quagga mussels were found to be present in Lake Piru in Ventura County, Southern California. This is the first time Quagga mussels have been found in California in a lake or reservoir, which does not directly receive Colorado River Water. Casitas Municipal Water District has had a strict water vessel tagging and quarantine program at Lake Casitas since 2008. While there appears to be no indication of an infestation of Quagga/Zebra mussels (collectively known as dreissenids mussels) in Lake Casitas, the infestation of Lake Piru has prompted Casitas Municipal Water District to re-evaluate the current dreissenid mussel prevention program, assess vulnerabilities and develop an action plan, which is both preventative and proactive.

Casitas Municipal Water District contracted RNT Consulting Inc. to review the existing Quagga/Zebra mussel prevention protocols as well as the operations of Lake Casitas Reservoir to further strengthen the existing efforts to prevent an introduction of invasive dreissenid mussels. The next step was to develop a plan of action should dreissenid mussels become introduced despite the best efforts of all concerned. The objective of the Control and Management Plan is to review existing provisions for prevention of introduction and to provide a road map forward on managing the mussel infestation in the reservoir, should it occur. The roadmap forward includes 5 main steps: monitoring, detection, delineation, containment and control. The last step, control, includes minimizing impact on manmade structures and preventing the mussels from spreading from the reservoir to other areas.

Based on the existing water quality data, the water chemistry of the Lake Casitas Reservoir is well suited to support a potentially massive infestation of Zebra or Quagga mussels in upper levels of the reservoir. Below the depth of 20 to 30ft, dissolved oxygen tends to drop off rapidly during summer months making this portion of the reservoir less suitable for mussel infestation.

There is a robust monitoring program in place to detect the presence and absence of dreissenid mussels. This program includes collection of monthly plankton samples from June to October, snorkel surveys and settlement samplers in strategic locations.

Casitas Municipal Water District has a strict water vessel tagging and quarantine program in place since 2008. In 2008 the Board of Directors of the Casitas Municipal Water District adopted Resolution #08-08 preventing any incoming boats, including canoes, kayaks and float tubes from entering the Lake Casitas Recreation Area until they are inspected and complete a 35 day quarantine. A tamper proof tag attaches the vessel to the boat trailer after the vessel passes an initial inspection. The thirty five day quarantine can be completed either inside or outside of the Recreation Area. Once the quarantine is completed, vessels can be moored at the Lake Casitas marina and used at will. If however a vessel leaves Lake Casitas, the inspection and quarantine would have to be repeated upon return unless the vessel is secured to the trailer with the tamper proof tag which makes it impossible for the boat to be used in another water body.

Public awareness and education has been used by Lake Casitas to prevent the introduction of aquatic invasive species, including Quagga/Zebra mussels. Additional signage, materials and programs are being developed as follows:

- Signage in remote areas of the lake indicating launching of non-tagged water craft is prohibited.
- Brochures and verbal reminders about not dumping bait buckets in the lake to be given to clients upon entry into the Recreation Area..
- Waterproof stickers reminding users to “CLEAN, DRAIN and DRY” and “Stop Aquatic Hitchhikers!”.
- Cooperative events with local educators, boating, recreation and sportsman associations. Casitas’ web site has links to the Department of Fish and Wildlife invasive species site as well as their rules and regulation are posted in several areas of the site.

Should Quagga/Zebra mussels become introduced into Lake Casitas, the Board of Governors may seek permission from the regulators to eradicate the mussels from the lake. At this time, two primary chemicals used for eradication are potash and copper-based algaecides (such as EarthTec QZ from Earth Science Laboratories, Inc.). Budget figure proposals suggest a cost between 2 and 4 million dollars (2015 pricing) for the eradication effort. Should other eradication options arise in the future, they will be considered and discussed with the regulators. While eradication options are being considered other actions will be taken in parallel to prevent the spread of Quagga/Zebra mussels out of Lake Casitas:

- The current boat tagging program will be adjusted to prevent boats from transporting mussels from Lake Casitas to other lakes.
- The existing monitoring protocol will be modified to determine the breeding season of the mussels, growth rates and distribution patterns within the lake.
- Additional signage will be placed on the exit ramps from Casitas to warn against transport of mussels to supplement existing education and outreach programs.

2. **Background Information**

2.1 History of the Reservoir. Lake Casitas was created under contract between the Ventura River Municipal Water District now called Casitas Municipal Water District and the United States under contract 14-06-200-5257 Ventura River Project. The Lake Casitas Recreation Area was also developed under that contract to accommodate the visiting public. All lands related to Lake Casitas being under, around, and in the watershed are federally owned by the Bureau of Reclamation. The water is owned by Casitas Municipal Water District.

Lake Casitas an artificial lake, was formed by the construction of the Casitas Dam in 1958 on the on Coyote Creek, two miles (3 km) before it joins the Ventura River. Santa Ana Creek and North Fork Coyote Creek also flow into the lake as does water from the Ventura River through the Robles diversion canal. The annual average flow of the Ventura River is 13,600 acre-feet. Ventura River is an intermittent stream, running usually only in the winter months during the wet season.

The dam was constructed of earth-fill and was completed in 1959. It is 279 ft. (85 m) tall and was built by the U.S. Bureau of Reclamation. The lake has a capacity of 254,000 acre-ft (313,000,000 m^3). The dam was built as part of the Ventura River Project and was strengthened in Jun-Dec 2000 as a seismic improvement to help withstand earthquakes greater than 6.5 magnitude. The underlying rock is thought to be limestone, as is the case with much of this geographical area.

Due to various meteorological events the lake was not fully filled and functional until 1978. Generally, the only outflow from the lake is the water withdrawn from Lake Casitas in the southern end through a submerged intake of the water treatment plant. From this plant the Casitas Municipal Water District supplies water to 60-70,000 people in Western Ventura County and to hundreds of farms. Lake Casitas has filled over capacity eight times in the last 50 years, and the spilled water flows into catch basin and the into the original site of Coyote Creek. Depending on the size of the spill, there exists a potential that the spilled water could reach Ventura River.

At this time, due to the persistent drought in Southern California, Lake Casitas is only partially filled and much of the lake bottom is visible as a "sandy" beach. The substrate appears quite firm with boat trailers being able to partially drive in without sinking.

There are Asian clams (*Corbicula fulminea)* present in the sediments of the reservoir. Asian clams were introduced to North America in 1938. The first collection of C*. fluminea* in the United States occurred along the banks of the Columbia River near Knappton, Washington (Counts 1986). Since this first introduction, the Asian clam is now found in 38 states and the District of Columbia. Human-mediated transport is the primary agent of dispersal. Methods of introduction include bait bucket introductions and accidental introductions associated with imported aquaculture species (Counts 1986). Bait bucket introduction is the most likely vectors by which Asian clams have reached Lake Casitas as the only other significant dispersal agent is thought to be passive movement via water currents; fish and birds are not considered to be significant distribution vectors (Counts 1986, Isom 1986).

Lake Casitas has an average calcium level of 57mg/L (S. McMahon pers. comm.). This level of calcium can support a massive infestation by dreissenid mussels (Mackie and Claudi 2010). The reservoir does have low level of dissolved oxygen below 30 foot depth for most of the summer. This lack of oxygen may limit the development of dreissenid population in this zone of the lake.

Lake Casitas is a reservoir with a dendritic pattern and considerable shoreline complexity characterized by a rugged coastline within numerous bays (**Figure 1**). Shore line shape (D_L) is important because it reflects the potential for development of littoral communities. High values of D_L reflects increased shoreline area for productivity, including that of invasive species. D_L is calculated by dividing the lake's shoreline length (SL) by $2 \cdot \sqrt{(\pi \cdot A_o)}$, A_o being the surface area of the lake. For Casitas Lake the shoreline development is 6.97 (using: SL = 32.4 mi; A_o = 1100 acres; π = 3.14). Circular lakes have a D_L near 1. What this means is that Quagga mussels in Lake Casitas have about seven times more opportunities to settle than in a circular lake such as Crater Lake, Oregon.

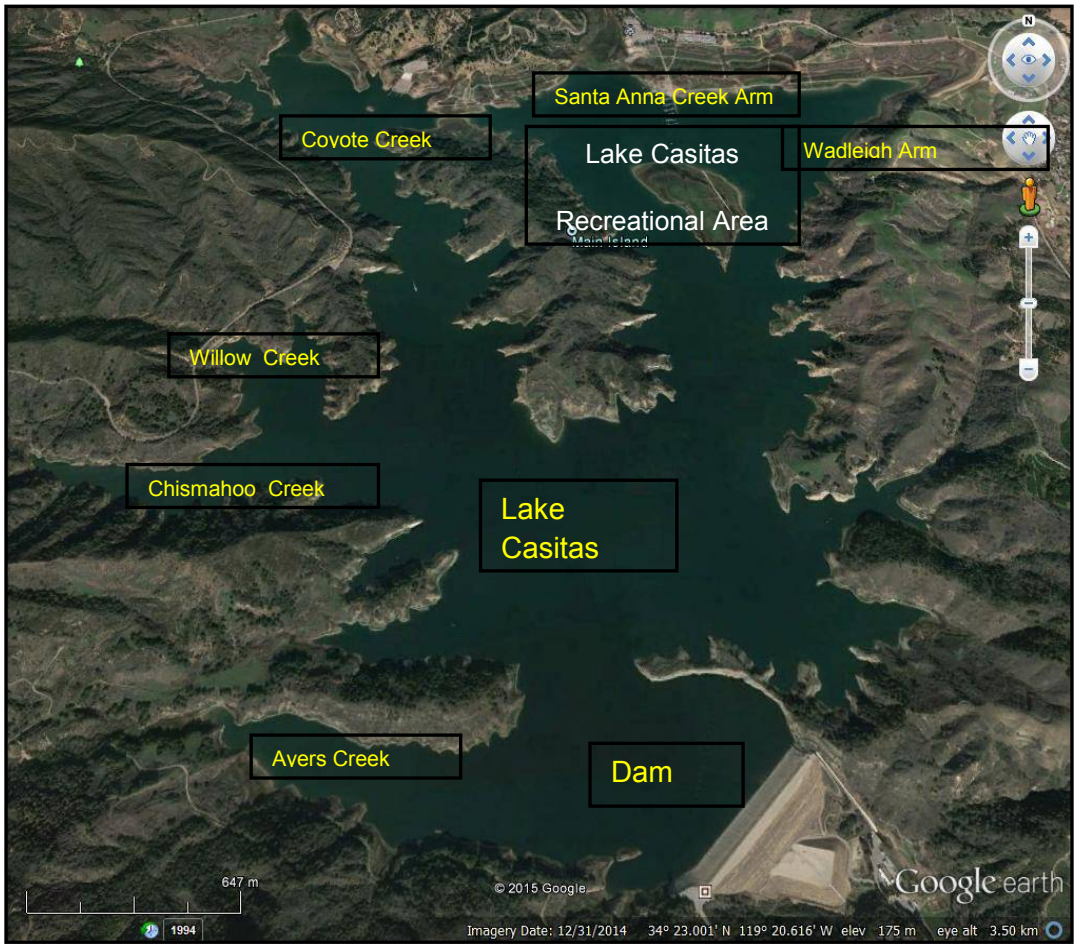

Figure 1 - Lake Casitas showing location of dam and the rugged shoreline pattern

There are no water releases from Lake Casitas beyond the withdrawal of water through the dam that supplies the drinking water plant unless water spills through the spillway of the dam during high water levels. Lake Casitas has filled to over capacity eight times in the last 50 years, and the spilled water flows into catch basin and the into the original site of Coyote Creek. Depending on the magnitude of the spill there is some potential for the spilled water to reach Ventura River.

2.2 Environmental Preferences and Impacts of Zebra and Quagga Mussels

2.2.1 Environmental Parameter Ranges. Though dreissenids have a distinct set of environmental preferences, they can survive in many subpar conditions, often successfully facing starvation, desiccation, extreme variances in temperature and variable oxygen levels provided adequate calcium and high enough pH levels are present. They can survive in static lakes and reservoirs and in the fast currents of pipelines, in both nutrient poor and nutrient rich lakes. Though a freshwater species, they can survive for some time in brackish areas, and are capable of tolerating a certain degree of pollution. If intolerable conditions are present, the mussel can close its shell for up to 2 weeks before reopening. Details on the biology of Quagga/Zebra mussels are found in **Appendix E**.

Table 2.1 was derived from the values reported by various authors in North America and Europe and gives the ranges of values for each of the environmental parameters as they relate to success of dreissenid mussel populations.

Parameter	Adults do not survive long-term	Uncertainty of veliger survival	Moderate Infestation Level	High Infestation Level
Calcium mg/L	<8 to <10	<15	16-24	≥24
Alkalinity mg CaCO3/L	< 30	30-55	45-100	>90
Total Hardness mg CaCO3/L	<30	30-55	45-100	≥90
pH	<7.0 or >9.5	7.1-7.5/ 9.0-9.5	7.5-8.0 or 8.8-9.0	8.2-8.8
Dissolved Oxygen mg/L (% saturation)	<3 (25%)	5-7 (25-50%)	7-8 (50-75%)	≥8 (>75%)
Chlorophyll a µg/L	<2.5 or >25	2.0-2.5 or 20-25	8-20	2.5-8
Total phosphorous µg/L	<5 or >50	5-10 or 30-50	15-25	25-35
Secchi depth m	<0.1 >8	0.1-0.2 or >2.5	0.2-0.4	0.4-2.5
Mean Summer Temperature °C	<2(36°F) >30(88°F)	2-10(36-50°F) or >28 (82° F)	10-16 (50 – 61°F) or 24-28 (75-82°F)	16-24 (61 - 75°F)
Conductivity µS/cm	<30	<30-60	60-110	≥100
Salinity g/L (ppt)	>10	8-10 (<0.01)	5-10 (0.005-0.01)	<5 (<0.005)

Table 2.1 - Criteria used in determining levels of infestation by dreissenids in temperate zone of eastern portion of North America and Europe (after Mackie and Claudi 2010)

The primary way of reaching unconnected bodies of water is with human assistance, including networks of canals, such as in Europe where the network of inland waterways is made up of >28,000 km of navigable rivers and canals, connecting 37 countries. They can be unknowingly transported on the hulls of ships and boats, in ballast water or bait buckets of sport fishermen.

2.2.2 Ecological, Social and Economic Impacts. Dreissenid mussel infestation has several serious ecological, social and economic impacts:

2.2.2.1 Colonization of Unionid Clams. Dreissenid mussels are not selective and will colonize all species of native clams (unionids). In many cases the infestation is so great that

unionids are unable to open their shells, and their locomotion and burrowing abilities are impaired. This puts our freshwater systems in jeopardy of losing rare and endangered species. Rare species become extinct first, while the other species dwindle.

2.2.2.2 Alteration of Freshwater Ecosystem. Dreissenid mussels have a great ability to clarify water, which is both a benefit and a concern for their ecosystem. The benefits are outlined in the following example. If 50 mussels were placed in water, 30% of which was polluted with activated sewage sludge, water clarity would be restored within 96 hours. Nearly all suspended organic material would be consumed and deposited on the bottom floor as pseudofeces. Lab studies show that Zebra mussels can effectively filter food particles as small as 0.7µ but have a preference for the 15-40µ range. Because dreissenid mussels prefer relatively shallow nearshore areas as habitat, it's likely that they are exposed to a great number of pollutants such as PCB, pesticides, herbicides, chromium, lead and mercury and assimilate them into the shell or body tissues.

The dreissenid ability to filter water may not always work in favor of the ecosystem and life it supports. By filtering, dreissenids remove suspended particles from the water column and deposit them into the sediment. This action makes nutrients available to the benthic species on the freshwater floor leaving less food material for the planktonic species. The increased clarity of water also means that the euphotic zone (water that the sunlight can reach) will increase. This in turn may stimulate the growth of rooted aquatic weeds in areas, which were previously too shady. These changes in habitat may have severe impacts on many freshwater species, and on commercial and sport fisheries.

2.3 Potential Size of Dreissenid Population in Lake Casitas based on Raw Water Chemistry

The success of an invasion by dreissenids depends on the quality of water, lake morphology, and the health of the receiving ecosystem.The quality of water in a lake depends in part on the chemistry of the water that supplies the lake. Every lake has its own watershed, and the chemistry of the soil and bedrock in the watershed will largely (but not entirely) dictate the chemistry of the water flowing through it and over it. The chemistry may change over time. The rate and amount of change depends on factors such as type and amount of bedrock, climate and the weathering processes which naturally and continually take place.

Lake morphology, including depth and surface area plays a role in the susceptibility of a lake to invasion by aquatic invasive species. Shoreline complexity is a key morphological trait that enhances the probability of species establishment by offering more bays and inlets for settlement. Lake Casitas not only has a dendritic pattern, which offers several large bays typical of many impoundments, but also many smaller bays and inlets that resemble a serrated shoreline (**Figure 1**). This pattern not only enhances chances of establishment, but makes delineations of infestations and monitoring of growth more complex.

The success of an invasion by an aquatic species depends on the health (physiological and ecological requirements and tolerances) of the species. Thus, a species' potential for invasion into a body of water not only depends on its dispersal potential and the shoreline pattern, but on the ability of the body of water to support a viable population. Detailed analysis of the environmental variable data is included in **Appendix G**.

As seen in **Table 2.2**, the environment of Lake Casitas, with some exceptions, is likely to support a massive population of Quagga/Zebra mussels should they become introduced. Therefore, the risk of establishment of a massive population upon introduction,1 (being low) to 5 (being high) is 5. For more details of the environmental variables found in Lake Casitas see **Appendix G**.

Parameter	Adults do not survive long-term	Uncertainty of veliger survival	Moderate Infestation Level	High Infestation Level	Lake Casitas
Calcium mg/L	<8 to <10	<15	16-24	≥24	57
Alkalinity mg CaCO3/L	< 30	30-55	45-100	>90	
Total Hardness mg CaCO3/L	<30	30-55	45-100	≥90	
pH	<7.0 or >9.5	7.1-7.5/ 9.0-9.5	7.5-8.0 or 8.8-9.0	8.2-8.8	7.2- 8.4
Dissolved Oxygen mg/L (% saturation)	<3 (25%)	5-7 (25-50%)	7-8 (50-75%)	≥8 (>75%)	0 to > 100%)
Chlorophyll a µg/L	<2.5 or >25	2.0-2.5 or 20-25	8-20	2.5-8	0 to 15
Total phosphorous µg/L	<5 or >50	5-10 or 30-50	15-25	25-35	
Secchi depth m	<0.1 >8	0.1-0.2 or >2.5	0.2-0.4	0.4-2.5	2 to 12
Mean Summer Temperature °C	<2(36°F) >30(88°F)	2-10(36-50°F) or >28 (82° F)	10-16 (50 – 61°F) or 24-28 (75- 82°F)	16-24 (61 - 75°F)	61 -75°F
Conductivity µS/cm	<30	<30-60	60-110	≥100	
Salinity g/L (ppt)	>10	8-10 (<0.01)	5-10 (0.005-0.01)	<5 (<0.005)	

Table 2.2 - Comparison of preferred environmental variables of Zebra and Quagga mussels with the environmental factors of Lake Casitas**.**

3. Monitoring Program for Water Quality and Presence of Dreissenids

3.1 Current Monitoring Program. The sampling for Zebra and Quagga mussel detection consists of several independent techniques including visual snorkel surveys, artificial settlement substrates, plankton tows and environmental variable monitoring as described below:

- Snorkel Surveys. The diving surveys are done in the Santa Anna marina (Fig.3.1 yellow oval), mostly on annual basis. During the survey the divers examine underwater structures such as the underside of the floating dock, boat ramp and mooring lines. There is also a survey of the shoreline, concrete structures and any debris which may be present.
- Artificial Settlement Substrates. Artificial settlement substrates have been placed in four separate locations in Lake Casitas; West Channel, dam intake, Coyote Creek and Santa Anna marina and recently in the Matilija Reservoir. The settlement substrates are examined visually every month for signs of new settlement by dreissenid mussels (**Figure 3.1** yellow squares)
- Plankton Samples. Plankton samples are collected monthly in four separate areas; East and West side of the Santa Anna Harbour, 100 yards outside of the harbor and in the Coyote Ramp area. The plankton samples are examined using a polarizing microscope for the presence of dreissenid veligers (**Figure 3.1** yellow stars).
- Environmental Variables in Lake Casitas. A lake profile is done on weekly basis during spring, summer and fall and on monthly basis during winter at the following four stations; Station Canyon Arm, Channel between West Shore and Main Island, main lake near Chismahoo Creek and near the intake at the Casitas Dam. The profile includes dissolved oxygen, temperature, pH and conductivity (**Figure 3.1** yellow triangle).

In addition, substrate sampling and snorkel survey has been added in 2015 for the Matilija Lake upstream of Lake Casitas (**Figure 3.2**). The position of Matilija Lake in relation to Lake Casitas is shown in (**Figure 3.3**).

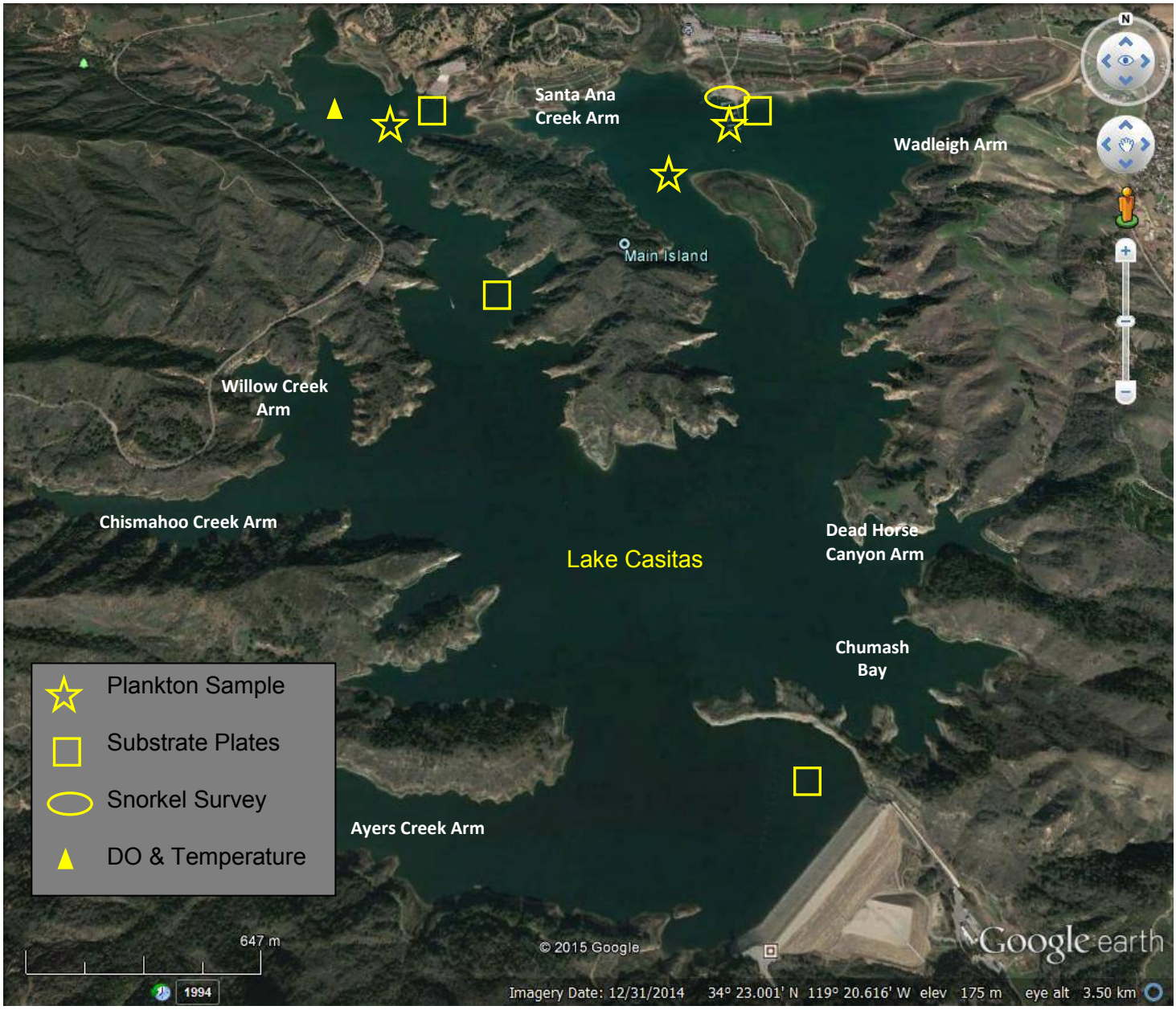

Figure 3.1- Sampling locations in Lake Casitas

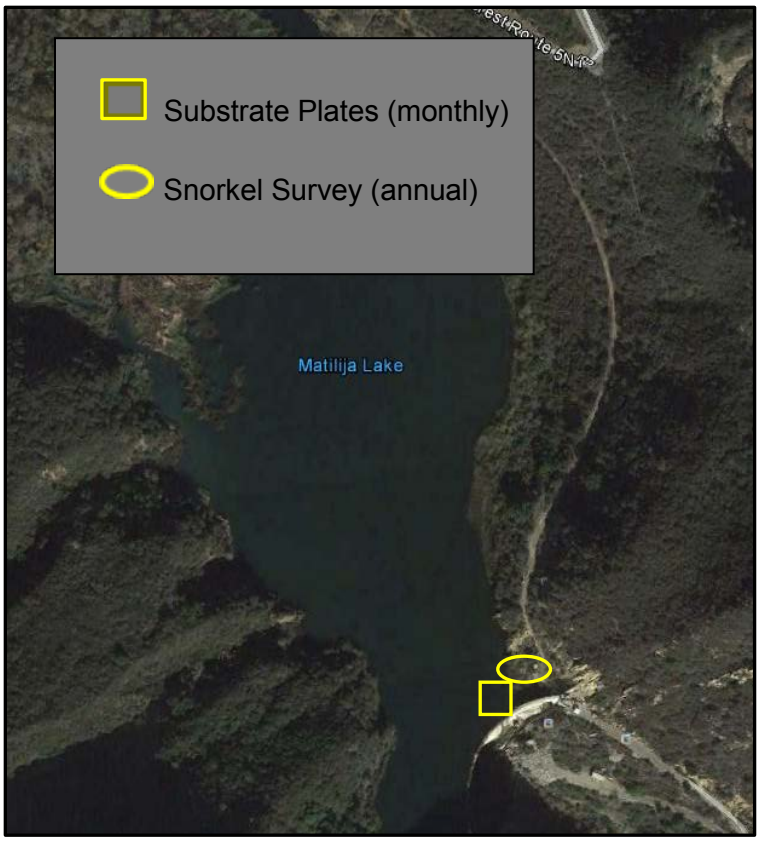

Figure 3.2 - Sampling locations in Matilija Lake

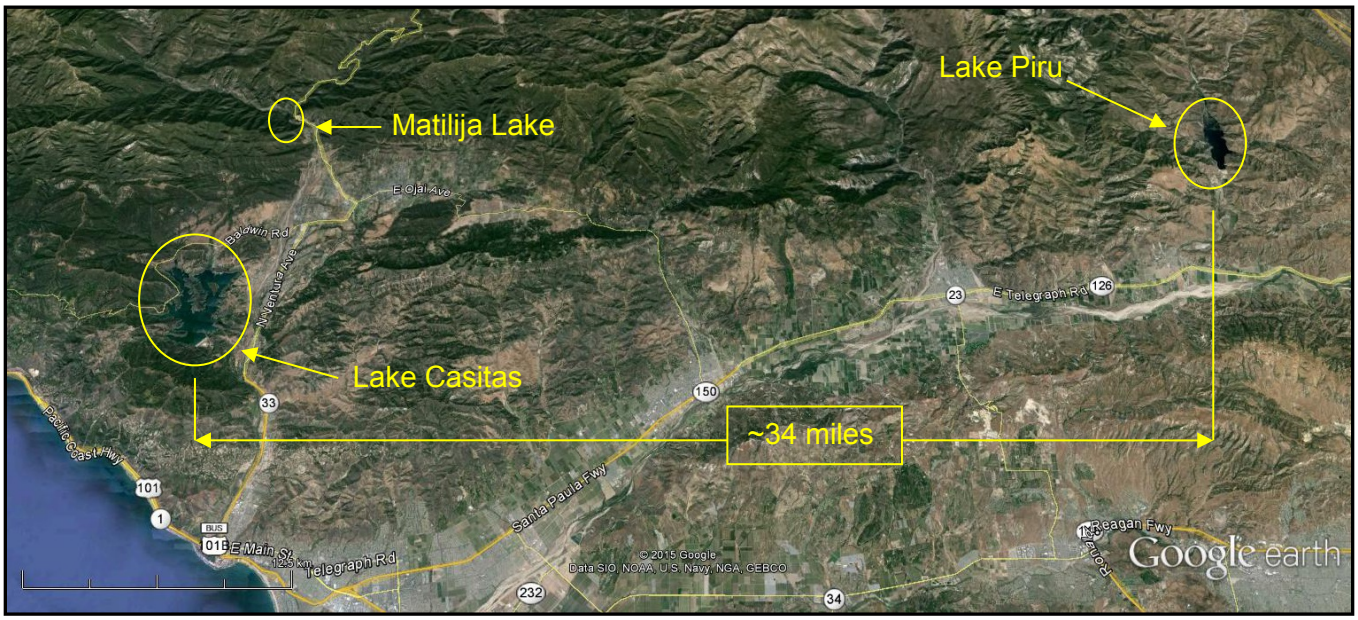

Figure 3.3 - Position of Lake Casitas in relation to other water bodies

3.2 Post Invasion Monitoring. Should a dreissenid invasion occur, the monitoring program will be changed from current presence and absence detection to determine the level of infestation at different times of the year, the periods of reproduction and of settlement, and the periods of most and least intense infestation levels. Growth rates and longevities will also be part of the analyses. The monitoring program will be a combination of best available techniques and staff preference and availability. The following items will be part of the monitoring program;

- Periods of settlement
- Densities of larvae and adults
- Maximum sizes and biomasses of adults
- Development rates of larvae
- Growth rates of adults

The monitoring program will meet the California Fish and Game requirement for delineation of infestation, including both adult mussels and veligers. The monitoring program outline for post invasion monitoring is included in **Appendix C**.

4. Management of Recreation at Lake Casitas

The Lake Casitas Recreation Area encompasses the northern end of Lake Casitas (**Figure 4**) and is a very popular destination site with over 650,000 visitors each year. Physical access to the reservoir is via a manned entrance. While camping draws the most attendance, boating and fishing activities have always been popular. Casitas Municipal Water District has a strict water vessel tagging and quarantine program in place since 2008. In 2008 the Board of Directors of the Casitas Municipal Water District adopted Resolution #08-08 preventing any incoming boats, including canoes, kayaks and float tubes from entering the Lake Casitas Recreation Area until they are inspected and complete a 35 day quarantine. A tamper proof tag attaches the vessel to the boat trailer after the vessel passes an initial inspection. The thirty five day quarantine can be completed either inside or outside of the Recreation Area. Once the quarantine is completed, vessels can be moored at the Lake Casitas marina and used at will. If however a vessel leaves Lake Casitas, the inspection and quarantine would have to be repeated upon return unless the vessel is secured to the trailer with the tamper proof tag which makes it impossible for the boat to be used in another water body. Detailed description of Lake Casitas policies for prevention of introduction are found in **Appendix A**.

As Lake Casitas is a drinking water reservoir, no body contact such as swimming, wading, or water skiing is allowed. There is a public pool (Casitas Water Adventure - **Figure.4**) on the site of the campground to offset this restriction.

Lake Casitas is considered a prime largemouth bass fishing lake. Stocking of trout has resumed in 2015 assuring a good fishing experience for anglers. Current efforts for assuring prevention of aquatic invasive species introduction through fish stocking are provided in **Appendix B.** Fishing may be done from a boat or from shore. Use of live bait is discouraged by Casitas Municipal Water District Ordinance 16-01 Establishing Rules and Regulations for the Public Use of the Lake Casitas Recreation Area and also by the Fish and Wildlife prohibition to transport invasive species. This ordinance is aimed at

preventing the transfer of aquatic invasive species via the use of live bait. Currently very few off-site sources of live bait exist in the area.

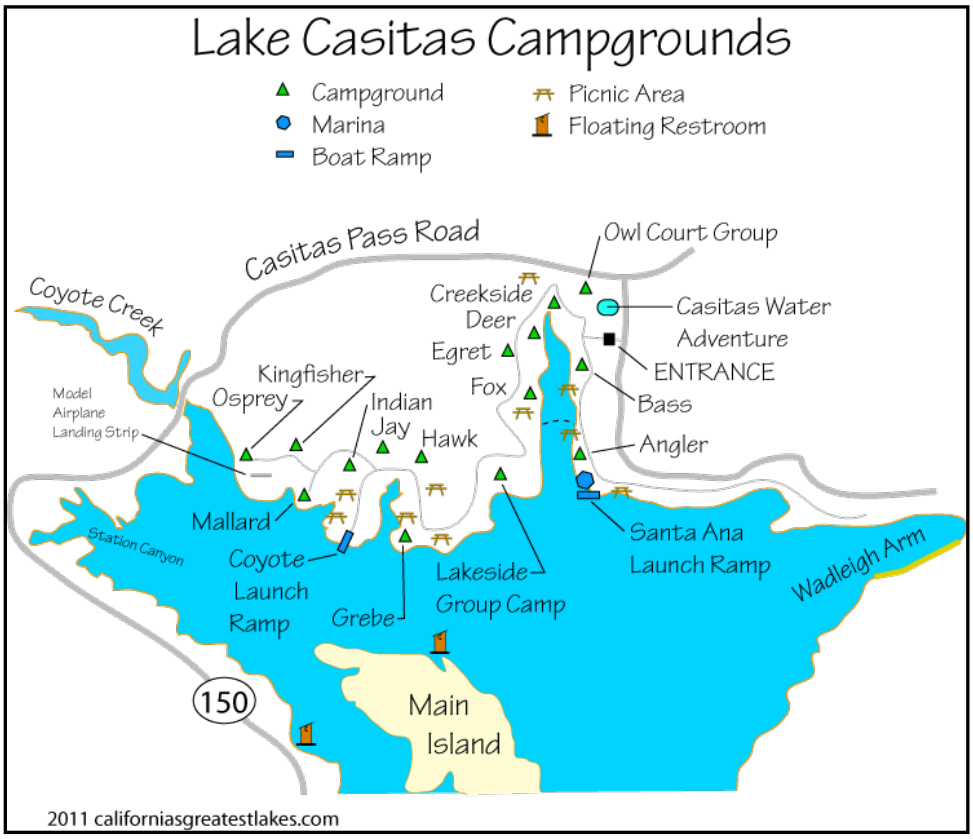

Figure 4.0 - Details of the Lake Casitas Recreational Area

5. Education and Outreach

Casitas Municipal Water District has been aware of the threat aquatic invasive species pose to the reservoir for a long time. As boating is the primary vector by which dreissenid mussels as well as other invasive species move from one body of water to another, Lake Casitas has had a strict water vessel tagging and quarantine program in place at Lake Casitas since 2008 to prevent such transfers. Signage at the main gate and each marina entrance have been installed to remind boater **(Figure 5)**. However, as all boats being used on Lake Casitas have passed through an extensive quarantine, there is no need for extensive Clean, Drain and Dry signage.

Figure 5 - Signage at Lake Casitas

At the manned entrance, material on aquatic invasive species is available to patrons (**Figure 6**). Additional material on use of live bait is planned.

Figure 6 - Staffed Entry at Lake Casitas

6. Responding to Mussel Infestation

6.1 Regulatory Requirements

6.1.1 Federal Strategy of Aquatic Invasive Species Control. The National Invasive Species Act (NISA) and the prior Non-indigenous Aquatic Nuisance Prevention and Control Act of 1990 were both reauthorized and amended by the National Aquatic Invasive Species Act of 2005 (NAISA). The control of *Dreissena* mussels is authorized by NAISA. Important authorizations under this law are the directives to states to develop Aquatic Nuisance Species Management Plans. The NISA provides the opportunity for federal cost–share support for a plan's implementation once it has been approved.

Section 302 established a rapid response fund to provide grants to states to implement approved rapid response contingency strategies.

Section 304 authorized the Environmental Protection Agency (EPA) to promulgate regulations to evaluate treatment methods to ensure no adverse effects on human health, public safety, or the

environment resulting from their use. The EPA was directed to publish lists of approved treatment methods.

Section 306 expanded educational programs of the National Park Service and others to address the spread of aquatic invasive species by recreational boats.

In the early 1990s, USFWS amended its regulations to include the Zebra mussel. The importation of live Zebra mussels, veligers or viable eggs into the United States, or transportation between the continental United States, the District of Columbia, Hawaii, the Commonwealth of Puerto Rico, or any territory or possession of the United States by any means is prohibited except by permit for zoological, educational, medical or scientific purposes. This prohibition includes any live species of the genus *Dreissena*. Under the amended regulation, viable eggs or progeny may not be sold, donated, traded, loaned, or transferred to any other person unless USFWS issues a permit.

Finally, the Federal Insecticide, Fungicide, and Rodenticide Act of 1947, as amended, (7 USC §136 et seq.) gives EPA authority to regulate pesticides, and calls upon federal agencies to combine the use of biological, cultural, physical, and chemical tools to control pests in a way that minimizes economic, health, and environmental risks. The Department of the Interior's pest management policy (517 DM 1) reinforces the requirement to use integrated pest management in management of aquatic invasive species including *Dreissena*.

6.1.2 State Legal Authorities and Contacts. Ventura County is under the jurisdiction of the Los Angeles Regional Board.

The California Fish and Game Code Section 2301 and 2302 apply to all mussel infested and non-infested waters respectively.

The section of FGC.2301 states:

> *"(d) (1) A public or private agency that operates a water supply system shall cooperate with the department to implement measures to avoid infestation by dreissenid mussels and to control or eradicate any infestation that may occur in a water supply system. If dreissenid mussels are detected, the operator of the water supply system, in cooperation with the department, shall prepare and implement a plan to control or eradicate dreissenid mussels within the system. The approved plan shall contain the following minimum elements:*
>
> *(A) Methods for delineation of infestation, including both adult mussels and veligers.*
>
> *(B) Methods for control or eradication of adult mussels and decontamination of water containing larval mussels.*
>
> *(C) A systematic monitoring program to determine any changes in conditions.*
>
> *(D) The requirement that the operator of the water supply system permit inspections by the department as well as cooperate with the department to update or revise control*

or eradication measures in the approved plan to address scientific advances in the methods of controlling or eradicating mussels and veligers."

6.2 Response Steps for Quagga Mussels in Lake Casitas. Once Quagga/Zebra mussel presence is observed in Lake Casitas the following actions will be implemented:

- Contact will be made with the appropriate CDFW Regional Scientist immediately. Contacts for the Regional Scientist can be found on the Department's website: https://www.wildlife.ca.gov/Conservation/Invasives/Quagga-Mussels
- In coordination with CDFW, verify the observed mussel finding is indeed an introduction.
- Using the post invasion monitoring strategy presented in **Appendix C** implement a program to delineate the infestation and to determine any changes in conditions with time.
- Prevent further spread by vector management.
- Implement a program to control or eradicate adult mussels and decontaminate water containing larval mussels.

6.3 Delineating the Mussel Infestation. Delineating a mussel infestation would begin as soon as the first mussel is found and introduction is verified. The location of the first find will be assumed to be an epicenter for invasion, but there may be more than one location where mussels are found. The quickest method for delineating an infestation is to examine submerged structures, such as large rocks, buoys and their chains and anchors, concrete/metal/wooden piers and pipes and hulls of boats that have been moored in the lake. Knowing the prevailing wind and water current patterns of Lake Casitas will help to delineate the infestation.

Sampling will proceed in either circumference or linear transects equidistant from the epicenter and proceed outward until mussels are no longer found. SCUBA divers will be used to search submerged surfaces and plankton hauls will be used to search for larvae. Particular attention will be paid at points on transects where prevailing winds/currents occur.

Generally, the epicenter of an invasion is the location where the largest adults are found. If more than one year class is found, it is probable that the species has already spread throughout much of the lake. If only juveniles are found the introduction is probably recent. If only larvae are found, there are two possible scenarios: a large volume of infested water was released nearby; or reproducing adults are present in the lake but not yet found. Delineation using the methods described above will be used to confirm the level of infestation.

6.4 Containing the Mussel Infestation. If in fact only one bay is infested, it may be possible to curtain off the mouth into the main body of water to contain the infestation, such as was done in Lake Winnipeg for three harbors where potash was used to eradicate the adults and any veligers which may have been present.

If mussels are confirmed as present in the entire body of Lake Casitas, all efforts will be made to contain the mussels and keep them from spreading to other water bodies. This will be accomplished by managing transportation pathways, and continuing to educate boaters, anglers, construction and

maintenance equipment operators and performing watercraft inspection and watercraft decontamination as required. Lake Casitas will:

- Work with law enforcement and management partners (state and local agencies, water districts), to contain the infestation through quarantine of watercraft, boater and angler education, watercraft inspection, and decontamination procedures which are already in place.
- Expand rigorous boat inspections which are currently in place for watercraft entering the lake. Should mussel be introduced into Lake Casitas the current procedures used to control boating on Lake Casitas will be applied to boats leaving the reservoir as well as entering it. This offers a high level of assurance of containment as the inspection and decontamination of boats leaving the reservoir will prevent the spread of dreissenids to other water bodies in California and possibly to other states via the boating vector
- Widely distribute brochures, pamphlets, erect signage, install wayside exhibits, and distribute other educational information.
- Install and maintain educational information where targeted visitors will see it. Given concerns with transportation pathways, signs and information literature will be placed at all marinas, launch ramps, parking lots around the lake.
- Initiate local community outreach. Distribute educational information to local businesses.
- Follow watercraft cleaning protocols for watercraft and other wetted equipment.
- Train project staff in the messages that should be conveyed internally and externally.

6.5 Control or Eradication of Larval and Adult Mussels. Once containment of the mussel infestation has been implemented and the size of the infestation has been assessed, a decision will be made if implementing an eradication protocol is appropriate. During this decision period control of mussels will rely on rigorous containment measures implemented as above. The benefits of eradication versus maintaining rigorous containment control of vectors which may result in the spread of Quagga/Zebra mussels, such as boating and bait buckets will be considered. Other federal and state agencies (particularly regulatory agencies such as the Environmental Protection Agency) will be consulted regarding compliance or permitting needs for eradication. Current and pending laws or regulations that contain provisions regarding access to affected properties for containment, treatment, and control or any legal or regulatory concerns related to treatment will also be considered during the decision making.

6.5.1 Available Control Measures for Adult Mussels in the Reservoir. Based on current information available, the paragraphs below outline the measures that are expected to be the most useful for control of dreissenid mussels in Lake Casitas. New control options may become available in the future and these will be considered at that time prior to committing to an eradication program. All control measures will be discussed with the regulators prior to use and permits will be obtained as required. Details of other control measures currently known to be available but not considered practical for implementation at Lake Casitas at this time are included in **Appendix F**.

6.5.1.1 Eradication. Chemical treatment is the only practical way to achieve eradication in Lake Casitas should dreissenid mussels become established. To date, chemical treatment has been demonstrated only in small bodies of water, or in bays that can be artificially

isolated from the main body of a large lake. The two primary chemicals used for eradication are potash and copper-based algaecides such as EarthTec QZ from Earth Science Laboratories, Inc. Budget figure proposals for use of these chemicals suggest a cost between 3 and 4 million dollars (2015 pricing) depending on the water level in the reservoir **Appendix D**.

6.5.1.2 Eradication Using Potash. Potassium compounds are toxic to most bivalves, including dreissenids and corbiculids. Acute treatment of 100 mg/L for two days at an ambient temperature of 15°C resulted in 100% mortality of dreissenid adult mussels. The length of treatment increased with decreasing temperatures. In 2006, ASI Group treated an isolated quarry in Virginia with potassium chloride in order to eradicate an infestation of Zebra mussels. A total of 131,000 kg of muriate of potash (KCl) solution was used with apparent success. Recently the Manitoba Government conducted very successful eradication of Zebra mussel in several harbours on Lake Winnipeg.

Potassium compounds are nontoxic to higher organisms such as fish. Potassium is an essential element in humans and is seldom, if ever, found in drinking water at levels that could be a concern for healthy humans. It occurs widely in the environment, including all natural waters. It can also occur in drinking-water as a consequence of the use of potassium permanganate as an oxidant in water treatment. In some countries, potassium chloride is being used in ion exchange for household water softening in place of, or mixed with, sodium chloride, so potassium ions would exchange with calcium and magnesium ions. Data from Canada indicate that average concentrations of potassium in raw and treated drinking water in different areas vary between 1 and 8mg/L. However, concentrations in drinking water have ranged up to 51 mg/l in Saskatchewan, which is the largest production area for potassium chloride in Canada (Health Canada, 2008).

In summary, an eradication treatment using potash would not impact fish and would have minimal impact on the drinking water produced from Lake Casitas. A special needs permit would likely be required for the use of potash for eradication from the regulators.

6.5.1.3 Eradication using Copper Based Products. Copper sulphate and the copper rich algaecide, Cutrine-Ultra® and EarthTec , have been reported to eliminate adult mussels while being used for algal control in various systems at levels of 30 to 50ppb as copper. In October 2008, an eradication of Zebra mussels was done in a small reservoir at an army base in Nebraska. Copper sulfate pentahydrate was applied to the surface of the lake using vortex spreaders. Although the eradication appeared to be a success, there was some fish mortality recorded during the treatment. The mortality may have been due to the uneven application and dissolution of the copper sulfate.

Table 4.1 shows detailed mortality of adult Zebra mussels exposed to a copper rich algaecide EartchTec QC applied for a number of days. EarthTec is NSF-approved for drinking water and is frequently applied in potable water lakes, reservoirs and at the intake of water treatment plants for algae control.

In August of 2013, EarthTec was granted federal EPA approval for use against Zebra and Quagga mussels. State labels have been granted in all 27 states that have dreissenid mussels, including California.

Dose as EarthTec	Dose as element	Mortality after: 6 days	11 days	13 days	19 days	25 days
3 ppm	150 ppb	100%				
2 ppm	100 ppb	100%				
1 ppm	50 ppb	50%	100%			
0.6 ppm	30 ppb	15%	55%	70%	80%	pending

Table 4.1 – Mortality of adult Zebra mussels when exposed to various levels of EarthTec under flow-through conditions.

The use of a copper rich substance for dreissenid eradication, approved for use in drinking water is a viable alternative for Lake Casitas provided there is an agreement from the regulator.

6.5.1.4 Eradication Using a Bio-pesticide Zequanox. It may be possible to reduce dreissenid mussel population growth in the lake with the use of a microbial biopesticide under the commercial name of Zequanox. This product, based on naturally occurring *Pseudomonas* bacteria is commercialized by Marrone Organic Bio-Innovations. The product is very specific to dreissenid mussels and has the following positive aspects according to Molloy and Mayer (2007):

- The toxin occurs in nature and dead bacteria kill equally as well
- Bacteria are readily ingested
- All mussel sizes are killed
- The higher the oxygen level, the higher the kill rate
- The higher the temperature, the higher the kill rate
- Most efficacious during periods of low particle loads
- Best not to disturb normal mussel feeding during application
- Recommend treating for about 6 hr for maximum kill (50-100 ppm (dry bacterial mass per unit volume)
- Has outstanding specificity and does not kill ciliates, fish, *Daphnia*, or native mussels

Given the size of Lake Casitas however, the cost and effectiveness of application may make this treatment impractical at present. However, cost may decrease in the future.

6.5.1.5 Hand Removal. Removal of mussels with divers is a possibility, but highly unlikely to be successful. If there was a very small finite and localized population then divers could remove mussels by hand or with a suction apparatus, however there would be no assurance that this would get a majority of the mussels much less any of the veligers which may have already been released into the water column. This method has been used at a few lakes where chemical parameters suggest that they are not suitable for colonization, such as Lake George in New York.

6.5.1.6 Drawdown. Lake drawdown is a possible strategy for mussel population control; however Lake Casitas generally maintains an even level in the reservoir throughout the year. Drawdown can be helpful in terms of minimizing the population of dreissenid mussels, particularly if the reservoir level can be dropped to a level where there was a lack of oxygen during summer month. This

would be a minimum of 30 to 60ft elevation drop in Lake Casitas. Dropping the level would expose the settled mussels to desiccation. If such a drawdown was to occur, it would be important to remove any buoys, floating docks and watercraft from the lake to make sure that there was no seed population of mussels remaining on such structures until the drawdown was completed. Continuing the analysis of dissolved oxygen levels throughout the year at different depths and modeling oxygen behavior during a major drawdown event would be important.

7. Resource Material

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Appendix A

Lake Casitas Existing Policies for Prevention of Quagga/Zebra Mussel Introduction

Appendix A.1 – Policy for Decontamination

CASITAS MUNICIPAL WATER DISTRICT
POLICIES & PROCEDURES FOR VESSEL DECONTAMINATION FOR
AQUATIC INVASIVE SPECIES
LAKE CASITAS RECREATION AREA

Board Approved: 8/12/15 Effective Date: 8/12/15

Park Services Manager Approval: C. Belser Date: 8/12/15

1. **POLICY**

All vessels and equipment entering the Lake Casitas shall be made free of invasive species, such as dressenid Quagga mussels. Casitas Municipal Water District (Casitas) has determined that there are operational and emergency requirements that cannot accommodate a 35-day quarantine that is specified by the Lake Casitas Recreation Area Vessel Quarantine, Re-Entry, Temporary Storage and Tamper-Proof Tag Program (Quagga Prevention Program). Casitas has determined that specific alternative decontamination methods can be applied to remove the risk of invasive species entering Lake Casitas and to lessen or remove the quarantine period.

The appropriately assigned Casitas staff are authorized under the procedures of this policy to perform inspection, alternative decontamination, and risk mitigation compliance of vessels and equipment belonging to Casitas and Casitas approved public agencies or agents that are performing under a Casitas agreement or contract.

The alternative decontamination procedures shall not be applied to recreational vessels belonging to the general public. The Lake Casitas Recreation Area Vessel Quarantine, Re-Entry, Temporary Storage and Tamper-Proof Tag Program Casitas Vessel Inspection and Tagging Program is the standard for such vessels.

Any deviation from the decontamination policy or the procedures will require a timely written submittal to the General Manager that includes, but is not limited to, a request for deviation naming the key persons in control of the vessel or equipment, evaluation of the risk posed by the vessel/equipment, supporting factual documentation, a justification for the deviation and an assessment of the risk that is associated with the deviation. A request for a deviation to the policy may not proceed without the written approval of the General Manager.

Emergency or life-threatening situations will be processed as expeditiously as possible within established decontamination protocols that are addressed in Memorandums of Understanding with Federal, State and County emergency response agencies.

2. PROCEDURES

A. **Notification**. It shall be incumbent upon the responsible Casitas Manager to:

(a) Provide a timely request to the Park Services Manager for inspection and decontamination services to be rendered by the Lake Casitas Recreation Area (LCRA) staff; and

(b) Provide correct information for the person(s) to contact and the purpose of the vessel entry.

When an emergency is deemed to be occurring and entry to Lake Casitas is required by emergency responders, the emergency response agency shall:

(c) Contact the Park Services Manager by direct telephone call to request access, state the emergency and requirements and methods to access Lake Casitas; and

(d) Comply with all pre-arranged decontamination procedures prior to accessing Lake Casitas waters.

In case of an emergency, the Park Services Manager will immediately notify the General Manager and follow up with a written report of the emergency action and measures taken to comply with this policy.

B. **Inspection and Decontamination**. In order to be consistent with policies, procedures and training, the Lake Casitas Recreation Area Vessel Decontamination Checklist will be completed on all vessel inspections and decontaminations. This document outlines the process that staff must complete before a vessel of any kind is authorized to enter the LCRA and launch in Lake Casitas. Each step in the Vessel Decontamination Checklist has specific expectations associated with it and will only be conducted by fully trained and Casitas approved staff. LCRA staff will follow a zero tolerance policy for completing the decontamination procedures following current Pacific States Marine Fisheries Commission (PSMFC) Watercraft Inspection Training II (WIT II) standards.

C. **Documents**. The Vessel Decontamination Policies and Procedures, Vessel Decontamination Procedures, Vessel Decontamination Checklist, Vessel Inspection Policies and Procedures, Vessel Inspection Checklist, Vessel Acknowledgement Forms and Casitas handouts have been developed to ensure proper inspections of vessels, trailers and vehicles to prevent Lake Casitas from becoming infested with invasive species. All documents pertaining to the Vessel Inspection and Vessel Decontamination Policies and Procedures are subject to change due to updated policies at the sole discretion of Casitas.

D. **Vessel Inspection and Decontamination Checklist**

(a) Staff will complete a Casitas Municipal Water District Clean and Dry inspection following the Policies and Procedures for Vessel Inspections for Invasive Species.

(b) Staff will write the state boating identification number and owner/operator's name and date on the Vessel Decontamination Checklist.

(c) Staff will check the Casitas generated database of vessels that have previously been denied access.

(d) Staff will request the owner/operator of the vessel to open all compartments.

(e) Staff will request the owner/operator of the vessel to remove all equipment or gear from the vessel.

(f) Should the owner/operator refuse to allow a complete inspection and decontamination, access to the LCRA and Lake Casitas shall be denied.

(g) The decontamination shall be performed at a location designated by Casitas that will not drain directly into a waterbody.

(h) Staff will decontaminate the vessel, trailer and vehicle with a hot water wash with water temperatures ranging from 120 degrees F to 140 degrees F on high and low pressures depending on the area of the vessel being washed as listed below. The hot water wash will comply with current (PSMFC WIT II) standards.

E. **Areas of Decontamination**. The following areas will be decontaminated by Staff:

(a) **Vehicle Rear**: The vehicle bumper, tailgate or spare tire may have mud, grass, weeds or other debris on it. If there are positive signs of mud, etc., the area will be decontaminated with a hot water wash using low pressure in compliance with (PSMFC WIT II) standards as may be modified from time-to-time. An infrared thermometer will be used to confirm the appropriate temperature has been reached. (See attached for current temperature requirements.)

(b) **Trailer Structure, Railings and Spare Tire**: The trailer, railings and spare tire may have mud, grass, weeds, debris or standing water. The area will be decontaminated with a hot water wash using high pressure in compliance with current (PSMFC WIT II) standards as may be modified from time-to-time. An infrared thermometer will be used to confirm the appropriate temperature has been reached. (See attached for current temperature requirements.)

(c) **Vessel Hull**: The vessel hull will be inspected for growth and debris. Growth may be visible if the vessel has been in the water for an extended period of time. Small mussels attached to a vessel can feel like sandpaper or sesame seeds. The area will be decontaminated with a hot water wash using high pressure in compliance with current (PSMFC WIT II) standards as may be modified from time-to-time. An infrared thermometer will be used to confirm the appropriate temperature has been reached. (See attached for current temperature requirements.)

(d) **Transom**: The transom is at the back of the vessel where the engine is attached. The transom may have several items of importance for inspection that mussels can attach to including outdrive, trim tabs, transducers, bilge plug area and through hull fittings. The transom must be checked to make sure the surface is smooth and visibly clear of all debris and growth. All areas will be decontaminated with a hot water wash in compliance with current (PSMFC WIT II) standards as may be modified from time-to-time. A high pressure wash will be used on all areas other than the transducers (see below). An infrared thermometer will be used to confirm the appropriate temperature has been reached. (See attached for current temperature requirements.)

(e) **Outdrive**: The Outdrive is attached to the transom on stern drive vessels and the lower unit on outboard vessels. It has intricate parts that make it easy for mussels to attach, hide and grow. Staff will feel and look for any signs of growth, debris or texture of sandpaper. The area will be decontaminated with a hot water wash using high pressure in compliance with current (PSMFC WIT II) standards as may be modified from time-to-time. An infrared thermometer will be used to confirm the appropriate temperature has been reached. (See attached for current temperature requirements.)

(f) **Propeller/Shafts**: Mussels can attach and live on or around where the propeller attaches to the lower unit of the drive shaft. Mussels can also attach to the shaft or connecting points of the vessel. These can be hard to see and must be inspected with a flashlight to verify if any mussels, debris or water are present. The area will be decontaminated with a hot water wash using high pressure in compliance with current (PSMFC WIT II) standards as may be modified from time-to-time. An infrared thermometer will be used to confirm the appropriate temperature has been reached. (See attached for current temperature requirements.)

(g) **Trim Tabs**: Trim tabs are located on the lower portion of the transom and are usually metal plates that help stabilize the vessel while underway. Staff will feel the corners, edges and look on the underside of the trim tabs for debris and growth. The area will be decontaminated with a hot water wash using high pressure in compliance with current (PSMFC WIT II) standards as may be modified from time-to-time. An infrared thermometer will be used to confirm the appropriate temperature has been reached. (See attached for current temperature requirements.)

(h) **Transducers:** These are located on the transom or bottom of the hull near the stern of the vessel. They are used in conjunction with a computer to determine depth, speed and water temperature. Growth or debris can appear on them. The area will be decontaminated with a hot water wash using low pressure in compliance with current (PSMFC WIT II) standards as may be modified from time-to-time. An infrared thermometer will be used to confirm the appropriate temperature has been reached. (See attached for current temperature requirements.)

(i) **Bilge Plug**: If the bilge plug is pulled when the vessel arrives at the lake, there should be no fluid or debris coming from it. Staff will check to determine if debris is blocking water from exiting. If the bilge plug is

not pulled, the owner/operator will be requested to pull the plug. The area will be decontaminated with a hot water wash using high pressure in compliance with current (PSMFC WIT II) standards as may be modified from time-to-time. An infrared thermometer will be used to confirm the appropriate temperature has been reached. (See attached for current temperature requirements.)

(j) **Through Hull Fittings**: Through hull fitting in all boats have the potential to store mussels in the right conditions. To check these fittings, Staff will use a flashlight to look inside and feel for irregularities. The area will be decontaminated with a hot water wash using low pressure in compliance with current (PSMFC WIT II) standards as may be modified from time-to-time. An infrared thermometer will be used to confirm the appropriate temperature has been reached. (See attached for current temperature requirements.)

(k) **Bait Tank/Live Well/Compartments**: Bait tanks, live wells and compartments should be dry and clear of all water and debris. Some compartments do not drain completely due to the way they are manufactured. Any debris in compartments is not acceptable. Common debris often found includes; fish scales, weeds, small pebbles, and trash. The area will be decontaminated with a hot water wash using low pressure in compliance with current (PSMFC WIT II) standards as may be modified from time-to-time. An infrared thermometer will be used to confirm the appropriate temperature has been reached. (See attached for current temperature requirements.)

(l) **Bilge**: The bilge is at the bottom of the inside stern of the vessel. It may not be visible in all boats due to various boat designs. The bilge should be clean from all water and debris. The area will be decontaminated with a hot water wash using low pressure in compliance with current (PSMFC WIT II) standards as may be modified from time-to-time. An infrared thermometer will be used to confirm the appropriate temperature has been reached. (See attached for current temperature requirements.)

(m) **Anchor/Fenders and Line**: Anchors can have mud or debris on them. If an anchor, fender and lines attached have been in infested water for an extended period of time then mussels and debris can attach. Staff must check these items for mud, growth and debris. The area will be decontaminated with a hot water wash using low pressure in compliance with current (PSMFC WIT II) standards as may be modified from time-to-time. An infrared thermometer will be used to confirm the appropriate temperature has been reached. (See attached for current temperature requirements.)

(n) **Trolling Motor**: Trolling motors can pick up plants and debris while being used and must be inspected. These items must be checked for mud, growth and debris. The area will be decontaminated with a hot water wash using high pressure in compliance with current (PSMFC WIT II) standards as may be modified from time-to-time. An infrared thermometer will be used to confirm the appropriate temperature has been reached. (See attached for current temperature requirements.)

(o) **Engine:** The engine will need to go through a hot water wash to insure no contaminated water or invasive species are present in the engine. The appropriate attachments will need to be connected to the engine to insure no damage is done. Cold water will need to be run through the engine while it is running until the engine is appropriately “warmed up”. Once the engine is “warmed up” the hot water wash can begin. The engine will be decontaminated with a hot water wash using low pressure in compliance with current (PSMFC WIT II) standards as may be modified from time-to-time. An infrared thermometer will be used to confirm the appropriate temperature has been reached. (See attached for current temperature requirements.)

F. **Compliance**

(a) If for any reason the decontamination is unable to be completed or there is good reason that Casitas staff believes that a risk still exists, the vessel will be denied entry into the LCRA and launching into Lake Casitas pending further review of the vessel’s condition and determination of a remedy. Staff will provide to the Park Services Manager and General Manager, in a timely manner by written report, all reasons and concerns that staff has identified, remedies staff recommends for decontamination, or reasons that decontamination cannot be attained by the alternate decontamination method. If the vessel is denied entry due to an incomplete decontamination, the General Manager’s direction must be obtained prior to any subsequent decontamination.

(b) Upon successful completion of the inspection and decontamination process, the vessel will be secured until the time the vessel is launched into Lake Casitas. Securing a vessel may include, but not be limited to, vessel cabling and tagging in accordance with the Casitas Quagga Prevention Program, or temporarily storing the vessel in a Casitas approved secure area at either the LCRA or Casitas Dam. If the removal of the cable-tag or removal of the vessel from the secured area causes Casitas to determine that the vessel decontamination has been compromised, re-inspection and decontamination will be required. Such a determination shall be immediately reported to the General Manager prior to proceeding with launching the vessel. The Vessel shall be denied entry into Lake Casitas until full disclosure is provided and a clearance for re-inspection and decontamination is given by the General Manager.

G. **Decontamination of Field Equipment**. This protocol applies to all dive gear used in all water bodies, not just water thought to be infested. Decontamination of field equipment shall occur prior to conducting field work in Matilija Canyon, upstream of Matilija Dam, Coyote Creek upstream of Casitas Dam, Santa Ana Creek upstream of Casitas Dam, and Lake Casitas.

Field equipment requiring inspection and decontamination includes equipment associated with wading, scuba, snorkeling and surface supplied air (SSA) activities. The alternative decontamination protocols adopted are specified in **Attachment B** hereto - Bureau of Reclamation Technical Memorandum No. 86-68220-07-05, entitled "Inspection and Cleaning Manual for Equipment and Vehicles to Prevent the Spread of Invasive Species" (2012 Edition).

Field staff may also apply 100% vinegar in a 20 minute dip bath or apply a 200 ppm chlorine bleach solution with a 10 minute contact time to achieve the decontamination of field equipment. The field personnel are cautioned, with the application of vinegar or chlorine, to thoroughly flush the field equipment with clean water. Residual vinegar or chlorine is unhealthful to breathe.

Waders and wading boots are a likely vector for transmission of invasive species, extra precautions are to be taken with boots. In addition to cleaning and washing, waders and wading boots are to be soaked in a saltwater bath for a minimum of 30 minutes. After soaking, the waders and wading boots are to be rinsed with freshwater. Snorkel gear is generally used one day per month to conduct surveys. All snorkel gear is to be cleaned with a mild detergent and rinsed with tap water. Generally this gear is dried for 35 days or more before the next survey.

A California Department of Fish and Wildlife (CDFW) study, Hosea and Finlayson 2005, found that bleach had deleterious effects on waders and wading boots. In addition, CDFW found bleach is ineffective for decontamination of New Zealand Mud Snail. NZMS has been observed in the Santa Clara River and in several streams in the Santa Monica Mountains. NZMS has been found to have a negative impact on trout.

Field staff shall document the application of the alternative decontamination protocol for each field equipment, date and location of field equipment use and date of decontamination being performed. The decontamination documentation shall be formally recorded and controlled by the Casitas Manager who is responsible for the field staff. The documentation shall be readily available for review at any time by the General Manager.

PACIFIC STATES MARINE FISHERIES COMMISSION (PSMFC)

WATERCRAFT INSPECTION TRAINING II (WITII) STANDARDS

AS OF MAY 2015

Area	Pressure	Temperature to Reach Degrees Fahrenheit	Confirm with Infrared Thermometer
Vehicle Rear	Low	120˚	Yes
Trailer Structure, Railings & Spare Tire	High	140˚	Yes
Vessel Hull	High	140˚	Yes
Transom	High	140˚	Yes
Outdrive	High	140˚	Yes
Propeller/Shafts	High	140˚	Yes
Trim Tabs	High	140˚	Yes
Transducers	Low	120˚	Yes
Bilge Plug	High	140˚	Yes
Through Hull Fittings	Low	120˚	Yes
Bait Tank/Live Well/Compartments	Low	120˚	Yes
Bilge	Low	120˚	Yes
Anchor/Fenders & Line	Low	120˚	Yes
Trolling Motor	High	140˚	Yes
Engine	Low	140˚	Yes

Expert from USBR: **ATTACHMENT B**

Technical Memorandum No. 86-68220-07-05

Inspection and Cleaning Manual for Equipment and Vehicles to Prevent the Spread of Invasive Species

2012 Edition

Page B26 through B29

Inspection and Decontamination Standards for Dive Gear and Related Equipment

In compliance with State and Federal laws, under no circumstances shall Zebra or Quagga mussels (including veliger) be transported away from an infested site. Therefore, all gear exposed to diving water must be treated onsite after the completion of the dive activities. Dive gear is often used in Zebra or Quagga mussel infested waters; therefore, it is vital that the equipment be properly treated using inspection and decontamination standards. Because dive gear is not exposed to Zebra or Quagga mussel infested waters over a long term, adult mussel infestation of dive gear is less of a concern. However, there is higher probability that mussel veliger could become trapped in or attached to dive gear during normal duration dives. Veliger would be invisible to the unaided human eye during visual inspection. Any adult mussels found on dive gear would be easily spotted and must be removed during visual inspection. Exposed dive gear requiring inspection and decontamination includes equipment associated with scuba, remotely operated vehicle (ROV), and surface supplied air (SSA) activities. This protocol applies to all dive gear used in all water bodies, not just waters thought to be infested.

Do not assume any diving water is uninfested.

When making dives at multiple sites, the known (or most likely) infested site should be the last dive of a multiple dive operation.

Drain water from all equipment before leaving the dive site. Remove all mud and vegetation from your equipment.

Visually inspect all gear for adult mussels attached to or trapped in equipment.

Feel surfaces by hand for rough spots that may indicate attached juvenile mussels.

Four suggested dive gear decontamination methods are listed below for veliger decontamination.

Dive Gear Decontamination Methods

Saltwater Treatment

Use saltwater (sodium chloride) as described below. Of these methods, perhaps the most challenging for dive team members to use involves a saltwater decontamination solution. While a saltwater solution is widely accepted in the literature as being very effective in killing Zebra and Quagga mussel veliger, and the solution is easy to prepare and use, disposal of the spent saltwater solution may be complicated by variable disposal requirements from State to State and among local governments.

What might be an acceptable disposal technique for the spent saltwater solution in one locale may not be acceptable in another. Therefore, it is not possible for the manual to discuss every saltwater disposal requirement that divers might encounter. If the saltwater decontamination method is selected, the dive team coordinator is advised to contact the environmental staff at the responsible field or area office. Advance contact with the environmental staff is highly recommended since discussion with other agencies may become necessary. It is preferable, when possible and if allowed by the local treatment plant authority, that the saltwater decontamination solution be disposed of into a domestic sewer drain. In remote locations with no reasonable access to domestic sewer drains, dispose of the spent saltwater solution on the ground near to the infested water body, or to another ground location recommended by the environmental staff or local facility manager.

Dedicated Equipment

The dive team would purchase and use a separate set of dive equipment dedicated for work in known infested water bodies only. Instead of purchasing extra dive equipment for all divers on the team, the dive team would select a limited number of divers with experience in performing Zebra and Quagga mussel inspection.

Quarantine

All exposed dive equipment must be contained (kept separated from other dive gear in bags, etc.) and then thoroughly dried in storage before using again. This would prohibit diving with possibly contaminated dive equipment for a minimum quarantine period of time based on storage humidity. This is more easily accomplished when a separate dedicated set of dive gear is purchased for the diving in infested waters only.

Cold Temperature

Freezing is a possible option in some places because many Reclamation facility locations are at high altitude and dive operations are conducted year round. When outdoor air temperature is below freezing, drain excess water from dive equipment and leave it outside overnight, or use a refrigerated freezer system, allowing equipment to freeze. Freezing is appropriate for dive equipment that does not contain water and does not break, such as dive suits, fins and gloves, etc. Ensure that freeze time is adequate for a complete freeze. Use caution with dive gear that could hold water, such as valves or hoses, because expanding water may damage equipment. Make sure all components are completely free of water before freezing, or use a different treatment method.

Notes on Saltwater Decontamination Treatment: Except for ROV, SSA, and other equipment as noted, the decontamination protocol below uses a desirable decontamination water temperature of 104 F for greater efficacy. However, heated water may not be available at remote locations when decontamination of dive gear is necessary. Therefore, decontamination of dive gear in the field using a cold saltwater solution is the recommended minimum treatment option. Zebra and Quagga mussel veliger are far more susceptible to salinity than adult mussels. Kilgour and Keppel (1993) recorded acute toxicity for Zebra mussel veliger at 4.5 parts per thousand (ppt) (or 0.45 percent) salinity. Mixing the saltwater decontamination solution at the rate of ½ cup of table salt per gallon of water approximates the salinity of seawater at 35 ppt (or 3.5 percent) salinity. The salinity of this solution is almost eight times more concentrated than the acute toxicity of 4.5 ppt noted.

Do not use a chlorine decontamination solution. Chlorine is not safe for dive gear decontamination due to a risk of residual chlorine gas inhalation through the regulator. It is also possible that chlorine could damage glue and other materials associated with diving gear from repeated chlorine washing. Equipment failure during diving may be hazardous to the diver. The use of normal chlorinated tap water (e.g., drinking water) to prepare the saline decontamination solution does not pose a chlorine risk to the diver.

Notes on Desiccation and Drying Time: Drying dive gear between dives is important, but the Reclamation dive team is often tasked to dive multiple locations over several days, making equipment drying difficult. Follow an accepted decontamination method and, whenever possible, allow dive gear to dry completely between dives. When used alone, drying is capable of killing mussels, but drying time effectiveness varies widely according to the mussel life stage, month of the year, location, and relative humidity; therefore, no

single drying time estimate can ensure a complete kill for all situations, unless a set maximum time is used. Zebra and Quagga mussel veliger are far more sensitive to desiccation than are adults. Although developed for adult mussels, as a guide, refer to the 100th Meridian *Quarantine Estimator* drying schedule at the following Web site: http://www.100thmeridian.org/Emersion.asp (100th Meridian Initiative, 2011).

Inspection and Saltwater Decontamination Protocol for Dive Gear

Flashlights, weight belt, mask, snorkel, fins, notepad, hood, gloves, regulator, buoyancy control device (BCD), etc.

1. Visually inspect inside of pockets. Scrub all surfaces with a brush as required to remove foreign material.

2. Carefully inspect the inside of BCD.

3. Soak all dive gear in saltwater. If available onsite, use hot water (104 F) to prepare the decontamination saline solution. Note that water temperatures greater than 104 F may shorten the life of dive gear due to glue or plastic failure. A failure in the equipment, at the seams of a wet suit for example, may be hazardous to the diver. Use a salt concentration of ½ cup commercial table salt per gallon of water.

4. Soak gear ½ hour, rinse with non-infested fresh water. Allow gear to dry completely prior to next use.

For Dry Suit:

1. Visually inspect inside of pockets and bottom of boots.

2. Close off valve, wrist, and neck openings of dry suit. Prepare and use the saltwater solution as described above. Immerse in saltwater for ½ hour.

3. Rinse with non-infested fresh water. Carefully inspect valves and zippers to prevent salt corrosion.

4. Allow to dry completely prior to next use.

Appendix A.2 - Tamperproof Tag Policy

CASITAS MUNICIPAL WATER DISTRICT
LAKE CASITAS RECREATION AREA
VESSEL QUARANTINE, RE-ENTRY, TEMPORARY STORAGE AND
TAMPER-PROOF TAG PROGRAMS

Date Issued: 4/3/08 Effective Date: 4/3/08

Park Services Officer Approval: Brent Doan Date: 4/3/08

Revision #1 Effective 12/17/08 PSO Approval: Brent Doan

Revision #2 Effective 2/12/14 Manager Approval: Carol Belser

THESE PROGRAMS ARE NOT AVAILABLE FOR
SKI BOATS WITH INTERNAL BLADDERS OR FLOAT TUBES.

Programs have been developed for quarantine procedures, tamper-proof cables and tags and provision for existing trailer storage and boat slip customers to remove their vessels from the park for servicing and return at a later date, and accommodate customers who do not have trailer storage spaces or boat slips.

A. **INSPECTION**

1. The customer must schedule a boat inspection appointment with either a Park Services Officer (PSO) or an Associate Park Services Officer (APSO). No other staff are authorized to conduct vessel inspections.

2. The customer must be informed that if temporary, long-term storage (other than in the Trailer Storage Area) is being requested, the customer will be required to sign a Self-Service Storage Facility Rental Agreement & Addendum and must provide current copies of the vessel and trailer registrations and driver's license.

3. The inspection will be conducted by a PSO or APSO only in accordance with the attached policy entitled "Policies & Procedures for Vessel Inspection for Quagga Mussels". If the vessel passes inspection the vessel will continue with the 35-Day Quarantine Process described in B below. If the vessel does not pass, the customer's name and state boating identification number will be placed on the 7-day wait list. The vessel may be re-inspected at the end of the 7-day wait period, i.e. the same weekday of the following calendar week, and if it passes will be subject to the 35-day quarantine process described below before being allowed to launch.

B. **35-DAY QUARANTINE PROCESS**

1. If the customer has been assigned a dry storage space (Trailer Storage Area):

   (a) Verify that the vessel has a current annual boat permit.
   (b) Enter release date in log book.
   (c) Escort the customer to his/her assigned space.
   (d) Secure vessel by using one (1) or more of the following methods:
      (i) Place tongue lock or cuff (boot) provided by Casitas over the tongue of the trailer.
      (ii) Affix a customer or Casitas owned Tamper-Proof cable on the vessel and secure with a Casitas provided lock.
      (iii) Affix a Casitas provided lock to secure canoe/kayak to rack or trailer as applicable.

(e) Advise customer to retain a copy of the Vessel Acknowledgement sheet containing the quarantine expiration date.

2. If the customer has an assigned Boat Rental slip:

(a) Verify that the vessel has a current annual boat permit.
(b) Enter release date in log book.
(c) Escort the customer to his/her designated quarantine space.
(d) Secure vessel by using one (1) or more of the following methods:
(i) Place tongue lock or cuff (boot) provided by Casitas over the tongue of the trailer.
(ii) Affix a Tamper-Proof cable and lock and secure with a Casitas provided lock.
(iii) Affix a Casitas provided lock to secure canoe/kayak to rack or trailer as applicable.
(e) Advise customer to retain a copy of the Vessel Acknowledgement sheet containing the quarantine expiration date.

3. If the customer **declines** to participate in the Tamper-Proof Tag Program and is completing the 35-Day Quarantine period inside the park:

(a) Direct the customer's attention to the disclaimer for temporary quarantine parking on the signed Vessel Survey.

(b) Enter release date in log book.

(c) Escort the customer to the designated space.

(d) Secure vessel by using one (1) or more of the following methods:

(i) Place tongue lock or cuff (boot) provided by Casitas over the tongue of the trailer.
(ii) Affix a Tamper-Proof cable and lock and secure with a Casitas provided lock.

(e) Advise customer to retain a copy of the inspection sheet containing the quarantine expiration date.

(f) Upon completion of the thirty-five (35) day quarantine collect applicable fees (e.g. day use or overnight boat, etc.).

4. The customer may complete the 35-Day Quarantine Process out of the park by participating in the applicable sections of the Tamper-Proof Tag Program described in B below.

5. At the end of the quarantine period, staff will remove the lock or cuff (boot). It is the responsibility of customers to immediately remove their vessels from the quarantine area. Any vessel left in the quarantine area longer than fifteen (15) days after release will be removed by Casitas and stored at the owner's sole cost and expense.

B. TAMPER-PROOF TAG PROGRAM

The purpose of this policy and procedure is to guarantee that vessels that enter and leave periodically have not been in any infected waters. This will be accomplished by installing a tamper-proof cable, padlock, and a tamper-proof security tag. The tamper-proof cable must be attached to both the vessel and the trailer. The connection points must be in a location that prevents a part of the vessel or trailer from being removed without damaging the cable or tamper-proof security tag.

1. All vessels are subject to a 35-day Quarantine period which may be completed inside or outside the park.

2. The customer will schedule an appointment with a Park Services Officer or Assistant Park Services Officer in order to be considered for the Tamper-Proof Tag Program. If eligible for the program, a boat inspection will be performed.

3. The inspection will be conducted by a Park Services Officer or Associate Park Services Officer only in accordance with the attached policy.

(a) If the vessel passes inspection it will continue with the Tamper-Proof Tag Program Process. Advise the customer to retain a copy of the Vessel Acknowledgement sheet containing the quarantine expiration date.

(b) If the vessel does not pass, the customer's name will be placed on the 7-day wait list. The vessel will not be eligible for re-inspection for a minimum of seven (7) days i.e. the same weekday of the following calendar week.

4. For Vessels Completing the Thirty-Five (35)-Day Quarantine Period Outside the Park

(a) Inform the vessel owner/operator that a security kit must be purchased. Inform the vessel owner/operator that the kit consists of a weatherproof tamper-proof steel cable, weather resistant padlock and a tamper-proof tag. Review the connection point areas with the vessel owner/operator and explain why these locations have been chosen.

(b) The vessel owner/operator shall install the equipment as needed. The connection points must be verified and relocated by the owner/operator if necessary.

(c) Install the tamper-proof security seal as required and fill out the Tamper Proof Tag Program Log. Make sure the vessel owner/operator verifies the tamper-proof security number and cable number and signs the Tamper Proof Tag Program Log. Explain to the vessel owner/operator that if the weatherproof tamper-proof steel cable and tamper-proof security tag are not in place or damaged in any way upon his/her return, a new inspection and thirty-five (35) day Quarantine period will be required.

(d) Instruct the vessel owner/operator that the vessel has been placed on a 35-Day Quarantine list. Tell them that they may leave the park and return after the 35-day Quarantine period has been completed.

(e) Vessels returning to the park after completing the Tamper-Proof Tag Program will have the weatherproof tamper-proof steel cable and tamper-proof security tag inspected by Staff and the cable and tag numbers verified with the entries in the Log. As long as the tamper-proof security cable and tag are not missing or damaged, the tamper-proof security tag can be removed by specifically designated or authorized Staff and the vessel will be allowed to enter the park and launch. **Special Note: A "Clean & Dry Inspection", will not be required because the vessel and trailer will not have been in any other body of water**. If there is **any** evidence that the weatherproof tamper-proof steel cable or tamper-proof security tag have been compromised, Staff must obtain a second opinion before the vessel is rejected.

(f) If repairs have been made to a vessel and the weatherproof tamper-proof steel cable or tamper-proof security tag have been damaged or removed, the vessel will **start the program over again**.

5. For Vessels Completing the 35-Day Quarantine Period Inside the Park Without Participating in the Tamper-Proof Tag Program

Any vessel returning to the park without participating in the Tamper-Proof Tag Program will start the inspection and 35-Day Quarantine period over again.

Appendix A.3 - Vessel Inspection Form

CASITAS MUNICIPAL WATER DISTRICT
POLICIES & PROCEDURES FOR VESSEL INSPECTION FOR INVASIVE SPECIES
LAKE CASITAS RECREATION AREA

Date Issued: __February 1, 2008_____ Effective Date: ____February 1, 2008_____

Park Services Manager Approval:_____B. Roney_____ Date: ____2/1/08_____

Revision #1 Effective ___2/12/14____ Manager Approval: _____Carol Belser_____

1. **Policies & Procedures**

The policies and procedures in this document are for inspection criteria for vessels entering the Lake Casitas Recreation Area. These policies and procedures are to ensure that invasive species do not enter Lake Casitas and impact treatment infrastructure and threaten the lake's ecosystem.

In order to be consistent with policies, procedures and training, the Lake Casitas Recreation Area Vessel Inspection Checklist will be used on all vessel inspections. This document outlines the process that staff must complete before a vessel of any kind is authorized to enter the Lake Casitas Recreation Area. The Vessel Inspection Checklist is a check off sheet outlining aspects of this policies and procedures document. Each step in the Vessel Inspection Checklist has specific expectations associated with it and will only be conducted by fully trained staff.

Lake Casitas Recreation Area staff will follow a zero tolerance policy for inspection criteria. If at anytime during an inspection a vessel fails a step on the Vessel Inspection Checklist, the vessel will fail the inspection process and a re-inspection will need to be scheduled. The re-inspection will be scheduled no sooner than seven (7) days, i.e. the same weekday of the following calendar week. Upon passing a re-inspection, the vessel will be quarantined for thirty-five (35) days.

At the discretion of Casitas Municipal Water District, vessels may be subject to random bilge water test that will examine water microscopically.

Vessel Inspection Checklist

(a) The owner/operator is to be informed that an inspection will be performed and that Casitas has a zero tolerance policy for any water, including condensation, debris, or growth found on any vessel, trailer or towing vehicle due to possible transportation of invasive species by vessels and trailers.

(b) Staff will write the state boating identification number and owner/operator's name and date on the Vessel Inspection Checklist.

(c) Staff will check the Casitas generated database of vessels that have previously been denied access due to inspection issues. A re-inspection cannot be performed until the due date.

(d) Customer will fill out and sign the "Vessel Quarantine, Re-Entry, Temporary Storage and Tamper-Proof Tag Acknowledgement" (Acknowledgement) in staff's presence. Customer is voluntarily signing the Vessel Vessel Acknowledgement under penalty of perjury. After the customer signs the Vessel Acknowledgement, he/she will be given the bottom yellow carbon copy of the Vessel Vessel Acknowledgement form.

(e) Staff has been directed to provide educational materials to the boating community and general public. Two handouts are given to each vessel operator/owner upon first entry to the park and in general as new

information becomes available as follows:

(1) Casitas flyer entitled “Take Action to Save Our Lakes from Quagga Mussels”.
(2) Department of Fish & Wildlife flyer entitled “Don’t Move A Mussel”.

(f) Staff will request the owner/operator of the vessel to open all compartments.

(g) The vessel, trailer and vehicle inspection will include looking for moisture, water, debris including but not limited to: mud, weeds, sand/pebbles or growth on or in any inspected area. Surfaces will also be touched to see if growth or mussels may be attached. The inspection will be completed the same way each time starting at one side of the vehicle, vessel and trailer and ending at the other side. Checking the “Yes” box indicates that the inspected material is dry and clear of debris. If the “No” box is checked the vessel has failed, will be placed on the Casitas 7-day wait list and will not be eligible for re-inspection for seven (7) days.

2. **Areas of Inspection**

The following areas will be inspected by Staff:

(a) **Vehicle Rear**: The vehicle bumper, tailgate or spare tire may have mud, grass, weeds or other debris on it. If there are positive signs of mud, etc., the inspection cannot continue. The vessel may return at a later date for re-inspection, towed by a different vehicle.

(b) **Trailer Structure, Railings and Spare Tire**: The trailer, railings and spare tire may have mud, grass, weeds, debris or standing water. If there are positive signs of mud, etc., the inspection cannot continue. The vessel may return at a later date for re-inspection or on a different trailer that is clean and dry.

(c) **Vessel Hull**: The vessel hull will be inspected for growth and debris. Growth may be visible if ~~it~~ the vessel has been in the water for an extended period of time. Small mussels attached to a vessel can feel like sandpaper or sesame seeds. If a vessel’s hull has any type of growth or debris, the vessel will not be eligible for re-inspection for a minimum of seven (7) days and will be placed on the Casitas 7-day wait list.

(d) **Transom**: The transom is at the back of the vessel where the engine is attached. The transom may have several items of importance for inspection that mussels can attach to including the out drive, trim tabs, transducers, bilge plug area and through hull fittings. The transom must be checked to make sure the surface is smooth and visibly clear of all debris and growth. If there are positive signs of growth, etc. the vessel will not be eligible for re-inspection for a minimum of seven (7) days and will be placed on the Casitas 7-day wait list.

(e) **Outdrive**: The outdrive is attached to the transom on stern drive vessels and the lower unit on outboard vessels. It has intricate parts that make it easy for mussels to attach, hide and grow. Staff will feel and look for any signs of growth, debris or texture of sandpaper. If there are positive signs of growth, debris or texture of sandpaper, etc. the vessel will not be eligible for re-inspection for a minimum of seven (7) days and will be placed on the Casitas 7-day wait list.

(f) **Propeller/Shafts**: Mussels can attach and live on or around where the propeller attaches to the lower unit of the drive shaft. Mussels can also attach to the shaft or connecting points of the vessel. These can be hard to see and must be inspected with a flashlight to verify if any mussels, debris or water are present. If there are positive signs of mussels, etc. the vessel will not be eligible for re-inspection for a minimum of seven (7) days and will be placed on the Casitas 7-day wait list.

(g) **Trim Tabs**: Trim tabs are located on the lower portion of the transom and are usually metal plates that help stabilize the vessel while underway. Staff will feel the corners, edges and look on the underside of the trim tabs for debris and growth. If there are positive signs of growth, etc. the vessel will not be eligible for re-inspection for a minimum of seven (7) days and will be placed on the Casitas 7-day wait list.

(h) **Transducers:** These are located on the transom or bottom of the hull near the stern of the vessel. They are used in conjunction with a computer to determine depth, speed and water temperature. Growth or

debris can appear on them. If there are positive signs of growth, etc. the vessel will not be eligible for re-inspection for a minimum of seven (7) days and will be placed on the Casitas 7-day wait list.

(i) **Bilge Plug**: If the bilge plug is pulled when the vessel arrives at the lake, there should be no fluid or debris coming from it. Staff will carefully insert fingers in the plug hole to determine if debris is blocking water from exiting. If the bilge plug is not pulled, the owner/operator will be requested to pull the plug. If water exits, the plug will be reinstalled to prevent additional water from being released. If there are positive signs of growth, etc. the vessel will not be eligible for re-inspection for a minimum of seven (7) days and will be placed on the Casitas 7-day wait list.

(j) **Through Hull Fittings**: Through hull fitting in all boats have the potential to store mussels in the right conditions. To check these fittings, Staff will use a flashlight to look inside and feel for irregularities. If water or debris is observed or felt, the vessel will be eligible for re-inspection for a minimum of seven (7) days and will be placed on the Casitas 7-day wait list.

(k) **Bait Tank/Live Well/Compartments**: Bait tanks, live wells and compartments should be dry and clear of all water and debris. Some compartments do not drain completely due to the way they are manufactured. Any debris in compartments is not acceptable. Common debris often found includes; fish scales, weeds, small pebbles and trash. If it does have positive signs of fish, etc., the vessel will not be eligible for re-inspection for a minimum of seven (7) days and will be placed on the Casitas 7-day wait list.

(l) **Bilge**: The bilge is at the bottom of the inside stern of the vessel. It may not be visible in all boats due to various boat designs. The bilge should be clean from all water and debris. If there are positive signs of water, etc. the vessel will not be eligible for re-inspection for a minimum of seven (7) days and will be placed on the Casitas 7-day wait list.

(m) **Anchor/Fenders and Line**: Anchors can have mud or debris on them. If an anchor, fender and lines attached have been in infested water for an extended period of time then mussels and debris can attach. Staff must check these items for mud, growth and debris. If there are positive signs of mud, etc. the vessel will not be eligible for re-inspection for a minimum of seven (7) days and will be placed on the Casitas 7-day wait list.

(n) **Trolling Motor**: Trolling motors can pick up plants and debris while being used and must be inspected. These items must be checked for mud, growth and debris. If there are positive signs of mud, etc., the vessel will not be eligible for re-inspection for a minimum of seven (7) days and will be placed on the Casitas 7-day wait list.

Denying a customer access to his/her favorite fishing lake can be very frustrating for both customer and staff. The following statement has been developed to help staff inform the customer of the results of his/her vessel's failure of the inspection.

"Your vessel has not cleared the inspection due to water and/or debris in one or more areas. Your vessel will be placed on the 7-day wait list as of today and may return for reinspection at the end of the 7 days. This zero tolerance policy has been established to protect the reservoir water quality, water distribution system and its ecosystem. Thank you for your cooperation."

The Vessel Inspection Procedures, Vessel Inspection Checklist, Vessel Acknowledgement Forms and Casitas handouts have been developed to ensure proper inspections of vessels, trailers and vehicles to prevent Lake Casitas from becoming infested with invasive species. All documents pertaining to the Vessel Inspection Procedures are subject to change due to updated policies at the sole discretion of the District.

Appendix A.4 - Decontamination Checklist

LAKE CASITAS RECREATION AREA

DECONTAMINATION CHECKLIST

CF #: _____ Owner/Operator (Print Name)
_____

- ☐ Computer check to see if vessel has been previously denied entry.
- ☐ Completed Vessel Acknowledgement. Have owner/operator complete and sign form.
- ☐ Remove all equipment from the vessel to insure easy access for decontamination.
- ☐ Request vessel owner to open all compartments and have the bilge plug pulled.
- ☐ Select an appropriate location to insure waste water from decontamination does not drain into watershed.

Vessel Decontamination: Decontaminate Vessel to current WIT standards using hot water wash.

Hot Water Wash Vessel Locations at the Following Temperatures: Check appropriate box below.

Yes	No	
☐	☐	Any equipment making contact with waterway (120˚ F with low pressure)**.**
☐	☐	Trailer structure, railings, spare tire (140˚ F with low to high pressure).
☐	☐	Vessel hull (140˚ F on low to high pressure).
☐	☐	Transom (140˚ F on low to high pressure).
☐	☐	Outdrive (140˚ F on low to high pressure).
☐	☐	Prop/shafts (propeller on the engine) (140˚ F on low to high pressure).
☐	☐	Trim tabs (140˚ F on low to high pressure).
☐	☐	Transducers (140˚ F on low pressure).
☐	☐	Bilge plug pulled (120˚ on low pressure).
☐	☐	Through hull fittings (120˚ on low pressure).
☐	☐	Bait tank/live wells/compartments (120˚ on low pressure).
☐	☐	Bilge (may not be visible) (120˚ on low pressure).
☐	☐	Anchor/fenders and line (120˚ on low pressure).
☐	☐	Trolling Motor (120˚ on low pressure).

☐ Your vessel has not cleared the Decontamination process due to inability to remove ANS. A zero tolerance policy has been established to ensure the safety of Lake Casitas water quality and its ecosystem. Thank you for understanding in this matter.

☐ You may enter the Lake Casitas Recreation Area on the date indicated on the Vessel Acknowledgement. Thank you for your cooperation.

Appendix A.5 - Vessel Decontamination Checklist

LAKE CASITAS RECREATION AREA - VESSEL INSPECTION CHECKLIST

CF #: _____ Owner/Operator (Print Name)
_____

- ☐ Computer check to see if vessel has been previously denied entry.
- ☐ Completed Vessel Acknowledgement. Have owner/operator complete and sign form.
- ☐ Informational handouts "Take Action to Save Our Lakes" and "Don't Move a Mussel" flyers given.
- ☐ Request vessel owner to open all compartments and have the bilge plug pulled.
- ☐ Inform owner/operator that Casitas has a no tolerance policy for any water, debris or growth found on any vessel due to possible transportation of invasive species by vessels and trailers.

Vessel Inspection: Check for **WATER, DEBRIS** or **GROWTH** and check all smooth surfaces for **"SANDPAPER"** feel.

Clear of Water, Debris and/or Growth: Check appropriate box below.

Yes	**No**	
☐	☐	Vehicle rear
☐	☐	Trailer structure, railings, spare tire
☐	☐	Vessel hull
☐	☐	Transom
☐	☐	Outdrive
☐	☐	Prop/shafts (propeller on the engine)
☐	☐	Trim tabs (located on back of hull near engine. Not all vessels have them)
☐	☐	Transducers
☐	☐	Bilge plug pulled – no fluid or debris
☐	☐	Through hull fittings
☐	☐	Bait tank/live wells/compartments
☐	☐	Bilge (may not be visible)
☐	☐	Anchor/fenders and line
☐	☐	Trolling Motor

☐ Your vessel has not cleared the inspection due to water and or debris in one or more areas. A re-inspection will need to be scheduled with staff. The re-inspection will be scheduled no sooner than seven (7) days, meaning the same weekday of today's date next calendar week. This zero tolerance has been established to ensure the safety of Lake Casitas water quality and its ecosystem. Thank you for understanding in this matter.

☐ You may enter the Lake Casitas Recreation Area on the date indicated on the Vessel Acknowledgement. Thank you for your cooperation.

Appendix B

Mussel Control Options for Fish Stocking

Aquatic Invasive Species Monitoring at CDFW Hatcheries
California Department of Fish and Game October 2014

1. Invasive Species

"Invasive species" are defined as plants or animals that cause environmental or economic harm, or harm to human health. Invasive species tend to be adaptable to new environments and multiply quickly. It is difficult to predict where an invasion will occur, which species may invade, or the consequences of their invasion; therefore, to protect facilities and the environment it is necessary to monitor for invasive species so that if an invasion does occur, efforts can be made quickly to prevent their spread within an area and to adjacent areas.

Invasive species threaten the diversity and abundance of native and desirable non- native species through competition for resources, predation, parasitism, hybridization, transmission of diseases, and/or causing physical or chemical changes to the environment. Invasive species also threaten man-made systems and structures, including water delivery and flood protection systems, agriculture, and developed lands.

Invasive species are commonly introduced into new areas as a result of human activities. Natural barriers, such as mountains, oceans, etc., historically confined species to their native range. Commerce and the advent of travel between remote locations has circumvented natural barriers, and trains, planes, ships, and vehicles are capable of transporting organisms great distances, often unknowingly and unintentionally. Hatchery activities have the potential to spread invasive species to new waterbodies, as well as between waterbodies, when stocking fish.

Invasive species in hatcheries pose a number of concerns. First, they may become established within a hatchery and impact operations, including clogging pipes, aeration devices, screens, and encrusting equipment, necessitating added maintenance. Second, they may be spread to other hatcheries and/or into the environment along with transferred or planted fish. Alternatively, invasive species may not directly impact operations at a hatchery, and thus go unnoticed, or pass through a hatchery in its source water. Both of these situations present the opportunity for hatchery activities to move invasive species to new environments in transport water, and therefore must also be addressed.

This protocol is limited to monitoring for aquatic invasive species (AIS); however, it is recommended that precautions to prevent the spread of terrestrial invasive species also be taken. This protocol does not address fish health issues or disease prevention. Monitoring for AIS is a component of a comprehensive Hazard Analysis- Critical Control Point (HACCP) Plan, which identifies pathways and preventatives for the introduction of AIS into a hatchery, the spread of AIS within a hatchery, and the release of AIS from a hatchery.

2. Sources of Aquatic Invasive Species

Many hatcheries use surface water for operation. Surface waters are susceptible to AIS contamination, particularly if accessible for recreation (boating, fishing, etc.).
Most of CDFW's anadromous mitigation hatcheries are located below dams and use water directly from an impounded reservoir that allows recreational access. Other hatcheries are located further

down-river from reservoirs, or on rivers where recreation occurs, and are also at risk of AIS contamination. Well water pumped directly into a hatchery is at very low risk of being contaminated with AIS.

Other potential pathways for the introduction of AIS into a hatchery include the importation of eggs or fish, or by picking up an AIS on equipment or vehicles in the course of planting fish. These pathways, and all others, should be addressed in a comprehensive HACCP Plan.

3. Aquatic Invasive Species of Concern and Aids to Their Identification

AIS believed to pose the greatest threat to California's hatcheries and the environment are quagga mussel, zebra mussel, and New Zealand mudsnail, and the monitoring methods described herein are specific for these three species. Other AIS of concern, including channeled apple snail, Brazilian waterweed, Eurasian watermilfoil, *Hydrilla*, and the algae *Didymosphenia geminata* (also known as didymo or rock snot), are described on page 55 and should be reported if found. Refer to page 55 for species descriptions, suitable environmental conditions, known range, and photos to assist in their identification.

(a) Quagga Mussel And Zebra Mussel – (*Dreissena bugensis* and *Dreissena polymorpha)*

Quagga and zebra mussels are separate species, but look very similar. The following description applies to both species. These freshwater mussels produce microscopic, free-floating larvae. The larvae eventually settle on surfaces and turn into the shelled adult form.

Species Description

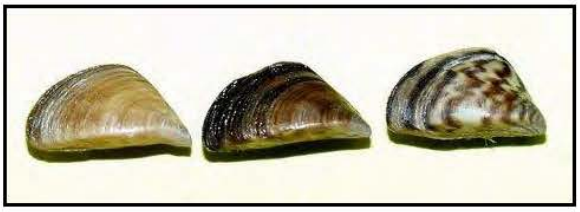
Body form – Juveniles and adults are 2-shelled (bivalve); may have dark colored "threads" on one edge. Larval life-stage is microscopic and cannot be seen by the unaided eye.
Size – Range in size from microscopic to up to 2" long; free-floating (planktonic) larvae are microscopic.
Color – Shells usually have alternating light and dark brown stripes, but can also be solid light brown to dark brown.

Suitable Environmental Conditions

Temperature – Survives in water temperatures between 32° F and 88° F.
Moisture – Aquatic, but can survive out of water for weeks under suitable conditions (longest at low temperatures and high humidity).
Substrate – Usually attached to soft and hard surfaces, including aquatic plants, but also known to detach from surfaces and crawl or be carried by water. Small, newly settled mussels feel like gritty sandpaper when attached to a smooth surface. Larger mussels may feel coarser, like a small pebble or sunflower seed. Mussels often adhere to surfaces firmly and when lightly touched may rock back and forth.
Known occurrences in California – San Bernardino, Riverside, San Diego, Imperial, Orange, and San Benito Counties. For current known locations visit http://nas.er.usgs.gov/taxgroup/mollusks/zebramussel/maps/CaliforniaDreissenaMap.jpg.

Key Features for Identification

Quagga and zebra mussels are not the only freshwater bivalve found in California, however they are the only freshwater bivalves that attach to surfaces. In the absence of attachment, a combination of characteristics including their alternating bands of color and evidence of "threads" can be used to identify.



Size and color variation in mussels

Quagga mussel showing 'threads'

(b) New Zealand Mudsnail – (*Potamopyrgus antipodarum)*

Small, fresh to brackish water aquatic snail that can be easily overlooked because it often blends in with its surroundings. New Zealand mudsnails are self-reproducing and give birth to live offspring, therefore a single snail can create a population.

Species Description

Body form – Single shell that is elongated and spiraled, when fully grown having 5-7 spirals.
Size – From microscopic up to ¼" long. Color – Variable; light to dark brown in color.

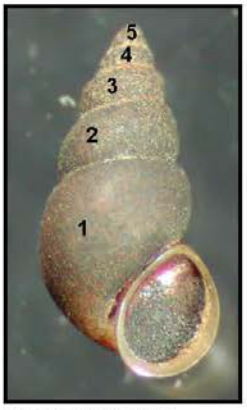
Suitable Environmental Conditions

Temperature – Survives in waters between 32° F and 83° F.
Moisture – Aquatic, but can survive for weeks under suitable temperatures and humidity.
Substrate – Soft (mud, silt, plants, etc.) and hard substrates. Also capable of detaching and floating in the water.
Known occurrences in California – For current known locations visit http://nas.er.usgs.gov/queries/collectioninfo.aspx?SpeciesID=1008.

Key Features for Identification

A key feature of live New Zealand mudsnails is the presence of an operculum (flap covering the shell opening). New Zealand mudsnails require expertise to accurately identify. Any snail ¼" or less should be forwarded for identification (see page 49).

Dead New Zealand mudsnail on metric ruler (5 millimeters =~¼") Operculum often absent in dead specimens.



Live New Zealand mudsnail showing operculum and spirals, numbered 1-5.

Dense colony of New Zealand mudsnails attached to the underside of a rock

4. Monitoring for Quagga and Zebra Mussels and New Zealand Mudsnail

(a) General Guidelines

Early detection monitoring concentrates efforts on areas where AIS are most likely to be found, rather than by randomly sampling. Attention should be directed to protected areas, such as crevasses, corners, and edges.

Hatchery personnel should always be on the look-out for unfamiliar plants and animals during daily operations. Current maintenance-intensive hatchery operations provide considerable opportunity to watch for AIS. Intensive maintenance could, however, inhibit the detection of AIS. Routine cleaning may prevent organisms from attaching to surfaces, becoming established, growing large enough to detect, or keep them at such low densities that they remain undetected.

In addition to watching for AIS during routine operations, hatcheries must inspect their facilities quarterly for AIS. Inspections provide only a snapshot in time, and do not guarantee that a facility is AIS-free. Increasing the frequency of inspections and using a variety of methods will improve the likelihood that an AIS is detected. In addition, monitoring may be useful in identifying the point of AIS introduction, should an infestation occur.

Because each AIS is different, no one method is effective for detecting all species. A combination of methods, including specialized sampling devices and examination of existing surfaces, is necessary. Monitoring methods and specific directions, as well as procedures for documenting and reporting monitoring, are provided below.

(b) Monitoring Source Water and Outflow

A means for continuous monitoring of non-well water entering the hatchery is necessary. Detecting AIS in water coming into a hatchery can exclude hatchery activities as the source of an AIS infestation. A portion of the inflow is routed into a flow-through system, referred to as a "biobox", designed to provide a suitable environment for some AIS species, making their detection possible. In addition, hatchery staff should examine debris, including plants, entrained on intake screens and

trash-racks for AIS. If it is not feasible to use a biobox at the inflow, then artificial substrates must be deployed near the water intake.

Because hatchery water is released into the environment untreated, AIS may be released as well. Monitoring hatchery outflow samples all the water passing through the hatchery, and is the final opportunity to detect AIS. Outflow monitoring can be achieved using either a biobox, artificial substrates and surface survey for depths three feet and greater, or surface survey for depths less than three feet.

Bioboxes

This method is suitable for detection of quagga mussels, zebra mussels and New Zealand Mudsnails

Bioboxes are flow-through aquaria, designed specifically to sample for the larval/settlement stage of quagga mussels, zebra mussels and New Zealand mudsnails. Microscopic larvae are suspended in the water, and upon reaching settlement stage, attach to surfaces. The biobox provides suitable conditions (surface and flow) for this to occur. Flow rates greater than 5 feet/sec inhibit mussel and mudsnail settlement, so a flow-through system must not exceed this velocity.

(1) Location(s) - If using bioboxes, one will be installed where raw water enters the facility and, if feasible, at each (if more than one) hatchery outflow, prior to discharge. Bioboxes are not needed on water drawn directly from a well. Bioboxes should be placed on a stable surface adequate to support its weight. If the water temperature inside the biobox is more than 2° F above the hatchery water temperature then the biobox must be shaded. Bioboxes should be located in areas that will not be damaged by water if the box were to overflow. Individual hatcheries may need to modify the Biobox during installment to adequately meet all flow and temperature requirements. There may also be infrastructure modifications needed to connect the Biobox to individual hatcheries inflow and outflow water supply.

(2) Monitoring Frequency - Bioboxes should be checked as needed to ensure they are operating correctly and maintaining the appropriate flow rate. A visual and tactile (touch) examination is conducted quarterly.

(3) Requirements for Biobox Design

- Minimum internal volume of 12 gallons
- Flow rate of 1.32 gallons/minute

The following design specifications meet the biobox requirements, above.

Biobox Construction and Assembly (Figure 1)
(Designed by Jody Rightmier, CDFW Yreka Screen Shop)

Biobox Materials Parts Listing (Material To Cover Single Box)

1" PVC ball valve female threaded ends, quarter turn design ..... 1 each
Nipple TBE SCH 80 1" x close PVC ..... 1 each
1" PVC 90 degree elbow slip x slip SCH 40 ..... 1 each
1" pipe x MIPT PVC insert male adapter ..... 2 each
1' PVC tank adapter SOCXFPT NPRN gasket ..... 2 each
1' x 2" (length) SCH 40 PVC pipe ..... 1 each
22 x 17 x 12" grey bins and divider box ..... 1 each
Snap F/DC3000 bins & divider box cover ..... 1 each
Short divider F/DC3080 (sold in 6 pk). Bins & divider box ..... 3 each/box
ER308L 3/32 x 36" TIG welding rod ..... 1 each
1/2 " bolt size medium flat washer 18-8 stainless/steel ..... 6 each

The plates slide down into "channel guides" on either side of the interior walls of the box (Figure 2) and water flows over and under the plates as it passes through the box. Plates are kept submerged with stainless steel wire and washers that allow for removal when inspecting the plates. Flow into the box is regulated by a valve on the incoming water line. The outlet is an overflow pipe that ensures the water level in the box remains at a constant level. All interior surfaces and plates are roughed up with fine (150-180 grit) sandpaper to maximize suitability for settlement.

Figure 2. Interior view of biobox plates that provide suitable surfaces for mussel and mudsnail settlement.

(4) Monitoring Procedure - To inspect biobox, begin by closing the inflow valve. One at a time, carefully remove each plate. Do not set the plates down as small or delicate organisms could be crushed. Hold the plate over a separate container to catch any dislodged organisms, and visually inspect it. Use a magnifying glass if necessary. Next, gently run fingers over the plates to feel for any organisms. Very small quagga or zebra mussels may be more easily felt than seen. Do not leave the plates out of the water so long that they dry; examine and return to the water immediately if no suspect organisms are found. When finished with the first plate, reinsert it and inspect the remaining plates the same way. Also examine the inner walls of the biobox. If walls are transparent, look in from the outside. If not, view from above. Next, gently run fingers over the walls as with the plates. When finished, open the valve to resume appropriate flow.

Artificial Substrates

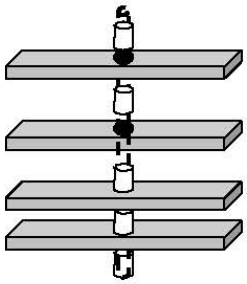
This method is suitable for detection of quagga and zebra mussels

If it is not feasible to use a biobox at the inflow or outflow, then artificial substrates must be deployed.

ARTIFICIAL SUBSTRATE MATERIALS PARTS LISTING: material to cover single substrate

6" x 6" x 0.25" black/grey PVC with 1" hole through center 4
1.5" x 1.375" (35mm) exterior diameter PVC or ABS tube 5
8.5" x 0.8125" (21 mm) exterior diameter PVC or ABS tube 1
~25 ft plastic coated cable or rope
Some form of attachment to keep plates from floating up
Weight
Laminated label with your contact information

To assemble the substrate, run the cable or rope through the 8.5" tube and secure at one end. From the loose end of the rope string on the remaining pieces, alternating between the short segments of tube and the plates, beginning and ending with the short tubes (see figure). Secure the top tube to the rope to prevent the pieces from floating up. If necessary, attach a weight to the bottom of the assembly. Attach the label to the cable where the cable is secured to the structure.



California Department of Fish and Game

Biological Research

PLEASE DO NOT DISTURB

(1) Deployment of the Artificial Substrates - Depending on water clarity and depth, the artificial substrate should be set below the euphotic zone (below the depth of light penetration) or 6 feet, whichever is deeper, and at least two few feet above the bottom. One to two substrates are deployed per site. If the site is shallower than 2 m, then raise the substrate about 0.5 m (2 ft) off of the bottom. Record the actual sampling depth. At sites that are deep and have little vertical mixing, a second substrate is installed at a depth of approximately 15 meters (50 feet) below the surface (or 1 meter off the bottom if the depth is less than 15 meters).

(2) Monitoring Procedure - To check an artificial substrate, first carefully lift it out of the water and place it in a large plastic tub (the tub will capture any mussels that fall off). Avoid knocking the substrate as you pull it out of the water because you may dislodge or crush any attached mussels. First visually inspect each plate (top, bottom, and sides), the spacers, the cable and the weight. Use a magnifying glass if necessary. Next, gently run fingers over the plates to feel for any organisms. Very small quagga or zebra mussels may be more easily felt than seen. After looking closely, attempt to gently push any attached organism that might be a mussel. Freshwater limpets and snails easily move or slide across the plate. Zebra and quagga mussels stick in place or are more securely attached. In all cases, if in doubt, bag it.

If no mussels are detected, lower the substrate back into the water. Zebra and quagga mussels are more likely to attach to a substrate that has some algal growth, however if the substrate becomes too heavily coated it may be unsuitable for mussel settlement. As necessary, gently remove heavy accumulations of algae to maintain suitable conditions for settlement.

Monitoring In-Hatchery and Outflow

In addition to monitoring at the inflow and outflows, surface surveys must be conducted within the hatchery facilities and outflows if a biobox is not used.

Surface Surveys

This method is suitable for detection of Quagga and Zebra Mussels and New Zealand Mudsnail

When areas are dewatered during hatchery operations, surfaces must be inspected for AIS. Many AIS blend in with their surroundings and prefer sheltered areas, so close inspection is necessary and most easily conducted when dewatered. In addition, surfaces and structures within the hatchery must be inspected quarterly.
Specific instruction on how to inspect surfaces is provided below.

(1) Locations and Frequency - Inspect 5% of dewatered surfaces as dewatering occurs. In addition, inspect 5% of surfaces throughout the facility each quarter. For example, if there are ten raceways, inspect the safely accessible surfaces equivalent to one-half of a raceway (10 raceways x 0.05 = 0.5 raceways), divided among the ten raceways. Spreading the 5% over all of the raceways increases the chance of finding an AIS if it is in the facility.

The 5% applies to surfaces, outflow settling ponds (if applicable) as well as equipment such as screens, tubing, lines, etc. As with all forms of early detection monitoring, the more you look, the more likely you are to find something if it is there. Always err on exceeding the minimum sampling requirement, rather than just meeting it.

If monitoring is conducted outside of secured areas of the hatchery there is greater potential that they are infested with invasive species. Do not allow gear that will be returned to the hatchery (including, but not limited to boots, waders, nets, etc.) to contact the settling ponds. In these cases gear dedicated to this purpose should be used and prominently labeled, and stored separately from other gear. If dedicated gear is not feasible, then gear must be decontaminated after monitoring outside of the hatchery according to the following protocols:

http://www.dfg.ca.gov/invasives/quaggamussel/

(2) Monitoring Procedure - Carefully examine surfaces both visually and tactilely by running fingers over them, with particular attention given to protected areas such as crevasses, corners, and edges, and areas where fish are excluded from. If needed, use a magnifying glass, flashlight, or other aides to thoroughly examine.

Summary of Monitoring Methods and Minimum Monitoring Frequencies

	Biobox	Surface Survey	Artificial Substrates
Inflow	Quarterly (January, April, July,	N/A	N/A
In hatchery	N/A	Dewatering and 5% Quarterly (January, April, July,	N/A
Outflow	Quarterly (January, April, July,	5% Quarterly (January, April, July,	Quarterly (January, April, July,

(3) Specimen Identification and Collection - If a suspect AIS is detected either during daily operations or monitoring, immediately contact your CDFW Regional AIS Scientist (page 12). To aid their identification, first take a close-up digital photograph of the organism next to a ruler so that there is a size reference. Next, collect the specimen(s) and place in a container where it will not be crushed and add enough 70% ethanol to cover it. Label the sample with hatchery name, location within the hatchery, date, suspected species, and the name of who collected it. If the entire substrate needs to be retained, place the entire unit in a plastic bag. E-mail the photos to the CDFW Regional AIS Scientist and they will try to identify the specimens from the photographs. If they are unable to identify the species from photographs, they may request the specimen(s) or substrate.

(4) Data Recording and Reporting - Quarterly monitoring is to be conducted during the months of January, April, July, and October. Quarterly monitoring datasheets must be completed to document monitoring, and are to be submitted by the end of the month of monitoring. Absence data is as important to document as presence, so complete and submit a datasheet (electronic form provided) even if no AIS are found. Hatcheries are to send an electronic copy of the datasheet to their respective regional Senior Hatchery Supervisor, Regional AIS Scientist, to the Fisheries Branch Fish Production Program Manager and Hatchery Coordinator via email, and retain the originals on-site. All data will be entered into a centralized monitoring database maintained by the Habitat Conservation Planning Branch AIS Program.

5. CDFW Regional Office Contacts for AIS Monitoring

Contact information subject to change. For the most up to date information refer to: http://www.nrm.dfg.ca.gov/FileHandler.ashx?DocumentID=4955.

Region 1 – Northern Region

Counties: Del Norte, Humboldt, Lassen, Mendocino, Modoc, Shasta, Siskiyou, Tehama, and Trinity
601 Locust Street, Redding, CA 96001
L. Breck McAlexander
Louis.McAlexander@wildlife.ca.gov Office:
(530) 225-2317
Fax: (530) 225-2381

Region 2 – North Central Region

Counties: Alpine, Amador, Butte, Calaveras, Colusa, El Dorado, Glenn, Lake, Nevada, Placer, Plumas, Sacramento, San Joaquin, Sierra, Sutter, Yolo and Yuba
1701 Nimbus Road, Rancho Cordova, CA 95670 Angie
Montalvo
Angie.Montalvo@wildlife.ca.gov
Office: (916) 358-2895
Fax: (916) 358-2912

Region 3 – Bay Delta Region

Counties: Alameda, Contra Costa, Marin, Napa, Sacramento, San Mateo, Santa Clara, Santa Cruz, San Francisco, San Joaquin, Solano, Sonoma, and Yolo
7329 Silverado Trail, Napa, CA 94558
Catherine Mandella
Catherine.Mandella@wildlife.ca.gov Mobile:
(831) 588-1463
Fax: (707) 944-5563

Region 4 – Central Region

Counties: Fresno, Kern, Kings, Madera, Mariposa, Merced, Monterey, San Benito, San Luis Obispo, Stanislaus, Tulare and Tuolumne
1234 E. Shaw Avenue, Fresno, CA 93710
Kelley Aubushon
Kelley.Aubushon@wildlife.ca.gov
Office: (559) 243-4017 X-285
Fax: (559) 243-4004

Region 5 – South Coast Region

Counties: Los Angeles, Orange, San Diego, Santa Barbara and Ventura 4665 Lampson Avenue, Los Alamitos, CA 90720
Eloise Tavares
Eloise.Tavares@wildlife.ca.gov
Office: (562) 342-7155
Fax: (562) 342-7153

Region 6 – Inland Deserts Region
Counties: Imperial, Inyo, Mono, Riverside and San Bernardino
P.O. Box 2160, Blythe, CA 92226 David
Vigil David.Vigil@wildlife.ca.gov Office:
(760) 922-4928
Fax: (760) 922-5638

6. Other Aquatic Invasive Species of Concern

The following species are known to occur in California and should be reported if found. Additional species accounts may be added as warranted.

Animals
Channeled apple snail

Plants and algae
Eurasian watermilfoil
Brazilian waterweed or Brazilian elodea Hydrilla
Rock snot or didymo

(a) Channeled Apple Snail – (*Pomacea canaliculata)*

Freshwater aquatic snail. Channeled apple snails leave the water to lay eggs and eat terrestrial vegetation. Eggs hatch and juvenile snails return to the water. Reproduction is dependant on food availability and water temperature, but usually occurs in the early spring and early fall.

(1) Species Description

Body form – Single shell with compact spirals that are deeply indented, hence the common name "channeled". Eggs are reddish in color, and loosely attached to each other in masses of 200-600.
Size – Adult shells can reach up to 3" long, individual eggs are 0.09-0.14" in diameter.
Color – Shell color is yellowish to brown.

(2) Suitable Environmental Conditions

Temperature – Survives in water between 65° F and 90° F.
Moisture – Aquatic, but commonly leaves water to lay eggs and eat. Can survive out of water for several months by closing the opening of its shell and bedding in the soil.
Substrate – Soft (mud, silt, plants, etc.) and hard surfaces.

Known occurrences in California – Lake Miramar, San Diego County, Norton Simon Museum pond, Los Angeles County, and Riverside County near the Salton Sea.

(3) Key Features for Identification

The large size of adult channeled apple snails and their egg masses is unique. Smaller specimens may be identifiable by their round, deeply indented shell.

Adult channeled apple snail shells

Egg masses

Newly hatched (5 day) channeled apple snail.

(b) Eurasian Watermilfoil – (*Myriophyllum spicatum)*

(1) Species Description

Plant – Reddish-brown or whitish-pink
Stems – Branched and 20-30" long, reddish-brown or whitish-pink.
Leaves – Olive green and occasionally reddish tinted and arranged circularly around the stem in groups of 3-6 (usually 4). Each leaf is less than 2" long, soft, and feather-like. Each leaf has a rib and 14-24 or so slender segments on each side of the rib.
Flowers – Individual flowers are reddish, very small, and many together form spikes several inches long that are held above the water.
Roots – Fibrous, often developed on small pieces broken off larger plant.

(2) Suitable Environmental Conditions

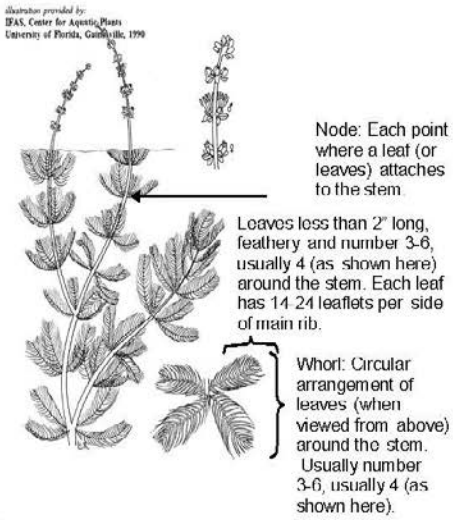
Temperature – Able to overwinter in frozen lakes and ponds in northern states and Canada; also able to grow in shallow, over-heated bays.
Moisture – Underwater; often found in water 1½" to 12' deep, and up to 30' in very clear water. Prefer lakes, ponds and slow-moving rivers and streams but can also grow in fast-moving water. Tolerates a wide range of water conditions, including spring water and even brackish water of tidal creeks and bays with salinity of up to 10 parts per thousand.
Substrate – Root in all types of substrates, and broken pieces float freely.

Known occurrences in California – Sacramento-San Joaquin Delta, San Francisco Bay Area and Central Valley ditches and lakes; margins of Southern California's south-east border.

(3) Key Features for Identification

Finely divided, feather-like leaves ½ to 2" long.

Color variation of Eurasian watermilfoil



Aquatic Invasive Species Monitoring at CDFW Hatcheries

(c) Brazilian Waterweed Or Brazilian Elodea – (*Egeria densa)*

(1) Species Description

Plant – Green
Stems – Highly branched and can reach 25' or more in length.
Leaf attachment to stem (nodes) – Densely spaced at growing tip and indistinguishable. Points of attachment are more widely spaced near the main stem and stems deeper in the water. Double nodes bear branches and flowers.
Leaves – Thin, ¾ – 1½" in length and 1/16 – 1/8" wide, arranged circularly around the stems when viewed from above (whorls) of 3-6 leaves. Spear- shaped leaves have tiny teeth that may require a magnifying glass to see. The number of leaves doubles or triples (up to 12 leaves per whorl) every 8-12 whorls.
Flowers – Three white petals and are about ¾" across on 1" stems above the surface of the water.
Roots – Thin

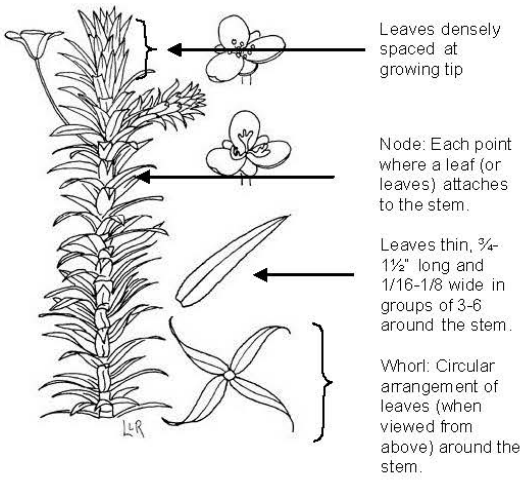
(2) Suitable Environmental Conditions

Temperature – Survives in water between 40°F and 90°F.
Moisture – Underwater, in both flowing and shallow and standing water.
Substrate – Roots in all types of substrates; broken pieces float freely.

Known occurrences in California – Throughout the Sacramento-San Joaquin Bay-Delta.

(3) Key Features for Identification

Robust 1-inch leaves closely spaced in whorls of 3-6 around the stem.



Aquatic Invasive Species Monitoring at CDFW Hatcheries

(d) Hydrilla – (*Hydrilla verticillata)*

(1) Species Description

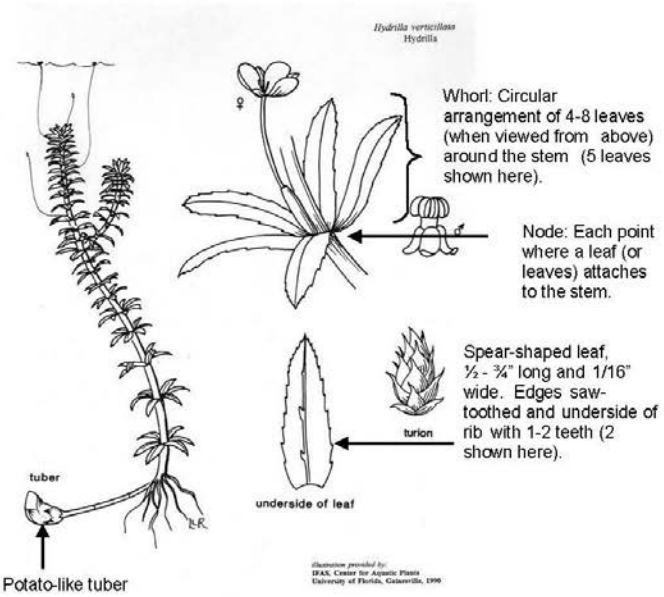
Plant – Green, up to 25' long.
Stems – Slender, branched.
Leaves – Spear-shaped, ½ - ¾" long and 1/16" wide arranged in groups of 4-8 leaves around the stem. Leaf margins distinctly saw-toothed. Often 1-2 sharp teeth along the underside of the leaf rib.
Flowers – Tiny, white flowers born on long stalks at the surface of the water.
Roots – Roots are white and may have yellowish, potato-like structures ½" long and ½" wide at the tips of the roots.

(2) Suitable Environmental Conditions

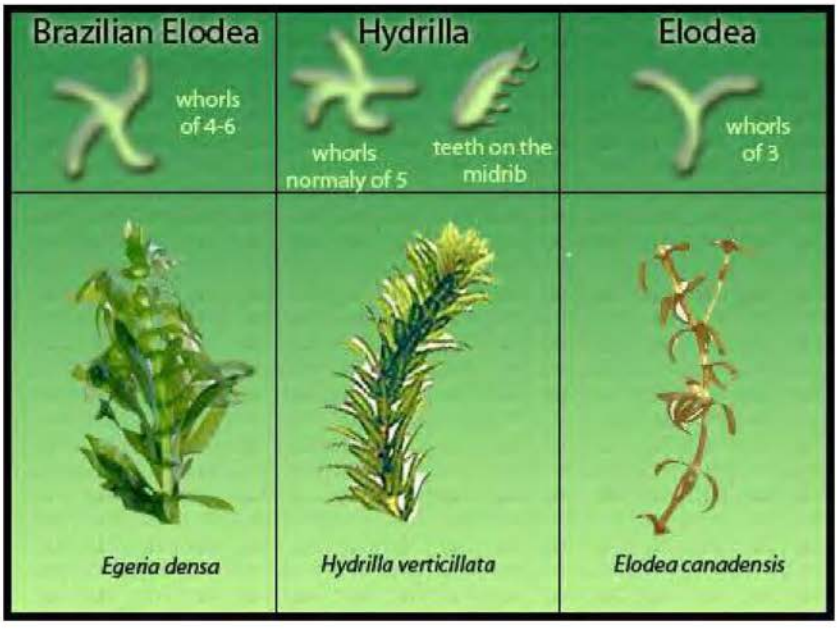
Temperature – Somewhat winter-hardy; its optimum water temperature is 68° F - 81° F; its maximum temperature is 86° F.
Moisture – Underwater, from a few inches deep to more than 20'.
Substrate – May be found in all types of water bodies including springs, lakes, ponds, marshes, ditches, canals, rivers, tidal zones. Broken pieces float freely.
Known occurrences in California – As of 2012, hydrilla is currently being eradicated from 9 locations in Calaveras, Imperial, Lake, Nevada, Shasta, Tulare, and Yuba counties.

(3) Key Features for Identification

Hydrilla has distinctly saw-toothed leaf edges and teeth on the leaf underside. In addition, potato-like tubers on roots are diagnostic.



Side-by-side comparison of two invasive aquatic plants, *Egeria densa* and *Hydrilla verticullata*, to that of the common native *Elodea canadensis*.



INVASIVE	INVASIVE	NOT INVASIVE

(e) Rock Snot Or Didymo – (*Didymosphenia geminate)*

Rock out of water, Colonized with rock snot

(1) Species Description

Growth form – Single-celled algae that forms thick mats.
Size – Starts as small clumps and can spread to cover entire wetted areas.
Color – Pale yellowish-brown to white.

(2) Suitable Environmental Conditions

Temperature – 32° F - 72° F
Moisture – Under water.
Substrate – Attaches to hard and soft su bstrates at depths of 4" to 6½'. Fragments float freely
Known occurrences in California – South Fork of the American River, Sierra Nevada.

(3) Key Features for Identification

Looks like slimy blobs attached to rocks or wet toilet paper trailing from rocks and aquatic plants in streams, and as mats in slow moving water. Appears slimy but feels coarse, like damp wool.

Rock snot structure, as seen under a microscope

Rock snot in flowing water

Appendix C
Post Invasion Monitoring Plan

Zebra and Quagga Mussel Artificial Substrate Monitoring Protocol*
California Department of Fish and Wildlife

*This protocol was adapted from the California Department of Water Resources *Monitoring Instructions for Zebra/Quagga Mussel Plate Samplers,* April 2, 2008.

Description of Zebra and Quagga Mussels

The zebra mussel, *Dreissena polymorpha*, and the quagga mussel, *Dreissena bugensis*, are small mussels found only in freshwater. They look very similar to each other. They commonly have alternating light and dark brown stripes, but can also be solid light brown or dark brown. They have 2 smooth shells that are shaped a little bit like the letter "D". These mussels are usually less than 2 inches in length. In new populations, most mussels are young and therefore very small (under ¼ -inch long).

Quagga Mussel *Dreissena bugensis*	**Zebra Mussel** *Dreissena polymorpha*
	
• Shell: D-shaped and triangular; thin, fragile; smooth or shallowly ridged; solid light to dark brown or dark concentric rings; paler near hinge • Attaches to hard and soft surfaces	• Shell: D-shaped and triangular; thin, fragile; smooth or shallowly ridged; solid light to dark brown or striped • Attaches to hard surfaces

Color variation in zebra and quagga mussels

Quagga and zebra mussels are freshwater mussels that can physically attach onto hard substrates. Like the mussels found clinging to the rocks along the California coastline, zebra and quagga mussels attach onto hard surfaces (e.g. pipes, screens, rock, logs, boats, etc.). They form colonies made up of many individuals attached onto an object and even onto each other. Small newly settled mussels feel like gritty sandpaper when attached to a smooth surface. Larger mussels will feel coarser (like a small pebble or sunflower seed) or be visually apparent.

Other Organisms Mistaken for Zebra/Quagga Mussels

Asian clam, Corbicula fluminea

People often mistake the very common Asian clam (also introduced) for zebra or quagga mussels. The Asian clam is widespread and abundant in California. It is brown and has ridges in concentric rings on its shells. The shells of older clams or of dead clams are white at the hinge (where the two shells join together). These clams do not attach onto surfaces. They live in mud or sand.


Asian clam

Snails and Freshwater Limpets

Small snails and freshwater limpets cling to hard substrates and can be mistaken for small juvenile mussels. They are similar in color and size to small zebra and quagga mussels. Snails have a spiral shape. Limpets have one shell and are flat. Zebra and quagga mussels attach on the edge of their shell and stick up and away from the surface.


Snail


Snails


Limpets

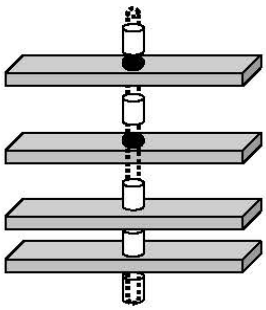
Artificial Substrate Construction and Assembly

To construct the artificial substrate you will need the following materials cut to size:

(4) 6" x 6" x 0.25" black/grey PVC with 1" hole through center
(5) 1.5" x 1.375" (35mm) exterior diameter PVC or ABS tube
(1) 8.5" x 0.8125" (21 mm) exterior diameter PVC or ABS tube

~25 ft plastic coated cable or rope
Some form of attachment to keep plates from floating up
Weight
Laminated label with your contact information

To assemble the substrate, run the cable or rope through the 8.5" tube and secure at one end. From the loose end of the rope string on the remaining pieces, alternating between the short segments of tube and the plates, beginning and ending with the short tubes (see figure). Secure the top tube to the rope to prevent the pieces from floating up. If necessary, attach a weight to the bottom of the assembly. Attach the label to the cable where the cable is secured to the structure.



California Department of Fish and Wildlife
Biological Research

PLEASE DO NOT DISTURB

For information about this study please contact:
Bob Smith, Environmental Scientist
(XXX) XXX-XXXX

Example of a label

Selection of Monitoring Site

Zebra and quagga mussels are transported between waterbodies by watercraft (boats, wave runners, etc), water diversions, and the natural downstream flow of a river system. Monitoring sites are selected with these factors in mind. Prime sites are areas with high boat traffic and downstream of source water. If you are sampling at a waterbody that allows boating, select a site that has a lot of boat traffic. Examples are boat ramps, gas docks or dockside marina stores. Then find a location with low flow and protection from vandalism. Marinas often offer all of these features. Within a marina, find a location with restricted public access. Avoid placing the artificial substrate at unsupervised boat ramps because of tampering by the general public and entanglement with the dock cabling system when the water level changes or the ramp is moved. If these types of structures are not available, find a site downstream of the boat traffic that offers as much protection from vandalism as possible. Examples include water quality monitoring

stations or towers and government agency boathouses. Always ask for permission before attaching artificial substrates to structures. Again, find a location that offers protection from vandalism and has low flow.

Deployment and Inspection of the Artificial Substrate

Depending on water clarity and depth, the artificial substrate should be set below the euphotic zone (below the depth of light penetration) or 6 feet, whichever is deeper, and at least two few feet above the bottom. One to two substrates are deployed per site. If the site is shallower than 2 m, then raise the substrate about 0.5 m (2 ft) off of the bottom. Record the actual sampling depth. At sites that are deep and have little vertical mixing, a second substrate is installed at a depth of approximately 15 meters (50 feet) below the surface (or 1 meter off the bottom if the depth is less than 15 meters).

A visual and tactile examination of the artificial substrate is conducted every month for attached zebra and quagga mussels. When mussels first attach they are very small (invisible to the naked eye) and are very delicate (shells are thin and easily crushed). A single mussel may feel like a grain of sand. If many mussels cover a surface, the surface feels gritty like sandpaper. In approximately 1 to 2 months a mussel grows large enough (1/4 inch) to be seen upon close inspection, but the shell is still very delicate. At this size it feels like a small pebble or sunflower seed.

To check an artificial substrate, first carefully lift it out of the water and place it in a large plastic tub (the tub will capture any mussels that fall off). Avoid knocking the substrate as you pull it out of the water because you may dislodge or crush any attached mussels. First visually inspect each plate (top, bottom, and sides), the spacers, the cable and the weight. After looking closely, attempt to gently push any attached organism that might be a mussel. Freshwater limpets and snails easily move or slide across the plate. Zebra and quagga mussels stick in place or are more securely attached. In all cases, if in doubt, bag it.

If no mussels are detected, lower the substrate back into the water and check again in a month. Zebra and quagga mussels are more likely to attach to a substrate that has some algal growth, however if the substrate becomes too heavily coated it may be unsuitable for mussel settlement. As necessary, gently remove heavy accumulations of algae to maintain suitable conditions for settlement.

Specimen Collection

If you suspect you have found a mussel immediately contact the appropriate CDFW regional mussel contact (list attached). To aid identification, first take a close-up digital photograph of each specimen. Next, collect the specimen(s) and place in a vial with 70% ethanol. Label the vial with location, date, and name of collector. If ethanol is not available, place the sample in a rigid container (to prevent crushing) without water, label, and refrigerate. E-mail the photos to the CDFW contact and they will try to

identify the specimens from the photographs, and may request the actual specimen(s) to make a positive identification.
If the entire artificial substrate needs to be retained for laboratory processing, place the entire unit in a large Ziplock bag or small garbage bag and keep it in a cooler with ice while in the field. Store the substrate in the freezer until ready to mail. Mail it "overnight delivery" on ice.

Replacement of Artificial Substrate

Replace a missing or broken artificial substrate with a new one. If the substrate is repeatedly lost or damaged look for a new deployment site that offers more protection. Report any incidents and the action(s) taken.

To prevent any possibility of contamination between monitoring sites (should mussels be present and not yet detected), never take a substrate from one site and place it at a different site (even within a single waterbody).

Data Recording and Reporting

Every time an artificial substrate is checked the data must be recorded on a datasheet before leaving the field. Absence data is as important to document as presence, so complete and submit a datasheet even if no mussels were found. Send datasheets to the appropriate CDFW regional contact. All data will be entered into a data reporting system and the datasheets will be retained on-site.

Artificial Substrate Datasheet

California Department of Fish and Wildlife

(One datasheet for each artificial substrate)

Collection Information		
Date:		
Waterbody:		
Substrate location (GPS or site description):		
Substrate depth (meters):		
Collector(s):	Affiliation:	
Contact information (email or phone # if not CDFW):		
Substrate		
Substrate (circle one): Present	Missing	
Condition (circle one): Intact	Damaged	
Comments:		
Mussels		
Mussels (circle one): Present Absent	Species (circle one): Quagga Zebra Unknown	
Where (circle all that apply): Plate surface Plate edge Spacers Rope (depth _____) Other (_____)	Total # of mussels on each part of substrate _____ _____ _____ _____ _____	
Plate dimensions (units): ____ x ____ (__)	Plate area (multiply plate dimensions):	
Plates:	Number of mussels	Density (# of mussels ÷ area)
Side 1 (top side of top plate)		
Side 2 (bottom side of top plate)		
Side 3 (top side of second plate)		
Side 4 (bottom side of second plate)		
Side 5 (top side of third plate)		
Side 6 (bottom side of third plate)		
Side 7 (top side of bottom plate)		
Side 8 (bottom side of bottom plate)		
Additional Information		
Other organisms present:		
Comments:		

Return completed datasheets to the appropriate California Department of Fish and Wildlife Regional office.

CDFW Regional Office Contacts for Quagga Mussel Monitoring

Region 1 – Northern Region
Counties: Del Norte, Humboldt, Lassen, Mendocino, Modoc, Shasta, Siskiyou, Tehama, and Trinity
601 Locust Street, Redding, CA 96001
L. Breck McAlexander
Louis.McAlexander@wildlife.ca.gov
Office: (530) 225-2317
Fax: (530) 225-2381

Region 2 – North Central Region
Counties: Alpine, Amador, Butte, Calaveras, Colusa, El Dorado, Glenn, Lake, Nevada, Placer, Plumas, Sacramento, San Joaquin, Sierra, Sutter, Yolo and Yuba
1701 Nimbus Road, Rancho Cordova, CA 95670
Angie Montalvo
Angie.Montalvo@wildlife.ca.gov
Office: (916) 358-2895
Fax: (916) 358-2912

Region 3 – Bay Delta Region
Counties: Alameda, Contra Costa, Marin, Napa, Sacramento, San Mateo, Santa Clara, Santa Cruz, San Francisco, San Joaquin, Solano, Sonoma, and Yolo
7329 Silverado Trail, Napa, CA 94558
Catherine Mandella
Catherine.Mandella@wildlife.ca.gov
Mobile: (831) 588-1463
Fax: (707) 944-5563

Region 4 – Central Region
Counties: Fresno, Kern, Kings, Madera, Mariposa, Merced, Monterey, San Benito, San Luis Obispo, Stanislaus, Tulare and Tuolumne
1234 E. Shaw Avenue, Fresno, CA 93710
Kelley Aubushon
Kelley.Aubushon@wildlife.ca.gov
Office: (559) 243-4017 X-285
Fax: (559) 243-4004

Region 5 – South Coast Region
Counties: San Diego
3883 Ruffin Road, San Diego, CA 92123
Russell Black
Duane.Black@wildlife.ca.gov
Office: (858) 467-4262
Fax: (858) 467-4299

Counties: Los Angeles, Orange, Santa Barbara and Ventura
4665 Lampson Avenue, Los Alamitos, CA 90720
Eloise Tavares
Eloise.Tavares@wildlife.ca.gov
Office: (562) 342-7155
Fax: (562) 342-7153

Region 6 – Inland Deserts Region
Counties: Imperial, Inyo, Mono, Riverside and San Bernardino
P.O. Box 2160, Blythe, CA 92226
David Vigil
David.Vigil@wildlife.ca.gov
Office: (760) 922-4928
Fax: (760) 922-5638

Zebra/Quagga Surface Survey Data

(Use Pencil Only)

Waterbody _____ **Date** __ __ / __ __ / __ __

Location _____ **Crew** _____

GPS _____ **(Decimal Degrees, WSG 84)**

Secchi Depth ☐☐☐ **Wave Chop** ☐

 # Linear Meters of:

Boat Ramp Bottom (30 m at marina, 60 m at ramp only)	☐☐☐	**Shoreline** (30 m at marina, 60 m at ramp only)	☐☐☐
Dock (60 m)	☐☐☐	**Concrete Structures** (30 m)	☐☐☐
Mooring Line (60 m)	☐☐☐	**Logs/Woody Debris** (30 m)	☐☐☐
Anchor/Dock Cable (30 m)	☐☐☐	**Other** _____	☐☐☐

% of Dock/Marina/Boat Ramp Searched ☐

Zebra/Quagga Mussels Present? Y / N **Specimens Collected?** Y / N

	Exact GPS Location (if isolated occurrences):	**Mussel Density** (# of mussels):	**Method** (circle one):
1	☐	☐ ☐ ☐ ☐ ☐	Ruler / Petri
	Ruler Length (if < 0.5 m)	____ ____ ____ ____ ____	
	Substrate Type	☐	
2	☐	☐ ☐ ☐ ☐ ☐	Ruler / Petri
	Ruler Length (if < 0.5 m)	____ ____ ____ ____ ____	
	Substrate Type	☐	
3	☐	☐ ☐ ☐ ☐ ☐	Ruler / Petri
	Ruler Length (if < 0.5 m)	____ ____ ____ ____ ____	
	Substrate Type	☐	

Corbicula Clams Present? Y / N **Snails Present?** Y / N

Other Mussel/Clam Species Present? Y / N **Specimens Collected?** Y / N

Quagga Mussel
Dreissena rostriformis bugensis

• Shell: D-shaped and triangular; thin, fragile; smooth or shallowly ridged; solid light to dark brown or dark concentric rings; paler near hinge
• Attaches to hard and soft surfaces

Zebra Mussel
Dreissena polymorpha

• Shell: D-shaped and triangular; thin, fragile; smooth or shallowly ridged; solid light to dark brown or striped
• Attaches to hard surfaces

Asian Clam
Corbicula fluminea

• Shell: fan-shaped and symmetrical; thick, hard; deep ridges; solid light to dark brown; may have a white patch near hinge
• Burrows into sand or mud; never attaches to structures
• Dead shells often found along shoreline

Map of sampling location:

Place empty circles (○) in areas that were surveyed but no mussels were found. Place circles with plus sign (⊕) where mussels were found, and number 1, 2, or 3 to correspond to GPS coordinates.

Did weather conditions negatively affect sampling conditions? Y / N

Comments _____

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Zebra/Quagga Mussel Surface Survey Protocol*
California Department of Fish and Wildlife

*This protocol was adapted from the California Department of Water Resources *Zebra/Quagga Mussel Surface Survey Protocol*.

Description of Zebra and Quagga Mussels

The zebra mussel, *Dreissena polymorpha*, and the quagga mussel, *Dreissena bugensis*, are small mussels found only in freshwater. They look very similar to each other. They commonly have alternating light and dark brown stripes, but can also be solid light brown or dark brown. They have 2 smooth shells that are shaped a little bit like the letter "D". These mussels are usually less than 2 inches in length. In new populations, most mussels are young and therefore very small (under ¼ inch long).

Quagga Mussel *Dreissena bugensis*	**Zebra Mussel** *Dreissena polymorpha*
	
• Shell: D-shaped and triangular; thin, fragile; smooth or shallowly ridged; solid light to dark brown or dark concentric rings; paler near hinge • Attaches to hard and soft surfaces	• Shell: D-shaped and triangular; thin, fragile; smooth or shallowly ridged; solid light to dark brown or striped • Attaches to hard surfaces

Color variation in zebra and quagga mussels

Quagga and zebra mussels are freshwater mussels that can physically attach onto hard substrates. Like the mussels found clinging to the rocks along the California coastline, zebra and quagga mussels attach onto hard surfaces (e.g. pipes, screens, rock, logs, boats, etc.). They form colonies made up of many individuals attached onto an object and even onto each other. Small newly settled mussels feel like gritty sandpaper when attached to a smooth surface. Larger mussels will feel coarser (like a small pebble or sunflower seed) or be visually apparent.

Other Organisms Mistaken for Zebra/Quagga Mussels

Asian clam, Corbicula fluminea

People often mistake the very common Asian clam (also introduced) for zebra or quagga mussels. The Asian clam is widespread and abundant in California. It is brown and has ridges in concentric rings on its shells. The shells of older clams or of dead clams are white at the hinge (where the two shells join together). These clams do not attach onto surfaces. They live in mud or sand.


Asian clam

Snails and Freshwater Limpets

Small snails and freshwater limpets cling to hard substrates and can be mistaken for small juvenile mussels. They are similar in color and size to small zebra and quagga mussels. Snails have a spiral shape. Limpets have one shell and are flat. Zebra and quagga mussels attach on the edge of their shell and stick up and away from the surface.


Snail


Snails


Limpets

Visual and Tactile Search for Zebra and Quagga Mussels

Gently run fingers over smooth surfaces, checking for gritty feeling or small "seed-like" or "pebble-like" objects. Areas likely to harbor mussels, if they are present, include:

- Dock floatation, buoys, mooring line, 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 all hard and soft substrates. Fan areas covered with silt to expose mussels.

Inspect dark areas (dark substrates and low light/shaded areas). Do not disturb private vessels or property.

Prime Areas to Search

Quagga and zebra mussels prefer dark substrates and low light/dark areas. They prefer concrete over other substrates. Search areas at or near boat ramps, gas dock, dock near marina store, other docks in high traffic areas, all concrete structures, and low flow areas.

Minimum Sample Size

The minimum number of linear feet to be searched per substrate is defined below. You can stop before meeting the minimum linear feet if quagga/zebra mussels are found in 3 or more locations within the survey location, or if all available substrate has been searched.

- 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

Make a notation in "Comments" section if minimum sample size requirements could not be met.

If Mussels are Found

Record the lat/long (in decimal degrees and use WSG 84) of the mussels' location(s) and mark/describe location(s) on the back of the datasheet. 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 specimens (4-5). Place in Ziploc bag with label. Label should include location, lat/long, date, and name of collector. Seal and keep dry or put in freezer. Do not put water in the bag.

If other species of clams or mussels are found, collect specimens (1-2) and place in bag with collection label. Seal and keep dry or put in freezer. Do not put water in the bag.

Data Recording and Reporting

Datasheets are available at:
https://nrm.dfg.ca.gov/FileHandler.ashx?DocumentID=4949

If mussels are found, immediately contact the appropriate CDFW regional mussel contact.

Every time a survey is made the data must be recorded on a datasheet before leaving the field. Absence information is as important to document as presence, so complete and submit a datasheet even if no mussels were found. Send datasheets to the appropriate CDFW regional contact. All data will be entered into a data reporting system and the datasheets will be retained on-site.

CDFW Regional Office Contacts for Quagga Mussel Monitoring

Region 1 – Northern Region
Counties: Del Norte, Humboldt, Lassen, Mendocino, Modoc, Shasta, Siskiyou, Tehama, and Trinity
601 Locust Street, Redding, CA 96001
L. Breck McAlexander
Louis.McAlexander@wildlife.ca.gov
Office: (530) 225-2317
Fax: (530) 225-2381

Region 2 – North Central Region
Counties: Alpine, Amador, Butte, Calaveras, Colusa, El Dorado, Glenn, Lake, Nevada, Placer, Plumas, Sacramento, San Joaquin, Sierra, Sutter, Yolo and Yuba
1701 Nimbus Road, Rancho Cordova, CA 95670
Angie Montalvo
Angie.Montalvo@wildlife.ca.gov
Office: (916) 358-2895
Fax: (916) 358-2912

Region 3 – Bay Delta Region
Counties: Alameda, Contra Costa, Marin, Napa, Sacramento, San Mateo, Santa Clara, Santa Cruz, San Francisco, San Joaquin, Solano, Sonoma, and Yolo
7329 Silverado Trail, Napa, CA 94558
Catherine Mandella
Catherine.Mandella@wildlife.ca.gov
Mobile: (831) 588-1463
Fax: (707) 944-5563

Region 4 – Central Region
Counties: Fresno, Kern, Kings, Madera, Mariposa, Merced, Monterey, San Benito, San Luis Obispo, Stanislaus, Tulare and Tuolumne
1234 E. Shaw Avenue, Fresno, CA 93710
Kelley Aubushon
Kelley.Aubushon@wildlife.ca.gov
Office: (559) 243-4017 X-285
Fax: (559) 243-4004

Region 5 – South Coast Region
Counties: San Diego
3883 Ruffin Road, San Diego, CA 92123
Russell Black
Duane.Black@wildlife.ca.gov
Office: (858) 467-4262
Fax: (858) 467-4299

Counties: Los Angeles, Orange, Santa Barbara and Ventura
4665 Lampson Avenue, Los Alamitos, CA 90720
Eloise Tavares
Eloise.Tavares@wildlife.ca.gov
Office: (562) 342-7155
Fax: (562) 342-7153

Region 6 – Inland Deserts Region
Counties: Imperial, Inyo, Mono, Riverside and San Bernardino
P.O. Box 2160, Blythe, CA 92226
David Vigil
David.Vigil@wildlife.ca.gov
Office: (760) 922-4928
Fax: (760) 922-5638

Appendix D

Budget Proposal for Dreissenid Eradication in Lake Casitas

Two methods of eradication are offered for consideration with a pricing confidence suitable for budgeting. The methods are both chemical treatments; method one is potash treatment and method two is copper based treatment using the Earthtec–QZ product.

POTASH TREATMENT

Appendix D.1 – Background

Zebra and Quagga mussels (*Dreissena polymorpha and D. bugensis*) (mussels) have been present in North American waters for nearly three decades. As a result industries and other raw water users along affected waterways have had to implement costly control programs to ensure that water supply to their facilities remains unobstructed.

ASI Group Ltd has worked extensively in this field since 1989 and has conducted or been involved in many of the initial experimental treatment programs which are ultimately used for mussel control today.

ASI Group Ltd conducted experiments on the effectiveness of potassium, in the form of muriate of potash, as a method of controlling Zebra mussel infestation in the early to mid-nineties. Through research with Niagara Mohawk and Ontario Power Generation, it was concluded that at 100 ppm potassium was acutely lethal to mussels. More importantly it was determined, through lab toxicity testing, that LC_{50} values for key non-target lab organisms such as Water Fleas *(Daphnia magna and Ceriodaphia dubia),* Rainbow Trout and Fathead Minnows were well below Potassium concentrations employed to control Zebra mussels. As a result new treatment techniques for controlling adult mussels in semi-static systems, such as fire protection systems were developed and since 1996 have been used regularly throughout industry.

During the same period ASI conducted experiments to determine the long term effects of Potassium on adult mussels. Research demonstrated that adult mussels could be controlled through chronic exposure to lower Potassium concentrations which range from 20 ppm to 40 ppm under varying treatment durations.

In 2006 ASI was retained by the Virginia Department of Game and Inland Fisheries to perform the first North American open water treatment for mussel colonization through exposure to Potassium. Using a Muriate of Potash ASI introduced approximately 131 tonnes of dry product mixed into a 20% solution achieving a 100 ppm target concentration throughout Millbrook Quarry, located in Haymarket, Virginia. The treatment was 100% successful with complete eradication occurring within 60 days under cold water conditions. ($<5^{o}C$) We are confident our treatment process can be scaled up to meet the challenges posed by Lake Casitas.

Appendix D.2 – Methodology

Appendix D.2.1 – Process. Aquatic Sciences' proposed treatment methodology for eradicating mussels will be extended exposure to potassium; in the form of agriculture grade potash (fertilizer), at a

level toxic (40 ppm) to adult mussels. Understanding the toxicity of potassium; while maintaining focus on sensitivities to the surrounding environment, ASI Group Ltd has designed a method that incorporates specialized equipment and operational protocol for controlling the introduction of potassium into the quarry.

ASI will use a two step conceptual approach to introduce potassium into Lake Casitas, incorporating both shore and water based operations.

A shore based staging area will be situated in close proximity to the Lake and will be used throughout the duration of the project. It will include two mixing / replenishment stations to ensure a constant supply of stock solution. A stock solution of approximately 12% potassium will be mixed on a daily basis where it will be kept in solution by an electric tank mixer. A reversible centrifugal pump system will be used to draw water from the Lake and supply the batch mixing tanks. When reversed, the pump system will draw stock solution from the batch tanks and supply a floating work platform with stock solution.

An inventory of dry 98% muriate of potash (MOP) will be stored onsite in two steel sea containers. The lockable and watertight containers will protect the MOP from the elements, ensure product security and prevent accidental release of the product to the environment. It is estimated that 14,000 tonnes of 98% MOP will be required to treat Lake Casitas at the current water level.

Water based operations will utilize our 22 ft. Sealander work boat outfitted with a specially designed diffuser assembly. Stock solution from the shore based storage tanks will continuously feed the diffuser through a floating 1.5 in. diameter supply line and shore based centrifugal pump transfer system.

Stock solution from the shore based mixing / replenishment tanks will be transferred to the work platform using the shore based centrifugal pump transfer system. Proper diffusion of potassium; opposed to batch dumping, is a critical element of what ASI considers to be an advantageous treatment methodology. This will ensure the shortest period of time required for uniform mixing throughout the water column and more importantly minimize impacts to non-target organisms, as there will be less chance for high concentration “slugs” of potassium-rich water to build up.

Treatment will proceed on a systematic basis by separating the Lake into segments or treatment zones being characterized by depth, length, width and location. This will be accomplished using the automated hydrographic survey system including HYPACK MAX software described above and being mounted on the work platform. A contour map resulting from the hydrographic survey will be uploaded into HYPACK and used to pre-plan survey lines that run contiguous with contours (e.g. 5’, 10’,...100’, etc.). Using HYPACK with a helmsman’s display, the work platform will be precisely navigated along pre-planned survey lines while the 12% potassium solution is being introduced through the diffuser assembly. The work platform based retractable 10 ft. by 4 ft. diffuser assembly will consist of ten perforated vertical flexible hoses having capped and weighted ends and being attached to the 10 ft. horizontal section. This will allow for an enlarged mixing zone to be achieved while the flexible hose will reduce damage due to submerged obstacles. An echo sounder will be used to monitor water depth along with the depth of the submerged diffuser assembly in order to maintain an optimum height above

the quarry bottom. This system will also reduce the risk of entangling the diffuser assembly on bottom features.

It is estimated that it will take 12 weeks to charge the entire Lake with potassium. Water samples will be collected during the charging phase to ensure that all areas are within the target concentration range of 40 ppm. If during operations it is determined that the potassium concentrations are not within the 40 ppm target then the dosing strategy will be modified to ensure the target concentration is achieved.

Once the target concentration of potassium has been achieved, bioassays using live adult dreissenid mussels will be placed in the Lake at varying depths with 100% mortality of mussels expected within 25 days, at water temperatures greater than 60˚ F.

Appendix D.2.2 - Measures of Effectiveness. To ensure the potassium diffusion system is operating efficiently and is attaining target potassium concentrations throughout the treatment zone, daily potassium monitoring will be completed following the initial treatment. Daily monitoring will provide ASI personnel with information on how quickly and how well the MOP is dispersing through the treatment zone. This information can be used to modify the treatment protocol, either by increasing the dosing rate to achieve the target concentration, or by reducing the dosing rate if the potassium levels are significantly exceeding targets. The target concentration of 40 ppm is optimum as the mussels will die within a three to four week period, depending on water temperatures.

Following the “charge” activities, and prior to bioassay initiation, a final sampling exercise will be conducted throughout the entire quarry to characterize potassium concentrations at various depth profiles at selected points on predetermined transects throughout the Lake to confirm that target levels have been achieved. Areas which do not contain adequate concentrations, will be re-charged and re-sampled to ensure that the target has been achieved.

Monitoring points along each transect will be spaced 250 feet apart depending on the width of the Lake at each transect location. Approximately 3 to 5 sites will be monitored along each transect to ensure feasible and maximum monitoring coverage of the treated transect area. Duplicate samples will be collected and analyzed for every tenth sample for QA/QC purposes.

To determine the potassium concentrations, water samples will be obtained by two different methodologies. Surface grabs will be conducted where water depths are less than six feet, and will be collected at least 0.5 feet below the surface. A peristaltic pump or Kemmerer bottle will be used to collect samples at depths greater than six feet. This methodology will enable ASI to determine if proper mixing is occurring and to ensure target concentrations are achieved throughout the entire water column.

Sample identification, location, depth, date, GPS coordinates for each monitoring point and other pertinent information will be recorded in the field logbook and on reporting log sheets. The field instruments will be calibrated prior to use every day with standards of known value.

Appendix D.2.3 - Mortality Monitoring (Bioassay). In situ bioassays will be utilized to determine the effectiveness of MOP at eradicating adult mussels within the Lake. The purpose of a bioassay is to provide an indication of when mussels succumb to the MOP treatment.

Bioassays involve placing 100 healthy adult mussels into a mesh basket, and then exposing the mussels to the potassium-charged water. The mussels are inspected at pre-determined intervals for mortality. Once complete (100%) mortality has been achieved in all bioassays, the treatment is considered effective.

Adult mussels will be provided by ASI for the bioassays. Adult mussels will be sorted into bioassay baskets, placed into untreated water and aerated in a climate-controlled site trailer. Prior to being seeded at the bioassay locations, checks for background mortality to confirm the health of the mussels will be completed.

Once charge activities have been completed, bioassay baskets, each containing 100 adult mussels, will be seeded in various locations throughout the Lake. These locations will be determined based on potassium analysis results, and will target areas and depths where potassium concentrations fluctuate. Bioassay locations will also target areas where mussels were most prolific prior to the treatment

In addition to the bioassays seeded in the Lake, a control bioassay will be conducted by monitoring 100 adult mussels contained in fresh, untreated water in a climate-controlled site trailer to mimic Lake water conditions. These mussels will be aerated and the water will be exchanged daily to avoid the build-up of waste products and to provide a continuous source of food. The control mussels will monitor the health of the population during the bioassay to ensure the reliability of the mortality results.

The exact mode of action which causes the mortality is unknown; however, evidence suggests that potassium kills mussels by interfering with the organisms' ability to transfer oxygen across gill tissue, resulting in asphyxia. Within approximately 48 hours of potassium intoxication, the mussels will suffocate, resulting in mortality. Since dead and intoxicated mussels appear similar (as both are gaped open and non-responsive to probing), it is necessary to provide a recovery chamber where the mussels' ability to recuperate in untreated water can be monitored. Recovery chambers will be located in the climate-controlled site trailer and used to determine when the mussels have succumbed to the treatment.

Forty eight hours after the mussels are seeded in the Lake; groups of ten potentially dead mussels exhibiting potassium intoxication will be removed ("pulled") from each bioassay basket and placed into a recovery chamber that contain untreated water for a period of 48 hours. It can take up to 48 hours for mussels to recover from potassium-induced intoxication. Therefore, it is necessary to allow the mussels 48 hours to recuperate from the exposure. Mussels will be inspected for latent mortality after 24 hours in recovery and again at 48 hours for actual mortality. Studies have indicated that mussels that have not recovered by 48 hours will not recover.

Mussels will continue to be "pulled" from each bioassay basket at 24 hour intervals and placed in recovery chambers until complete actual mortality is observed in mussels that were in the recovery chamber for 48 hours.

Appendix D.2.4 – Pricing. **ASI Group Ltd. (ASI) can provide the following "turn key" Potash treatment of Lake Casitas at an estimated cost of $4 million** (net 30 days, taxes extra).

Detailed budget can be developed if dreissenid mussels invade Lake Casitas. The project cost may decrease if the water level of the lake could be lowered.

Service provided for this project charge include:

Project Support:

- Mobilization/Demobilization
- System installation
- System commissioning and operation
- Provision of chemical metering system with tanks; bioassay apparatus, application and sample vessels (boats), chemical hose and diffuser assembly, barrier membranes, test organisms, and Zebra mussel monitoring plates.
- Final Report

Operations Support:

- Project Management
- Operating Personnel
- ASI site vehicle supplied as required
- Bulk chemicals are based on a maximum system target K^+ concentration of 40 mg/L, and total Lake volume of 5.5 Billion USG.
- Use of ASI owned analytical equipment as required

This proposal is subject to the following terms and conditions:

Project Term. The project term is based on, mobilization, installation, commissioning and ramp-up of equipment, daily treatment operations, demobilization, and final report production.

Scheduling. Quotation assumes project schedule is established at least six weeks prior to mobilization. Once scheduled, additional charges may apply to any delay or deviation from the scheduled treatment caused by factors outside ASI's standard rates. Incremental material and equipment costs will be billed at cost +20%.

Other

- Quotation is for budgeting purposes only. A firm cost estimate can only be provided following a detailed site inspection.
- Please reference ASI Group Proposal MU14-006 on all correspondence.
- A service charge of 1.5% per month (19.5% per annum) may be charged on past due balances.

EARTHTEC-TREATMENT

Earth Science Laboratories, Inc. **Phone 800.257.9283**
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Bentonville, Arkansas 72712 www.earthsciencelabs.com

Lake Casitas Mussel Control Initiative

Pre-Proposal - March 2015

Disclaimer: This "pre-proposal" has been prepared with minimal background information about Lake Casitas, its water characteristics, management procedures, and stakeholder priorities. It is a "good faith" estimate of the measures and costs required to achieve the lake managers' mussel-control objectives, as we understand them. If there is sufficient interest, Earth Science Labs will prepare a more detailed proposal in cooperation with managers and stakeholders at Lake Casitas, or their agents.

Objective - To apply EarthTec QZ at the minimum concentration required to achieve 100% mortality of the dreissenid (Quagga and/or Zebra) mussels present in Lake Casitas, Ventura County, California. Earth Science Laboratories, manufacturer of EarthTec QZ, anticipates this will require 2-4 separate applications, separated by days or weeks.

Background - EarthTec is a copper-based algaecide/bactericide with a record 20+ years of safe and effective use throughout the U.S. EarthTec is applied in a wide variety of sites, including treatment of potable water reservoirs, lakes, pipelines, canals, aqueducts, and even within water treatment plants. Although most frequently applied for control of algae and cyanobacteria, some water districts use EarthTec to reduce geosmin and other compounds that cause taste and odor problems in drinking water. It is also approved for agriculture, including irrigation lines (e.g., keeping drip irrigation lines and their emitters free from algae and bacteria) and rice fields (control of tadpole shrimp) At doses recommended for control of mollusks and most algae it is safe for fish, as evidenced by its popularity among aquaculture farmers, especially those who culture catfish.

EarthTec is NSF-approved for drinking water and is frequently applied in potable water lakes, reservoirs and at the intake of water treatment plants.

EarthTec's unique formulation maintains the copper in the cupric ion form (Cu++) – the biologically active form of copper – and this formulation is the reason EarthTec performs well at a significantly lower copper dose than other copper-based products. This cupric ion remains in solution until it is consumed by a cell, so there is virtually no waste or loss to precipitation or settling, and for that reason we believe EarthTec is the most environmentally safe and responsible way to apply copper for pest control.

In August of 2013, EarthTec was granted federal EPA approval for use against Zebra and Quagga mussels. Studies by widely respected authorities on mussels indicate that EarthTec QZ is one of the most effective and practical products currently available for mussel control. State labels have been granted in all 27 states that have dreissenid mussels, including California.

Advantages of EarchTec:

- It is a liquid formulation and is self-dispersing, thus greatly reducing time and labor for application.
- The copper is formulated in the biologically-active form (as cupric ion, Cu++), and stays in solution until it encounters a cell wall to bind to and penetrate, so virtually 100% of the copper applied is effective, with no waste or copper precipitating into bottom sediments.
- EarthTec is NSF-certified for drinking water, reservoirs, lakes, irrigation canals, and even (under another brand name and label) for swimming pools & spas. It's also approved for raw water intakes and sedimentation basins within water treatment plants.
- Does not contain precursors of disinfection by-products like THMs and HAA5s
- Greatly reduces taste and odor, and the organisms that cause them.
- Long history of effective use with no negative impacts on fish and other non-targets.

Project Goals:

- Treat Lake Casitas with the minimum dose or doses required to achieve 100% mortality of dreissenid mussel adults, juveniles, and larvae.

- Minimize collateral damage to non-target species such as fish, amphibians and native mollusks.

Proposed Method: Based on existing information, our proposed approach is to:

- Dose with sufficient EarthTec QZ to achieve 0.24 mg/L (ppm) copper equivalent in Lake Casitas.
- Monitor copper concentrations beginning the day prior to application and then every 24 hours at key spots around the lake.

- For the 6 days following the initial treatment, apply additional “bump” treatments as necessary to maintain a free copper concentration at or above 0.12 mg/L for at least 120 hours (6 days).

- Beginning on Day 3, check adults every few days for any survival and monitor for any living veligers using plankton tows.

- If any adults are still living after 6 days, apply supplementary doses of EarthTec QZ as necessary to maintain 0.12 mg/L free copper during the subsequent 5 days.

- Interface with local agents who regularly monitor veliger presence using plankton tows and settlement plates for the subsequent 6 months.

Preliminary Cost Estimate:

Assumptions:

- Lake at 30% of full capacity = 76,000 acre-feet of water = 24.8 billion gallons
- Treat 100% of lake volume*.
- Initial dose at 0.24 mg/L, as copper = 100,000 gallons of EarthTec QZ.
- 2 supplemental doses at 0.12 mg/L, as copper.
- Discounted bulk pricing.
- Application will be done by a licensed, private, third-party contractor at competitive market rates.

A Special Local Needs permit will be required.

Cost Estimate: $2.0 million in chemical cost for three treatments expected to achieve 100% control. Any further treatments, if required, will be handled through a cost-sharing arrangement with the customer. The cost of an applicator's service is expected to be in the range of $100,000 to $200,000.

More precise cost estimates will be possible as further details of the situation become available.

Next Steps:

On-Site Survey - A site visit by reps of Earth Science Labs will verify conditions in the field.

Small-Scale Trial - A field trial would serve as proof of concept to stakeholders and funding sources, and a way to answer site-specific questions you may have regarding efficacy, effects on non-targets, persistence of copper in the water, etc.

Regulatory - Gauge the response and potential for support from agencies such as Fish & Wildlife, NOAA, Bureau of Reclamation, etc.

Stakeholder Engagement - Sport fishermen and other recreational users may have concerns about the collateral impacts of an eradication effort, for example on game fish; ESL emphasizes that our goal is zero "take" (by-kill) of fish and we believe this is achievable. Regardless, we can't lose sight of the fact that dreissenids are highly destructive invasive species that completely alter an ecosystem through their effects on fish, bivalves, phytoplankton, zooplankton, etc. Dreissenids were first detected in Lake St Clair, Ontario, which at that time was the area of highest mollusk biodiversity in all of Canada, yet in the 5 years following their appearance in North America at least 12 species of native mussels were driven to extinction.

We look forward to a meeting during which we can discuss in greater detail the particulars of the situation at Lake Casitas and how best to meet your needs.

Contact – David Hammond, Ph.D., 510 289-3310 dhammond@earthsciencelabs.com

Appendix E

Biology of Zebra and Quagga Mussels

Quagga and Zebra mussels are members of the dreissenid family of bi-valves. These non-native, invasive mussels are an environmental and economic nuisance across North America and Europe. An understanding of the biology of the dreissenid mussels, especially their differences to native aquatic species, is essential for control of these invaders. A basic description of mussel characteristics follows in the subsequent paragraphs.

Dreissenid mussels are bivalve mollusks that have:

- Two equal sized shells, also referred to as valves
- Unequal adductor muscles - the main muscular system that opens and closes the two valves. All freshwater bivalve mollusks have two adductor muscles, one anterior and one posterior. The muscles are strong enough to enable the animal to close its valves tightly when necessary, such as when the bivalve is exposed to the air during low water levels, when attacked by a predator or exposed to a noxious chemical.
- They are filter feeders, using an inhalant siphon to bring in food, sieving small particles from the water using cilia on the gills, and exhaling the sieved water and waste through the exhalant siphon. Any material not digestible is wrapped in mucous and expelled as “pseudofeces” through the inhalant siphon.

There are four main species of freshwater bivalves in North America:

Native Bivalves

- The Sphaeriidae or Fingernail Clams (named for their shape)
- The Unionidae, or Pearly Mussels (named for the mother-of-pearl layer on the interior of their shell)
- All native bivalves are burrowers and because they spend most of their time within the substrate they are referred to as “infaunal” mollusks

Introduced/Exotic Bivalves

- The Corbiculidae, or Asiatic or Asian Clam (named for their Asiatic origin)
- The Dreissenidae, Zebra and Quagga Mussels (named for the Zebra-stripe pattern on their shells) and Conrad’s false mussel are the only fresh water mussels in North America that possess a byssus - a bundle of strong filaments secreted by the foot of the animal to attach themselves to surfaces (**Figure E.1**).
- The Asian clams are infaunal mollusks, like the sphaeriids and unionids.

- The dreissenids spend most of their lives attached to the surfaces on the substrate, like rocks, concrete, native mussels, plants, piers, etc, Because they spend most of their time on surfaces they are referred to as epibenthic (epi = upon, benthic = substrate) mollusks

Figure E.1 - Zebra mussel with a byssus

Appendix E.1 - External Biology

The shell of the Zebra mussel is distinct, taking its name from its Zebra-like stripes on the exterior of its shell. Its scientific name (*Dreissena polymorpha*) refers to the many variances (or morphs) that occur in the shell's color pattern, which can include albino, black and brown. The Quaggas have an equally variable pattern to their shell, but the bottoms of their shells are more rounded than those of Zebra mussels. Usually the way to tell Zebra and Quagga mussels apart is to place each shell on its ventral side; the Quagga mussel will topple over due to its rounded bottom surface, while the Zebra mussel will remain upright (**Figure E.2**).

Figure E.2 - Zebra mussel on the left, Quagga mussel on the right

Occasionally, Zebra and Quagga mussels are confused with a third species – *Mytilopsis leucophaeta*, Conrad's false mussel. This species is distinct in that it has unique structure on the inside of the shell (an interior apophysis or septum), which is absent in Zebra and Quagga mussels and generally the shell is uniformly dark and not striped.

Most adult dreissenid shells average 1 - 2.5 cm, but may reach 4 cm on occasion. Their shells are designed to survive on hard surfaces. Their strong byssal attachment makes it difficult for predators to pry the mussels from surfaces. If cross-sectioned, the shells are tent shaped, again making it difficult for predators to grasp.

Appendix E.2 - Interior Biology

The shell's hinge has a ligament that joins the two vales dorsally. The ligament has a built-in torque that opens the valves, which is why most dead bivalves are found gaping. The pointed end of the shell has an apical septum, or myophore plate to which attaches the small anterior adductor muscle – one of two that help to close the two valves. The broad, round posterior end of the shell, houses the large posterior adductor muscle. Each of these posterior and anterior adductor muscles serves to close the valves. The ligament serves to open the valves when the adductors relax.

A thin tissue, called the mantle, envelops the internal body of the mussel. The mantle (also known by the Latin word pallium, meaning mantle, robe or cloak) is a significant part of the anatomy of mollusks: it is the internal dorsal body wall that covers the visceral mass and usually protrudes in the form of flaps ornamented with tentacles well beyond the visceral mass itself. In all mollusks the epidermis of the mantle secretes calcium carbonate to create a shell.

The mantle has two openings for the inhalant siphon (lower opening) and exhalent siphon (upper opening). Siphons are tube-like structures in which water flows in and out. The water flow is generated by gill cilia used for feeding; the gills also serve for respiration and elimination of waste. The siphons are part of the mantle. In the native bivalves the gills also serve as reproductive structures, with brood sacs in sphaeriids, and marsupia in unionids.

The inhalant siphon is the larger opening and is ringed with 80 to 100 tentacles, which assist in selecting food particles. The exhalent siphon is cone-shaped, has no tentacles and is dorsal to the inhalant siphon. Ventrally, the small foot (reduced in size due to its epibenthic habit) protrudes through the pedal gape, which occurs when the valves gape. However, there is a permanent opening that allows for the extrusion of the large byssus while the shells are closed. Dreissenids have a small muscular foot, which is used to pull the animal over the substrate (typically rock, sand or gravel). It does this by repeatedly advancing the foot, expanding the end so it serves as an anchor, and then pulling the rest of the animal forward. It also serves as a fleshy anchor when the animal is stationary.

The byssal glands are housed adjacent to the foot, and are responsible for secreting byssal threads, which allow mussels to adhere to objects. The threads are formed one at a time, branching from a central stem. In order to detach itself from an object, enzymes are secreted at the base of the byssal mass and the entire mass of byssal threads are released – the mussel then secretes new threads. Mussels 2.5 cm in length may have up to 600 threads holding it in place.

On each side of the body of dreissenid mussels are gills, which are divided into a series of water tubes by septa or filaments – these filaments make up sheets or lamellae (thin plate-like structures with space in between). Through the small openings in the lamellae, lake water is able to circulate.

The dreissenid mussels' gills are covered with small cilia, which create currents that aids in pulling water through the inhalant siphon, into the mantle cavity and over the gills. As digestible particles pass over the gills, they are removed by the cilia, and directed towards the mouth for digestion. Inedible particles are wrapped in mucous and rejected as pseudofeces.

The mouth is comprised of a pair of flaps called labial palps and is located at the anterior end of the body around the mouth. The labial palps assist in guiding and selecting digestible food into the mouth, through a short esophagus and into a large, thin-walled stomach. Undigested food is passed by cilia from the stomach to eventually be expelled at an anal papilla located within the exhalant siphon.

Appendix E.3 - Reproduction and Life Cycle

Zebra and Quagga mussels have separate male and female gender. Eggs and sperm begin maturing when the water temperature reaches about 12°C, but their numbers don't peak until the end of May/June when water temperatures near 15-17°C. After eggs and sperm are released by the adults, fertilization occurs externally in the water. Some females can produce up to 1 million eggs in 2 years.

In the Great Lakes the peak reproductive season is in June/July, but the larvae that are born in the spring can reach sexual maturity (at length of 8 to 10mm) by mid-summer and contribute to the production of new larvae (veligers) by the fall. Spawning may last 3-5 months though it can last longer in warmer climates. The development from fertilized egg to ready-to-settle larvae requires 3-5 weeks depending on the ambient temperature of the water.

Appendix E.4 - Larval Life Cycle

The larval life cycle has three stages (**Figure E.3**).

Veliger Stage: After fertilization the embryos develop into free-swimming larvae in 6-20 hours. Several days after fertilization, the veliger secretes its first larval shell and continues to grow for the next 3 to 5 weeks. The next stage is D-shaped or straight hinge shape, followed by a clam shape. Up to this point all of the larval stages are capable of limited "swimming" using an apparatus called the velum. This ability makes it possible for them to maintain their position in the water column. However, it is not possible for them to swim against any current. Eventually the larvae lose their velum, acquire a foot and the name pediveliger. Unless carried by current, they fall to the bottom seeking a place to attach.

The pediveliger uses its foot for crawling on surfaces. It seeks out appropriate surfaces, secretes its byssal thread and undergoes metamorphosis to become a plantigrade (a stage between pediveliger and an adult shape).

The plantigrade continues to grow, acquiring the adult triangular shape. It is now called a juvenile, and with time, further growth and sexual maturity, an adult. Mussels can grow incredibly fast, as much as 0.5 - 1mm/day. Typically, adults grow 1.5-2cm/year with average daily growth rates in summer at about

0.10mm – 0.15mm/day. Depending on water temperature and food supply mussels can reach sexual maturity in as little as eight weeks. In the Great Lakes the maximum lifespan of the adult mussels appears to be 2 to 3 years.

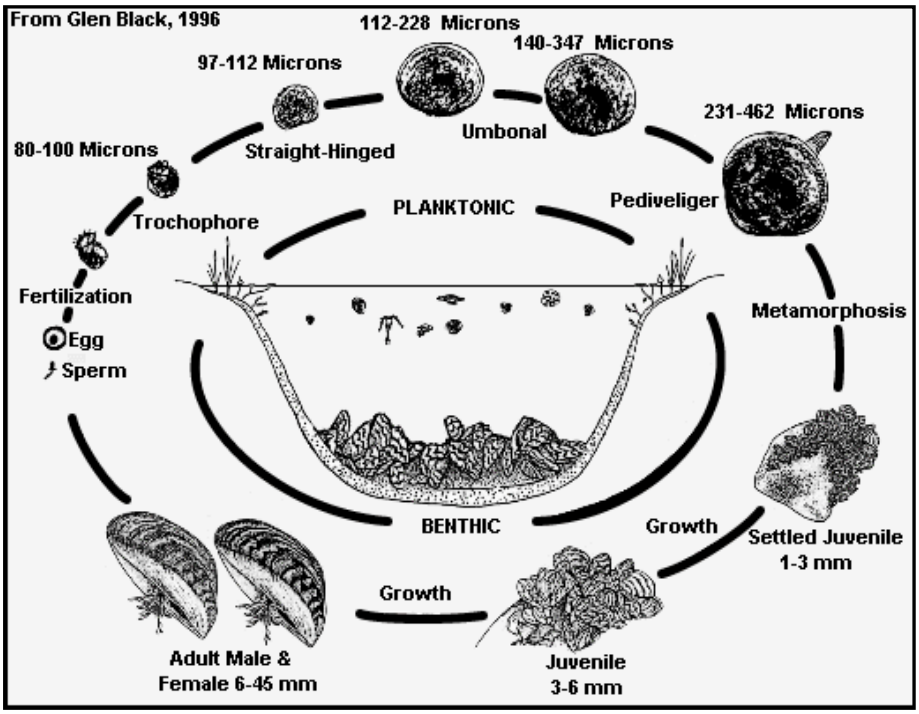

Figure E.2 - Dreissenid life cycle

Appendix E.5 - Habitat

Dreissenids are epifaunal, living upon or on top of all types of solid substrates – rocks, floating logs, break-walls, pipelines, cooling water systems, wet wells, intake structures, hulls of boats and large living invertebrates such as large unionid shells and crayfish. All other freshwater bivalves are infaunal living partially or completely buried in sediments.

Dreissenids are found at varying depths. Quagga mussels have been found as deep as 120 meters in Lake Ontario. They tend to be most numerous in the zone below ice formation and above the thermocline (1 meter to 10 meters). Densities of up to 100,000/m^2 have been recorded in many infested areas.

Young mussels will settle in internal piping where the water flow is slow (less than 1.5 – 2m/sec), allowing for easy attachment. When they first settle they increase the coefficient of friction within most pipes often causing a decrease in head pressure. Further settlement and growth will result in a decreased supply of water to vital areas, obstruction of valves, and loss of heat exchange efficiency. If mussels are allowed to infest a system and are then eliminated, a large number of byssal threads are left behind, up to 500 per mussel. This large number of byssal threads can continue to disturb the flow of water through pipelines. Byssal threads can also affect iron and steel pipelines by increasing corrosion rates under areas of attachment. Bacteria thrive underneath the mussel colonies and

anaerobic respiration produces acidic compounds, which can accelerate corrosion and pitting of pipelines.

Dreissenids will attach to any non-toxic hard surface. They also attach to each other, which creates large clump-like colonies. These clumps can break off and cause downstream fouling of intake structures, pipes etc. The clumps, called druses, also act as substrate for settlement, particularly on soft substrates like sand that otherwise is inappropriate for dreissenids.

Appendix F

Mussel Control Options and Alternatives

Appendix F.1 - Use of Chemicals for Mussel Control

The treatment of choice for most facilities tends to be one of chemical control, as it has often proven to be convenient and effective. To date, chemical control has been the common practice in both Europe and North America. The major advantage offered by chemical treatments is that they can be engineered to protect almost the entire facility, from intake to discharge. The difficulty in pursuing treatment through chemical means is in limiting the discharge of toxic materials to the environment and meeting local environmental regulations. As facilities continue to find themselves in an increasingly stringent regulatory environment, mitigation based on use of chemicals may have to be limited. The exception to this is the new biopesticide Zequanox from Marrone Bio Innovations. This product is specific to dreissenid mussels and requires no detoxification. In Canada this product has a label which allows use only in once-through cooling systems of hydraulic generating stations but less stringent labeling is currently under negotiation. When fully approved, it could be used in-once through cooling systems of any facility.

A wide variety of chemical treatment strategies are available for controlling mussel populations. One objective, however, should always be to minimize local environmental impact whenever possible and practical. It is, therefore, essential to work with the local regulators to ascertain that the chemical of interest is acceptable to them, especially when treated water is to be discharged into the local waterway. In closed systems, or under static conditions, a wider variety of chemical treatments can be used, provided there is no release to the environment.

Appendix F.1.1 - Reactive Options using Chemical Control. Reactive chemical control strategies are used after adult mussels have become established in a raw water system. At this time, there are no reactive treatments using chemicals for fouled external structures.

Appendix F.1.2 - End-of-Season Treatment. End-of-season treatment is performed after the mussel breeding season is complete. Sufficient oxidizing or non-oxidizing chemical is applied for a long enough period to kill all adults established in the system. The end-of-season treatment pre-supposes that the pipe system in question can tolerate one season's worth of macrofouling and that the accumulated biomass and shells can be removed from the system after the treatment. Adult mussels will release from the internal walls of systems during and after the treatment. The system components must be able to tolerate the predicted mass of shell material that is released, and maintenance staff must be on hand to remove the debris. It is very hard to predict the rate at which the release of shell material will take place so it is wise to prepare for both early post-treatment release of large amounts of shells and ongoing release of shells for several weeks thereafter.

When deciding on the timing for an end-of-season treatment, operating experience in the continental northeast suggests that mussels tend to be most vulnerable just after spawning. Therefore, adults may be most easily eliminated in the fall at the end of the spawning cycle.

Appendix F.1.3 - Periodic Treatment. Periodic treatment is a variation on the end-of-season treatment. Once again, adults are targeted, but the chemical is applied more often, basically eliminating the fouling while the densities and physical size of the adult mussels remain fairly low. The chemical concentration needed and the duration of application will be similar to that used for the end-of-season treatment. The biomass that has to be removed following the application is proportionally smaller, but the system in question still must be capable of tolerating a high degree of fouling. If implemented frequently, periodic treatment will prevent the presence of large individuals in the system.

Appendix F.1.4 - Proactive Options using Chemical Control**.** The following chemical treatments are designed to be used proactively to prevent the settlement of mussels in raw water systems.

Appendix F.1.5 - Intermittent Treatment**.** Chemical dosing at frequent intervals (every 12-24 hours) is aimed at preventing infestations before they begin. It is generally accepted that the freshly settled post-veligers are more susceptible than adults. Therefore, the concentration of chemical used and the duration of application to control this life stage will be significantly less than if adults are targeted. Most intermittent treatments will not eliminate adults already present in the system or translocators that gain access.

Effective treatments include:

- Chlorine as sodium hypochlorite used for 30 minutes every 12 hours, at 2 mg/L to prevent freshly settled post-veligers from developing. This strategy was used at several plants belonging to Ontario Hydro for a number of years with good results.
- The addition of 5 – 8 mg/L of ozone for 5 minutes every 12 hours can prevent the development of dreissenid mussel populations.
- Chlorine dioxide applied for 15 minutes every 6 hours at a concentration of 0.25 ppm and ambient temperature of 12.8ºC, has been shown to achieve 95% reduction in new settlement.
- An intermittent strategy using the molluscicide Mexel has been developed in Europe. An addition of 6 mg/L of the Mexel chemical for 3 hours prevents infestation. More recently, the manufacturer suggests that a once per day 30-minute addition of Mexel at a level of 4 ppm to 5 ppm will control freshly settled mussels and avoid infestation of the system.

Appendix F.1.6 - Semi-Continuous Treatment**.** The semi-continuous treatment was developed after observing the response of Zebra mussels to a chemical irritant. Upon exposure to a noxious substance (oxidizing chemical), mussels will stop filtering and quickly close their shell. It will then take 15 to 30 minutes before they will reopen the shell and attempt to resume filtering. This means that the treatment schedule can be adjusted to 15 minutes on and 15 to 45 minutes off. This is particularly advantageous to facilities that have multiple systems to be treated. The chemical addition system will work continuously, but the chemical can be directed sequentially to the different systems to be treated. This strategy has resulted in complete control of all stages of Zebra mussels in the piping, while using significantly less chemical than if applied continuously and minimum discharge levels due to large volume of water available for dilution.
This semi-continuous strategy has been further refined under the trademark Pulse-chlorination®. Using electrodes attached to shells of mussels within a specially constructed monitor, Pulse-chlorination® determines the precise timing for semi-continuous chlorine treatment by observing if the mussels in the monitor have their shell open or closed. The system only applies chlorine when the mussels have

opened their shells and discontinues the addition when the shells are closed. This technique significantly reduces the amount of chlorine required (up to 50%) for a treatment compared to a continuous application.

Appendix F.1.7 - Continuous Treatment**.** The continuous treatment strategy is designed to eliminate any level of settlement in the system. The incoming larvae (veligers) do not necessarily suffer 100% mortality, but the presence of a noxious substance is enough to discourage settlement. Any adults present will either succumb to the toxin (if the low level chemical addition is carried out for the entire reproductive season) or detach themselves and attempt to leave the system being treated. The concentrations of chemical needed can be quite low but the application must be continuous. Typically, continuous treatment is chosen for systems which cannot tolerate even the smallest degree of fouling. Fire protection and other safety related systems for example, often utilize this type of treatment. To date, this type of treatment has been attempted primarily with oxidizing chemicals such as chlorine or with continuous feed of copper ions. Potentially, other chemical strategies, such as depression or elevation of the pH or continuous addition of flocculants, could be used as a continuous treatment.

Appendix F.2 - Types of Chemical Options Available

If fouling organism mortality was the only consideration when designing a treatment, any number of chemicals could be successfully used to control fouling. Due to economic and environmental concerns though, only a relatively small number of chemicals are ever likely to be used in practice. When approached by a vendor of either new or existing chemical treatment for macrofouling control, it is best to direct them to the local regulatory agency for an assessment of their product. In many cases, the manufacturer will not be willing or able to provide the money, data, or empirical studies required by regulators to gain approval for use. This reality sometimes keeps promising new products from reaching the market.

Appendix F.2.1 - Oxidizing Chemicals. Oxidizing chemicals have been utilized as disinfecting agents in water supply systems for over one hundred years. In most cases, their effect on the environment is understood and well documented. Treatment with oxidizing chemicals (primarily chlorine) has been the most frequently used proactive chemical treatment to date. Oxidizing chemicals have also been used in periodic and end-of-season treatments by a number of different industries.

Chlorine - One of the most effective and popular methods of macrofouling control is chlorination, where chlorine is added as diatomic chlorine gas, liquid sodium hypochlorite, or solid calcium hypochlorite. Chlorine has been used for over one hundred years in the treatment of potable water. It is a well-known and studied chemical with well-documented use and by-products. One of the major concerns in using chlorination in surface water supplies is that it will combine with various organic compounds to form trihalomethanes (THMs), which are considered carcinogens. Many regulatory agencies permit the use of chlorine in flow through systems but have stringent limitations on the level of total residual chlorine in the discharge water. To meet these requirements, most facilities have to de-chlorinate the treated stream, or else use a storage lagoon or a large volume of diluting water. Before deciding on a chemical treatment strategy, it is wise to contact the local regulatory agency to check on their policy for chemical treatment in general and chlorine in particular.

Chlorine based mitigation can be used for all strategies discussed above. Chlorine treatment strategies and concentrations used to control Zebra mussels also successfully control Quagga mussels.

Chlorine Dioxide - Chlorine dioxide (ClO_2) has been implemented as a disinfectant in the water treatment industry for over fifty years. It acts effectively on both aerobic and anaerobic bacteria. Unlike chlorine based treatments, chlorine dioxide does not form trihalomethane by-products and is equally effective at all pH levels. Chlorine dioxide does not react with ammonia and therefore does not form chloramines. The by-products generated in the breakdown of ClO_2 in aqueous solution consist primarily of sodium chlorite, chlorate, and chloride, all considered to be acceptable at low levels to regulatory bodies. However, the United States Environmental Protection Agency (EPA) did find that bromate and aldehyde by-products can be formed by chlorine dioxide addition to water. The by-products include propanal to decanal series, benzaldehyde, methyl glyoxal, and glyoxal which may be of some interest depending on specific facility concerns.

Chlorine dioxide can be manufactured on-site from various precursors such as sodium chlorite and hydrochloric acid, sodium chlorite and chlorine gas, sodium chlorite and sodium hypochlorite, and hydrochloric acid or sodium chlorate and hydrogen peroxide and sulphuric acid. The manufacture of chlorine dioxide requires specialized equipment, and there have been past concerns regarding worker safety. In Germany, chlorine dioxide generators are permitted for drinking water applications only if they meet the technical requirements for automatic and airtight generation on-site.

Recently, manufacturers have started producing 3000 ppm solutions of chlorine dioxide off-site and delivering these solutions to the client. Although an aqueous solution of 3000 ppm chlorine dioxide is not classified as a hazardous substance, at room temperature it will sublimate into a gaseous phase, which is extremely poisonous. If the addition equipment is not airtight and carefully controlled, this can lead to health and safety concerns. For this reason, on-site generation with state of the art equipment is recommended.

Chloramines - Chloramines are formed when free available chlorine (HOCl and OCl) reacts with nitrogen containing compounds, such as ammonium and amino acids. Chloramines are formed naturally when chlorine or sodium hypochlorite is added to lake water. The more ammonium that is present, the higher the level of chloramines formed. Chloramines can be generated in bulk by co-injection of ammonium as either ammonium gas or ammonium hydroxide and sodium hypochlorite. Although chloramines have generally been found to be a less powerful oxidant than hypochlorous acid, they have been used as disinfectants in various applications. Monochloramine (NH_2Cl) has been used as a disinfectant in drinking water, and it was also found effective in controlling veligers of the Asiatic clam. At two French power plants, monochloramine is produced on-site by mixing sodium hypochlorite and ammonium chloride, and it is used to control Zebra mussels as well as bryozoans (*Plumatella sp).* At this time, it would seem that the use of chloramines over chlorine may hold some advantages for some facilities. This is particularly true if the formation of trihalomethanes is a concern.

Ozone - Ozone is a well-known bactericidal agent in the sewage treatment and water treatment industry. The first experiments with ozone in drinking water treatment were conducted in France in the late19th century. It was first used commercially as a drinking water disinfectant at Nice in 1906. Since that time, ozone has gained increasing popularity worldwide, particularly for its viral and bacterial

inactivation properties. Viruses and bacteria are completely eliminated within thirty seconds by a dissolved ozone residual of less than 0.5 mg/L. Ozone improves taste, odor, and color of drinking water, and can also be used to prevent various other forms of biofouling. Concentrations of 0.25 mg/L to 0.5 mg/L have been reported to eliminate the blue mussel (*Mytilus*) from seawater systems in some European studies. In terms of contact time at comparable residual levels, ozone outperforms other oxidizing chemicals. The most significant negative aspect to an ozone based mitigation strategy is the high initial capital cost of the equipment and the difficulties involved in maintaining it. Additionally, one of the main characteristics of ozone that make it attractive for use in once-through systems also turns out to be a major drawback. The relatively unstable ozone molecule dissipates quickly in water depending on a number of factors including temperature, pH, and organic matter concentration.

In practical applications ozone has performed remarkably well in controlling dreissenid infestations. In Canada, ozone treatment is currently being used in an electricity generating station on Lake Ontario to prevent biofouling of once-through service water systems. The ozone generating equipment was installed in the spring of 2000 and put into immediate use. Ozone is injected at the start of the system at 0.5 mg/L to 0.3 mg/L continuously throughout the mussel breeding season. At this location, ozone has provided excellent control of all biofouling, including the prevention of Zebra mussel settlement. It has also eliminated any adults which had previously settled in the system prior to the installation of the ozone generator. This elimination took place within the first six months of the initiation of the treatment system. Caged fish fingerlings placed in the discharge stream of the generating station did not suffer any mortality, upholding ozone's reputation as an ecologically friendly treatment option. The Lake Ontario data mirrors the experience in Belgium at a power plant on the river Meuse. At this installation, ozone was injected at the level of 0.3 mg/L to 0.5 mg/L. This treatment achieved complete control of Asian clams and Zebra mussels, as well as bacteria and algae in the secondary cooling system. The discharge into the river had less than 10 ppb of residual ozone. Significant mortality of adults was observed after 20 days of exposure, with complete mortality achieved in 48 days.

A fish hatchery in New England currently utilizes an ozone treatment system. The facility is relatively small, using approximately 11 MGD of raw water. The mussel-control regime involves continuous application of ozone at a concentration of 0.3 mg/L. The system is designed to treat a 2,500 ft. long pipeline, inactivating the Zebra mussel veligers in order to limit infestation in the hatchery raceways. The ozone injection at the intake is followed by removal of ozone at the hatchery using ultraviolet light.

Hydrogen Peroxide - Hydrogen peroxide has the reputation of being a benign oxidizing agent, dissociating into hydrogen and oxygen and leaving no detrimental environmental by-products. While this may not be completely true, it is frequently used as an algaecide or biocide in small, contained systems such as spent fuel bays in nuclear generating stations.

Several trials on both adult Zebra mussels and veligers have shown that relatively high doses of hydrogen peroxide are required to induce mortality. A concentration of 12 mg/L was required for adults and 6 mg/L was needed for veligers. Ninety percent mortality of adult Zebra mussels in 21 days of exposure to hydrogen peroxide was achieved at a concentration of 5.4 mg/L. The duration of the treatment decreased with increasing hydrogen peroxide concentration. Total mortality was achieved after 7.8, 4.8, and 3.0 days at concentrations of 10, 20, and 40 mg/L, respectively. In the same study, Asiatic clams were observed to be less sensitive to hydrogen peroxide than Zebra mussels. Total

mortality for the clams was observed after 13.5, 9.5, and 9 days at concentrations of 10, 20, and 40 mg/L, respectively.

As hydrogen peroxide is quite expensive when compared to sodium hypochlorite, it would not seem economically practical to treat large volume, flow-through systems using this chemical.

Potassium Permanganate - Potassium permanganate is another oxidizing chemical commonly used in municipal facilities for water purification. It is widely utilized to protect against oxidation of iron and manganese, and for control of taste and odor problems. Effective control of adults has been achieved at a concentration of 2.0 mg/L and veliger settlement was prevented using a concentration of 1.0 mg/L. These results suggest that potassium permanganate may prevent the settlement of mussels, but that it is not acutely toxic to either veligers or adults.

The Paul M. Neil Water Treatment Facility has employed the use of potassium permanganate at the intake structure on Lake Michigan, successfully preventing mussel settlement in the 2 miles of piping leading to the treatment facility for several years. Utilizing potassium permanganate as a mitigation strategy seems most applicable in potable water treatment facilities, especially considering that many already utilize this chemical for sanitation purposes or to eliminate trihalomethanes already in solution.

Appendix F.2.2 - Non-oxidizing Chemicals. A number of non-oxidizing chemicals have been developed for bacterial disinfection, algae control, and as molluscicides. Some of these chemicals have regulatory registration for use in once-through cooling systems. With few exceptions, these products require detoxification upon discharge to the environment. Most of these products are used for end-of-season or periodic treatments.

Proprietary Molluscicides - The term molluscicide is somewhat of a misnomer as generally these formulations are toxic to a wide variety of species and not just molluscs. Many of these proprietary formulations are based either on quaternary amines (Betz-Clamtrol) or on isothiazolones (Buckman-Bulab 6002) or on other organic compounds (Bayer-Baylucide). The use of these products in closed systems is unrestricted. In once-through applications, most of the products have to be detoxified with the addition of bentonite clay slurry.

The major form of use for these chemicals is as an end-of-season or, in some cases, periodic treatment. These chemicals are not detected by mussels as noxious compounds, allowing them to continue filtering normally without closing up until death. Thus, mortality can be achieved quite quickly. Depending on the concentration used and the ambient temperature of the water, significant mortality can occur in 4 to 24 hours. Non-oxidizing chemicals have been used with good results in a number of facilities primarily as an end-of-season or periodic treatment. In some of these applications, operators have been able to set up closed loop systems where the same chemical was recirculated for the required period of time. This type of application significantly decreases the volume of chemical required, which is of both environmental and economic benefit.

There are two considerations when using non-oxidizing chemical treatments. First, when a facility uses bentonite clay for detoxification of periodic or seasonal treatments; the amount of material which will accumulate in the discharge over the period of some years needs to be considered. The active product

will adhere to the clay particles and be carried to the bottom. The fate of some of these complex products in sediment is not well documented, but some products are believed to be quite persistent. Second, most of these products require relatively warm ambient temperatures to work swiftly. In temperate zones, this may mean a treatment well in advance of the end of spawning, leaving a fairly sizable population of macrofoulers in the system to grow over the winter.

One category of non-oxidizing chemicals is proprietary compounds which act as filming agents and are based on fatty amines. The Mexel® line of products belongs in this category. These products consist of filming aliphatic amines which are thought to inhibit corrosion, prevent slime, scaling, and various forms of macrofouling. The active ingredient in Mexel® is an alkyltrimethylenediamine (ATMD). Mexel ® was found to inhibit the formation of byssal threads of dreissenid mussels at concentrations of 2, 6, and 10 mg/L. Unlike other proprietary products, Mexel® can be used as an intermittent treatment. When added at the water intake point, typically once a day for 30 minutes at a level of 4-5 ppm, Mexel® has been reported to keep all treated systems free of dreissenid mussels. Unlike other proprietary products, Mexel® does not require detoxification on discharge. High concentrations of total suspended solids (TSS) or organic matter content in the water will require larger concentrations of chemical to maintain an effective residual treatment level.

Zequanox - Over the last decade, an enormous amount of work was undertaken by a team led by Dr. Dan Molloy from the New York State Museum studying the use of a common soil bacterium as a specific control agent for dreissenids. The team found that the bacterial species *Pseudomonas fluorescens*, strain CL145A, has the ability to cause mortality in adult mussels. When dreissenid mussels ingest artificially high densities of the bacteria (living or dead), a toxin within the bacterial cell destroys the mussels' digestive system. To date, no other aquatic species tested has demonstrated any susceptibility to this bacterium.

Zequanox is currently in the commercialization stage and concurrently going through the regulatory approval process in Canada. Marrone Bio Innovations is the company behind this effort. At this time the product is very expensive but with economies of scale it could potentially offer a significant alternative to all forms of chemical control.

Ammonium Nitrate - At concentrations of 400 mg/L to 500 mg/L, ammonium nitrate has been reported to cause 100% mortality of adults in 5 to 6 days when ambient water temperature was 61°F to 67°F (16.1°C to 19.4°C). Ammonia concentrations exceeding 3 mg/L have been reported to cause 100% mortality in veligers. This treatment is not feasible for once-through systems, but could be used within a closed loop and also in agricultural circumstances where chemical fertilization is already being used. Ammonium nitrate does not appear to offer any advantages over the commercial molluscicides mentioned above except perhaps economics.

Copper Ions - Dissolution of copper and aluminum anodes by electrolysis has been used to protect ship cooling systems from macrofouling for at least forty years. Based on the marine experience, a series of experiments was conducted to determine if the same technology could be used against dreissenid mussels. A continuous dose of 20 ppb of copper ions appears to limit veliger settlement in systems protected in this manner. This technology was commercialized under the trademark of MacroTech Copper Ion generator. Wisconsin Energy Corporation utilizes this copper ion

technology to control dreissenid mussel infestations in its Oak Creek Power Plant service water system in west Lake Michigan. The copper ion generator does not eliminate all macrofouling in the service water system, but the level of infestation is acceptable to the plant personnel. The copper ion generator equipment has significant short-comings for use in industrial setting such as uneven release of copper ions, no built-in feedback loop, and no alarm system for low levels of copper. The discharge of copper ions into the aquatic ecosystem may not be permitted in all jurisdictions.

Copper sulphate and the copper rich algaecide, Cutrine-Ultra® and EarthTec, have been reported to eliminate adult mussels while being used for algal control in various systems at levels of 30 to 50ppb applied for a number of days (**Table F.1**).

Dose as EarthTec	Dose as element	Mortality after: 6 days	11 days	13 days	19 days	25 days
3 ppm	150 ppb	100%				
2 ppm	100 ppb	100%				
1 ppm	50 ppb	50%	100%			
0.6 ppm	30 ppb	15%	55%	70%	80%	pending

Table F.1 – Mortality of adult Zebra mussels when exposed to various levels of EarthTec under flow through conditions

Potassium Salts - Potassium compounds are toxic to most bivalves, including dreissenids and corbiculids. ASI Group has been using potassium chloride as an end-of-season treatment for a number of different systems. They have found that 100 mg/L for two days at an ambient temperature of 15°C resulted in 100% mortality of dreissenid adult mussels in the system treated. The length of treatment increased with decreasing temperatures. In 2006, ASI Group treated an isolated quarry in Virginia with potassium chloride in order to eradicate an infestation of Zebra mussels. A total of 131,000 kg of muriate of potash (KCl) solution was used with apparent success. Recently the Manitoba Government conducted very successful eradication of Zebra mussel in several harbours on Lake Winnipeg.

Although potassium compounds are nontoxic to higher organisms such as fish, the toxicity to native bivalves makes the approval for use of potassium salts in once-through systems unlikely. In closed loop systems, however, the use of potassium salts is an attractive option.

Sodium Metabisulfite - Dreissenid mussels are relatively intolerant of low dissolved oxygen concentrations (< 25% of full air saturation levels), which at 20°C (68°F) is approximately 2.3 mg/L at sea level or 1.8 mg/L at an elevation of 2133 m (7000 feet). Systems with less than 3 mg/L at 20°C (68°F) would have little chance of mussels surviving. Dissolved oxygen concentrations exceeding 50% saturation seem to be required for sustained, healthy populations. Depressing the dissolved oxygen level in a system infested by dreissenids could be a form of end-of-season treatment. Several dual intake water treatment plants in Wisconsin have received permission to add either chlorine or sodium bisulphite to the intake they wish to take out of service. The chemical is added just before the intake is capped and kept static for four to ten weeks. At the end of the lay-up period, all Zebra mussels will be dead either from the effects of chlorine or from anoxia caused by sodium bisulphite removing all available oxygen.

The use of sodium metabisulfite as a dechlorinating and oxygen stripping agent prompted speculation if this chemical could be used effectively as a treatment for Zebra mussels. Sodium metabisulfite by itself is not very toxic to Zebra mussels. A minimum concentration of about 177 mg/L of sodium metabisulfite would be required to kill all adult mussels in closed systems. Below this level, toxic effects are absent. Anoxia caused by the addition of sodium metabisulfite will contribute to mussel mortality on prolonged exposure as sodium metabisulfite is an effective oxygen stripper. Depending on facility-specific conditions, anoxic conditions combined with higher water temperatures will increase dreissenid mortality more than the effects of either alone.

Sodium metabisulfite is not considered to be a practically feasible chemical to kill Zebra mussels in pipelines or conduits because enormous amounts of the compound are required for treatment where water is renewed continuously. However, it may be practical for use in closed systems, such as fire protection systems, which hold water for long periods of time. The potential for unacceptable growth of sulphate-reducing bacteria should be evaluated before using this method as the bacteria can cause serious corrosion problems in the system.

pH Adjustment - Dreissenid mussels have a range of pH values within which they flourish and outside of which they do not survive for prolonged periods of time. Given the relatively narrow range of pH tolerance, water systems which draw water with pH near the limit for successful survival of dreissenid veligers may be protected if the pH is either further depressed below 7.0 or raised above 9.5 at the raw water intake. This could create a hostile environment which would preclude dreissenid settlement.

Recent research suggests that, at pH 6.9 and pH 9.6, new settlement by veligers is essentially prevented. Furthermore, a pH of 3 as well as a pH of 12 will cause adult mussel mortality in approximately 140 hours.

If practical, pH adjustment would act as a continuous chemical treatment preventing all settlement and growth. The lowering of pH can be particularly useful for drinking water facilities which adjust the pH of the incoming water before processing it. If the point of pH adjustment could be moved to the intake of a facility, it would protect all subsequent structures and systems.

Increasing the pH to 9.6 will not only prevent mussel settlement but it may also inhibit bio-film formation in the system treated. However, if the raw water has a high calcium saturation index, precipitation of calcium carbonate may occur when pH is increased. In such water bodies, high pH treatment will not be a viable option.

Chemical Cleaning - Chemical cleaning is an option to be used in the event that small diameter piping or perhaps heat exchangers become plugged by mussels and mechanical cleaning is difficult or impossible at that location. Several products exist on the market, mostly proprietary inorganic acid mixtures (e.g. phosphoric acid mixtures), which will rapidly dissolve mussel shells. The chemicals will often remove accumulated corrosion products as well. The suitability of the pipe material of construction needs to be checked to ensure the pipe will not be degraded beyond acceptable limits. The vendor generally assists in delivering the product in a suitable container. The chemical product is circulated through the piping in a closed loop manner for three to four hours and then removed for

recycling by the vendor. The system is then flushed and, if found satisfactory, is returned to service. This is an expedient remedy for small, neglected systems but is not appropriate for large volume systems.

Appendix F.3 - Non-Chemical Mussel Control

Just as there are proactive and reactive techniques using chemicals, there are proactive and reactive non-chemical strategies for macrofouling control.

Appendix F.3.1 - Non-Chemical Proactive Techniques

Infiltration Galleries and Sand Filters - Infiltration galleries and sand filters are capable of removing all stages of all mollusc macrofoulers and protecting all downstream systems and components. An infiltration gallery can be described as a "built-in-place" rapid or slow sand filter. Those designed as rapid sand filters have flow rates of 7 to 15 L/min (2 to 4 gpm) per 0.1 m^2 of filter area. Others slow filter at a rate of 0.15 to 0.3 L/min (0.04 to 0.08 gpm) per 0.1 m^2. Given these projected flow rates, obtaining large amounts of filtered water would require construction of an infiltration area of substantial dimensions. Such an undertaking undoubtedly requires regulatory approval as it takes place in or near a water body and generally involves shoreline alteration. Additional engineering factors which have to be incorporated into the design process include raw water quality, proximity to sources of high turbidity, hydraulic considerations, and cleaning method and frequency.

Although infiltration galleries and sand filters offer full system protection, they are not appropriate for existing facilities using large volumes of water. The retrofit required is likely to be very expensive, difficult to implement, and may result in an unacceptable pressure drop to the system. For new intakes, an infiltration gallery could be a viable option. Currently, infiltration galleries are being considered for a number of water withdrawal applications.

Mechanical Filtration - Mechanical filtration is capable of removing all stages of all mussels if an appropriate screen size and configuration is used. Most conventional industrial strainers have strainer screen openings which will prevent some translocating mussels and most shell debris from fouling the raw water systems. None, however, will protect against the introduction of larval stage organisms. In most instances, it is not possible to retrofit existing strainers with finer screens and hope for successful mitigation. The performance of such a modified strainer or filter tends to deteriorate, excessive clogging of the screen may result in stretching and tearing of the material, the backwash system may prove to be inadequate, and the pressure drop caused by the strainer may be unacceptable.

Different types of filters, designed primarily for the removal of small particles, have been tested for dreissenid veliger control by a number of different organizations. Wedge wire slot filters have difficulty in excluding larval stages of macrofoulers. This is likely due to the fact that wedge wire type screen filters are designed to remove inorganic matter such as quartz or metal shavings, but they are not designed to stop organic matter from passing through the screen. Organic particles, due to their flexible nature, tend to "sneak through" the wedges of the screen. Excellent results were obtained by

Ontario Hydro using a continuous backwash, pleated screen filter and by the New York Power Authority using a modified clean-in-place bag filter to eliminate dreissenid veligers from incoming water.

Hydro-cyclone or centrifugal separators were initially thought to be a mitigation option for facilities that already employ this technology for silt removal. Studies have shown that centrifugal separators removed at most 50% of veligers present.

Many filters are very good at removing all or most particles from the water stream, but most filters are not able to process large volumes of water efficiently. Filters which use stainless steel, square weave mesh and periodic backwash seem to have the best balance between particle removal efficiency and volume of water filtered. A number of manufacturers produce such filters and the evaluation process of individual units can be confusing. We offer the following points as aid in evaluation of filters.

Filtermesh - Some manufacturers do not distinguish between nominal and absolute size of the pores in the mesh they offer. It is important to understand the difference. There are various test methods used to establish the absolute size of pores in woven wire cloths. One such method is the Bubble Point Test. The absolute mesh size rating done using this test corresponds to the diameter of the largest, hard spherical particle which can pass through the filter medium under steady flow conditions. Nominal value, on the other hand, is an arbitrary term generally corresponding to removal of 98% of all incident particles larger than the nominal value given. Various methods are used to determine the nominal rating and the reproducibility using these methods is poor. Therefore, it is advisable to determine the quality and the absolute mesh size rating the filter manufacturer is offering.

Smythe *et al.* (1993) reports on the performance of the Kinney Strainer (equipped with a 40-, 95-, or 142-micron mesh) and the Bromm Filter (nominal mesh size 60 µm and 100 µm). Although the Kinney Strainer (40 nominal micron mesh) and the Bromm Filter (60 micron nominal mesh) reduced the densities of ready-to-settle veligers (>250 micron) in the filtrate by up to 97%, they did not totally exclude all individuals from the system. Examination of the mesh used in each case revealed that the nominal micron ratings were not reliable indicators of the largest opening found in the mesh.

Even great quality wire weave mesh will allow some organic particles greater than the absolute micron size to pass through. This is not surprising given the test protocol which uses hard spherical particles. Soft or flexible particles of size greater than the absolute mesh pore rating will be able to pass through. During recent filter trials, it was noted that a 120-micron absolute mesh allowed some veligers of up to 200 µm through. A 57-micron absolute screen passed some veligers of up to 100 µm in size.

In order to have as much open area as possible in the mesh, the wires used to create the mesh tend to be very thin. This means that unless the mesh is properly supported, the individual pores may be distorted by pressure and the cloth may be torn by the backwash system. Strong support of the screen to prevent distortion and tearing is essential. Three to four layers of “sandwich” is recommended. The various layers should be sintered together for best support and performance.

Filter Construction - Sturdy materials of construction are essential. Plastic parts generally do not stand up to the rigors of industrial application. Excellent sealing between filter components is required to prevent water interchange between filtered and non-filtered water in different chambers.

Filter Backwash System - The more water a filter uses for its backwash, the less there is available for application use. Under normal conditions, 1 to 3 percent of the total filtered flow is required for backwash. This percentage increases as the total suspended solid (TSS) load increases. The filter should be capable of backwash cycles that are based on both time elapsed and differential pressure across the screen. The greater the differential pressure across the screen, the more likely it is that soft organic material will be forced through. A differential of no more than 3 to 5 psi is generally recommended.

In addition to removing all larval stages of macrofoulers, filters remove substantial portions of particulate matter, such as sediment. How much they remove is a question of mesh size and size distribution of the particulate matter in the water column. At one installation, it was estimated that a self-cleaning filter installed on a system carrying 4,000 L/min of water removed over 10,000 kg of silt each year. Sediment removal necessarily results in improved performance and a decrease in maintenance for most industrial systems.

Filtration systems are not appropriate for water streams with continuously high sediment load such as exist in Red River. Under such conditions, the backwash system may not be able to remove the sediment cake which builds up on the screen. Very efficient backwash systems are capable of coping with higher sediment loads. BallastSafe® reported that a filter using a 40-micron screen continued to perform even when incoming water had 250 ppm of TSS. The filter flushed continuously, with the backwash consuming between 8% and 12% of the total flow water. Since the amount of TSS a filter is able to cope with is somewhat related to the particle size distribution in the incoming water, a small-scale, site specific trial with the filter being considered is recommended.

Filter Field Installation - Operating experiences suggest that, in critical applications, a backup system (i.e. a parallel arrangement of multiple units) is a must if filtration is to be considered as a viable control measure option. For example, two filters, each capable of filtering 100% of the flow, would represent a guarantee that only filtered water reached downstream systems. If some ingress of unfiltered water can be tolerated, a system by-pass may be installed to guarantee uninterrupted supply of water in case of filter upset.

To monitor the performance of the filter, at least one manufacturer suggests installing a small fixed filter screen downstream of the self cleaning filter. The fixed screen should be the same or a slightly larger pore size than that used in the self cleaning filter. If this fixed screen becomes plugged, it is an alert that the self cleaning filter is passing particles larger than the rating would suggest.

In the United States of America (USA), the State of Vermont has successfully used a series of Amiad® automatic backwashing filters for Zebra mussel control at the Edgar Weed Fish Culture Station facility since 1996. At this installation, due to the line pressure required by the filtration unit, the filter had to be located downstream from the pump. This requirement means that the intake piping must be

mechanically cleaned periodically using a “pigging” unit, and that the pump itself must be allowed to dry out biannually to allow for mussel desiccation and elimination.

In the fall of 1999, a full-scale filter experiment was set up at the Nanticoke Thermal Generating Station (TGS) by Ontario Power Generation. The self-cleaning filter, equipped with a 40-micron absolute woven mesh, was installed downstream of a self-cleaning wedge wire strainer with an approximately 3 mm gap. The designed filter capacity was 12,000 gpm but the system rarely required more than 6,000 gpm. Typically, backwashing cycles were triggered about once every hour. During a backwash cycle, the water flow would drop down to about 4,500 gpm. This represents a drop of about 15-20%. The design specifications required that a minimum 30-psi differential across the cleaning nozzles be available for the system to work effectively. This had to be increased to about 45-50 psi for the filter to cope with the incoming sediment load. The system generally ran well when total solids loading was 15 mg/L or less. The filter was able to handle a TSS loading of 60-80 mg/L, but it had to backwash almost continuously. It was concluded that the system would be unable to cope when the turbidity exceeded 80 mg/L.

In terms of efficacy, defined as the difference between veligers entering the system and those passing through the filter (dead or alive), the filter achieved between 95.9% and 100% veliger removal. In all instances where veligers did pass through the filter screen, they were dead. The downstream bio-box sampler was free of any adult settlement at the end of the experiment, while the bio-box placed just ahead of the filter had hundreds of large mussels settled on walls and sampling plates.

Recent advances in filtration technology have allowed several manufacturers to design filters capable of removing all particles greater than 25 µm from relatively large streams of water. These filters are designed to minimize pressure drop in the system and have corrected many of the problems encountered in the above described installation. Several of these filters are currently being tested as part of ballast water treatment systems.

Note on filter construction for mussel exclusion: The shape of mussels is somewhat like a flat disc. In addition, at the age where they are ready-to-settle their shell still has some limited flexibility allowing them to be flattened beyond their normal thickness without harm. Therefore wedge wire filters are not effective at excluding mussels. The recommended filter basket material is woven wire square mesh designs. The diagram below depicts a suitable commercial mesh (**Figure F.1**).

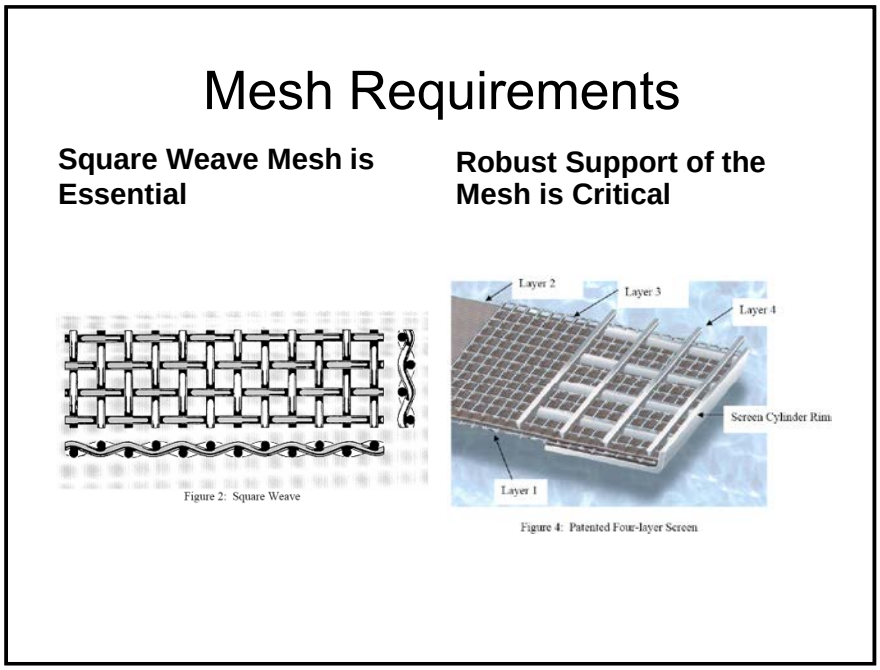

Figure F.1 - Recommended Filter Screen Construction for Mussel Exclusion

Ultraviolet Light - The use of ultraviolet (UV) radiation is appropriate for larval stages of mussels which have transparent shells. The term ultraviolet is applied to electromagnetic radiation emitted from the region of the spectrum lying beyond the visible light and before x-ray wavelength. The UV light ranges between 190-400 nm and has been subdivided into UVA, UVB, and UVC. Based on work by numerous authors in the early 1990s, UVB and UVC wavelengths were found to be most effective for dreissenid veliger control. The basis for the control is thought to be the impact of the UV light on the essential functions of the veliger, thereby inactivating the organism and preventing attachment. The most effective wavelength and the radiation dose (Dose = intensity x residence time) which the veliger must receive to experience either immediate or latent mortality have been the subject of numerous experiments.

A full sized pilot UV system was installed at a power plant on Lake Huron in 1999. Twenty medium pressure lamps were arranged in four frames each containing five lamps. The total volume treated was 760 L/s (12,000 gpm). The system was sized to deliver a radiation dose of 0.07 to 0.1 Watt-seconds/cm^2 to all particles passing through. This UV system was the only means of protection for the power plant cooling system. During the operation of the UV system, lamps had to be serviced, the system experienced numerous upsets, and, occasionally, it was even taken out of service accidentally. Despite these confounds, there was an 85% reduction in settlement in the system when compared to control.

A study aimed at treatment of ballast water in 2002 attempted to determine an effective treatment regime for ballast water systems. They found that, after the water was passed through a 50-micron filter, any remaining organisms could be eliminated by a dose of 200 mW/cm^2/s applied at a flow rate of 1000 gpm.

The effectiveness of a UV system is dependent on the characteristics of the raw water being treated. Factors such as water transmittance, presence and size of suspended solids, iron, hardness, and temperature all affect the efficacy of the UV system. Treatment systems must be designed for the worst case scenarios. This means designing for peak flows, end of lamp life intensity, minimum transmittance, and maximum suspended solids at the installation location. The aim of the system is to achieve 100% immediate or latent mortality in all ready-to-settle veligers which pass through. If an adequate dose is not delivered at this point, downstream settlement will occur as UV based systems have no residual toxicity which could impact areas outside the influence of the lamps.

In 2012 Atlantium Technologies sponsored an evaluation of Atlantium medium pressure UV system as preventative treatment for the settlement of Quagga mussel veligers. This study was carried out on the Lower Colorado River. Four separate experiments each one with a UV dose levels between 80 and 20 $mW/cm^2/s$ were carried out. Each level provided settlement inhibition in excess of 95% (**Figure F.2**).

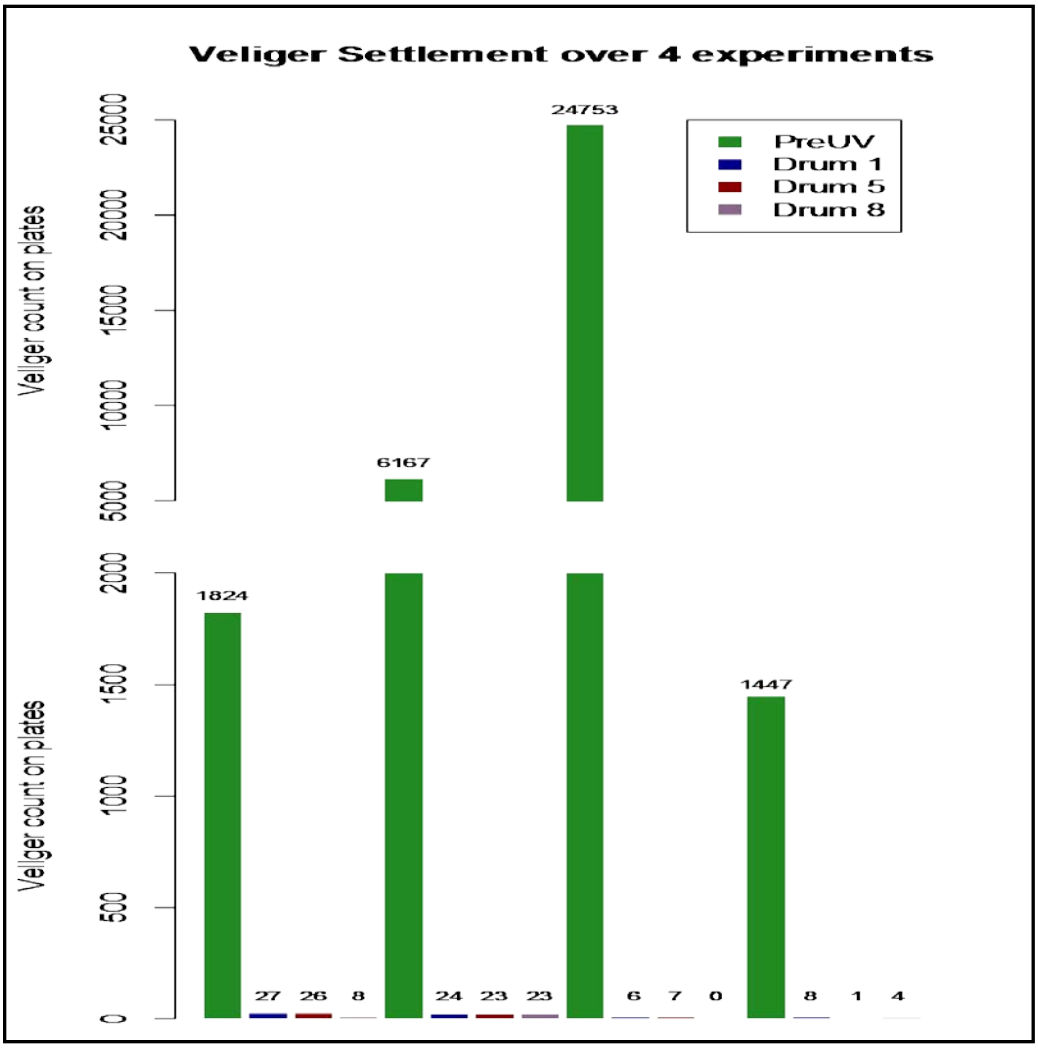

Figure F.2 - Overview of veliger settlement before and after UV treatments of varying strengths

In 2013 Davis Dam installed a full sized medium pressure UV system from Atlantium Technologies to protect all of the cooling water (total flow of total flow of 3550gpm) on power generating Unit 3. Davis Dam management agreed to allow the UV system to be adjusted so as to deliver various levels of UV irradiation. This in turn allowed for second evaluation of downstream Quagga veliger settlement after exposure to various UV doses using an actual industrial installation (**Table F.2**).

Cycle	UV Dose	Settlers		% Reduction
		Control	Test (after UV)	Box 1 to 2
1	50	160	8	95%
2	40	386	8	98%
3	20	223	26	90%
4	40	1445	18	99%
5	40	810	76	91%

Table F.2 - Total settlement of mussels per square foot, including percent reductions

For complete elimination of all settlement UV doses between 100 – 120 mW/cm^2/s are recommended.

Anti-Fouling and Foul Release Coatings - Historically, the majority of developmental work in anti-fouling paints/coatings has been directed towards prevention of barnacle growth on ships. In fresh water, anti-fouling coatings' primary use has been for the prevention of mussel attachment to structures exposed to raw lake water. Coatings do not offer any protection to the rest of a facility and therefore have to be combined with other mitigation strategies. For new facilities, appropriate selection of materials of construction may minimize the need for coatings. The following is a general substrate preference by mussels when using settling plates: copper < galvanized iron < aluminum < acrylic < PVS < teflon < vinyl < pressure treated wood < black steel < pine < polypropylene < asbestos < stainless steel. For pipes the preference is as follows: copper < brass < galvanized iron < aluminum < acrylic < black steel < polyethylene < PVC < ABS. Pipes oriented horizontally had significantly greater settlement than vertical pipes, and rough surfaces were more heavily colonized than smooth. The strength of attachment of Zebra mussels also varies with substrates. Within the substrate, the strength of attachment increases with surface roughness. Strongest attachment is to limestone and mild steel of all roughness. Attachment strength is intermediate on marine concrete, polyvinyl chloride, stainless steel, and coal tar epoxy coated mild steel. Smooth polytetrafluoroethylene, polymethylmethacrylate, and aluminum have the weakest attachment. However, most facilities have to deal with existing structures and therefore coatings present one of the best methods for minimizing the fouling on external surfaces.

The overall trend is toward the use of environmentally benign foul release coatings which form a physical barrier to attachment. The most promising coatings at this time are nontoxic silicone based paints which prevent or greatly decrease the strength of attachment. Silicone based coatings applied to the pump well wall at a nuclear power plant were found to be effective at minimizing mussel settlement for almost ten years. The silicone based coatings usually require several different layers to be applied to a perfectly clean, white metal surface or very clean, almost dry (10% or less moisture level) concrete. This tends to make them very costly ($80 -$100/m^2). In addition, the foul release coatings tend to perform better in areas of high or moderate flow, rather than in quiescent areas.

DWR Division of Operations and Maintenance, Operations Support Office, evaluated the performance of anti-fouling coatings along with anti-corrosion coatings commonly used in the SWP. The best performing coatings were those developed by Fuji Film Company and Intersleek manufactured by International Paints.

Vendors with known successful anti-fouling coatings include:

- CPM Coatings/Chugoku Paint (Bioclean-Si)
- Kansai Paint (Biox Si)
- International Paints (Intersleek)
- GE Coatings (Exsil)
- Fuji Film Smart Surfaces

The U.S. Bureau of Reclamation (USBR) also has a coatings research program that has evaluated many of the same coatings and has published the summary report from a six year study (http://www.usbr.gov/mussels/docs/MERL2014-64Coatings.pdf).

When considering which coating to choose to protect external structures of a facility, consider the cost of coatings and the problems associated with the application (e.g. sandblasting of surfaces, exposure of personnel to toxic fumes, problems of keeping large areas dewatered, etc.) with that of mechanical cleaning and the disposal of mussel debris on a regular basis. If, after this evaluation, coating is still the appropriate strategy, carefully examine the data provided by the vendor. Make sure that the coating has been successfully used in an industrial environment for at least three years and has shown a capability to prevent settlement of mussels. Furthermore, make sure that no toxic substances are likely to either leach from this coating or be released into the environment when the "top-coat" of the coating is "reactivated" (i.e. abraded to expose fresh coating). Check with the local regulatory agency as to any possible constraints on the use of any particular product.

Speed of Flow - When the speed of flow in a raw water system exceeds 1.5 m/s (4.9 ft/s), there is minimal, if any, veliger settlement observed. However, very few systems are designed for such fast flow rates and it would involve a major expense to redesign the systems. In fact, intake structures are frequently designed to maintain as slow a rate of flow as possible to prevent entrainment of fish.

Appendix F.3.2 - Non-Chemical Reactive Techniques

Thermal Shock - Hot water has proven very effective in killing mussels (**Table F.3**). Thermal backwash appears feasible for some facilities and systems as an end-of-season or periodic treatment.

The temperature and duration of the treatment can be combined in different ways. A temperature of 32°C (89.6°F) for 48 hours has caused 100% mortality in dreissenids, as has 40°C (104°F) for one hour. In between these temperatures lays a grey area where the exact temperature and time to death is dependent on several factors. One factor is the acclimation temperature of the mussels (i.e. the ambient temperature of the water). The lower the acclimation temperature, the more susceptible the mussels are. A second factor is the rate of temperature increase. If the rate of increase is very gradual, the mussels may acclimate during the process and survive for a longer period than anticipated. The last factor is the possible genetic variation in local populations. It is possible that Zebra mussels from a particular geographic area may be more temperature tolerant than mussels many miles away.

Test Temperature	**Acclimation Temperature**			
	5°C	**10°C**	**20°C**	**25°C**
34°C	419	396	687	-
35°C	243	231	271	525
36°C	209	107	202	261
37°C	116	52	126	153
38°C	-	-	66	78

Table F.3 - Resistance time (in minutes) for 100% mussel mortality in relation to temperature.

There are problems associated with using thermal shock for mussel control. Regulations governing discharge of heated water have to be considered. Plants which do not already possess the capability to recirculate hot water are likely to be unable to retrofit to do so and will only be able to apply thermal shock in small systems using an external heat source such as a steam generator. As plants have to be either taken off-line or production curtailed during thermal treatment, the cost of treatment tends to be quite high. In addition, manual cleaning of components may be required after a thermal treatment to clear away accumulated dead mussels and shells. Nevertheless, a number of facilities have used this method of treatment and achieved very good results. Commonwealth Edison heat treated one of its plants by raising the water temperature from 31.6°C to 37.2°C (89°F to 99°F) in ten hours. They then maintained this temperature for six hours, resulting in 100% mussel mortality. Plants in Italy, France, and Spain have also used thermal treatments for mussel control. It is certainly worth considering a periodic or an end-of-season heat treatment as an alternative to chemical treatment. Most regulatory authorities regard heat treatment as a more environmentally safe and benign method than chemical treatment.

Desiccation - Desiccation involves the draining of systems and subjecting the mussels to drying. Unless the process is speeded up by the use of hot air circulating in the pipes, a prolonged shutdown may be required. Adult dreissenid mussels can survive considerably more than 10 days in a cool (below 15°C), moist environment. On the other hand, at 25°C, Zebra mussels can survive for less

than 150 hours regardless of relative humidity. At 35°C, death occurs in less than 40 hours particularly at high relative humidity. It appears that the inability of mussels to cool tissues through evaporation at high relative humidity accelerates mortality rates rather than the actual loss of water from the tissues.

Oxygen Deprivation - Oxygen deprivation could be accomplished by adding an oxygen scavenging chemical into a closed system or by keeping a system such as a pipeline static for a sufficient time period. Mortality due to lack of oxygen occurs faster at higher temperatures (**Table F.4**)**.**

O_2 Partial Pressure (Torr)	O_2 % Saturation (%)	Temperature (°C)		
		5°C	15°C	25°C
7.9	5	*x	70	12
11.9	7.5		x	15
15.9	10		x	19
23.8	15	x	x	x

*x = mortality was observed but 100% mortality was not reached in the experimental time frame.

Table F.4 - Approximate number of days to 100% mortality for Zebra mussels at different oxygen and temperature levels**.**

For facilities which have two intakes but only need to use one, oxygen deprivation could be an efficient method of control. One intake is capped until the other one is fouled and then the two are switched. The treatment would work best at high ambient water temperatures. A word of caution is given here; lack of oxygen frequently results in a dramatic increase of sulphate reducing bacteria which in turn are responsible for some microbially induced corrosion (MIC). Limiting the amount of oxygen in a system may exacerbate corrosion problems.

Mechanical Cleaning - Accumulated Zebra mussel populations can be removed from all external structures and some large diameter piping by a variety of manual methods. This provides a short-term solution which must be repeated at regular intervals. New tools for mechanical cleaning are being introduced at such frequent intervals that it is impossible to mention them all.

To date, all mussels removed by all types of mechanical cleaning have been disposed of in regular landfill sites or composted at site. Several tests done on these mussels did not uncover any high concentrations of toxic materials which would have forced disposal at a hazardous waste site.

Mechanical Cleaning of Large Diameter Pipes - Mechanical "pigs" or scrubbers have been used effectively to knock and scrape mussels and other debris from large-bore pipelines. Pigs are available in a wide variety of designs and they are manufactured to clean pipes up to 180 cm (70 inches) in diameter.

The pipeline is unavailable during cleaning, and the disposal of mussels dislodged can cause a problem. Drinking water plant intakes are particularly suitable for this method. However, several have expressed concern that their structures may not be able to withstand the pressure generated by the mechanical pig on the pipeline.

Underwater Cleaning Using Divers - Due to operational requirements, Ontario Hydro has concentrated on developing an efficient and economic strategy for underwater cleaning. A number of different diver-operated tools and techniques were tested during the summer and fall of 1990 on a variety of infested surfaces. A continuous flow, 6-inch hydraulic pump reduced to 3-inch (600 gpm) equipped with two scraper assemblies (two diver operation) was found to be the best available option for the cleaning of vertical walls. Power wash was used on the pump bells with some success, but a more efficient technique is needed.

New diver-operated tools are being introduced all the time. This, as well as the development of remotely-operated tools, could make mechanical cleaning a viable option for pipelines and external structures.

High and Low Pressure Water Cleaning - Hydro-blasting, or hydro-lasing, has been used to remove corrosion products, unwanted coatings, and biofouling. The area to be cleaned is generally dewatered and then cleaned with a jet of water. It is advisable to proceed with cleaning as soon as the structure is dewatered. If the mussels are allowed to die in place, the cleaning crew will be faced with very unpleasant working conditions. At Detroit Edison, a jet at 3000 psi was adequate to remove a thick build-up of mussels on the concrete wall of the pumpwell. A variety of nozzle and hose configurations are possible as is a combination of pressure and volume. The choice will depend on the personal preference of the user. However, the integrity of the surface being cleaned has to preserved, and it is desirable to remove as much of the byssal thread and byssal pad as possible. In 2008, the U.S. Bureau of Reclamation initiated a demonstration project on the use of water jetting for removal of mussels from an underwater intake pipeline. A water jetting nozzle delivering a water stream at 10,000 psi was inserted into a 25-cm (10-inch) diameter pipe which was over 100 feet in length. The pipe was heavily fouled by adult Quagga mussels. The water jet was able to remove majority of the fouling and restore the pipe to fully operational conditions.

Design Changes - Occasionally, a system design change may be the most expeditious way to cope with mussels. If well water or municipal water is available, the fire suppression system may be connected to these mussel free water sources. Old equipment that is being upgraded such as air compressors, electricity transformers, or HVAC units may consider air cooled models as opposed to models that are cooled with raw water. If trash racks are being replaced, consider designs that are easy to remove for cleaning and painting.

Appendix G

Analysis of the Environmental Variables from Lake Casitas

Appendix G.1 - Calcium

Dreissenid mussels need calcium in order to build their shells (**Table G.1**).

Parameter	Adults do not survive long-term	Uncertainty of veliger survival	Moderate Infestation Level	High Infestation Level
Calcium mg/L	<8 to <10	<15	16-24	≥24
Alkalinity mg CaCO3/L	< 30	30-55	45-100	>90
Total Hardness mg CaCO3/L	<30	30-55	45-100	≥90
pH	<7.0 or >9.5	7.1-7.5/ 9.0-9.5	7.5-8.0 or 8.8-9.0	8.2-8.8
Dissolved Oxygen mg/L (% saturation)	<3 (25%)	5-7 (25-50%)	7-8 (50-75%)	≥8 (>75%)
Chlorophyll a µg/L	<2.5 or >25	2.0-2.5 or 20-25	8-20	2.5-8
Total phosphorous µg/L	<5 or >50	5-10 or 30-50	15-25	25-35
Secchi depth m	<0.1 >8	0.1-0.2 or >2.5	0.2-0.4	0.4-2.5
Mean Summer Temperature °C	<2(36°F) >30(88°F)	2-10(36-50°F) or >28 (82° F)	10-16 (50 – 61°F) or 24-28 (75-82°F)	16-24 (61 - 75°F)
Conductivity µS/cm	<30	<30-60	60-110	≥100
Salinity g/L (ppt)	>10	8-10 (<0.01)	5-10 (0.005-0.01)	<5 (<0.005)

Table 2.1Table G.1 – Criteria used in determining levels of infestation by dreissenids in temperate zone of eastgern portion of North America and Europe (aftger Mackie and Claudi 2010)

The larval forms of dreissenids (veligers) require higher levels of calcium in order to develop than is required by adult mussels for survival. Therefore, adult mussels if introduced into a body of water with low calcium may survive for some time, but the population may fail to reproduce and therefore will be eliminated over time. Calcium is considered the most essential environmental constituent when assessing the liklihood of

long term mussel survival. The initial water quality review has determined that dreissenids would be able to survive and thrive in Lake Casitas as it has an average calcium level of 57mg/L (S. McMahon pers. Comm.)

Appendix G.2 – pH

Values of pH above 7.5 are generally required for veliger development. A pH of 7.5 is usually given as the lower limit for long term veliger survival. Higher values, up to a pH of 9.0 are suitable for mussel development and survival. From the 2014 Lake Casitas data (**Figure G.1)** it would appear that pH falls below the critical level at depth of 60 feet or greater from roughly June to October. Survival of veligers below the depth of 60 feet is unlikely during most of the reproductive season.

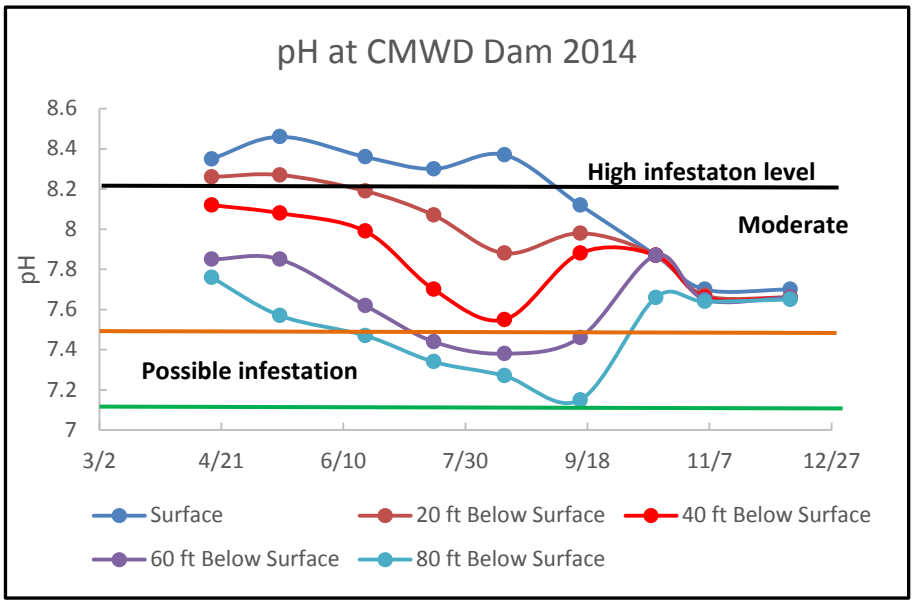

Figure G.1 - pH levels recorded in 2014 near the Lake Casitas Dam

The variations in pH with depth and season are dictated by biological processes in the lake. Surface values are affected mostly by photosynthetic processes that introduce oxygen into the water. The photosynthetic process removes carbon dioxide from the water:

carbon dioxide + water $\xrightarrow[\text{chlorophyll}]{\text{sunlight}}$ glucose + oxygen

The removal of carbon dioxide increases the pH of the water. This process occurs down to depths where photosynthesis prevails, that is when more oxygen is produced than carbon dioxide. When production of carbon dioxide exceeds that of oxygen, reduction processes occur, CO_2 combines with water to produce carbonic acid that has a pH of 5.6. A study of dissolved oxygen saturation levels shown below helps to explain the variations in pH with depth and season (**Figure G.2)**, where declines in pH begin occurring when dissolved oxygen levels begin to fall. The uniform pH levels from November to December are due to lake turnover when bottom waters mix with surface waters.

Appendix G.3 - Dissolved Oxygen

To settle, survive and grow into adults each mussel larva has to land on firm substrate. The settlement

stage of larvae experience major mortality. During this settlement stage, if the dissolved oxygen levels near the bottom are less than 3 mg/L (**Table G.1)**, the pediveligers are unlikely to survive and develop into adults. As shown in **Figure G.2**, the dissolved oxygen level plummets below 40 feet in Casitas Reservoir making this area of the reservoir inhospitable to settling pediveligers. However, temperature affects the solubility of oxygen with the solubility increasing with decreasing temperature until 4°C when solubility decreases between 0°C and 4°C. **Figure G.3** shows dissolved oxygen saturation levels at 80 feet are less than 25% during early June to mid-October and at 60 feet between mid-July and early October. At these saturation levels pediveligers are unlikely to survive and develop. Dissolved oxygen saturation levels are stressful throughout most of the year at 60 and 80 feet.

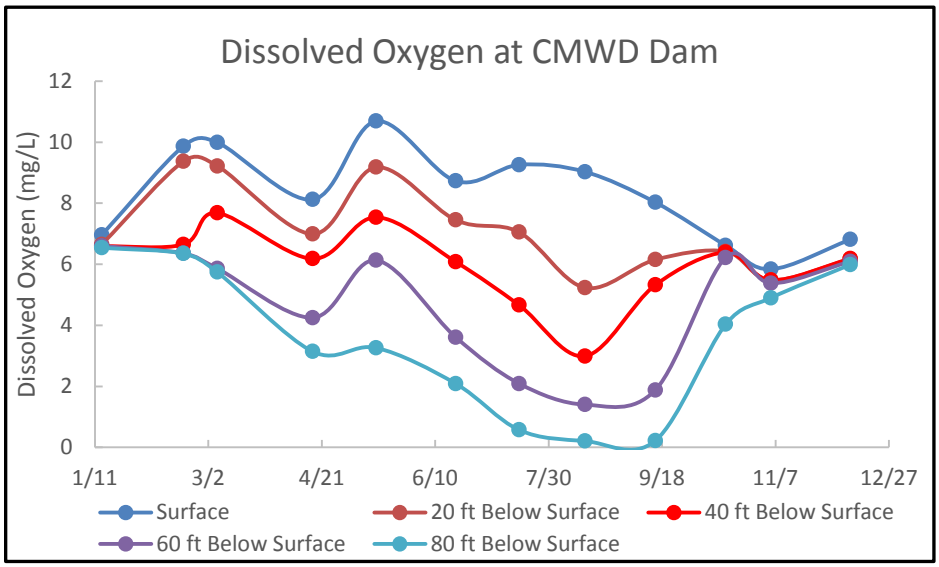

Figure G.2 - Dissolved oxygen levels (mg/L) recorded in 2014 near the Lake Casitas Dam.

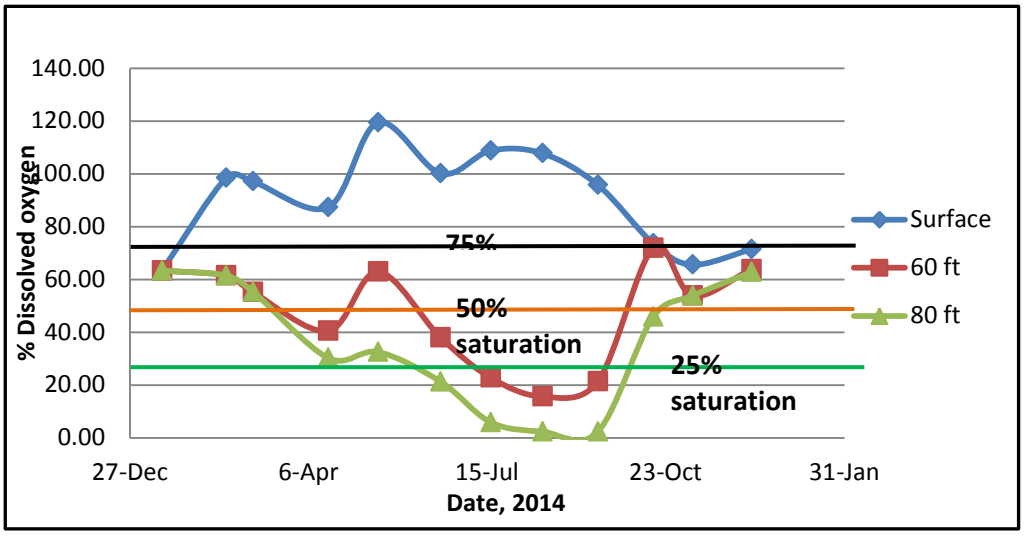

Figure G.3 - Percent Dissolved Oxygen saturation levels in 2014 near Lake Casitas dam at three depths.

Oxygen levels are between 25 and 50% saturation from March to October (**Figure G.3**). Surface waters, however are pretty much above 75% saturation throughout the year, with supersaturation

occurring between late May to mid-September **(Figure G.3)**. It is clear that oxidation processes from winds and photosynthesis prevail throughout the year in the epilimnion but reduction processes (e.g. carbon monoxide production from decomposition of sediments) predominate in the hypolimnion. There is a distinct thermal resistance to mixing by the metalimnion from end of May to late October as evidenced by the troughs in oxygen saturation at 60 and 80 feet and the increase in oxygen saturation in the surface water over the same period.

Appendix G.4 -Temperature

Temperature is another important variable, which determines the length of the reproductive season and also the rate of growth of adults. The release of eggs and sperm and subsequent fertilization in the dreissenid mussel population occurs when the ambient water temperature reaches 54°F - 59°F (12°C to 15°C). Reproduction ceases when the water temperature falls below 54 °F (12°C) but veligers usually continue to be present in the water column for about three weeks after reproduction stops. After this time veligers generally lose their ability to swim, develop a foot and leave the water column to settle and attach to substrate.

The upper thermal limit for survival of veligers is between 82 and 89°F (28 and 32°C). Given the temperature profile recorded in 2014 (**Figure G.4**) at the Casitas dam, temperature is not likely to have moderating effect on the dreissenid population should it be introduced.

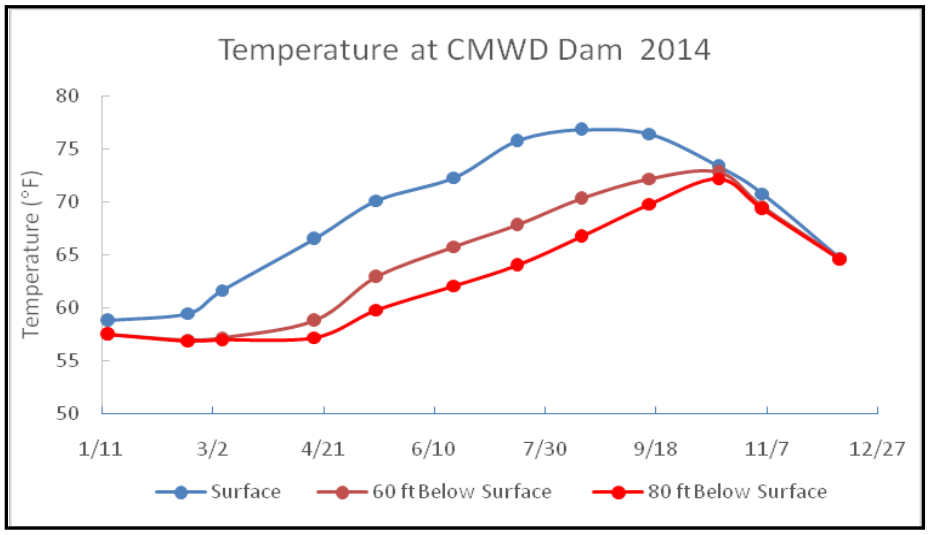

Figure G.4 - Temperature levels recorded in 2014 near the Lake Casitas Dam

Appendix G.5 - Chlorophyll "a"

Chlorophyll "*a*" is used as an indicator of the presence of green algae, which is considered the primary food source for dreissenid mussels. Levels of chlorophyll "*a*" between 2.5 and 8 µg/L are considered optimum. Concentrations of chlorophyll "*a*" lower than these values may represent inadequate food supply to support adult dreissenid population. Concentrations greater than 25 µg/L may signify an algal bloom and high turbidity which in turn may interfere with veliger survival in the water column. The

peaks in chlorophyll "*a"* on August 7 and 28, 2014 **(Figure G.5**) correspond to the supersaturation of dissolved oxygen in the surface waters at this time **(Figure G.3**).

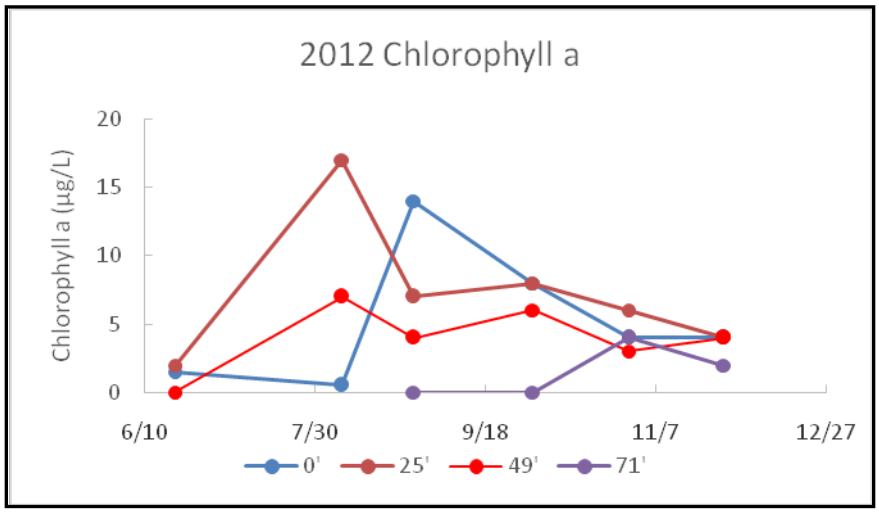

Figure G.5 - Chlorophyll "a" levels in Lake Casitas in 2012 (Susan McMahon)

From the one year of chlorophyll "*a"* data it would appear that there is more than adequate food available in Lake Casitas. Collection of additional chlorophyll data is recommended.

Appendix G.6 - Secchi Depth

Secchi depth is a measure of turbidity, the lower the Secchi depth the greater the turbidity. Turbidity consists of living (e.g. algae) and dead (e.g. moribund algae) organic material, as well as inorganic material (e.g. silt). If turbidity consists mostly of algae, one would expect an increase in oxygen saturation with a decrease in Secchi depth. The lower Secchi depths from May 15 to September 15 **(Figure G.6)** correspond to the high oxygen supersaturation values in (**Figure G.3**). It is not likely that any upwelling of moribund organic material from the hypolimnion contributed to the turbidity because of the thermal resistance to mixing during this period (see discussion of dissolved oxygen). The dramatic increase in Secchi depth on April 17 corresponds to the "dips" in dissolved oxygen saturation in (**Figure G.3**). This exceptional increase in water clarity may have occurred during the end of the turnover period prior to which oxidized bottom waters were mixing with surface waters. By May 15 the water was stratified and primary production increased leading to the gradual decline in Secchi depth. While further research is required to determine the upper turbidity limit for dreissenids, there is some documented evidence that turbidity/TSS can negatively impact metabolic function of dreissenids (Madon et.al. 1998) and that high turbidity/TSS can have a negative effect on pumping rates of individual mussels (Garton et.al. 2014). Madon et.al. (1998) reported that suspended inorganic sediment above 1mg/L greatly reduced the ability of adult Zebra mussels to feed. Schneider et.al. (1998) also concluded that conditions of high suspended inorganic sediment concentrations in turbid rivers represent difficult growth environment for Zebra mussels. Alexander et.al. (1994) concluded that periodic turbidity between 10 and 20 NTU affects the metabolic rate of Zebra mussels, particularly at high ambient temperatures (25 °C). The Missouri River, with turbidity variations between 10 to 1,000 NTU (average levels between 25 to 54 NTUs) has remained essentially free of dreissenid infestation to this date.

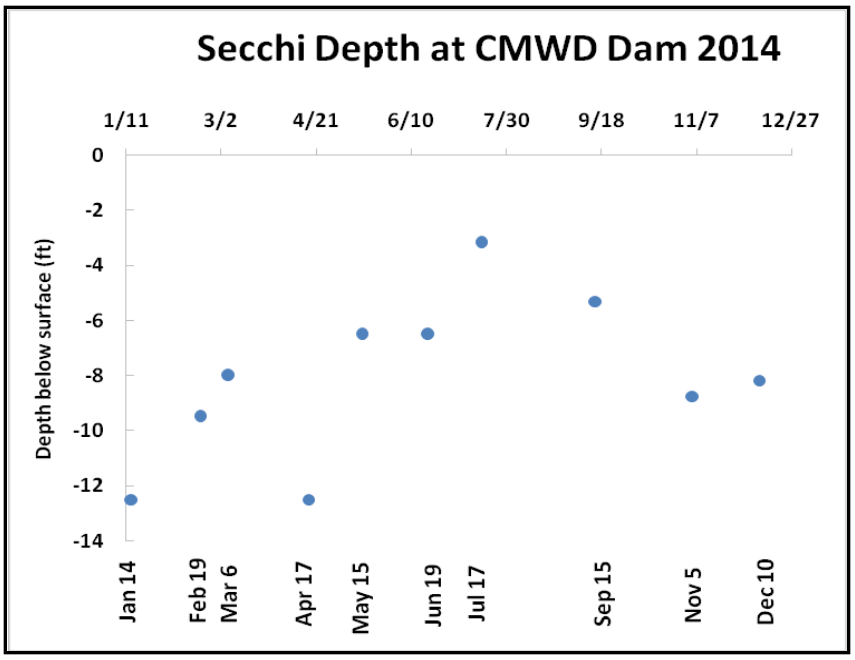

Figure G.6 - Secchi depth recorded in 2014 near the Lake Casitas Dam

The impact of turbidity on survival of dreissenid veligers is unknown, but likely to be even more profound than the impact on adults, particularly if the algal community consists mostly of filamentous species.

The Secchi depth recorded in 2014 suggests turbidity in the optimum range for dreissenids to thrive, 6 to 12ft. (Mackie and Claudi 2010).

In summary, with the exception of the low dissolved oxygen levels in the deeper parts of Lake Casitas there are no mitigating environmental factors which would prevent the development of a massive dreissenid population should they become introduced. As seen in (**Table G.1**), the environment of Lake Casitas, with some exceptions, is likely to support a massive population of Zebra or Quagga mussels should they become introduced. The risk of establishment for 1 (being low) to 5 (being high) is 5.

A small pond on private property is located approximately 1.25 miles from the entrance to Lake Casitas. The pond is approximately 160 yards x 90 yards and has an approximate elevation of 710 feet ASL as compared to Lake Casitas at an approximate level of 560 feet ASL. There is a small dock that exists on the north side of the pond. Santa Ana Road ends approximately 1/4 mile south east of the pond and from there a private road of unknown condition and access proceeds to and beyond the pond. The contour of the surrounding area is such that if an overflow from the pond occurred there is a potential water path that would enter the northwest arm of Lake Casitas near a creek overpass on Highway 150 after travelling a path of approximately 1.5 miles.

CASITAS MUNICIPAL WATER DISTRICT
INTEROFFICE MEMORANDUM

TO: STEVEN E. WICKSTRUM, GENERAL MANAGER

FROM: TODD EVANS, ASSISTANT ENGINEER

SUBJECT: AUTHORIZE GENERAL MANAGER TO SIGN AN AGREEMENT FOR PROFESSIONAL SERVICES

DATE: 07/07/2016

Recommendation:

It is recommended that the Board of Directors authorize the General Manager to enter into an agreement for professional services with Hasan Consultants for the sum not to exceed **$75,000.00.**

Background and Discussion:

Over the course of operating the Lake Casitas Recreation Area and providing a variety of recreational experiences to the public, the District has developed practices for the handling of wastewater generated by the public. There are significant environmental and health considerations associated with the handling and discharge of wastewater. These wastewater handling practices have prevented contamination of the adjacent drinking water supplies of Lake Casitas. There is a need to evaluate the current wastewater handling practices and examine other methods to safely and appropriately deal with present and anticipated wastewater loadings. A feasibility study will provide an overview of current practices and the alternatives that may be available to the District. A feasibility study will also provide the necessary information to apply for grant funding, if appropriate grant funding becomes available.

A request for qualifications (RFQ) was published. Several firms were contacted and asked submit their qualifications. See the list below:

FIRM	RESPONSE
MNS Engineers Inc.	Submitted
Water Resources Engineering Associates	No Response
Hasan Consultants	Submitted
KEH & Assoc.	Submitted
WaterWorks	No Response
HDR	No Response
Flowers & Associates/Cannon	Submitted
West & Assoc.	Submitted
Stantec	Submitted

After carefully reviewing qualifications from all firms that submitted, Hasan Consultants was selected as the firm with experience and qualifications that most closely aligned with the desired goals set forth in the Request for Qualifications.

$75,000 was budgeted in the FY 2016-17 Budget.

CASITAS MUNICIPAL WATER DISTRICT
INTEROFFICE MEMORANDUM

TO: STEVE WICKSTRUM, GENERAL MANAGER

FROM: NEIL COLE, PRINCIPAL CIVIL ENGINEER

SUBJECT: ADOPT RESOLUTION TO AWARD CONTRACT – WATER TREATMENT PLANT ELECTRICAL UPGRADES, SPECIFICATION 16-387

DATE: JUNE 20, 2016

RECOMMENDATION:

It is recommended that the Board of Directors adopt the resolution accepting the proposal submitted by the lowest responsive and responsible bidder and award the contract for the construction of the Water Treatment Plant Electrical Upgrades, Specification 16-387 to Oilfield Electric Inc. in the amount of $267,900. It is further recommended that the President of the Board execute the agreement for said work and the Board authorize staff to proceed with the administration of the contract.

BACKGROUND AND DISCUSSION:

The Marion R. Walker Treatment Plant is twenty years old. The electrical service panel is operating at its maximum capacity. This project will replace and increase the size of the electrical service panel and correct some long term issues the plant has had with the electrical system, including the emergency power generating system.

The project was advertised through F.W. Dodge and on the District's web site. Five firms submitted proposals. The bid results are as follows:

FIRM	AMOUNT
Oilfield Electric	$267,900
Venco Electric	$282,000
Taft Electric	$296,880
GA Technical Services	$315,000
Irwin Industries	$399,920

Oilfield Electric has completed several similar projects for Casitas in the past. Oilfield Electric has a current and active contractor's license, a satisfactory safety record and a current DIR registration number. The FY 2016-17 Budget includes $280,000 to complete this work.

This project is categorically exempt from CEQA under Section 15301.

CASITAS MUNICIPAL WATER DISTRICT

RESOLUTION AWARDING A CONTRACT
TO CONSTRUCT WATER TREATMENT PLANT ELECTRICAL UPGRADE
SPECIFICATION 16-387

WHEREAS, the District invited bids from qualified contractors for the above-referenced project, and

WHEREAS, the construction of the electrical upgrades at the Water Treatment Plant will improve system reliability and extend the life of the facility, and

WHEREAS, the District received five bids, with the lowest responsive and responsible bid submitted by Oilfield Electric Company, Inc. in the sum of $267,900.

NOW, THEREFORE, BE IT RESOLVED by the Board of Directors of the Casitas Municipal Water District as follows:

1. 1. That the bid from Oilfield Electric Company in the amount of $267,900 be accepted to construct Water Treatment Plant Electrical Upgrade, Specification 16-387 and a contract awarded.

2. That staff is hereby authorized and directed to proceed with the administration of the contract.

ADOPTED this _____ day of _____, 2016.

_____
President,
Casitas Municipal Water District

ATTEST:

_____
Secretary,
Casitas Municipal Water District

Consumption Report

Water Sales FY 2015-2016 (Acre-Feet)

Classification		Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Month to Date 2015 / 2016 Total	Month to Date 2014 / 2015 Total
AD	Ag-Domestic	422	517	547	509	464	403	22	177	149	328	391	0	3929	4085
AG	Ag	298	375	377	353	298	270	31	137	108	233	278	0	2758	3231
C	Commercial	58	83	81	60	39	27	9	21	27	41	64	0	510	496
DI	Interdepartmental	8	8	8	7	7	5	3	3	3	4	8	0	64	141
F	fire	0	0	0	0	0	0	0	0	0	0	0	0	0	0
I	Industrial	1	2	2	1	1	1	0	0	1	1	1	0	11	28
OT	Other	17	13	13	13	14	10	3	4	7	7	14	0	115	159
R	Residential	106	122	127	103	103	95	50	67	71	80	97	0	1021	1300
RS - P	Resale Pumped	50	81	172	150	131	131	27	34	41	49	80	0	946	864
RS - G	Resale Gravity	456	487	453	363	338	422	228	217	160	258	431	0	3813	4712
TE	Temporary	6	1	1	0	1	0	0	0	0	0	1	0	10	31
Total		1,421	1689	1781	1559	1396	1364	373	660	567	1001	1365	0	**13,176**	15,047
Total 2014 / 2015		2286	1972	2317	1506	1187	432	483	688	1410	1283	1483	1601	**N/A**	**16648**

** July 2015 was the first month when all customers were on monthly billing. July 2015 now reflects actual consumption for July.

CFD No. 2013-1 (Ojai) - Cost Analysis

	Services & Suplies	Legal Fees	Labor Expense	Other Services	Total Expenses
2011 / 2012	*-289.50*	*42,560.00*	*11,098.37*	*0.00*	*53,368.87*
2012 / 2013	*831.82*	*223,462.77*	*14,836.68*	*0.00*	*239,131.27*
2013 / 2014	*29.89*	*91,878.06*	*3,835.65*	*0.00*	*95,743.60*
2014 / 2015	*0.00*	*68,457.10*	*0.00*	*0.00*	*68,457.10*
July	0.00	0.00	0.00	0.00	0.00
August	0.00	1,022.00	0.00	0.00	1,022.00
September	0.00	2,140.00	0.00	0.00	2,140.00
October	0.00	21,424.00	0.00	0.00	21,424.00
November	0.00	24,356.00	0.00	0.00	24,356.00
December	0.00	16,494.00	440.42	0.00	16,934.42
January	0.00	7,112.00	0.00	0.00	7,112.00
Feburary	0.00	37,616.90	0.00	0.00	37,616.90
March	0.00	1,024.56	0.00	0.00	1,024.56
April	6.12	2,144.00	1,338.26	0.00	3,488.38
May	0.00	33,834.29	928.09	0.00	34,762.38
June	0.00	0.00	232.09	0.00	232.09
Total YTD Cost	*6.12*	*147,167.75*	*2,938.86*	0.00	*150,112.73*
Total Cost	*578.33*	*573,525.68*	*32,709.56*	0.00	*606,813.57*
Tax Assessment - County of Ventura:		2015 / 2016			*-460,342.64*
Total CMWD CFD 2013-1 Cost					***146,470.93***

CASITAS MUNICIPAL WATER DISTRICT
TREASURER'S MONTHLY REPORT OF INVESTMENTS
07/06/16

Type of Invest	Institution	CUSIP	Date of Maturity	Adjusted Cost	Current Mkt Value	Rate of Interest	Date of Deposit	% of Portfolio	Days to Maturity
	Federal Farm CR Bank	31331VWN2	4/13/2026	$937,028	$942,270	1.901%	5/9/2016	4.77%	3517
*TB	Federal Farm CR Bank	3133EFK71	3/9/2026	$854,525	$848,207	2.790%	3/28/2016	4.30%	3483
*TB	Federal Farm CR Bank	3133EFNR4	11/18/2024	$808,814	$804,153	2.870%	11/18/2015	4.07%	3012
	Federal Farm CR Bank	3133EFYH4	2/8/2027	$1,015,749	$1,005,980	3.000%	3/24/2016	5.10%	3812
*TB	Federal Farm CR Bank	33133EFHV2	10/13/2022	$588,133	$581,131	2.200%	10/23/2015	2.94%	2257
*TB	Federal Home Loan Bank	313381TA3	1/17/2023	$277,619	$285,006	2.240%	9/8/2014	1.44%	2351
*TB	Federal Home Loan Bank	313379EE5	6/14/2019	$1,369,442	$1,382,873	1.625%	10/3/2012	7.00%	1058
	Federal Home Loan Bank	3130A0EN6	12/10/2021	$546,418	$541,705	1.107%	5/9/2016	2.74%	1954
*TB	Federal Home Loan Bank	3130A5R35	6/13/2025	$771,596	$784,655	2.875%	2/19/2016	3.97%	3217
*TB	Federal Home Loan Bank	31338OA98	8/14/2024	$126,966	$132,005	2.500%	7/3/2014	0.67%	2918
676633	Federal Home Loan Bank	3133XFKF2	6/11/2021	$670,072	$680,014	5.625%	1/16/2013	3.44%	1775
*TB	Federal Home Loan MTG Corp	3134G43A4	10/30/2024	$849,441	$885,248	2.500%	7/3/2014	4.48%	2994
*TB	Federal Home Loan MTG Corp	3137EADB2	1/13/2022	$677,796	$705,573	2.375%	9/8/2014	3.57%	1987
*TB	Federal Home Loan MTG Corp	3137EABA60	11/17/2017	$1,050,435	$1,060,660	5.125%	1/3/2012	5.37%	491
*TB	Federal National Assn	3136G0K67	4/9/2021	$192,000	$192,029	2.000%	12/2/2014	0.97%	1713
*TB	Federal National Assn	3135G0ES80	11/15/2016	$684,065	$685,131	1.375%	3/12/2012	3.47%	129
	Federal National Assn	31315P2J7	5/1/2024	$808,389	$810,398	1.721%	5/1/2016	4.10%	2815
	Federal National Assn	3135G0ZR7	9/6/2024	$1,486,855	$1,512,306	2.625%	5/25/2016	7.66%	2940
	Federal National Assn	3135G0K36	4/24/2026	$2,532,596	$2,596,275	2.125%	5/25/2016	13.15%	3528
*TB	US Treasury Inflation Index NTS	912828JE10	7/15/2018	$1,121,928	$1,164,269	1.375%	7/6/2010	5.90%	729
*TB	US Treasury Inflation Index NTS	912828MF4	1/15/2020	$1,119,942	$1,183,820	1.375%	11/18/2015	6.00%	1269
*TB	US Treasury Note	912828WE6	11/15/2023	$768,868	$849,211	2.750%	12/13/2013	4.30%	2649
	Accrued Interest				$108,842				
	Total in Gov't Sec. (11-00-1055-00&1065)			**$19,258,675**	**$19,741,758**			**99.98%**	
	Total Certificates of Deposit: (11.13506)			**$0**	**$0**			**0.00%**	
**	**LAIF as of: (11-00-1050-00)**		N/A	**$448**	**$448**	0.46%	Estimated	**0.00%**	
***	**COVI as of: (11-00-1060-00)**		N/A	**$2,854**	**$2,848**	0.50%	Estimated	**0.01%**	
	TOTAL FUNDS INVESTED			**$19,261,977**	**$19,745,054**			**100.00%**	
	Total Funds Invested last report			$19,263,000	$19,559,835				
	Total Funds Invested 1 Yr. Ago			$19,027,483	$19,055,689				
****	**CASH IN BANK (11-00-1000-00) EST.**			**$4,983,839**	**$4,983,839**				
	CASH IN Western Asset Money Market			**$63**	**$63**	0.01%			
	TOTAL CASH & INVESTMENTS			**$24,245,878**	**$24,728,956**				
	TOTAL CASH & INVESTMENTS 1 YR AGO			$23,243,310	$23,271,516				

*CD CD - Certificate of Deposit
*TB TB - Federal Treasury Bonds or Bills
** Local Agency Investment Fund
*** County of Ventura Investment Fund
Estimated interest rate, actual not due at present time.
**** Cash in bank

No investments were made pursuant to subdivision (i) of Section 53601, Section 53601.1 and subdivision (i) Section 53635 of the Government Code.
All investments were made in accordance with the Treasurer's annual statement of investment policy.