PINTO LAKE

RESTORATION PROJECT

FINAL REPORT

Watershed

Pinto Lake Watershed

HUC 12 Number:

180600020803, Salsipuedes Creek subwatershed (Includes Pinto Lake Watershed)

Project Type:

Implementation

Funding Source:

Clean Water Act § 319(h) – Nonpoint Source Implementation Grant Program

Agreement number 14-424-253

Total Grant Funds (Cost of Project):

$750,000

MAY 31, 2018

CITY of WATSONVILLE · CALIFORNIA ·

Photo 1 Cover Photo: Algal bloom at the Pinto Lake City Park, October 4, 2016

ACKNOWLEDGEMENTS

Many individuals and organizations have made important contributions to this project. This project was made possible by the dedicated staff of the City of Watsonville with support from staff at the Resource Conservation District of Santa Cruz County, Santa Cruz County, Friends of Pinto Lake, and Watsonville Wetlands Watch and, along with our dedicated partners.

The following individuals played important roles in the "Pinto Lake Restoration Project:"

City of Watsonville:
Charles Montoya, Steve Palmisano, Jackie McCloud, Emma Kluzniok, Ben Heinstein, Robert Ketley

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Photo credits:
City of Watsonville,
Resource Conservation District of Santa Cruz County,
Catherine Bosley (HAB Aquatic Solutions, LLC.)

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EXECUTIVE SUMMARY

Agreement # 14-424-253 between the City of Watsonville and the State Water Resources Control Board implemented strategies to reduce pollutant loads per the Total Maximum Daily Load to restore the nonpoint source nutrient impaired Pinto Lake.

Project goals:

» Reduce harmful cyanobacteria-stimulating nutrients in Pinto Lake through the implementation of nutrient trapping strategies both in-lake and throughout the watershed and tributaries.

» Engage and educate the agricultural community and residents in the watershed on nutrient management practices.

Through this agreement and matching contributions, the City of Watsonville and project partners:

» Coordinated with a Technical Advisory Committee to advise on and evaluate project activities,

» Applied polymer to Pinto Lake,

» Conducted 10 site assessments representing 305 acres,

» Designed, permitted, and implemented 3 sediment management projects at priority sites, and assisted 4 growers with winter preparedness practices,

» Conducted 6 stakeholder events to educate and engage the community on strategies to improve water quality in Pinto Lake, and

» Assessed project effectiveness, made determinations regarding adaptive management, and provided follow-up technical assistance where needed.

Project highlights:

» Application of 118,000 gallons of aluminum sulfate and buffer to Pinto Lake over an eight day period in early April 2017.

» Only 1 lake closure in 2017 for 3 weeks compared to 1-3 month closures in 2015 and 2016.

» Collaboration between multiple agencies and stakeholders to implement various parts of the project.

» Two sediment management practices that were implemented resulting in 100% reduction of sediment to adjacent tributaries.

» Implementation of a vegetated filter strip in order to minimize nutrients and sediment from entering Todos Santos.

» Reached over 5,000 people to promote and educate the community on nutrient management practices.

» Over 250 adults and children attended the iSpy Science event at Pinto Lake City Park where they engaged in outdoor nature activities and learned about keeping the lake healthy.

PROJECT BACKGROUND AND PURPOSE

BACKGROUND

Pinto Lake is a shallow, hypereutrophic, 120-acre lake located in the Pajaro River watershed in the City of Watsonville (the City) in southern Santa Cruz County. It has an average depth of six feet and a maximum depth of 25 feet. It was created approximately 8,000 years ago, when seismic activity on the Zayante-Vergales fault caused land subsidence along Pinto Creek. Pinto Creek continues to flow seasonally to the lake. The lake is also supplied by springs, from shallow groundwater. Pinto Lake discharges to Corralitos Creek.

The 1,485-acre watershed includes farmland (22%), urban (15%), grazing (7%), other land (49%), and open water (7%)[1]. There are also two public parks that border Pinto Lake. The project is located in and directly benefits the Disadvantaged Community of Watsonville as shown in **Figure 1**

PROJECT RELATIONSHIP TO EXISTING TMDLS

This project sought to target the Pajaro River Nutrient Total Maximum Daily Load (TMDL), as Pinto Lake is a heavily impaired waterbody in the Pajaro River watershed. Nutrient contamination of surface and ground waters are primary resource concerns in the Pajaro River watershed. The United States Environmental Protection Agency (US EPA) approved

1 https://www.waterboards.ca.gov/centralcoast/water_issues/programs/tmdl/docs/pinto_lake/progress_report_041817_final.pdf

Figure 1 The geographical relation of Pinto Lake, the public parks bordering Pinto Lake, and the Disadvantaged Community of Watsonville

a TMDL for nitrate in the Pajaro River in 2006 and nutrients in 2016. A TMDL for nutrients in the Pinto Lake Watershed is currently under development. Nutrient TMDLs in the Pinto Lake subwatershed also seek to address biostimulation resulting from high nutrient levels (specifically nitrogen and phosphorus) that can cause excessive algal growth, including harmful algal blooms observed episodically in Pinto Lake. Within the Pinto Lake sub-watershed, research[2] shows lake sediments account for roughly 85% of nutrient loads to Pinto Lake, while seasonal runoff from the watershed contributes roughly 15% of nutrient loads from a combination of agricultural operations, residential septic systems, and erosion of phosphorus-rich sediment.

In particular, the project addressed water quality impairments from excessive amounts of nitrates and phosphorus in Pinto Lake and the watershed that contributes to cyanobacteria blooms. Every year, the lake experiences massive cyanobacteria blooms. The primary cause of these toxic algal blooms is the presence of elevated nutrients in the lake sediments and nutrient-rich runoff from the surrounding watershed. These blooms produce cyanotoxins, which include dozens of potent hepatotoxins and neurotoxins. The lake's toxin levels are typically at or above the World Health Organization (WHO) limit (0.8 ppb) year-round. Toxin levels increase in the late summer and fall, often reaching levels over 10,000 ppb. One sample exceeded 2,893,000 ppb - over three million times the health limit.

2 Pinto Lake Total Maximum Daily Load Planning and Assessment Project, State Water Resources Control Board Grant no. 10-443-553-2, April 2013.

Photo 2 Algal bloom at Pinto Lake City Park Dock, October 26, 2016

Photo 3 Algal bloom at Pinto Lake City Park Dock, October 26, 2016

Of the 16 beneficial uses listed in the Central Coast Regional Water Quality Control Board (CCRWQCB) Basin Plan, the most critically impacted due to current conditions at Pinto Lake are freshwater habitat, water recreation, spawning, reproduction and early aquatic development, sport fishing and agricultural supply. Cyanotoxins are known to adversely affect animal and human health. The death of over 31 endangered southern sea otters in the Monterey Bay region has been potentially attributed to these cyanotoxins, with Pinto Lake being identified as a likely source[3]. Recreational use of the lake is severely impacted. Boaters must sign health waivers before launching. During periods when toxin levels exceed 20 ppb, the lake is cordoned off to limit public access to the water. Pinto Lake used to be an irrigation source for organic food crops. Growers were forced to abandon the use of lake water and drill wells to tap into a deep aquifer because of threats to food and worker safety posed by the toxins.

Photo 4 Algal bloom at Pinto Lake City Park Dock, October 27, 2016

Treatment of the lake with aluminum sulfate (a well-known water treatment chemical) and treatment of phosphorus laden sediment from reaching the lake were identified as a priority management measure. Aluminum sulfate and other polymer/coagulants have been successful in controlling nutrient levels in impaired lakes in many countries, including the US.

PROJECT PURPOSE

The Pinto Lake Restoration Project was based on the findings of the Pinto Lake 319(h) Planning and Assessment project, completed in 2013, and the extensive research completed as part of the planning study.

The main objectives of the project were as follows:

- Treat internal nutrient loadings that drive cyanobacteria blooms using environmentally safe and proven technologies including polymers/coagulants such as aluminum sulfate (alum) or similar.
- Treat nutrient loadings from the tributaries (which flow seasonally into the lake) with a flow-based polymer/coagulant (such as alum) dosing system and/or through implementation of nutrient best management practices (BMPs) within the watershed.
- Coordinate with watershed stakeholders to gain participation in implementation efforts that reduce loadings to Pinto Lake.
- Collect and analyze water quality data verifying reduction of nutrients in-lake and from the watershed as a result of treatment efforts.

3 http://www.plosone.org/article/info%3Adoi/10.1371/journal.pone.0012576

PROJECT GOALS AND DESCRIPTION

This project was funded through the Clean Water Act § 319(h) – Nonpoint Source (NPS) Implementation Grant Program, agreement number 14-424-253, administered by the CCRWQCB to the grantee, the City.

The purpose of this project was to reduce pollutant loads per the TMDL to restore the NPS nutrient impaired Pinto Lake.

The Project Goals were to:

1. Design tributary treatment program
2. Design in-lake treatment program
3. Implement strategies to reduce the internal and external nutrient loads causing cyanobacteria
4. Education and Outreach
5. Post Treatment Analysis

Depending on the practices implemented, the desired outcomes of the project are:

1. Successfully install tributary treatment practices.
2. Reduce sediment bound phosphorus loads over the course of the useful life of a selected sediment control practice.
3. Apply coagulant to the lake.
4. Reduce internal loading of Pinto Lake through dosing of applicable coagulant type and dose.
5. Outreach to stakeholders through meetings to educate farmers and residents about runoff.
6. Determine effectiveness of treatment in both the tributaries and the lake.

The overall targets of the project were to:

1. Reduce 50% of the sediment bound phosphorus load from the watershed over the course of the useful life of the selected sediment control practices.
2. Reduce internal loading of phosphorus in Pinto Lake by 80% with 95% coverage of the lake through dosing of applicable coagulant type and dose.
3. Facilitate a minimum of 4 stakeholder meetings.
4. Reduce nutrient loading. Measure this reduction by collecting depth sample measurements (key indicators being total phosphorus and orthophosphate concentration reductions).
5. Reduction in cyanobacteria blooms evaluated by concentration of microcystins.
6. Reduction in required posted warnings at Pinto Lake, as Pinto Lake is posted year round.

Project elements included:

1. Coordination: Coordinating with TAC, local nutrient management experts, and stakeholders to coordinate implementation strategies and site selection criteria.
2. Identification, Selection, and Design of Treatment Systems: Evaluating available information to develop dosing strategy for in-lake treatment, and to identify a minimum of two high priority sediment control practices.
3. Implementation and Adaptive Management: Providing technical and financial assistance to implement selected treatment strategies both in-lake and in tributaries.
4. Post Treatment Analysis: Evaluating of implementation effectiveness using site-specific strategies.
5. Education and Outreach: Engaging the agricultural community and residents in the watershed with the primary objective of educating stakeholders regarding improvements in erosion control and nutrient management that result in reduced cyanobacteria blooms in-lake, and reducing runoff containing sediments and nutrients from the tributaries.

COORDINATION

The goal of coordination activities was to ensure that all practices and watershed stakeholder work were aligned, and to allow for post implementation analysis to occur.

Over the course of the grant period, City staff participated in a number of meetings with local partners, stakeholders, and contractors to coordinate project services and outreach strategies to achieve maximum project benefit, participation, and success. Regional partnerships that the City engaged in included the Friends of Pinto Lake and Watsonville Wetlands Watch. City staff also coordinated closely with Santa Cruz County and CCRWQCB grant managers to coordinate Pinto Lake watershed treatment activities funded through this agreement and other funding sources.

The City convened a Technical Advisory Committee (TAC). The TAC team was comprised of stakeholders that represented a variety of perspectives. Two TAC meetings were held to coordinate activities. The TAC included representatives from the Santa Cruz County, University of California Santa Cruz (UCSC), Resource Conservation District of Santa Cruz County (RCDSCC), and University of California Davis. During the first TAC meeting (August 15, 2018), there was consensus among the TAC to move ahead with the polymer/coagulant treatment in-lake and to move forward with sediment control practices in the tributaries (as feasible). As a result of this meeting the City submitted a deviation request to try to align the language in the grant agreement with TAC recommended priorities. The deviation was completed in Q3 2016 and signed on July 7, 2017. The deviation included modifications to the agreement to support implementation of sediment control practices in the Pinto Lake tributaries as recommended by the TAC previously. The City held a second TAC meeting which included HAB Aquatic Solutions, LLC., on January 17, 2017. At this meeting, Dr. John Holz and Mr. Tadd Barrow gave an overview of alum treatment, as well as project specifics. A final TAC meeting was completed on February 8, 2018. The City provided an overview of project implementation and data associated with all implemented practices to date.

Additionally, City staff participated in a grant start up presentation at the CCRWQCB in San Luis Obispo on July 9, 2015 and the wrap up presentation on June 4, 2018.

IDENTIFICATION, SELECTION AND DESIGN OF TREATMENT SYSTEMS

IN-LAKE ALUM

The City explored management measures identified through the previous 319(h) Planning and Assessment grant (#104-443-553-2). Some of the options that were considered for in-lake treatment were: floating island technology, aeration at the bottom of the lake, carp removal, and alum or similar coagulant treatment.

The City utilized in house staff to research cost, effectiveness, and feasibility of each of the proposed in-lake treatment practices. Through an alternative funding source (State of California Coastal Conservancy Agreement #13-086) the City was able to implement carp removal.

Photo 5 California Department of Fish and Wildlife (CDFW) electrofishing boat used in the carp removal project, March 5, 2014

Photo 6 CDFW Biologist removes a carp, an invasive species, from Pinto Lake, March 5, 2014

The City was then able to research floating island technologies, aeration and alum and/or similar technology. The City looked to Green Lake in Seattle, Washington; Lake Chabot and Lake Temescal in Oakland, California; Loch Lomond in Felton, California; and Canyon Lake and Lake Elsinore in Riverside County, California for feasibility and constraints.

The City partnered with HAB Aquatics Solutions, LLC. to collect four sediment cores, in Pinto Lake. These cores provided information on the in-lake available phosphorus sources from the lake's sediment. More detail is provided in the next section.

Photo 7 Jackie McCloud (City of Watsonville) and Tadd Barrow (HAB Aquatics Solutions LLC.) collect a sediment core from Pinto Lake, October 21, 2014

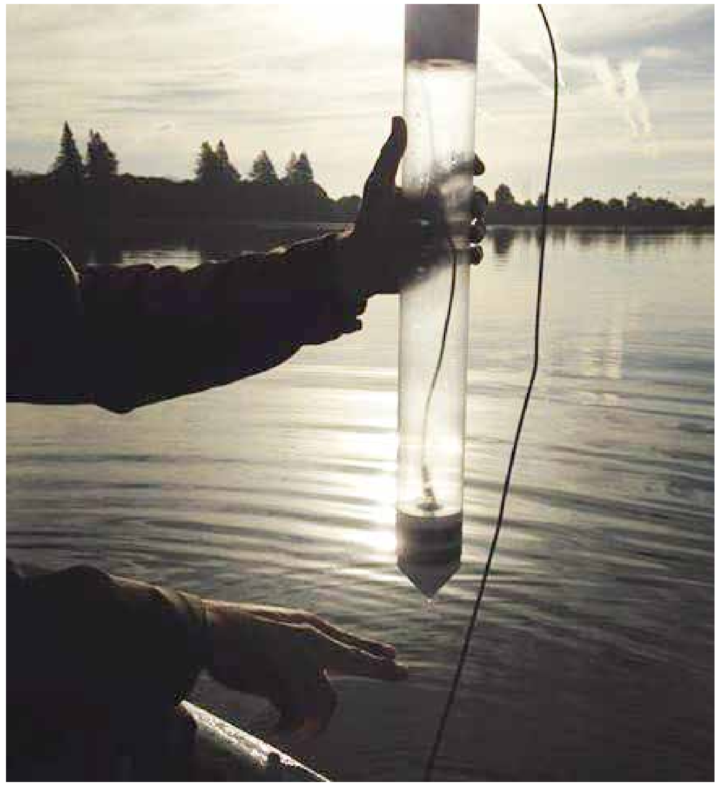


Photo 8 Sediment corer, collected from Pinto Lake, October 21, 2014

Below are the considerations that were given to each treatment:

Aeration: The reasons this option was not pursued included cost and long term effectiveness. Staff's research determined that aerating the lake was not cost-efficient when the majority of nutrients are sequestered in the sediment at the bottom of the lake. After reviewing raw data from active units in Australia, staff determined there was not a significant reduction in blooms. Given the depth of the lake, staff decided that this method was not going to be effective in reducing blooms.

Floating island technology: The reasons this option was not pursued included cost and long term effectiveness and feasibility. Floating islands are similar to what is already naturally occurring at the edges of the lake where there is well established wetland habitat. Although, staff determined that wetlands are very efficient at removing nutrients, it was unclear that the floating wetlands would alleviate the nutrient source embedded in the bottom of the lake. As such, it was determined that given the cost/acre of treatment it was not a priority practice to implement at this time, although it could be considered as a potential strategy for capturing nutrients closer to the tributary mouths.

Alum or similar technology: The reasons this option would be challenging included cost, long term effectiveness, and feasibility. The City determined that while alum is more costly than other treatments, it would capture the majority of in-lake phosphorus loads. The treatment would also allow time for the City to work in the watershed to control nutrient loadings associated with runoff.

SEDIMENT PRACTICES

Prioritization

Originally the City had intended to utilize polymer injection systems in the selected tributaries of concern: Amesti Creek, Todos Santos and Pinto Creek. These creeks carry the majority of nutrient loadings to the lake. Staff researched the M.A.I.D. injection systems used in Florida. These systems required space around the tributaries that wasn't available. The long term maintenance of the systems was also cost prohibitive.

City staff attended a TAC meeting for the RCDSCC and determined that partnering on implementation of practices in the watershed would be more valuable in the long term than implementing polymer injection within each tributary. The City decided by implementing BMPs to control sediments and runoff there would be improvement to the amount of nutrients entering the lake. These practices are also more cost effective and feasible in the Pinto Lake subwatershed.

Recruitment and Outreach

The initial sediment control practices, Pinto Lake County Road Sediment Control Practices, were implemented during Q3 2016. The road sediment control practices were identified through recruitment and outreach activities that occurred under a previous State Water Resources Control Board (SWRCB) grant (Agreement # 13-515-553-0). During Q4 2016 and Q1 2017, the City and the RCDSCC began outreach to identify additional sediment control practices. Specifically, the RCDSCC and the City performed the following outreach activities:

1. Created and distributed a flyer advertising the availability to technical assistance and funding.
2. Surveyed the watershed by car.
3. Communicated with two landowners in the Amesti and CCC watersheds.
4. Communicated with two landowners in the Pinto Creek watershed.
5. Toured two grower's properties adjacent to Pinto Lake, one off of Green Valley Rd, and on property off of Amesti Rd.
6. Coordinated with NRCS to contact growers with existing EQIP contracts in the watershed.
7. Surveyed the Pinto Lake County Park and Pinto Lake City Park for additional resource concerns.
8. Mailed a postcard advertising technical and funding assistance to all landowners in Pinto Lake watershed.
9. Conducted site visits with seven landowners throughout the watershed.
10. Communicated with an additional landowner by phone, but did not conduct a site visit.

As a result of these outreach activities, multiple potential practices were identified. However, certain practices were determined to be a higher priority than others. In addition, some landowners communicated to the RCDSCC and the City that they were interested in implementing the identified practices, but were not interested in cost share assistance as part of grant agreement #14-424-253, due to a perceived liability associated with the pubic nature of on-site water quality and monitoring data that would be collected.

Site Assessment and Selection

Site prioritization and selection criteria included:

1. Grower willingness to participate and adhere to grant requirements (including maintenance).
2. Feasibility of implementing the selected practices within the grant timeline (function of project complexity).
3. Potential for surface and/or ground water quality improvement.
4. Watershed area (acres) treated.
5. Cost effectiveness of practice(s) to be implemented.
6. Ability to leverage partner contributions and match funding.
7. Feasibility of demonstrating practice effectiveness (willingness of grower to use site as demo site to educate others on project impacts).
8. Grower willingness to implement supplemental conservation practices that increase the overall success and/or effectiveness of the project.
9. Co-benefits (for example, habitat improvement or species benefits)
10. Possibility of better production for the grower due to project implementation.
11. Vulnerability to sea level rise or other climate change impacts.
12. Project risk (e.g., chance of failure after implementation).

13. Project maintenance requirements.
14. Project impacts to site (permanent or temporary).
15. Within budget.
16. Project uncertainty (e.g., design concept feasibility, ability to permit from other resource agencies).

Figure 2 Postcard mailed to Pinto Lake landowners for recruitment purposes.

IMPLEMENTATION AND ADAPTIVE MANAGEMENT

The focus of this agreement was on project implementation. The City and project partners designed, permitted, and implemented alum treatment across 98 surface acres of Pinto Lake, and implemented three sediment management practices in the watershed.

Application of alum in Pinto Lake occurred over a ten day period in April 2017. The application produced a "floc" that settled to the bottom of the lake. The floc has ironically charged sites where phosphorus in the sediments becomes chemically bound as it released from the lake bottom sediment. The floc effectively intercepts and binds the phosphorus, which makes it unavailable for the algae to use for growth. The goals of the project were to dramatically reduce the internal loading of phosphorus from the sediments, lower the amount of phosphorus available to algae in the water, reduce the amount of algae and associated toxins, and remove the recreational restrictions at the lake.

The main goal of the three implemented sediment control practices was to addresses the nutrient rich run-off in the Pinto Lake Watershed by reducing transport of sediment and sediment-bound nutrients into Pinto Lake. Reducing transport of sediments and sediment-bound nutrients is one key strategy to reducing toxic algal blooms and related impacts to wildlife and human health in Pinto Lake.

The Pinto Lake County Road Sediment Control Practices included the installation of five (5) rolling dips and a drainage swale to reduce stormwater related sediment entering Pinto Lake at Amesti Creek. For analytical results the City used Amesti Creek as the baseline receiving water for any upstream improvements, while also sampling at the project implementation site. The Dips eliminated the runoff from the Pinto Lake County Park road into Amesti Creek. Therefore, there was a 100% reduction of total suspended solids (TSS) and total phosphorus (TP) entering Amesti Creek from the Road. Additional water quality benefits in Amesti Creek are the post-implementation results show significant decreases of TP (approximately 66%) and TSS (approximately 89%) concentrations due to implementation of the rolling dips.

Table 1 Summary of Implementation Activities and Outcomes

Project Name	Project Type	PAEP Target	Outcome
Alum Treatment (In-Lake)	Active Treatment	TAC approval of lake treatment program and design which includes a design reduction of 80% of the nutrient load.	Measured at least 93.5% reduction of nutrient load in-lake.
		95% coverage of lake	95% coverage of lake
		Plan of monitoring locations.	Long-term monitoring locations established.
Pinto Lake County Rd Sediment Control Practices	Tributary Sediment Control: Erosion Control	Reduction of 50% of the sediment bound phosphorus load over the course of the useful life of the selected practice.	Reduction of 100% sediment loading as a result of implementation of selected practice.
Virgin Mary Road Improvement Project	Tributary Sediment Control: Erosion Control	Reduction of 50% of the sediment bound phosphorus load over the course of the useful life of the selected practice.	Reduction of 100% sediment loading as a result of implementation of selected practice.
County Park Pump Track Vegetated Filter Strip	Tributary Sediment Control: Sediment capture and treatment	Reduction of 50% of the sediment bound phosphorus load over the course of the useful life of the selected practice.	Due to timing constraints, water quality monitoring data was not able to be obtained for this project prior to the end of the grant agreement. Instead load reductions estimated using the US EPA Region 5 model and were modeled to be TSS: 2,580 lbs/yr, TN: 27 lbs/yr, and TP 5 lbs/yr.

Implementation of the Virgin Mary Road Improvement Project included implementing sediment control practices on an unpaved road, with high public visibility, leading down a steep, compacted slope to the edge of Pinto Lake and adjacent to the Todos Santos tributary. The sediment control practices of installing five (5) rolling dips, forty (40) linear feet of drainage swale, and repairing existing ruts on the road prior to the grading and installation of 950 sq ft of Class II aggregate road base rolling dips, eliminated the runoff from the Virgin Mary Road, into Pinto Lake. There was a 100% reduction of TSS and TP entering the Lake, from the Road.

Implementation of the County Park Pump Track Vegetated Filter Strip was designed to minimize and mitigate pollutant and hydrologic impacts associated with the Pinto Lake Bike Pump Track Project. Stormwater runoff from the bike pump track will be directed to catch basins within the pump track and outlet flow will be directed to the vegetated filter strip. The goal of implementing this project is to capture any nutrient rich sediment before it enters the Todos Santos tributary. Estimate load reductions provided by the US EPA Region 5 model are TSS: 2,580 lbs/yr, TN: 27 lbs/yr, and TP 5 lbs/yr.

The City evaluated the effectiveness of each project using site-specific evaluation strategies developed with consultation from technical advisors and in collaboration with the Grant Manager.

IMPLEMENTATION

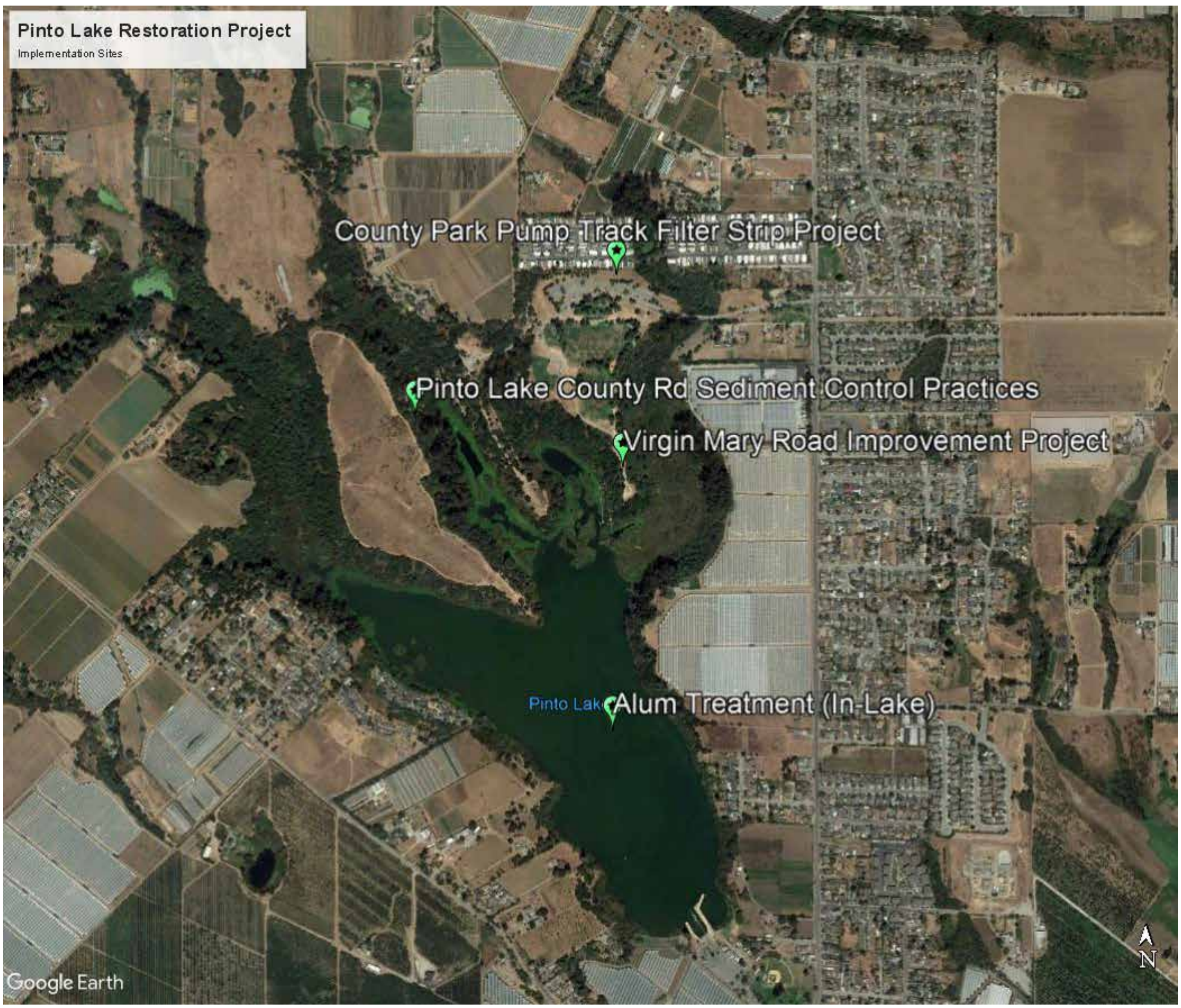


Figure 3 The implemented project sites of the Pinto Lake Restoration Project

PROJECT NAME: ALUM TREATMENT (IN-LAKE)

Location: Pinto Lake

Practice Type: Nutrient removal

Acres treated: 98 surface acres

Global Positioning System (GPS) point of implementation site: 36°57'18.42"N, 121°46'13.44"W

Figure 4 GPS printout of on barge tracking of the alum treatment, HAB Aquatics Solutions LLC.

PAEP Targets

» TAC approval of lake treatment program and design, which includes a design reduction of 80% of the nutrient load.

» 95% coverage of lake.

» Plan of monitoring locations.

» Successful installation of treatment system in Pinto Lake.

PROJECT DESCSRIPTION

Alum Dose

The following section is taken from the August 5, 2016 Memo4 that described calculations associated with selecting the appropriate alum dose for Pinto Lake.

Sediment constituents were determined at four depths in four sediment core locations. The cores were sectioned at 5 cm intervals to a depth of 20 cm. The alum treatment targeted Mobile-P and labile organic P for inactivation. Mobile-P

4 Memo, dated August 5, 2016 from Harry Gibbons, Gene Welch, Shannon Brattebo and Robert Plotnikoff (Tetra Tech) to Jackie McCloud and Emma Kluzniok nee Pickering with the City of Watsonville. Cc – John Holz and Tadd Barrow (HAB Aquatic Solutions, LLC.)

Photo 9 Algal bloom at Pinto Lake City Park Dock, October 26, 2016, before alum treatment

Photo 10 Algal bloom at Pinto Lake City Park Dock, October 26, 2016, before alum treatment

is the readily available form of sediment phosphorus that can migrate to the overlying water and is comprised of iron bound phosphorus (Fe:P) and loosely sorbed phosphorus. Liable organic phosphorus was estimated as one third of the organically bound phosphorus that ranged from 65 to 116 mg/g (dry weight). The fraction of organic-P can vary, but comparisons in other lakes indicate that one third estimate is reasonable. Although these organic-P values are not especially high concentrations for hypereutrophic lakes, the very high hypolimnetic water phosphorus concentrations ranging from 0.5 to 1.6 mg/L at Pinto indicates that this mobile-P and labile org-P source is effective in delivering a high internal loading rate to the overlying lake water.

The potential doses of alum were calculated based on inactivating the sediment mobile-P and labile organic-P to depths of 10 and 20 cm of sediment respectively. Calculating the alum dose for the two depths was used to define the potential impact of sediment-P potential availability to help understand the best target depth of sediment for inactivation. Using an aluminum added to aluminum-phosphorus formed ratio of 20:1, doses were 115 and 256 g/m^2 of Al for the two depths, respectfully (**Table 2 on page 18**). Inactivating mobile-P to 20 cm (or even deeper) is considered most desirable for ensuring maximum longevity, but the lower dose would have a similar short-term effect on limiting algal over production in the lake. Please note that the aluminum dose needed to inactivate the water column P is added to the final aluminum dose as mg/L for all sediment inactivation dosing.

As an example, hypereutrophic Lake Ketchum, WA, was treated at 50 Al g/m^2, which was only 60% of planned inactivation dose of 84 Al g/m^2 calculated at a 10 cm depth. The result was a decrease of the pre-treatment phosphorus release rate of 21 P mg/m^2 per day to a negative rate (-3.6 P mg/m^2 per day). However, treatment longevity is not expected to be as long as would have been provided with the full dose. Therefore, the lower dose that was calculated for 10 cm to Pinto Lake (115 Al g/m^2) should provide for substantial reduction in internal loading for a period of time yet to be determined. However, sediment mobile-P deeper than 10 cm will not be sufficiently inactivated with this dose so additional alum may be necessary in the future to prevent the occurrence of toxic algal blooms.

The dose of alum to inactivate phosphorus in the water column and in the top 10 cm sediment would require 128,500 gallons of alum and 64,250 gallons of sodium aluminate (buffer to alum) at an applied cost of $643,665. This dose is based upon lake water volume. However, the current budget is limited to $395,000. Hence, the recommended dose for this first phosphorus inactivation treatment is for 79,000 gallons of alum and 39,500 gallons of sodium aluminate at a liquid applied ratio of 2:1. The cost associated with this application is $3.333/gallon of alum and buffer solution applied. This amount covers all costs associated with the alum application, including the chemicals and HAB Aquatics Solutions, LLC's labor. Applying 79,000 gallons of alum and 39,500 gallons of buffer solution, results in approximately 60% of the recommended inactivation dose calculated for the 10 cm depth. This is a higher partial phosphorus inactivation dose than was used in Green Lake, WA in 1991 (25% of full inactivation dosed used in 2004) that resulted in several years of no algal blooms and no cyanotoxin generation (Data Analysis Report, Green Lake Phytoplankton Study, 2016). The partial dose for Pinto Lake is 60% of full inactivation dose and should result in immediate reduction in phosphorus concentration and sediment loading that will translate to a reduction in phytoplankton production.

Alum Implementation Plan

To manage the lake's water quality effectively in the future, the water quality monitoring program should be carried out every year. From these data, a phosphorus mass balance budget for the lake can be developed and updated annually to provide input into the optimization of the frequency and intensity of management alternatives needed to meet the water quality management goals.

Photo 11 Alum being delivered at Pinto Lake City Park, April 2017 [Photo Credit: Catherine Bosley, HAB Aquatic Solutions, LLC.]

To this end, the first step is to begin to manage the phosphorus loading to the lake. It is critical to reduce the external loading to the lake through source prevention and BMPs. This is long-term and an on-going effort through the implementation of an adaptive program to identify and control watershed phosphorus sources. At the same time, it is necessary to provide immediate water quality improvements and begin to address the internal load. To do this, reducing the bioavailable phosphorus within the lake that leads to excess cyanobacterial production, and ultimately to the production of cyanotoxins, must be targeted. To date the most successful approach to reducing phosphorus concentrations and cyanotoxin production while still improving overall water quality has been through the addition of alum. The aluminum in alum must be introduced into lake under strictly controlled conditions (i.e., properly buffered and dose controlled by speed of boat and water column depth). The alum will immediately remove phosphorus from the water column and form aluminum bound phosphorus as it will also bind with sediment mobile-P to form aluminum bound phosphorus. That compound, which contains phosphorus, is biologically unavailable (inactivated) because aluminum bound, phosphorus is insoluble. This phosphorus reduction in the overlying water and sediment leads to limiting the growth of algae.

Specifically, for Pinto Lake, the single largest source of phosphorus driving excess production of cyanobacteria leading to cyanotoxin generation is phosphorus recycling from its sediments. Hence, the first in-lake activity is planned for the early spring of 2017 in early March or late February, when the temperature of the water is at or above 5 degrees Celsius. This timing allows for maximizing the direct introduction of aluminum to the sediment, removal of the phosphorus loading from winter and spring external phosphorus inputs to the lake from the watershed, and limits the interference of aquatic plants from allowing the alum to reach the sediments quickly.

Photo 12 Dr. John Holz (HAB Aquatics Solutions LLC.) calibrating the pH probe, in preparation for alum dosing, April 2017. [Photo Credit: Catherine Bosley, HAB Aquatic Solutions, LLC.]

Photo 13 Dr. Holz measuring alkalinity of the lake prior to alum treatment, April 2017

Photo 14 HAB Aquatic Solutions, LLC. staff prepare the barge for alum treatment at Pinto Lake, April 2017 [Credit: Catherine Bosley, HAB Aquatic Solutions, LLC.]

Photo 15 HAB Aquatic Solutions, LLC. barge dosing Pinto Lake with alum, April 2017 [Credit: Catherine Bosley, HAB Aquatic Solutions, LLC.]

Photo 16 HAB Aquatic Solutions, LLC. barge dosing Pinto Lake with alum, April 2017. [Credit: Catherine Bosley, HAB Aquatic Solutions, LLC.]

Photo 17 HAB Aquatic Solutions, LLC. staff during alum treatment, April 2017. [Credit: Catherine Bosley, HAB Aquatic Solutions, LLC.]

In order to maximize the delivery of aluminum to the lake in an environmentally proven safe process, water treatment grade liquid alum will be simultaneously applied with a pH buffer liquid sodium aluminate. Both compounds are aluminum based and when applied at a 2:1 volumetric ratio of alum:sodium aluminate, the existing pH of the lake water will be maintained. The alum and sodium aluminate will be applied separately, but at the same time, and at the 2:1 ratio just below the water surface. The rate of application will be at a water column concentration of 45.5 mg Al/L. This dose will be controlled by the applicator using computer controlled pumps that account for lake depth and speed of the boat. The lake will be treated in a tracked pattern in one direction and then recovered using a 90-degree travel pattern to ensure complete and total coverage of the lake sediment at a depth of greater than 3 feet. No application of alum will take place in the "fingers" of the lake due to Department of Fish and Wildlife's concern with any effects on endangered species, such as the Western Pond turtle. Depending upon conditions at the lake at the time of application, it is estimated that the treatment will take two weeks or less. This includes 2 to 4 working days to mobilize and demobilize and 3 to 8 days to conduct the application.

Based on alum treatments conducted in other lakes, most alum treatments result in an immediate 80 – 95% reduction in water column phosphorus concentration and typically exhibit a significant reduction in the phosphorus sediment release rate. However, we cannot state that there will absolutely be an 80% reduction in phosphorus loading using a 60% alum dose because this statement cannot be made without a mass balance and complete understanding of the phosphorus loading dynamics, for which we do not have data. If Pinto Lake behaves like many of the other lakes treated nationally, it is reasonable to assume an immediate reduction in water column phosphorus concentrations and a reduction in internal phosphorus loading.

An example of lake response to a partial alum dose is summarized in **Table 2**. In 2011 and 2012 only 40% of the lake surface area at Grand Lake St. Mary's (GLSM) was treated with a partial alum dose. Although the 2012 dose to the middle 40% of the lake area was slightly higher (23.6 mg Al/L, 49.6 g/m2) than in 2011 (21.5 mg Al/L, 45.2 g/m^2), these doses combined were still less than the recommended total dose of 86 mg Al/L (120 g/m^2). The combined doses in 2011 and 2012 together equaled 70% of the recommended treatment for the mid-lake area. **Table 2** also summarizes the reduction in internal phosphorus loading for the entire lake following the partial alum treatments. Average summer sediment release rates were reduced overall by 55% and gross summer internal phosphorus loading by 57%. This is a significant reduction given the partial dose and limited treatment area.

Table 2 Sediment compositions and calculated Al dose based on mobile-P including labile org-P and depths calculated from sediment core analyses at the deep sites (Point and Abyss in Pinto Lake)

Mobile P + 1/3 Organic P (mg/g)	% Water	% Solids	Sediment Bulk Density (g/cm3)	Solids concen-tration (g/cm3)	Sediment Depth (cm)	Al added:Al-P formed ratio	Al dose, mg/cm2	Al sediment inactivation dose, g/m2	Lake Mean Depth (m)	Al sediment inactivation dose, mg/L	Water Column Stripping Dose, mg/L	Al Total Dose, mg/L
0.196	75.40%	24.60%	1.326	0.326	20	20	25.6	255.8	1.8	142.1	10	152.1
0.176	75.40%	24.60%	1.326	0.326	10	20	11.5	114.8	1.8	63.8	10	73.8
Because of budget constraints, the 10 cm inactivation value of 73.8 mg/L will be reduced to 45.5 mg/L, which is just over 60% of the calculated value for full inactivation at 10 cm.												

Calculations

Description = (solids concentration)(mobile P)(Unit conversion)(depth)(unit conversion)(ratio of Al added to Al-P formed)

Al sediment inactivation dose g/m^2 = (solids conc. g/cm^3) (mobile P mg/g) (104 cm2/m2)(20 cm)(10-3 g/mg) (20)

Al sediment inactivation dose g/m^2 at 20 cm = (0.326 g/cm^3)(0.196 mg/g)(104 cm2/m2)(20 cm)(10-3 g/mg)(20) = 255.8 g/m^2

Al sediment inactivation dose g/m^2 at 10 cm = (0.326 g/cm^3)(0.176 mg/g)(104 cm2/m2)(10 cm)(10-3 g/mg)(20) = 114.8 g/m^2

Description=(solids concentration)(mobile P+1/3 organic P)(Unit conversion)(depth)(unit conversion)(ratio of Al added to Al-P formed)

Al Total Dose (mg/L) = (Sediment inactivation dose g Al/m2/ mean lake depth)(unit conversion)(unit conversion) + (Water column Dose mg Al/L)

Al Total Does at 10 cm (mg/L) = (114.8 g/m2/1.8 m)(1000mg/1g)(1m3/1000L) + 10 mg/L = 73.8 mg/L

Photo 18 Dr. Holz, Jackie McCloud, Shanta Keeling (CCRWCB), and Melissa Daugherty (CCRWQCB) at the Pinto Lake City Park after the alum treatment, April 2017. [Credit: Catherine Bosley, HAB Aquatic Solutions, LLC.]

Photo 19 View from the end of Pinto Lake City Park Dock, July 18, 2017, after alum treatment.

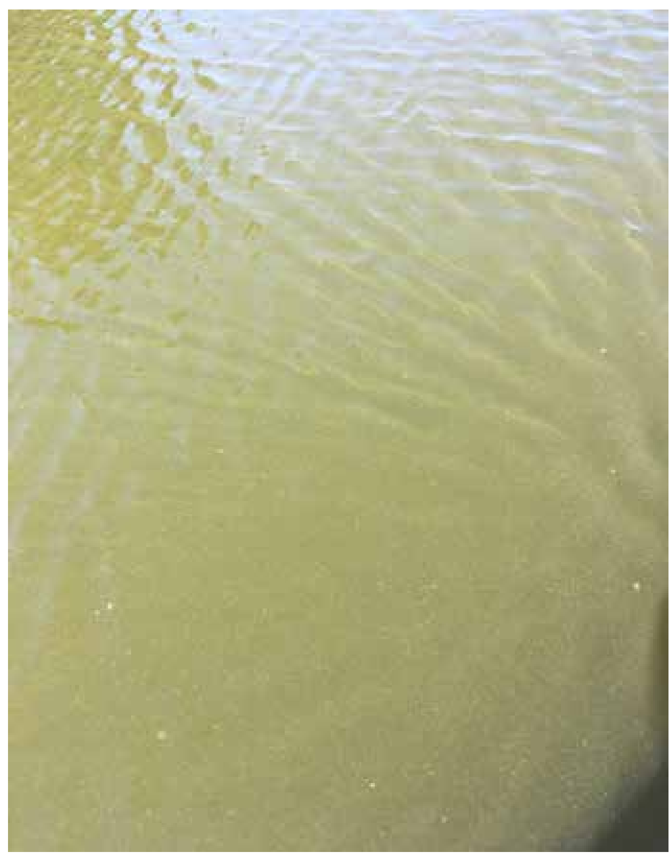


Photo 20 View from Pinto Lake City Park Dock, April 7, 2018, after alum treatment

PROJECT EFFECTIVENESS EVALUATION

Narrative Baseline Conditions

Pinto Lake is hypereutrophic due to the excessive amount of nitrates and phosphorus in the lake's water and sediment. Due to the excessive nutrients, the lake experiences harmful algal blooms (HABs) in the spring and fall.

Usually, the bloom starts in spring, with Aphanizomenon, an algae species. The bloom then, commonly, shifts to Microcystis, another algae species, in the late summer. Cyanobacteria compositions were analyzed, five times, during a pre-treatment active bloom, by Dr. Rosalina Hristova with California State University San Marcos (CSUSM). CSUSM results below.

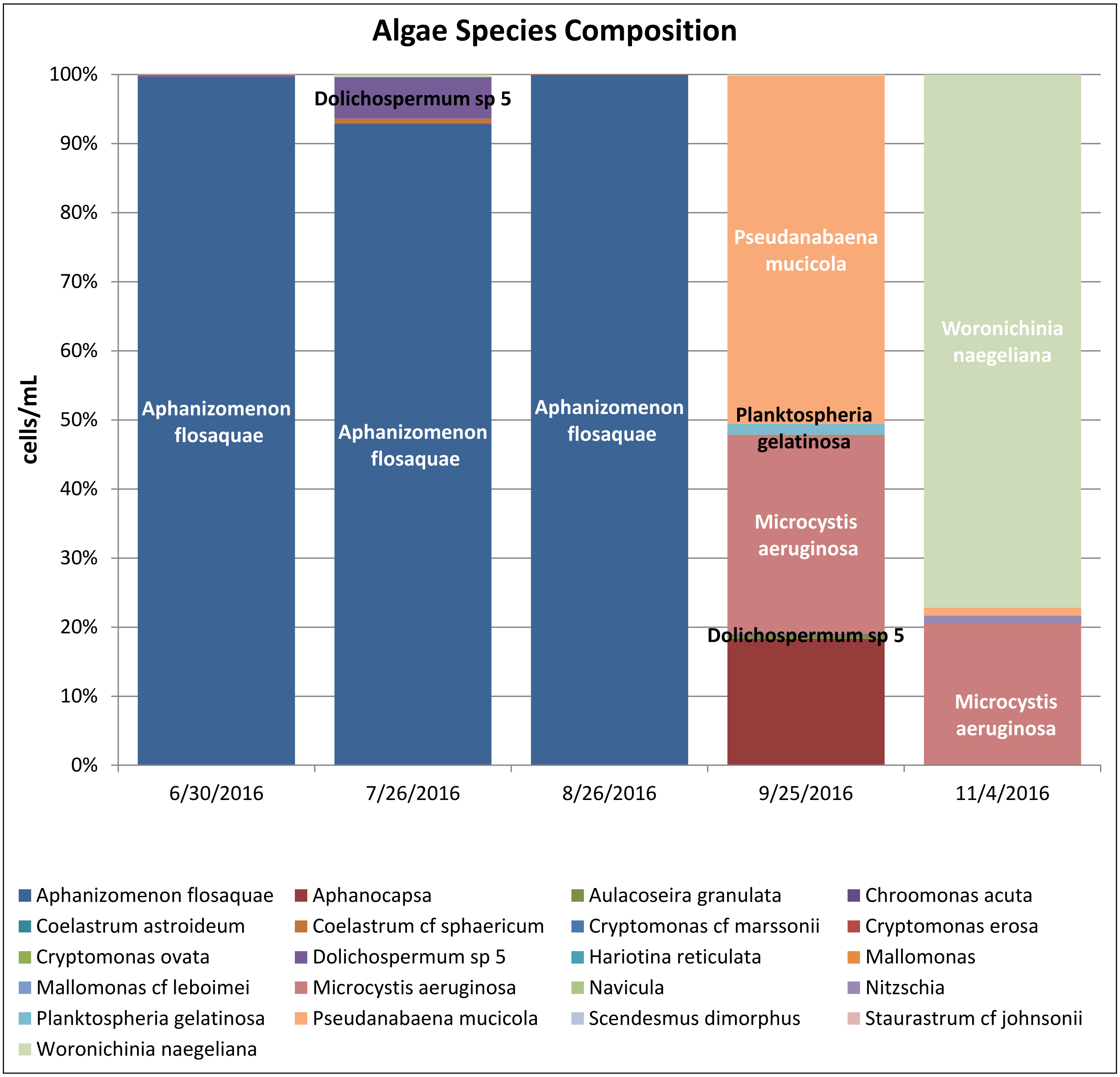


Figure 5 Algal species composition during an active bloom, results analyzed by CSUSM

The bloom's toxicity, indicated by the toxin, Microcystin, peaks around October or November. Cyanotoxin concentrations are measured weekly by Dr. Raphael Kudela with UCSC. UCSC uses the solid phase adsorption toxin testing (SPATT) technique to analyze cyanotoxins. The pre-treatment results, dating back to 2011, are found in **Figure 6**. Note that there

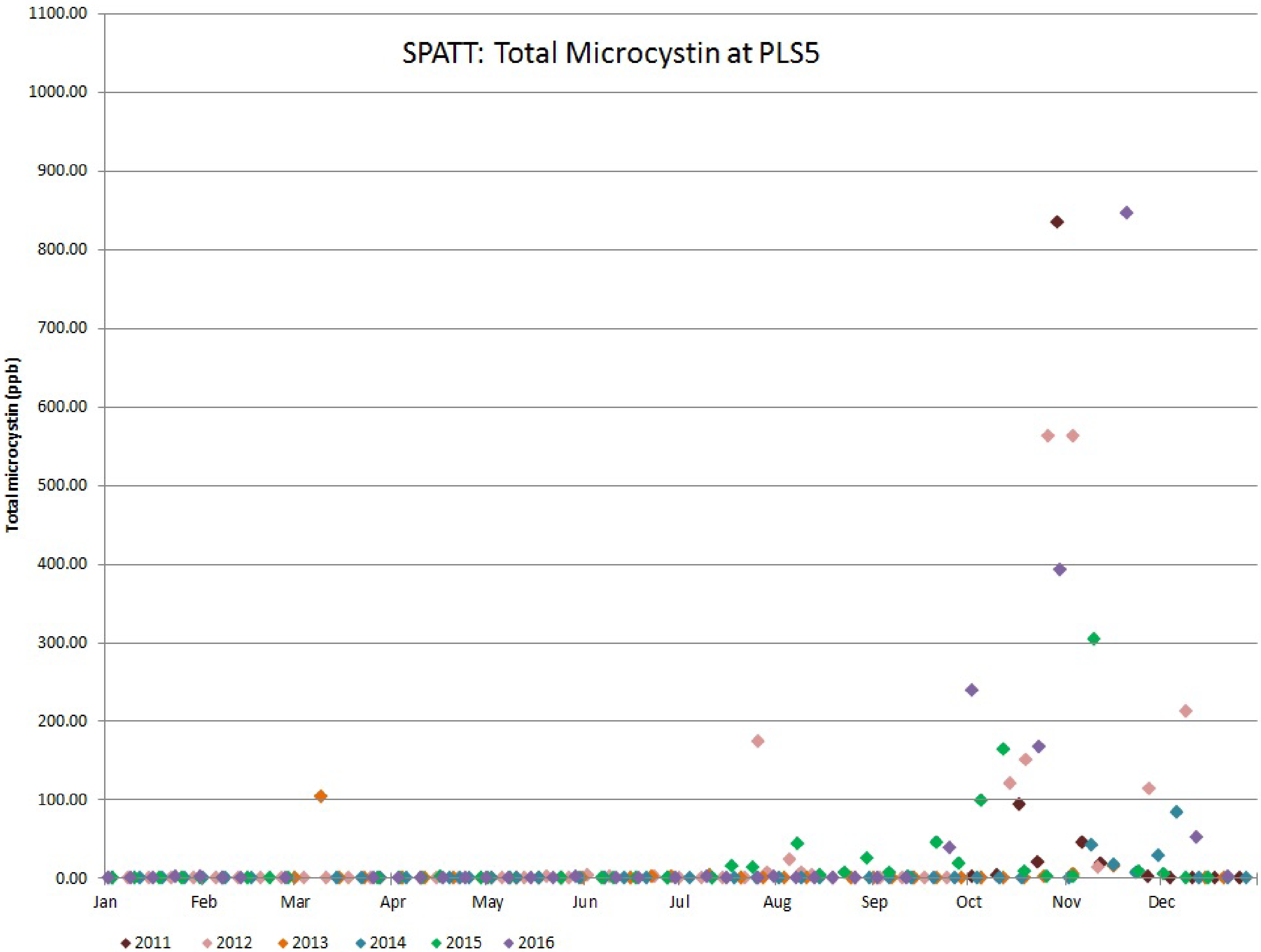


Figure 6 The baseline conditions of the total microcystin at the Pinto Lake City Park Dock, prior to alum treatment.

were measured values of up to 3,766.07 ppb in 2012 and 1,493.08 ppb in 2016. In the effort of constructing a meaningful graph, the y-axis scale was maximized at 1,100 ppb, to capture the majority of the data points.

Ammonia, nitrate, orthophosphate, total Kjeldahl nitrogen (TKN), total phosphorus (TP), and total suspended solids (TSS), were measured three times, pre-treatment. Ammonia, orthophosphate, TKN, TP and TSS[5] all increased from spring through fall, and decreased during winter. Nitrate gradually decreased from spring through fall, then sharply increased during winter. These results, plus, sediment core data was used to determine the alum doses.

Summary of Data

The parameters monitored were ammonia, nitrate, orthophosphate, TKN, TP, TSS, cyanotoxins, and cyanobacteria composition. At each monitoring site, samples are collected a foot below the surface, mid-water column, and one foot above the sediment interface. These depths were determined based on the surface elevation of the lake at time of monitoring.

5 It should be noted that the TSS samples from the monitoring event, at the end of fall, may have been collected below the sediment-water-interface, resulting in extremely high levels of TSS at two of the four bottom sites.

Monitoring Schedule

Figure 7 The in-lake monitoring sites of the Pinto Lake Restoration Project

Table 3 Summary of In-Lake Monitoring Schedule

Parameter	Location	Frequency
Ammonia	PLS1, PLS2, PLS3, PLS4	No active bloom: 3 pre-treatment, 3 post-treatment
Cyanotoxin concentrations	PLS5	Weekly
Cyanobacteria composition	PLS5	During an active bloom
Nitrate	PLS1, PLS2, PLS3, PLS4	No active bloom: 3 pre-treatment, 3 post-treatment
Orthophosphate	PLS1, PLS2, PLS3, PLS4	No active bloom: 3 pre-treatment, 3 post-treatment
TKN	PLS1, PLS2, PLS3, PLS4	No active bloom: 3 pre-treatment, 3 post-treatment
TP	PLS1, PLS2, PLS3, PLS4	No active bloom: 3 pre-treatment, 3 post-treatment
TSS	PLS1, PLS2, PLS3, PLS4	No active bloom: 3 pre-treatment, 3 post-treatment

Analytical Methods

Table 4 Summary of Analytical Methods for In-Lake Monitoring

Analytical Method	Analyte	Container	Preservative	Hold time
Standard Methods 4500-NH3 B&C	Ammonia	250mL Poly	H2SO4 to pH<2	28 days at 4°C
Standard Methods 4500-NH3 D				
Standards Method 2540 D.	TSS	1000mL Poly	None	72 hours at 4°C
EPA Method 300.0	Nitrate	125mL Poly	None	48 hours at 4°C
US EPA Method 300.0	Orthophosphate	125mL Poly	None	48 hours at 4°C
Standard Methods 4500-NH3 BCE	TKN	500mL Poly	H2SO4 to pH<2	28 days at 4°C
US EPA Method 351.2				
Hach 8190	TP	500mL Poly	H2SO4 to pH<2	28 days at 4°C
US EPA Method 365.1				
Mekebri et al. 2008	Cyanotoxin concentrations:	Amber glass bottle with deionized water	4°C, dark	indefinitely at -80° C
	Microcystin LR, Microcystin RR, Microcystin YR, Microcystin LA			
ANSP Protocol P-13-52	Algal identification	100mL Poly	None	14 days 4°C
	Algal enumeration	100mL Poly	Lugol's	indefinitely at 4° C

Results And Discussion

<u>Total Phosphorus and Orthophosphate</u>

The reductions of total phosphorus (TP) and orthophosphate (PO43-), due to the alum treatment, were significant. The average TP lake-wide percent reduction was 91%. This was calculated using the average of all of the results from the three pre-treatment sampling events (0.57 mg/L), and the average of all of the results from the three post-treatment sampling events (0.05 mg/L). Note that two analytical methods were used. See the values, in the following tables.

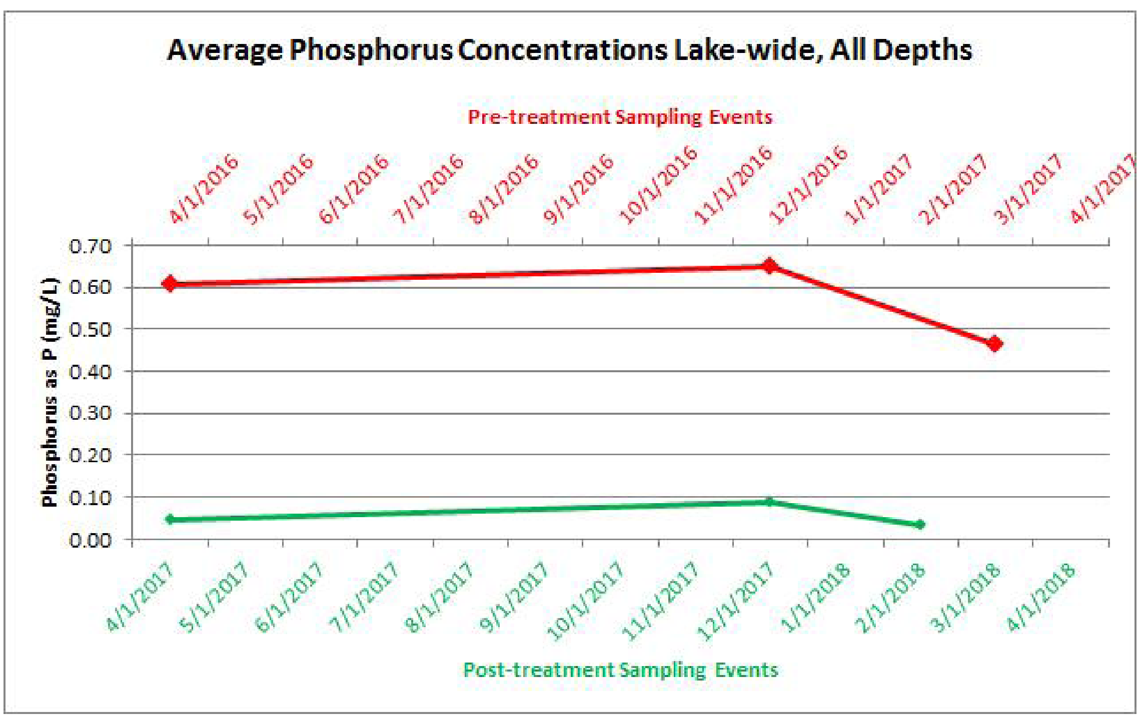


Figure 8 A comparison of the average pre-treatment (red trend) and post-treatment (green trend) phosphorus concentrations lake-wide, at all depths

Table 5 Total phosphorus concentrations at the in-lake monitoring sites, pre-treatment

Sample Site	27-Apr-16	5-Dec-16	23-Mar-17
	(Hach 8190) | (mg/L)	(Hach 8190) | (mg/L)	(Hach 8190) | (mg/L)
PLS1, surface	0.4	0.66	0.4
PLS1, mid	0.45	0.66	0.4
PLS1, near bottom	1.3	0.62	0.48
PLS2, surface	0.41	0.66	0.43
PLS2, mid	0.48	0.64	0.42
PLS2, near bottom	1.6	0.67	0.47
PLS3, surface	0.41	0.62	0.4
PLS3, mid	0.43	0.62	0.51
PLS3, near bottom	0.53	0.64	0.72
PLS4, surface	0.4	0.67	0.37
PLS4, mid	0.43	0.67	0.4
PLS4, near bottom	0.45	0.67	0.56

Table 6 Total phosphorus concentrations at the in-lake monitoring sites, post-treatment

Sample Site	27-Apr-17	19-Dec-17	26-Feb-18
	(Hach 8190) | (mg/L)	US EPA 365.1 | mg/L	US EPA 365.1 | mg/L
PLS1, surface	0.03	0.04	0.03
PLS1, mid	0.04	0.05	0.03
PLS1, near bottom	0.03	0.1	0.04
PLS2, surface	0.03	0.04	0.03
PLS2, mid	0.03	0.04	0.03
PLS2, near bottom	0.08	0.08	0.05
PLS3, surface	0.03	0.03	0.02
PLS3, mid	0.05	0.04	0.03
PLS3, near bottom	0.13	0.52	0.04
PLS4, surface	Not Detected (ND)	0.03	0.02
PLS4, mid	0.03	0.04	0.03
PLS4, near bottom	0.04	0.05	0.03

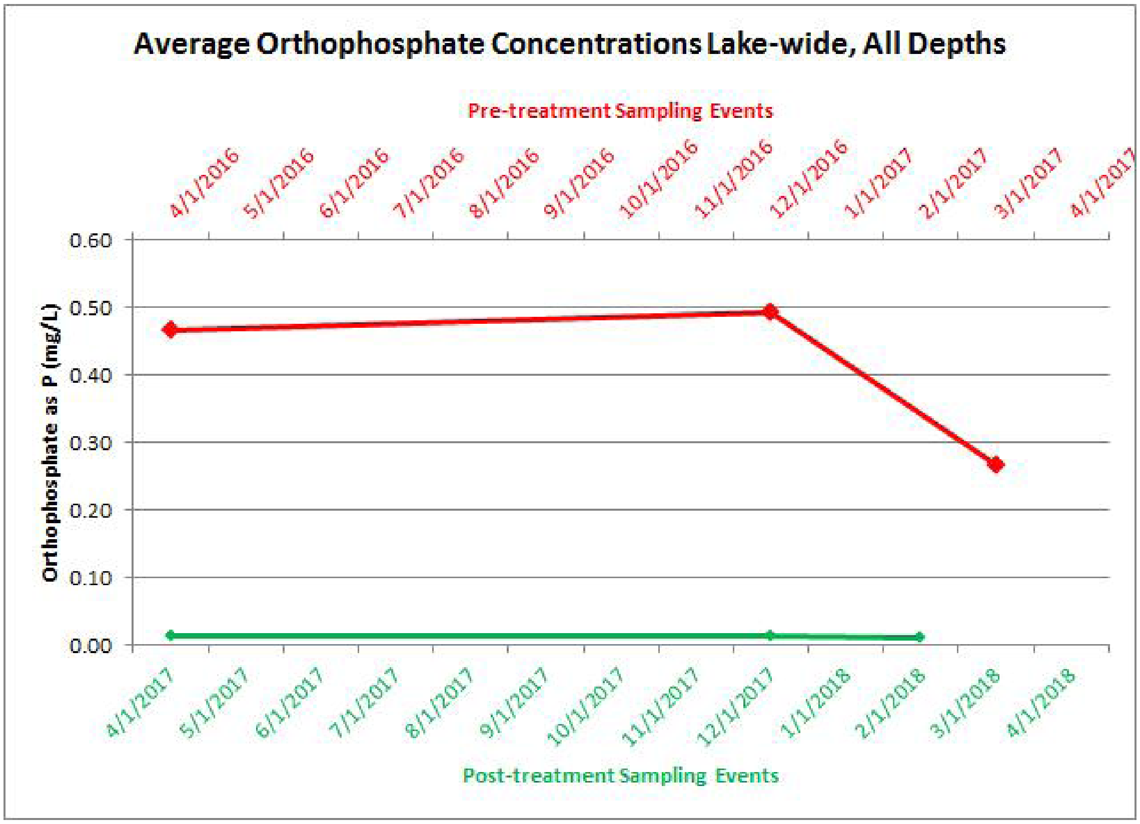


Figure 9 A comparison of the average pre-treatment (red trend) and post-treatment (green trend) orthophosphate concentrations lake-wide, at all depths

The average orthophosphate ($PO4^{3-}$) lake-wide percent reduction was 98%. This was calculated using the average of all the results from the three pre-treatment sampling events (0.41 mg/L), and the average of all the results from the three post-treatment sampling events (0.01 mg/L). This reduction can be further illustrated by pointing out that 34 of the 36 post-treatment samples were below the reporting limit (of 0.02 mg/L).

Table 7 Orthophosphate concentrations at the in-lake monitoring sites, pre-treatment

Sample Site	27-Apr-16	5-Dec-16	23-Mar-17
	(US EPA 300.0) | (mg/L)	(US EPA 300.0) | (mg/L)	(US EPA 300.0) | (mg/L)
PLS1, surface	0.4	0.5	0.23
PLS1, mid	0.4	0.4	0.23
PLS1, near bottom	0.7	0.5	0.24
PLS2, surface	0.4	0.5	0.23
PLS2, mid	0.4	0.5	0.25
PLS2, near bottom	0.8	0.5	0.29
PLS3, surface	0.4	0.5	0.22
PLS3, mid	0.4	0.5	0.34
PLS3, near bottom	0.5	0.5	0.35
PLS4, surface	0.4	0.5	0.23
PLS4, mid	0.4	0.5	0.34
PLS4, near bottom	0.4	0.5	0.32

Table 8 Orthophosphate concentrations at the in-lake monitoring sites, post-treatment

Sample Site	April 27, 2017 (US EPA 300.0) | (mg/L)	December 19, 2017 (US EPA 300.0) | (mg/L)	February 26, 2018 (US EPA 300.0) | (mg/L)
PLS1, surface	<0.02	<0.02	<0.02
PLS1, mid	<0.02	<0.02	<0.02
PLS1, near bottom	0.03	0.03	<0.02
PLS2, surface	<0.02	<0.02	<0.02
PLS2, mid	<0.02	<0.02	<0.02
PLS2, near bottom	<0.02	<0.02	<0.02
PLS3, surface	<0.02	<0.02	<0.02
PLS3, mid	<0.02	<0.02	<0.02
PLS3, near bottom	<0.02	<0.02	<0.02
PLS4, surface	<0.02	<0.02	<0.02
PLS4, mid	<0.02	<0.02	<0.02
PLS4, near bottom	<0.02	<0.02	<0.02

Other Nutrients and Total Suspended Solids

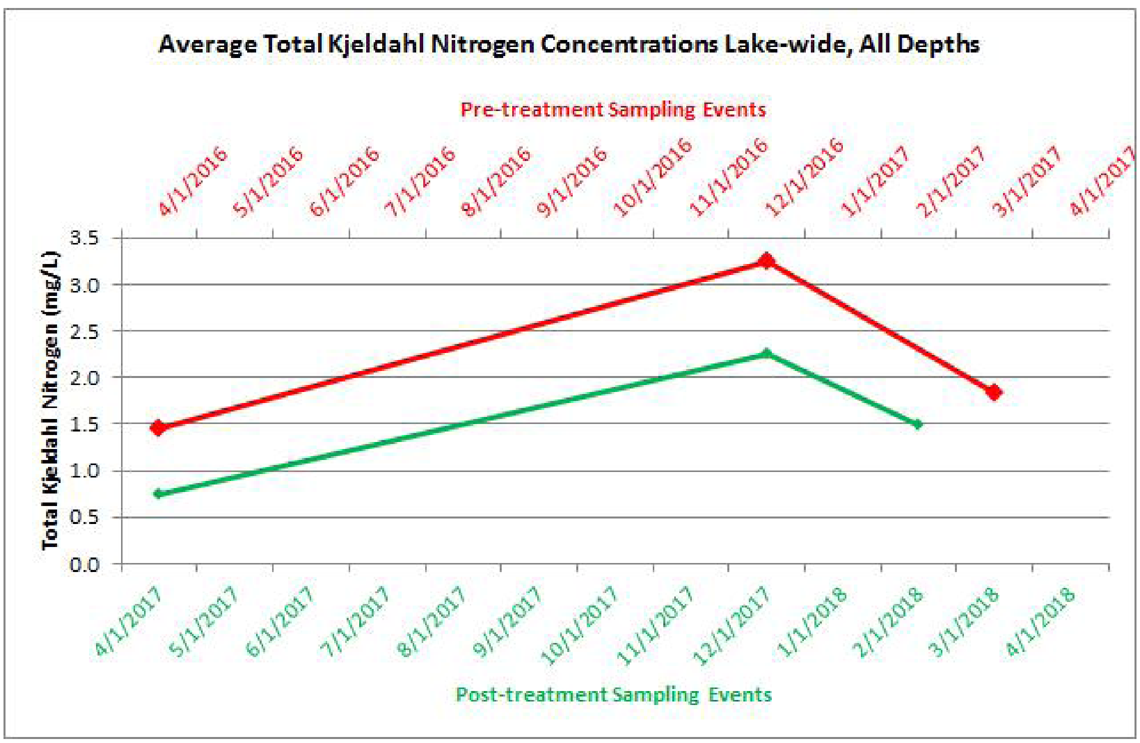


Figure 10 A comparison of the average pre-treatment (red trend) and post-treatment (green trend) orthophosphate concentrations lake-wide, at all depths

The average Total Kjeldahl Nitrogen (TKN) lake-wide percent reduction was 31%. This was calculated using the average of all the results from the three pre-treatment sampling events (2.17 mg/L), and the average of all the results from the three post-treatment sampling events (1.5 mg/L). Note that the alum treatment was not intended to reduce TKN levels.

Table 9 TKN concentrations at the in-lake monitoring sites, pre-treatment

Sample Site	April 27, 2016 (SM 4500-NH3 B,C v19) | (mg/L)	December 5, 2016 (SM 4500-NH3 B,C v19) | (mg/L)	March 23, 2017 (SM 4500-NH3 B,C v19) | (mg/L)
PLS1, surface	1.1	3.3	2.7
PLS1, mid	1.3	3.3	1.6
PLS1, near bottom	1.8	3.1	1.8
PLS2, surface	1.0	3.0	1.3
PLS2, mid	1.3	4.7	1.6
PLS2, near bottom	3.6	3.4	1.5
PLS3, surface	1.0	3.1	1.7
PLS3, mid	1.1	3.0	2.2
PLS3, near bottom	1.5	3.2	2.7
PLS4, surface	1.1	2.9	2.7
PLS4, mid	1.1	2.9	0.8
PLS4, near bottom	1.4	3.0	1.3

Table 10 TKN concentrations at the in-lake monitoring sites, post-treatment

Sample Site	April 27, 2017 (SM 4500-NH3 B,C v19) | (mg/L)	December 19, 2017 (US EPA 351.2) | (mg/L)	February 26, 2018 (US EPA 351.2) | (mg/L)
PLS1, surface	ND	2.1	1.53
PLS1, mid	ND	2.1	1.5
PLS1, near bottom	2.2	2.7	1.51
PLS2, surface	0.5	2.2	1.57
PLS2, mid	0.5	2.1	1.57
PLS2, near bottom	0.7	2.1	1.39
PLS3, surface	ND	2.1	1.43
PLS3, mid	1.0	2.1	1.34
PLS3, near bottom	1.3	3.1	1.54
PLS4, surface	ND	2.2	1.39
PLS4, mid	0.9	2.1	1.47
PLS4, near bottom	0.7	2.2	1.51

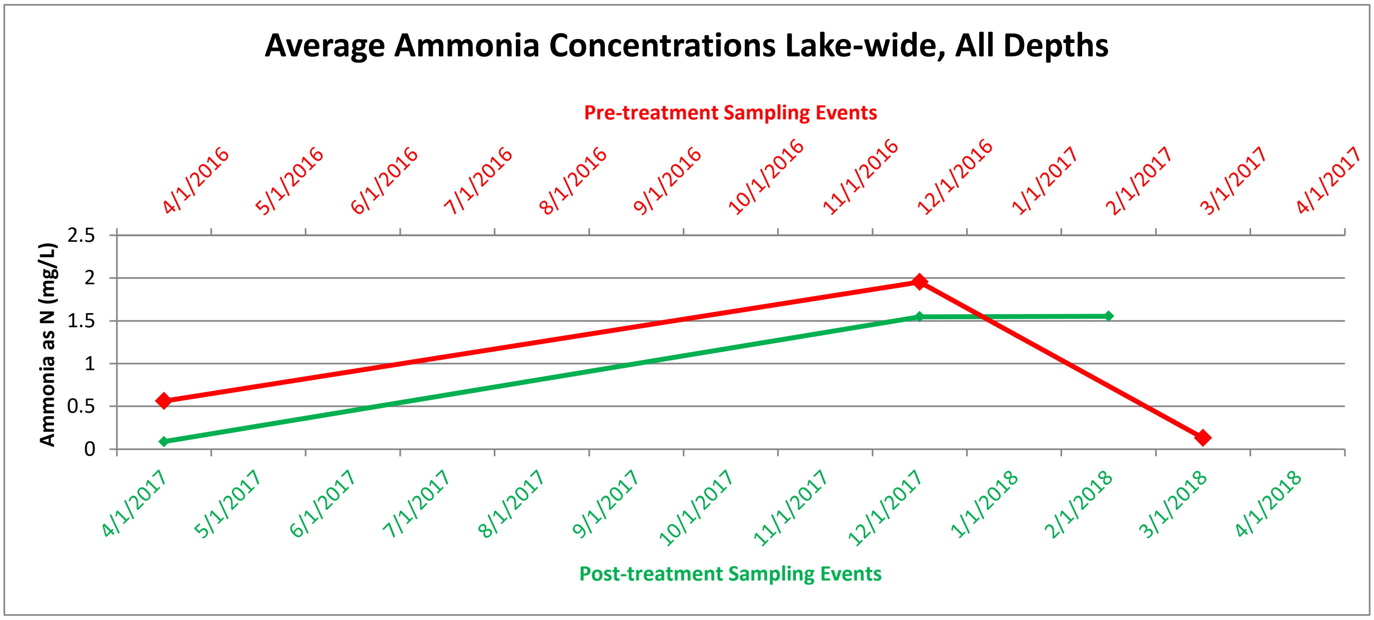


Figure 11 A comparison of the average pre-treatment (red trend) and post-treatment (green trend) ammonia concentrations lake-wide, at all depths

The average ammonia (NH4+) lake-wide percent increase was 20%. The data contributing to this increase can be attributed to the final post-treatment sampling event, where the ammonia concentrations didn't decrease, as seen in the pre-treatment conditions. This could be due to the temporary reduction in available oxygen, following the alum treatment or to seasonal changes in availability of oxygen to the lower part of the lake. The percent change was calculated using the average of all the results from the three pre-treatment sampling events (0.88 mg/L), and the average of all the results from the three post-treatment sampling events (1.06 mg/L). Note that the alum treatment was not intended to reduce ammonia levels.

Table 11 Ammonia concentrations at the in-lake monitoring sites, pre-treatment

Sample Site	April 27, 2016	December 5, 2016	March 23, 2017
	(SM4500NH3) | (mg/L)	(SM4500NH3) | (mg/L)	(SM4500NH3) | (mg/L)
PLS1, surface	ND	1.99	0.06
PLS1, mid	ND	2.02	0.05
PLS1, near bottom	1.8	1.89	0.07
PLS2, surface	ND	2.00	<0.05
PLS2, mid	ND	1.98	0.05
PLS2, near bottom	2.2	1.98	0.09
PLS3, surface	ND	2.06	0.06
PLS3, mid	ND	2.07	0.31
PLS3, near bottom	0.5	2.07	0.48
PLS4, surface	ND	1.82	0.08
PLS4, mid	ND	1.83	0.07
PLS4, near bottom	ND	1.75	0.21

Table 12 Ammonia concentrations at the in-lake monitoring sites, post-treatment

Sample Site	April 27, 2017 (SM4500NH3) | (mg/L)	December 19, 2017 (SM4500NH3) | (mg/L)	February 26, 2018 (SM4500NH3) | (mg/L)
PLS1, surface	<0.05	1.4	0.92
PLS1, mid	<0.05	1.36	0.92
PLS1, near bottom	0.21	1.22	0.90
PLS2, surface	<0.05	1.53	1.0
PLS2, mid	<0.05	1.58	1.9
PLS2, near bottom	0.10	1.46	2.2
PLS3, surface	<0.05	1.46	1.9
PLS3, mid	<0.05	1.68	2.1
PLS3, near bottom	0.46	1.75	2.0
PLS4, surface	<0.05	1.66	1.2
PLS4, mid	<0.05	1.74	1.6
PLS4, near bottom	0.07	1.73	2.0

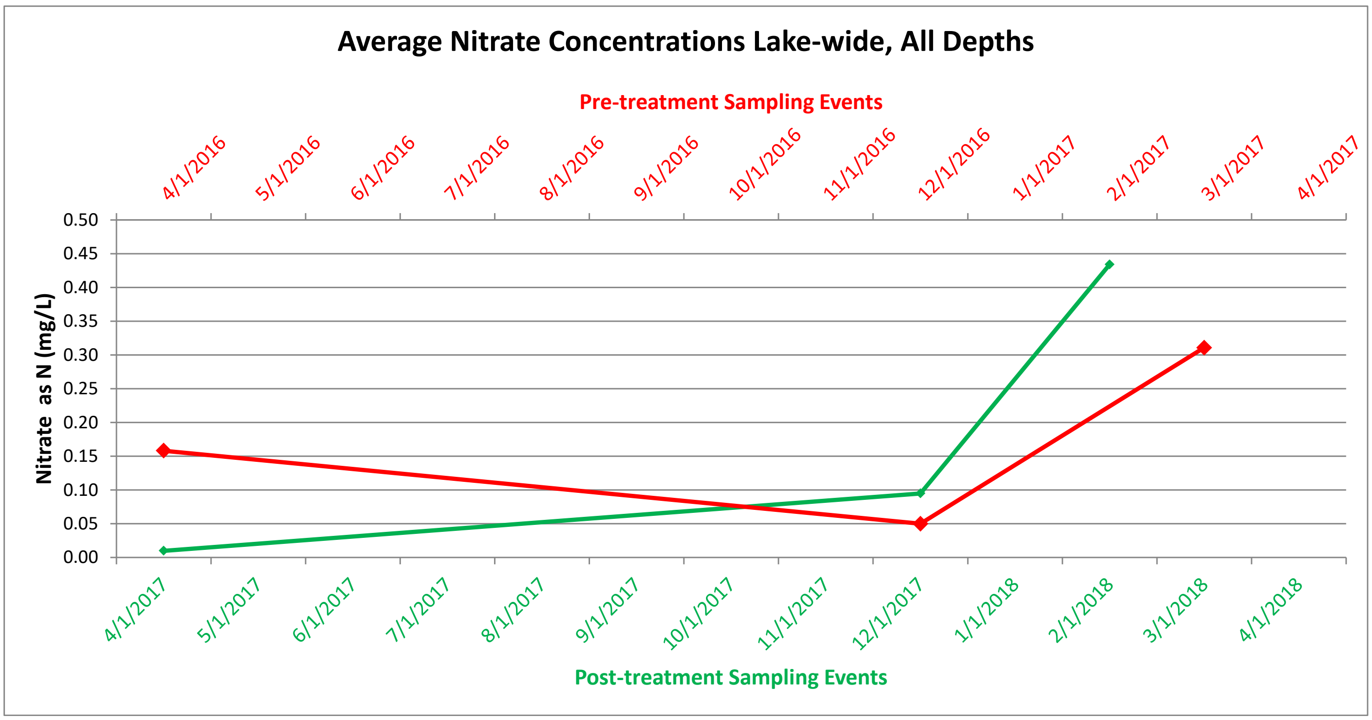


Figure 12 A comparison of the average pre-treatment (red trend) and post-treatment (green trend) nitrate concentrations lake-wide, at all depths

There was a very small increase in the average nitrate (NO3-) lake-wide, approximately 6%. This increase is small and most likely not due to the alum treatment as there are no effects of the alum that would produce this result. This was calculated using the average of all the results from the three pre-treatment sampling events (0.17 mg/L), and the average of all the results from the three post-treatment sampling events (0.18 mg/L). Note that the alum treatment was not intended to reduce nitrate levels.

Table 13 Nitrate concentrations at the in-lake monitoring sites, pre-treatment

Sample Site	April 27, 2016 (US EPA 300.0) | (mg/L)	December 5, 2016 (US EPA 300.0) | (mg/L)	March 23, 2017 (US EPA 300.0) | (mg/L)
PLS1, surface	0.2	ND	0.23
PLS1, mid	0.2	ND	0.21
PLS1, near bottom	ND	ND	0.25
PLS2, surface	0.2	ND	0.18
PLS2, mid	0.1	ND	0.27
PLS2, near bottom	ND	ND	0.40
PLS3, surface	0.2	ND	0.23
PLS3, mid	0.2	ND	0.49
PLS3, near bottom	0.1	ND	0.49
PLS4, surface	0.2	ND	0.23
PLS4, mid	0.2	ND	0.27
PLS4, near bottom	0.2	ND	0.48

Table 14 Nitrate concentrations at the in-lake monitoring sites, post-treatment

Sample Site	April 27, 2017 (US EPA 300.0) | (mg/L)	December 19, 2017 (US EPA 300.0) | (mg/L)	February 26, 2018 (US EPA 300.0) | (mg/L)
PLS1, surface	<0.02	0.09	0.44
PLS1, mid	<0.02	0.10	0.44
PLS1, near bottom	<0.02	0.11	0.44
PLS2, surface	<0.02	0.09	0.43
PLS2, mid	<0.02	0.09	0.43
PLS2, near bottom	<0.02	0.11	0.52
PLS3, surface	<0.02	0.09	0.43
PLS3, mid	<0.02	0.09	0.43
PLS3, near bottom	<0.02	0.10	0.39
PLS4, surface	<0.02	0.09	0.42
PLS4, mid	<0.02	0.09	0.42
PLS4, near bottom	<0.02	0.09	0.42

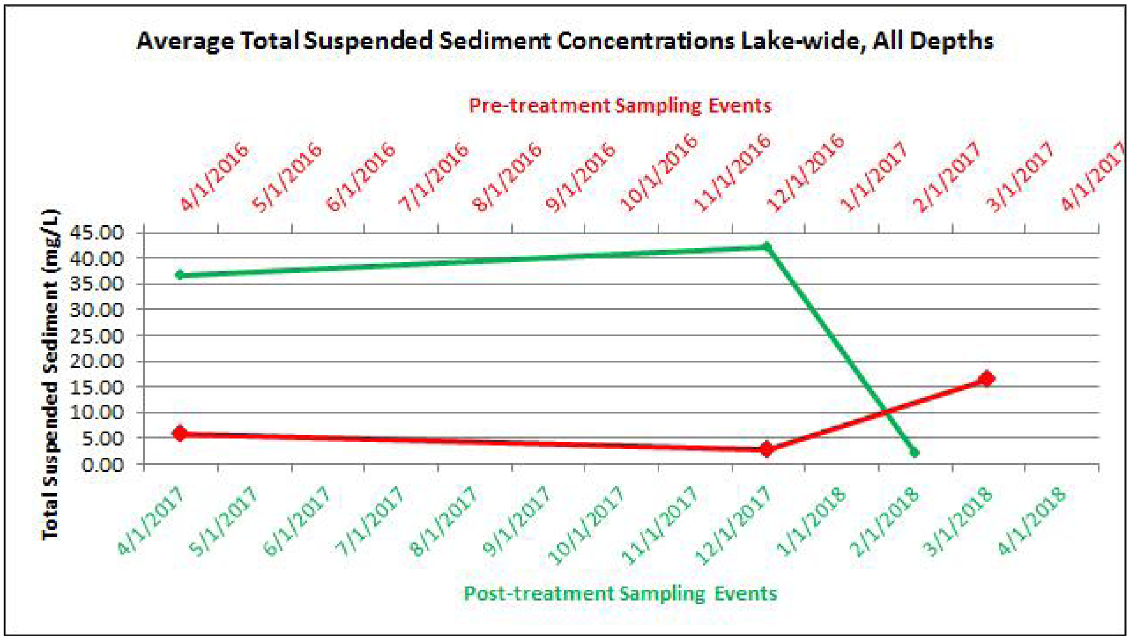


Figure 13 A comparison of the average pre-treatment (red trend) and post-treatment (green trend) TSS concentrations lake-wide, at all depths. Note that 2 data points (PLS3, near bottom and PLS4, near bottom), from the December 5, 2017 sampling event, are excluded from this graphic as samples may have been collected below the sediment-water-interface, resulting in extremely high levels of TSS.

The average Total Suspended Solids (TSS) lake-wide percent increase was approximately 212%. This was calculated using the average of the results[6] from the three pre-treatment sampling events (8.63 mg/L), and the average of all the results from the three post-treatment sampling events (26.95 mg/L). Note that the alum treatment was not intended to reduce TSS levels.

It should be noted that the TSS samples from the pre-treatment monitoring event, on December 5, 2017, may have been collected below the sediment-water-interface, resulting in extremely high levels of TSS at two of the four bottom sites. The interface is often nebulous, and determining the depth for the sample was challenging.

Another potential factor for the unusually high TSS concentrations could be disturbance of the sediment prior to sampling. This may have occurred during deployment of monitoring site buoys and their anchors. This could have also occurred if there were extremely windy conditions, which caused the anchors to drag along the bottom of the lake.

Table 15 TSS concentrations at the in-lake monitoring sites, pre-treatment

Sample Site	April 27, 2016 (SM2540D) | (mg/L)	December 5, 2016 (SM2540D) | (mg/L	March 23, 2017 (SM2540D) | (mg/L
PLS1, surface	2.8	1.61	6.2
PLS1, mid	4.3	1.44	9.0
PLS1, near bottom	18.3	13.6	26.0
PLS2, surface	2.0	1.11	11.2
PLS2, mid	2.3	1.22	5.6
PLS2, near bottom	18.8	2.32	8.4
PLS3, surface	2.1	1.3	4.4
PLS3, mid	2.6	1.13	11.4
PLS3, near bottom	3.7	13960	78.8
PLS4, surface	5.4	1.04	5.4
PLS4, mid	3.4	1.6	5.2
PLS4, near bottom	5.0	18600	24.8

6 Note that 2 data points (PLS3, near bottom and PLS4, near bottom), from the December 5, 2017 sampling event, are excluded from the pre-treatment average as samples may have been collected below the sediment-water-interface, resulting in extremely high levels of TSS.

Table 16 TSS concentrations at the in-lake monitoring sites, post-treatment

Sample Site	April 27, 2017	December 19, 2017	February 26, 2018
	(SM2540D) | (mg/L	(SM2540D) | (mg/L	(SM2540D) | (mg/L
PLS1, surface	3.9	3.1	1.3
PLS1, mid	7.7	5.3	1.5
PLS1, near bottom	330	320	5.4
PLS2, surface	5.0	4.0	1.5
PLS2, mid	4.49	4.3	1.9
PLS2, near bottom	28.6	52.0	2.2
PLS3, surface	4.3	2.2	1.9
PLS3, mid	11.8	3.5	2.1
PLS3, near bottom	20.0	4.0	2.0
PLS4, surface	4.7	1.7	1.2
PLS4, mid	5.3	3.2	1.6
PLS4, near bottom	12.4	104.0	2.0

Microcystin Toxicity

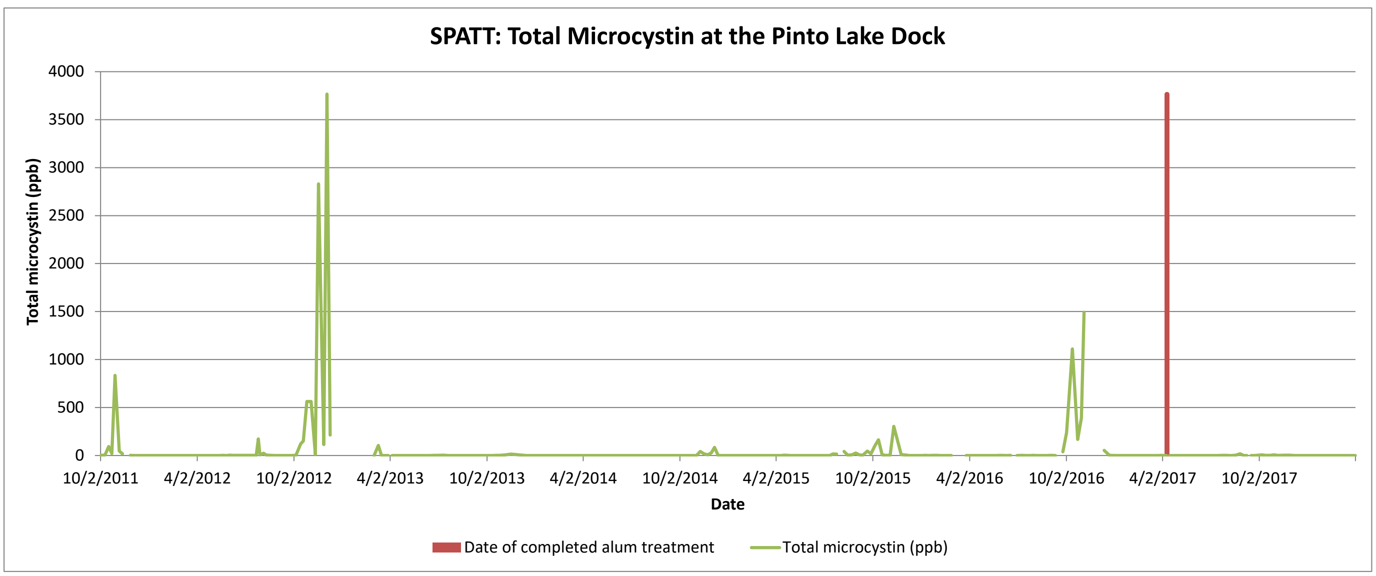


Figure 14 Total microcystin at the Pinto Lake City Dock spanning October 2, 2011 through April 1, 2018. The vertical red line indicates the approximate completion of alum treatment, on April 10, 2017.

After alum treatment in April 2017, the Lake experienced a relatively short and insignificant microcystin toxicity event compared to previous years when the lake was heavily impaired by toxicity events. The average microcystin concentration post alum treatment was 1.27 ppb mg/L, which is a 98% reduction in concentration compared to the pre-treatment average. The pre-treatment average, 63.32 ppb, was calculated using five and a half years worth of data (approximately 2011 – end of March 2017). The post-treatment average, 1.27 ppb, was calculated using about a year's worth of data (approximately April 2017 – April 2018), due to the reporting deadlines associated with the grant.

Table 17 Alum Treatment (In-Lake) Project Costs

Name	Designs	Implementation/ Construction	Construction Oversight	Permitting	Monitoring	Total (not including personnel)
Alum Treatment (In-Lake)	$7,887.00	$437,831	$6,592.88	$2,874.76	$10,000.00	$465,185.64

Post alum treatment results show dramatic decreases in in-lake phosphorus loadings, as well as a significant decrease in the duration and severity of the fall microcystin toxicity.

Due to the shorter toxic conditions, the City only had to close the lake for approximately three weeks in fall 2017 as opposed to the approximately three months in the previous fall 2016.

PROJECT NAME: PINTO LAKE COUNTY RD SEDIMENT CONTROL PRACTICES

Location: The project is located within the following specific USGS 7.5 minute topographic quadrangles: Watsonville, Township 11S, Range 2E, Section 20, ¼ Section NW. The property is located adjacent to Amesti Creek at the northeast boundary of Pinto Lake Park (757 Green Valley Road in Watsonville, CA 95076). The project area is owned and operated by Santa Cruz County Parks.

Practice Type: Sediment Control - Rolling Dips

Acres treated: 2.5 acres

GPS point of implementation site: 36°57'42.66"N, 121°46'32.46"W

PAEP Targets

» TAC approval of tributary treatment program and design, which includes a design reduction of 50% of the phosphorus load over the course of the useful life of the selected practice.

» Successful installation of treatment system in tributaries.

PROJECT DESCRIPTION

The project constructed five (5) rolling dips, forty (40) linear feet of drainage swale, and repaired existing ruts on the road prior to the grading and installation of 950 sq ft of Class II aggregate road base. Prior to the project, there was considerable storm water that flowed down the road during the rainy season, carrying with it sediment from the roadway as well as landslides that were occurring adjacent to the road. The intent of the road improvement practices is to redirect storm water to reduce erosion and sediment inputs into the Amesti mainstem and Pinto Lake. This project was implemented under the Santa Cruz County Partners in Restoration Permit Coordination Program and required coordination with the following permitting agencies: CCRWCQB, CDFW and the Santa Cruz County Master Permit.

Photo 21 Downcutting observed prior to implementation, on the access road.

Photo 22 Downcutting and erosion farther up the road from photo 21, on the access road.

Photo 23 The implemented rolling dips in action, moving water off the access road to inhibit downcutting.

Photo 24 The implemented rolling dips in action, moving water off the access road to inhibit downcutting, October 28, 2016

PROJECT EFFECTIVENESS EVALUATION

Narrative Baseline Conditions

Amesti Creek, a tributary to Pinto Lake, is highly ephemeral and dependent on rainfall. The Creek is crossed by a Pinto Lake County Park access road. This road is prone to erosion resulting in highly sediment-laden stormwater runoff entering the Amesti Creek.

Photo 25 Pinto Lake, at the Amesti Creek tributary, December 2015

Photo 26 Image 26: Amesti Creek, upstream, March 2016

Photo 27 Amesti Creek, downstream, March 2016

Photo 28 Pinto Lake County Park access road, adjacent to Amesti Creek, March 2016

Summary of Data

Parameters monitored were ammonia, nitrate, TKN, TP, and TSS.

Monitoring Schedule

Figure 15 The Pinto Lake County Rd Sediment Control Practice monitoring sites, of the Pinto Lake Restoration Project

After the Rolling Dips were constructed, the intent was to monitor the stormwater runoff entering and exiting the Dips. However, the Dips were 100% successful in diverting runoff into surrounding vegetation, leaving no runoff to exit the Dips into the Amesti Creek. Therefore, samples were taken at a point entering the Dips (PLAmestiUp) and in the Creek itself (PLAMESTI).

Photo 29 City staff collecting samples from upstream of the Pinto Lake County Rd Sediment Control Practice Rolling Dips, December 2016.

Table 18 Summary of the Pinto Lake County Rd. Sediment Control Practice Monitoring Schedule

Parameter	Location	Frequency
Ammonia	PLAMESTI	3 pre-implementation storms, 3 post-implementation storms
	PLAmestiUp	3 post-implementation storms
Nitrate	PLAMESTI	3 pre-implementation storms, 3 post-implementation storms
	PLAmestiUp	3 post-implementation storms
TKN	PLAMESTI	3 pre-implementation storms, 3 post-implementation storms
	PLAmestiUp	3 post-implementation storms
TP	PLAMESTI	3 pre-implementation storms, 3 post-implementation storms
	PLAmestiUp	3 post-implementation storms
TSS	PLAMESTI	3 pre-implementation storms, 3 post-implementation storms
	PLAmestiUp	3 post-implementation storms

Analytical Methods

Table 19 Summary of Analytical Methods for the Pinto Lake County Rd Sediment Control Practice

Analytical Method	Analyte	Container	Preservative	Hold time
Standard Methods 4500-NH3 B&C	Ammonia	250mL Poly	H2SO4 to pH<2	28 days at 4°C
Standard Methods 4500-NH3 D				
Standards Method 2540 D.	TSS	1000mL Poly	None	72 hours at 4°C
US EPA Method 300.0	Nitrate	125mL Poly	None	48 hours at 4°C
Standard Methods 4500-NH3 BCE	TKN	500mL Poly	H2SO4 to pH<2	28 days at 4°C
US EPA Method 351.2				
Hach 8190	TP	500mL Poly	H2SO4 to pH<2	28 days at 4°C
US EPA Method 365.1				

Results and Discussion

Total Phosphorus

The dips completely eliminated the runoff from the Pinto Lake County Park access road into Amesti Creek. Therefore there was a 100% reduction of TP entering Amesti Creek from the access road. The values below represent the concentration of phosphorus prevented from entering Amesti Creek, during three separate storm events.

Table 20 Total phosphorus concentrations upstream of the post-implementation Pinto Lake County Rd Sediment Control Practice's Rolling Dips

Phosphorus as P at PLAmestiUp			
Pre-implementation Sampling Event:	8-Dec-16	15-Dec-16	3-Jan-17
Method:	Hach 8190	Hach 8190	Hach 8190
Result (mg/L):	2.1	5.1	0.52

The City used Amesti Creek as the baseline receiving water for any upstream improvements, while also sampling at the project implementation site, the dips. The additional water quality benefits in Amesti Creek show significant decreases of TP concentrations (approximately 66%) due to implementation of the dips. This was calculated using the average of the results from the three pre-implementation sampling events (1.83 mg/L), and the average of the results from the three post-implementation sampling events (0.63 mg/L). See the values, in the following tables.

Table 21 Total phosphorus concentrations in the Amesti Creek monitoring sites pre-implementation

Phosphorus as P at PLAMESTI			
Pre-implementation Sampling Event:	January 5, 2016	January 19, 2016 (AM)	January 19, 2016 (PM)
Method:	Hach 8190	Hach 8190	Hach 8190
Result (mg/L):	1.4	2.2	1.9

Table 22 Total phosphorus concentrations in the Amesti Creek monitoring sites post-implementation

Phosphorus as P at PLAMESTI			
Pre-implementation Sampling Event:	December 8, 2016	December 15, 2016	January 3, 2017
Method:	Hach 8190	Hach 8190	Hach 8190
Result (mg/L):	0.81	0.49	0.6

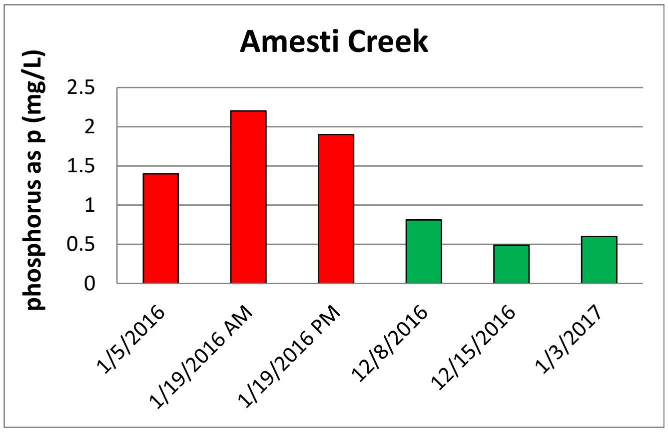


Figure 16 Total phosphorus concentrations in the Amesti Creek, with the red bars representing the pre-implementation concentrations, and the green bars representing the post-implementation concentrations.

Other Nutrients and Total Suspended Solids

The dips greatly reduced sediment loading. The RCDSCC calculated that the dips resulted in an estimated sediment load reduction of 13.54 tons per year. Furthermore, the average percent reduction of TSS in Amesti Creek was approximately 89%. This was calculated using the average of the results from the three pre-implementation sampling events (242.67 mg/L), and the average of the results from the three post-implementation sampling events (25.7 mg/L).

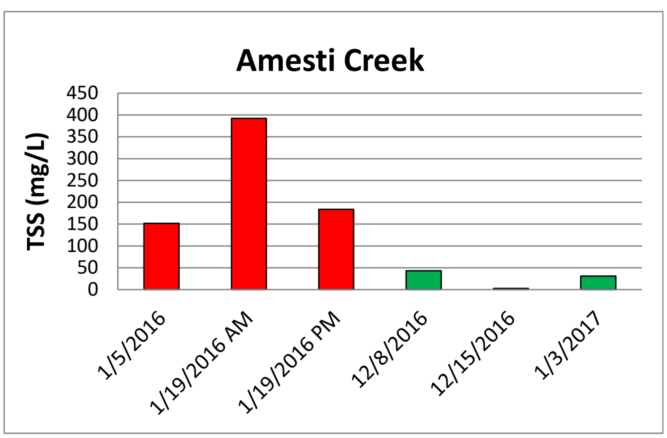


Figure 17 Total suspended sediment concentrations in the Amesti Creek, with the red bars representing the pre-implementation concentrations, and the green bars representing the post-implementation concentrations.

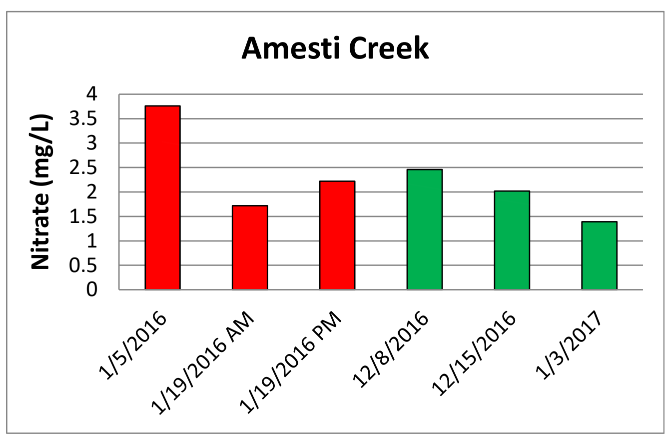


Figure 18 Nitrate concentrations in the Amesti Creek, with the red bars representing the pre-implementation concentrations, and the green bars representing the post-implementation concentrations.

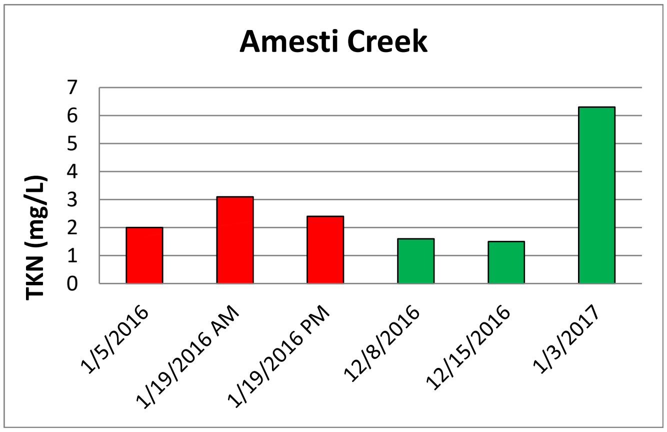


Figure 19 TKN concentrations in the Amesti Creek, with the red bars representing the pre-implementation concentrations, and the green bars representing the post-implementation concentrations.

Note that the ammonia concentrations in the Amesti Creek were all below the reporting limit (0.05 mg/L) in all the samples analyzed for the Project. Therefore, a graph was not needed.

Table 23 Pinto Lake County Rd. Sediment Control Practice Project Costs

Name	Designs	Implementation/ Construction	Construction Oversight	Permitting	Monitoring	Total (not including personnel)
Pinto Lake County Rd Sediment Control Practices	**$12365.48***	**$13,047.18**	**$2000***	**$1951.5***	**Provided by City personnel**	**$29,364.16**

**Designs, Permitting, and Construction Oversight were funded under SWRCB grant (Agreement # 13-515-553-0)*

The dips completely eliminated the runoff from the Pinto Lake County Park access road into Amesti Creek. Therefore, there was a 100% reduction of TSS and TP entering Amesti Creek from the road.

Additional water quality benefits in Amesti Creek, the baseline receiving water, show significant decreases of TP (approximately 66%) and TSS (approximately 89%) concentrations due to the implementation of the dips.

PROJECT NAME: VIRGIN MARY ROAD IMPROVEMENT PROJECT

Location: The project is located within the following specific USGS 7.5 minute topographic quadrangles: Watsonville, Township 11S, Range 2E, Section 20, ¼ Section NW. The property is located adjacent to Todos Santos Creek at the south east boundary of Pinto Lake Park (757 Green Valley Road in Watsonville, CA 95076). The project area is owned and operated by Santa Cruz County Parks.

Practice Type: Sediment Control - Reverse Grade Dips, Drainage Swale

Acres treated: 5.6 acres

GPS point of implementation site: 36°57'38.63"N, 121°46'12.46"W

PAEP Targets

» TAC approval of tributary treatment program and design, which includes a design reduction of 50% of the phosphorus load over the course of the useful life of the selected practice.

» Successful installation of treatment system in tributaries.

PROJECT DESCRIPTION

The project was identified during an on-foot survey of Pinto Lake County Park conducted during Q1 2017 and include Santa Cruz County Parks staff who contributed local knowledge. The project included implementing sediment control practices on the unpaved road leading down a steep, compacted slope to the edge of Pinto Lake and adjacent to the Todos Santos tributary to what is locally known as the "Virgin Mary Shrine." Dozens of people visit the shrine daily, and the road had become severely bare, compacted, and eroded. In addition, runoff from the upland area had concentrated and created a gully down one side of the road contributing sediment directly to Pinto Lake. Because the Pinto Lake County Park, and particularly this site, is highly visible to the public, and it is located directly adjacent to Pinto Lake, at the mouth of Todos Santos, additional work in this area was a high priority. The Project was constructed in September 2017 and consisted of minor grading of the road to repair ruts and direct runoff in a non-erosive manner by installing three reverse-grade dips and 72 linear feet of drainage swale. The project also included the installation of road surfacing, consisting of approximately 2,500 sq. ft. of Class II aggregate road base. This project only required a California Environmental Quality Act (CEQA) Notice of Exemption (NOE) and CEQA concurrence with the SWRCB as the project stayed within the footprint of the existing road and did not result in any significant environmental impacts.

Before Photo:
Approximate reverse grade dip location 1
(Direction: Looking Southwest)

During Photo:
Approximate reverse grade dip location 1
(Direction: Looking Southwest)

Post Construction Photo:
Reverse grade dip location 1
(Direction: Looking West)

Figure 20 Before and after photos of the Virgin Mary Road Improvement Project, reverse grade dip 1.

Before Photo: Staging Area.
(Direction: Looking Southwest)

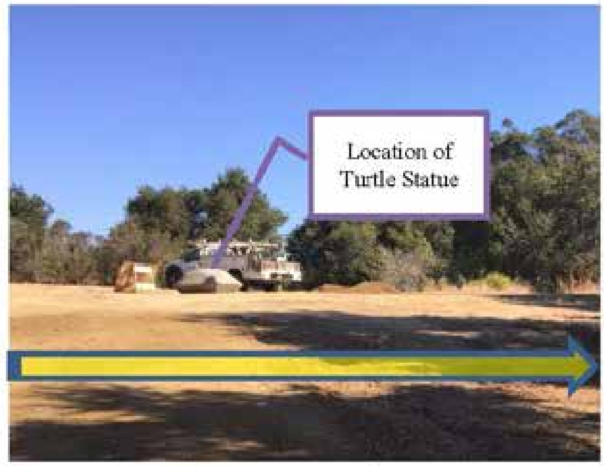
During Photo: Staging Area
(Direction: Looking Southwest)

Before Photo: Start of erosion leading to downstream gully.
(Direction: Looking Northeast)

After Photo: Staging Area
(Direction: Looking South)

Figure 21 Before and after photos of the Virgin Mary Road Improvement Project, staging area.

Before Photo: Approximate reverse Grade dip location 3 (Direction: Looking Southwest)



During Photo: Approximate reverse grade dip location 3 (Direction: Looking Northeast)

After photo: Reverse grade dip location 3 (Direction: Looking Southwest)

After photo: Reverse grade dip location 3 (Direction: Looking South)

Figure 22 Before and after photos of the Virgin Mary Road Improvement Project, staging area.

 Before Photo: Approximate location of 72 linear feet of drainage swale. Gully can be seen adjacent and to the right of the blue line. (Direction: Looking West)	 During Photo: Approximate location of 72 linear feet of drainage swale. Gully repair can be seen adjacent and to the right of the blue line. (Direction: Looking West)
 After Photo: Location of 72 linear feet of drainage swale. (Direction: Looking West)	 After Photo: Location of 72 linear feet of drainage swale. (Direction: Looking East)

Figure 23 Before and after photos of the Virgin Mary Road Improvement Project, drainage swale.

Before Photo: Approximate location of culvert inlet to transport water under the road. Gully can be seen adjacent and to the right of the blue line. (Direction: Looking West)

After Photo: Culvert inlet location. (Direction: Looking West)

Photo 6: Bottom Section of the Road, Adjacent to Pinto Lake.

Before Photo: Erosion can be seen on bottom section of road before it drains to lake. Gully can be seen adjacent and to the right of the blue line. (Direction: Looking West)

After Photo: Gully has been filed and road has been sloped to address future surface flows. (Direction: Looking West)

Figure 24 Need Caption 22.1

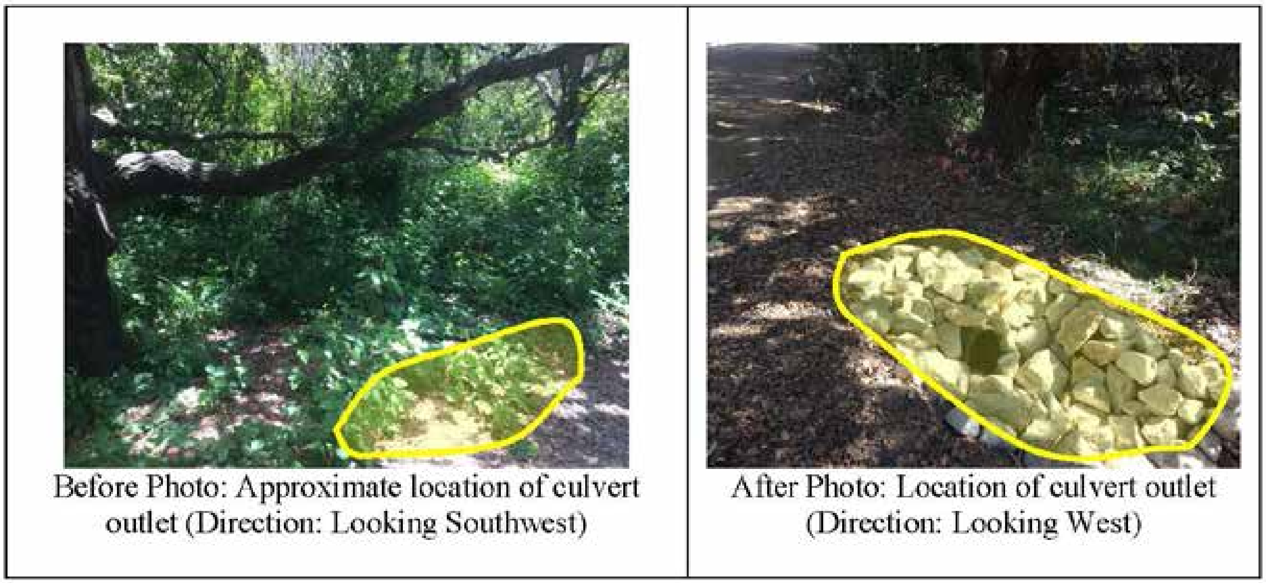


Figure 25 Before and after photos of the Virgin Mary Road Improvement Project, culvert outlet location.

PROJECT EFFECTIVENESS EVALUATION

Narrative Baseline Conditions

The Virgin Mary Road provides public access to a viewing and fishing platform in the Pinto Lake County Park. This road is prone to erosion resulting in highly sediment-laden stormwater runoff entering the Pinto Lake.

Summary Of Data

Parameters monitored were ammonia, nitrate, TKN, TP, and TSS.

Monitoring Schedule

Figure 26 The Virgin Mary Road Improvement Project monitoring sites of the Pinto Lake Restoration Project.

After the rolling dips were constructed, the intent was to monitor the stormwater runoff entering and exiting the dips. However, the dips were 100% successful in diverting runoff into surrounding vegetation, leaving no runoff to exit the Dips (at the PLVIRGINsite) into Pinto Lake. Therefore, samples were taken at a point entering the Dips (PLVIRGININLET).

Photo 30 At the first Rolling Dip, on the Virgin Mary Road Improvement Project, during an active storm, November 16, 2017.

Table 24 Summary of the Virgin Mary Road Improvement Monitoring Schedule

Parameter	Location	Frequency
Ammonia	PLVIRGIN	3 pre-implementation storms, 3 post-implementation storms
	PLVIRGINLET	No runoff from storms to be monitored
Nitrate	PLVIRGIN	3 pre-implementation storms, 3 post-implementation storms
	PLVIRGINLET	No runoff from storms to be monitored
TKN	PLVIRGIN	3 pre-implementation storms, 3 post-implementation storms
	PLVIRGINLET	No runoff from storms to be monitored
TP	PLVIRGIN	3 pre-implementation storms, 3 post-implementation storms
	PLVIRGINLET	No runoff from storms to be monitored
TSS	PLVIRGIN	3 pre-implementation storms, 3 post-implementation storms
	PLVIRGINLET	No runoff from storms to be monitored

Table 25 Summary of Analytical Methods for the Virgin Mary Road Improvement Monitoring.

Analytical Method	Analyte	Container	Preservative	Hold time
Standard Methods 4500-NH3 B&C	Ammonia	250mL Poly	H2SO4 to pH<2	28 days at 4°C
Standard Methods 4500-NH3 D				
Standards Method 2540 D.	TSS	1000mL Poly	None	72 hours at 4°C
US EPA Method 300.0	Nitrate	125mL Poly	None	48 hours at 4°C
Standard Methods 4500-NH3 BCE	TKN	500mL Poly	H2SO4 to pH<2	28 days at 4°C
US EPA Method 351.2				
Hach 8190	TP	500mL Poly	H2SO4 to pH<2	28 days at 4°C
US EPA Method 365.1				

Results and Discussion

Total Phosphorus

As the Dips completely eliminated the runoff from the Virgin Mary Road into Pinto Lake, there was a 100% reduction of TP entering the Lake. The values below represent the concentration of phosphorus during three separate storm events.

Table 26 Total phosphorus concentrations at the Virgin Mary Road Improvement monitoring sites, post-treatment.

Phosphorus as P at PLVIRGININLET			
Pre-implementation Sampling Event:	November 16, 2017	January 8, 2018	March 1, 2018
Method:	US EPA 365.1	US EPA 365.1	US EPA 365.1
Result (mg/L):	2.4	0.49	0.35

Other Nutrients and Total Suspended Solids

The dips greatly reduced sediment loads. The RCDSCC calculated that the dips resulted in an estimated sediment load reduction of 5.62 tons per year.

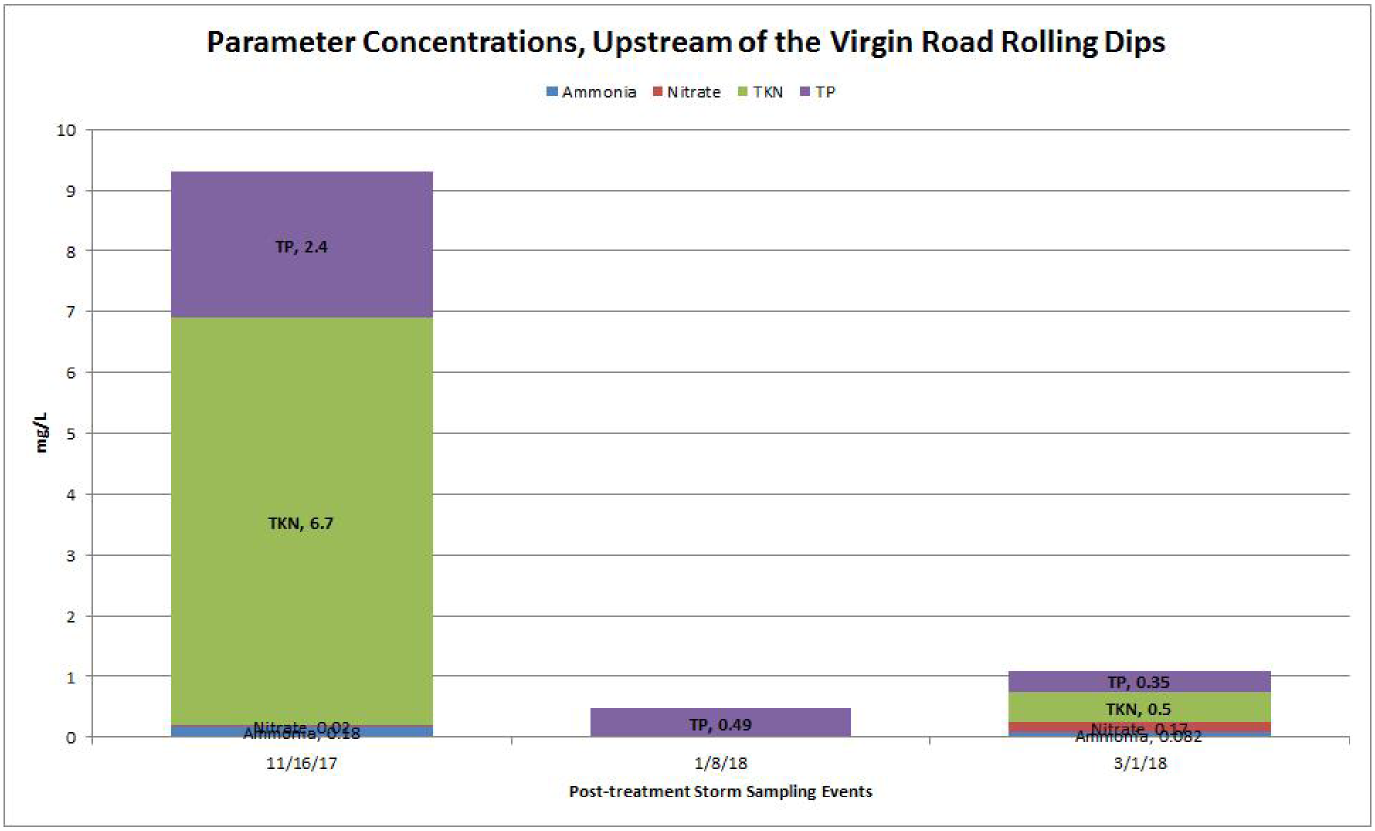


Figure 27 The monitored parameter concentrations upstream of the rolling dips.

Table 27 Virgin Mary Road Improvement Project Costs

Name	Designs	Implementation/ Construction	Construction Oversight	Permitting	Monitoring	Total (not including personnel)
Virgin Mary Road Improvement Project	4,990.00	37,682.25	7,179.83	50.00	Provided by City personnel	$53,999.23

The dips completely eliminated the runoff from the Virgin Mary Road into Pinto Lake. Therefore there was a 100% reduction of TSS and TP entering the Lake.

PROJECT NAME: COUNTY PARK PUMP TRACK FILTER STRIP PROJECT

Location: The project is located within the following specific USGS 7.5 minute topographic quadrangles: Watsonville, Township 11S, Range 2E, Section 20, ¼ Section NW. The property is located adjacent to Todos Santos Creek at the north east boundary of Pinto Lake Park (757 Green Valley Road in Watsonville, CA 95076). The project area is owned and operated by Santa Cruz County Parks.

Practice Type: Vegetative Filter Strip

Acres treated: 0.55 acres

GPS point of implementation site: 36°57’53.44”N, 121°46’13.06”W

PAEP Targets

» TAC approval of tributary treatment program and design, which includes a design reduction of 50% of the phosphorus load over the course of the useful life of the selected practice.

» Successful installation of treatment system in tributaries.

PROJECT DESCRIPTION

The County Park Pump Track Filter Strip Project is designed as a BMP to minimize and mitigate pollutant and hydrologic impacts associated with the Pinto Lake Bike Pump Track Project. Stormwater run-off from the bike pump track will be directed to catch basins within the pump track and then outleted to the vegetated filter strip via an 8” storm drain pipe. At the outlet of the storm drain, a flow spreader will be installed. Due to the timing of the installation of the vegetated filter strip, installation of the flow spreader will be performed by a contractor working under the direction of Santa Cruz County Parks Department after completion of the vegetated filter strip and during construction of the pump track during the summer of 2018. Once stormwater exits the flow spreader, the vegetated filter strip is designed to support sheet flow of water over the vegetation. Native perennial vegetation has been planted to slow the water, reduce the likelihood of erosion, and promote infiltration and bioreaction to reduce any potential pollutant loading into the downstream Todos Santos creek and Pinto Lake.

Following staking of the site location by a Santa Cruz County Parks Department designee, site preparation included clearing and grubbing of the area to remove all vegetation. Site preparation work was done with a tractor and bucket with a roto-tiller and box scraper to establish grades generally consistent with those shown in the engineers drawings for the Pump Track Project. Following site clearing and grubbing and associated site preparation, lines of 0.5 gph inline drip tubing was run throughout the site at 1’ intervals and stapled in place. Following installation of the drip tubing, a biodegradable coco-fiber erosion control blanket was stapled in place throughout the area of the vegetated filter strip. Irrigation was connected to the existing irrigation line between the project site and the parking area. Work entailed connecting a 1” pvc irrigation line and associated trenching from the existing line to a utility box placed at the project site. A battery operated solenoid valve was placed within the box to operate the drip system.

Following site preparation, 1746 native plants were installed at 1’ – 18” on center, depending on species type, throughout the project area, per the plant list in **Table 28.** Maintenance will consist of regular irrigation, bi-weekly for the first few weeks and tapering off to monthly through the growing season. Non-native plants will be removed as needed to facilitate establishment of native perennial plants. Watsonville Wetlands Watch staff will also meet with the contractor who will be installing the flow-spreader and do any post installation maintenance actions needed. Because of the timing of the grant, maintenance and irrigation may be incorporated into the plant unit cost as needed. The maintenance period will extend through July 2019 or beyond as funding is available. Per plant unit costs are expected to therefore be approximately $8.50 per unit.

Table 28 Native Plants

<table>
<tr><th>Species</th><th>Common Name</th><th>Size</th><th>Total</th><th>Seed</th></tr>
<tr><td>Artemisia douglasiana</td><td>Mugwort</td><td>2x5”</td><td>17</td><td rowspan="5">4 lb (PLS)
Elymus glaucus
(Wild Blue Rye)</td></tr>
<tr><td>Carex barbarae</td><td>Santa Barbara sedge</td><td>3”</td><td>110</td></tr>
<tr><td>Carex tumilacola</td><td>Hill-dweller sedge</td><td>3”</td><td>45</td></tr>
<tr><td>Elymus glaucus</td><td>Blue wild rye</td><td>cones</td><td>700</td></tr>
<tr><td>Elymus triticoides</td><td>Creeping wild rye</td><td>3x5”</td><td>80</td></tr>
<tr><td>Festuca rubra</td><td>Creeping red fescue</td><td>cones</td><td>600</td><td rowspan="5">3 lb (PLS)
Horeum bracyantherum
Meadow Barley</td></tr>
<tr><td>Juncus patens</td><td>Spreading rush</td><td>cones</td><td>160</td></tr>
<tr><td>Sisyrinchium bellum</td><td>Blue eyes grass</td><td>3”</td><td>12</td></tr>
<tr><td>Stachys ajugoides</td><td>Woodmint</td><td>3”</td><td>7</td></tr>
<tr><td>Symphyotrichum chilense</td><td>California Aster</td><td>3”`</td><td>15</td></tr>
</table>

Photo 31 Before photo of location of County Park Pump Track Filter Strip Project. Looking downstream towards the riparian area adjacent to Todos Santos (trees seen in background of photo).

Photo 32 After photo of newly planted County Park Pump Track Filter Strip Project. Looking downstream towards the riparian area adjacent to Todos Santos (trees seen in background of photo).

PROJECT EFFECTIVENESS EVALUATION

Narrative Baseline Conditions

The vegetative filter strip will drain stormwater associated with the planned Santa Cruz County Park bicycle pump track and adjacent residential mobile home park. A pump track is a type of off-road terrain for cycle sport consisting of a circuit of banked turns and features designed to be ridden completely by riders "pumping" - creating momentum by up and down body movements. The area where the pump track is to be implemented is currently open space vegetated by volunteer vegetation during the winter and spring seasons. The area is not irrigated in the summer. The pump track will consist of a variety of unpaved compacted bicycle jumps. Compacted soil is susceptible to breaking down, and weather and user-based erosion is expected. Erosion concerns on pump tracks are similar to those on a BMX track, dirt jumps or flow trails.

Due to the timing of implementation of the County Park Pump Track Filter Strip Project, which occurred after the 2017-18 winter rains, and directly prior to the end of the grant in June 2018, **water quality monitoring was not possible**. Instead City staff estimated load reductions utilizing the EPA Region 5 model.

Monitoring Schedule

Not Applicable.

Analytical Methods

The US EPA Region 5 model was used to estimate load reductions from the County Park Pump Track Filter Strip Project. The US EPA Region 5 model developed to measure water quality impacts at the conservation level. Assumptions included in the model include:

» The amount of sediment delivered to the edge of the field may be 100% in the case of streambank or gully erosion sites directly on or adjacent to a water body. In the case of upland erosion sites, the percent of soil delivered to the water as sediment will be less than 100%.

» Once the system of BMPs is established, the stabilized condition is assumed to control all the erosion. Therefore the "before" condition is measured in average annual tons of sediment generated (i.e. without treatment), and the "after" condition (after treatment) is assumed to be negligible.

» Phosphorus and nitrogen reductions are assumed to come from reduction in sediment-borne nutrients. Nutrients that are dissolved and carried by runoff waters are not included.

The benefits of the simplistic nature of the US EPA Region 5 Model are that it allows for less technical and complex data entry than many other models, and it has lower margin of error than more complex load estimation tools.

Results and Discussion

Table 29 Estimated load reduction from the implementation of the County Park Pump Track Filter Strip

Parameter	Load before BMP (lbs/yr)	Load after BMP (lbs/yr)	Load Reduction (lbs/yr)
TSS	3,534	954	2,580
TN	68	41	27
TP	10	6	5

Table 30 Virgin Mary Road Improvement Project Costs

Name	Designs	Implementation/ Construction	Construction Oversight	Permitting	Monitoring	Total (not including personnel)
County Park Pump Track Vegetated Filter Strip	Included in implementation cost	$25,201.52	$8,305.00	0*	Provided by City personnel	$41,518.50
*CEQA NOE covered as part of Pinto Lake Winter Preparedness Program						

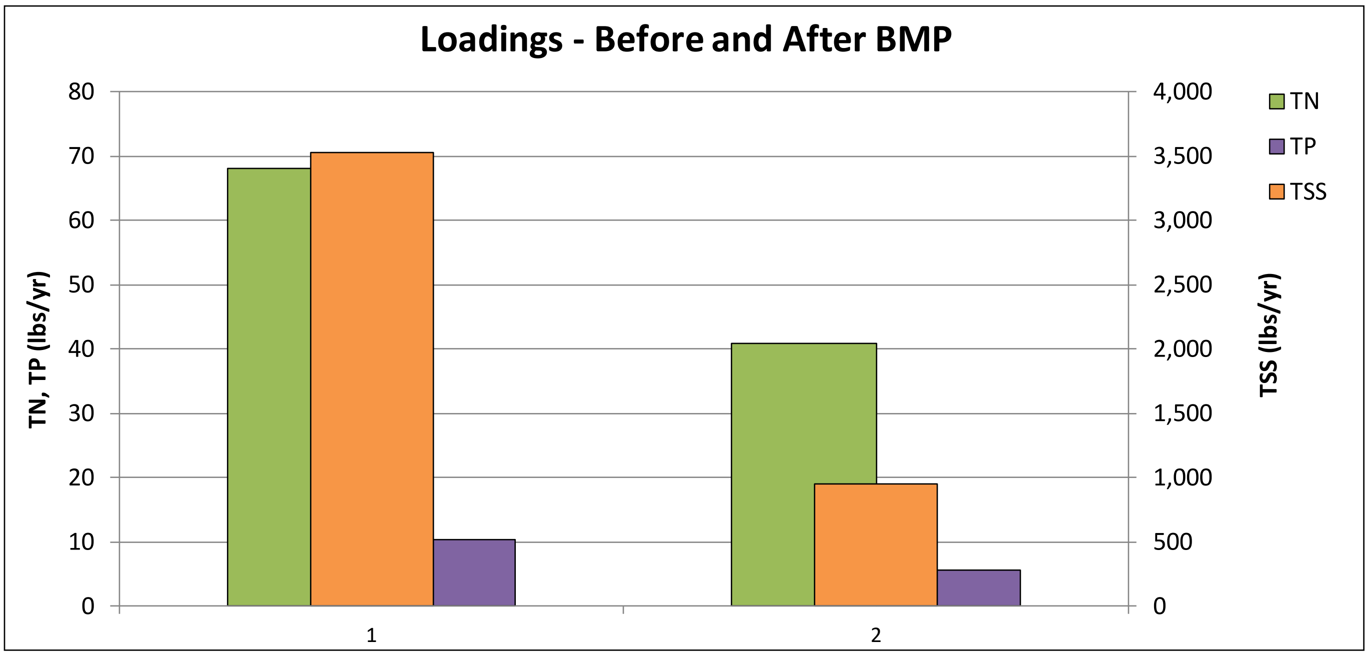


Figure 28 The estimated load reduction before and after the implementation of the County Park Pump Track Filter Strip

The estimated post-implementation load reductions show decreases of the TSS (approximately 73%), TN (approximately 40%) and TP (40%) entering Todos Santos Creek, a tributary to Pinto Lake.

ADAPTIVE MANAGEMENT

The task of Adaptive Management was included as part of this agreement as complex issues surrounding the Pinto Lake Watershed have and will continue to require the establishment and maintenance of partnerships between managers, scientists, and other stakeholders to ensure progress towards a more sustainable ecosystem. The task of Adaptive Management allowed City staff to maintain flexibility in their decisions, knowing that uncertainties would exist. This provided the latitude to adjust direction to improve progress towards desired outcomes.

Below are some examples of Adaptive Management Actions that were taken during the agreement:

- In August of 2015, City staff worked with the Grant Manager to execute a deviation request to align the language in the grant agreement with most recent recommendations made by the TAC. Under the original grant agreement language, the only authorized treatment option to reduce nutrient loads to Pinto Lake for the tributaries was alum/polymer treatment. However, upon review of current viable treatment options, the TAC recommended that implementation of management measure(s) in the tributaries was the preferred option and a greater priority. As such, the deviation was executed, and the City worked with RCDSCC staff to implement sediment management practices in the tributaries.
- During Q3 2016, HAB Aquatic Solutions, LLC. and the City realized upon review of the in-lake treatment design, that the majority of the alum treatment would bind the phosphorus and treat a minimal amount of nitrogen. As such, City staff initiated discussions with the grant manager to determine the best way to align goals and objectives of the grant with the latest information, as well as the most recent updates to the Pajaro Nutrient TMDL. As a result of these discussions a grant amendment was completed.
- During Q4 2017 the City and RCDSCC explored the idea of implementing a small floating island within Pinto Lake to uptake additional nutrients outflowing from the tributaries. RCDSCC and City staff spent time contacting the floating island distributor and coordinating with Watsonville Wetlands Watch and Waterways Engineering to discuss feasibility. Ultimately it was decided that given the current funding constraints, it would not be possible to implement an island large enough to provide the uptake warranted for the expenditure of funds. Furthermore, there currently exists an aversion by the public regarding floating islands in Pinto Lake as a result of the natural floating island that occurred in 2016, and ultimately damaged the fishing dock forcing a temporary closure of access to the lake. As such, the City decided not to pursue this alternative under this grant agreement.
- As part of the adaptive management requirement task, the City worked with partners to determine what next steps to take in the watershed. As an outcome of the TAC meeting, it was determined that Santa Cruz County Environmental Health would continue to sample TP/TKN in the watershed, start source control monitoring from septic systems on the Amesti side of the lake, and try to rehabilitate the wells that were funded in the prior 319(h) planning and assessment grant. The rehabilitation of the wells would allow Santa Cruz County to sample for phosphorus constituents to rule out shallow groundwater influences into the lake.

EDUCATION AND OUTREACH

The City utilized City Council and Friends of Pinto Lake meetings to engage stakeholders. In April 2016 staff presented to Council about the intended implementation grant and expected outcomes. City Council meetings are televised and recorded so that residents can watch again later. The City attended multiple Friends of Pinto Lake meetings prior to implementation. Approximately 15 people attended each meeting. Questions that came out of that meeting involved habitat, wildlife and expected usage of the lake in the long term. City staff plans on presenting the final results to City Council in June 2018.

During alum treatment, the City engaged local TV news station KSBW, Santa Cruz Sentinel, and the Register Pajaronian to the lake to discuss the treatment with HAB Aquatic Solutions, LLC and City staff. The City also had Regional Board representatives from the Central Valley and Central Coast visit the lake during treatment. HAB Aquatic Solutions, LLC created a website (https://pintolakealum.wordpress.com/) for community members, regulatory agencies, or other municipalities considering alum treatment to follow the progress of Pinto Lake's alum treatment. During the treatment, the City hosted approximately 35 University of Liverpool students (Professor John Boyle) visiting the lake. Dr. John Holz led a discussion on nutrient balancing in the watershed as well as highlighted the treatment that was occurring at the lake.

The City, in partnership with the RCDSCC, outreached to growers and residents within the Pinto Lake Watershed to raise awareness of the services available and to identify landowners interested in receiving technical assistance and/or in participating in the implementation of a sediment control project. The RCDSCC leveraged existing outreach channels including community meetings on related water quality topics, grower tailgates, workshops, Farm Bureau meetings and newsletters, industry meetings, referrals, and one-on-one site visits. The RCDSCC reached over 5000 people through these outreach channels. As a result, 10 landowners requested site assessments through this grant. Additional growers requested technical assistance for conservation which the RCDSCC provided through alternate funding programs.

The following outreach and education products were achieved:

- Brochures in English and Spanish were created for distribution at watershed stakeholder meetings highlighting erosion control, nutrient management, and septic tank maintenance.
- Postcard invitations were mailed in Q2 2017 to all property owners in the Pinto Lake Watershed (526 total) for the July 31 stakeholder meeting (workshop #1). This workshop (#1) was a general public event to discuss ongoing sediment reduction work and alum treatment.
- Workshop #2 was conducted on November 16, 2017 and presented on how residents can prepare for winter storms in a manner that protects their properties and the environment. Specifics included drainage, road management, stream and riparian protection, well and septic maintenance and local assistance programs and resources available to landowners. Related publications were handed out to participants along with a winter preparedness checklist.
- A community volunteer planting day was held n November 18, 2017 with Watsonville Wetlands Watch in the Santa Cruz County Park (workshop #3). The event was well attended, and almost 400 plants were planted around Santa Cruz County's sediment basin located on CCC creek (implemented with previous 319(h) funding- Agreement #13-515-553) to provide winter erosion control of the bank and upstream area.
- RCDSCC staff collaborated with UCCE and a strawberry grower to host a cover crop workshop on October 12, 2017 (workshop #4). While the workshop took place outside of the Pinto Lake Watershed (in Las Lomas), 2 growers who operate within the Pinto Lake watershed attended (out of a total 10 grower attendees). Topics discussed included the benefits, challenges, and management strategies for cover crops to control winter erosion and other scenarios.
- On October 24, 2017 RCDSCC conducted a site visit with a grower along the CCC drainage of Pinto Lake to discuss winter preparedness and erosion control strategies to reduce runoff and maximize effectiveness of the newly installed downstream sediment basin on the Santa Cruz County Park property.

Photo 33 Volunteers helped put over 350 native plants in the ground surrounding the sediment basin at Pinto Lake.

» During Q3 2017, after awarding the contract to the Virgin Mary Rd Improvement Project contractor, the City, RCDSCC and the grant manager discussed how best to utilize the remaining grant funds. As part of these discussions, the group decided to execute Pinto Lake Winter Preparedness Program for the 2017-2018 fall and winter season, including a fifth workshop. As part of this program, RCDSCC staff prepared and distributed outreach materials in English and Spanish for the 2017 Winter Preparedness - Ca$h for Cover, cover crop seed rebate program. Four growers within the Pinto Lake watershed applied for cover crop seed rebates for winter erosion control. 157 acres were cover cropped across the four participating ranches. RCDSCC staff assisted growers with rebate applications and provided technical advice on seed selection and cover crop establishment and management.

» RCDSCC staff, in coordination with UC Cooperative Extension and the USDA Agricultural Research Service, hosted an additional winter preparedness workshop (workshop #5) focused on cover crops on April 5, 2018. The workshop, while hosted at a farm in the Watsonville Slough watershed, targeted growers in the Pinto Lake watershed and was an opportunity for growers to engage in peer to peer learning while sharing their experiences and learning about the latest research for cover crops as a strategy to control erosion, save water, and build soil health. The RCDSCC mailed invitations to the Cover Crop Workshop to 116 ag operators and large parcel owners in the Pinto Lake watershed.

Photo 34 Growers learn about the benefits of cover crops in reducing sediment and nutrients to waterways.

» A family oriented outreach event titled "I Spy Science" (workshop #6) was held on May 19, 2018 and engaged the public while inspiring a sense of responsibility and stewardship for the Pinto Lake. Various activities were available for the public to engage in during the event that included testing your observation skills in a plant and animal ID and treasure hunt, conducting water and soil tests, meeting captive native salamanders, turtles, and other critters, learning fishing basics and safety related to Pinto Lake, hearing about a day in the life of a field scientist and exploring a groundwater education trailer.

» Three interpretive signs were designs and installed to inform park visitors about BMPs implemented with grant funds as well as educate them on the issues facing Pinto Lake.

» Two Pinto Creek signs were installed where Pinto Creek crosses Pioneer Road to help inform residents of the connection of the local creeks and runoff to Pinto Lake.

Figure 29 Pinto Lake iSpy Science event poster.

CONCLUSIONS, LESSONS LEARNED AND FOLLOW UP ACTIVITIES

PAEP RESULTS

The focus of this grant agreement was to reduce pollutant loads per the TMDL to restore the nonpoint source nutrient impaired Pinto Lake. The City successfully achieved or exceeded all PAEP targets. Ongoing evaluations of practice effectiveness will continue beyond the grant period to more accurately assess and demonstrate the achievement of pollutant reduction targets called out in the PAEP. The table below indicates the project goals and targets laid out in the PAEP, and the results achieved through this grant agreement.

Table 31 PAEP Results

Goal	Targets	Results
1. Design tributary treatment program	TAC approval of tributary treatment program and design, which includes a design reduction of 50% of the phosphorus load over the course of the useful life of the selected practice.	Three (3) sediment control practices were implemented adjacent to Pinto Lake Tributaries. Two of the practices resulted in 100% sediment bound phosphorus load reduction, and the third due to timing was not able to be monitored prior to the end of the grant agreement. However, it is estimated that it will achieve a similar target as the other two practices during the next winter season.
2. Design in-lake treatment program	TAC approval of lake treatment program and design which includes a design reduction of 80% of the nutrient load. 95% coverage of lake Plan of monitoring locations.	Design approved to reduce 80% of phosphorus load in-lake, covering 95% of lake surface. Long-term monitoring locations established.
3. Implement strategies to reduce the internal and external nutrient loads causing cyanobacteria	Successful installation of treatment system in tributaries and lake.	Treatment systems in the lake and tributaries were installed successfully.
4. Education and Outreach	A minimum of four (4) stakeholder meetings will be conducted Follow-up with a minimum of 10% of bilingual growers attending Spanish stakeholder meeting(s).	Six (6) stakeholder workshops were conducted as well as a Pinto Lake Winter Preparedness Program during the 2017-18 winter season that resulted in the implementation of over 157 acres of agricultural lands being cover cropped. All bilingual growers requesting additional support were provided with assistance.
5. Post Treatment Analysis	Measure by means of depth samples that nutrient loading has been reduced. The key indicators will be total phosphorus and orthophosphate reductions. Reduction in cyanobacteria blooms evaluated by concentration. Any reduction in required posted warnings at Pinto Lake, as Pinto Lake is posted year round. Increased number of visitors at Pinto Lake measured by comparing number of visitors per year.	The average lake-wide percent reduction, in TP, was 91%. The average lake-wide percent reduction, in orthophosphate, was 98%. The average microcystin concentration post alum treatment was 1.27 ppb, which is a 98% reduction in concentration[7]. Due to shorter cyanobacteria bloom duration, post alum treatment, the City only had to close the Lake for approximately three weeks in Fall of 2017 as opposed to the approximately three months in the previous Fall of 2016. The City saw an average of 1000 visitors to the park in 2016-2017.

7 The pre-treatment average, 63.32 ppb, was calculated using 5 and half years worth of data (approximately October 2011 – end of March 2017). The post-treatment average, 1.27 ppb, was calculated using about a year's worth of data (approximately April 2017-April 2018), due to the reporting deadlines associated with the grant.

PROJECT COST

Table 32 Grant Budget

Activity	Grant Allotment (w/Adjustments)	Total Match Required (w/Adjustments)	Total Budget
Personnel Services	$72,362.00	$0.00	$72,362.00
Operating Expenses	$0.00	$0.00	$0.00
Professional/ Consultant Services	$677,638.00	$0.00	$677,638.00
Construction	$0.00	$0.00	$0.00
TOTAL	$750,000.00	$0.00	$750,000.00
Activity	**Actual Grant Funds Spent (Expected)**	**Actual Match Provided (Expected)**	**Total Grant Cost**
Personnel Services	$72,362.00	$0.00	$72,362.00
Operating Expenses	$0.00	$0.00	$0.00
Professional/ Consultant Services	$577,638.00	$0.00	$577,638.00
Construction	$100,000.00	$0.00	$100,000.00
TOTAL	**$750,000.00**	**$0.00**	**$750,000.00**

The City is considered a Disadvantaged Community (DAC) which allowed staff to apply for a funding match waiver, which was granted, therefore no match was required. The TAC recommended implementation of management measure(s) in the tributaries was preferred and a greater priority rather than polymer injection systems in the selected tributaries of concern. As a result, $100,000 was transferred from the Professional Consultant category to the Construction category to aid in implementation of sediment control practices.

CONCLUSIONS, LESSONS LEARNED AND FOLLOW UP ACTIVITIES

This section discusses conclusions and lessons learned. This grant achieved or exceeded all the goals it set out to achieve. Primarily, microcystin concentrations and duration of blooms are dramatically reduced. Phosphorus and sediment loading from the watershed was reduced. Additionally, this grant succeeded in reaching out to the public through a number of public meetings and events. In evaluating grant activities, several lessons were learned that can inform future grants and/or implementation efforts in the watershed.

CONCLUSIONS

Following alum treatment, microcystin concentrations were dramatically reduced. The graph below displays the total microcystin, at the Pinto Lake City Park (PLS5), spanning pre (October 2011 - March 2017) and post (April 2017 through April 2018) alum treatment. The data confirms that the post alum treatment concentrations have stayed well below extreme concentrations, seen in years 2011-2016.

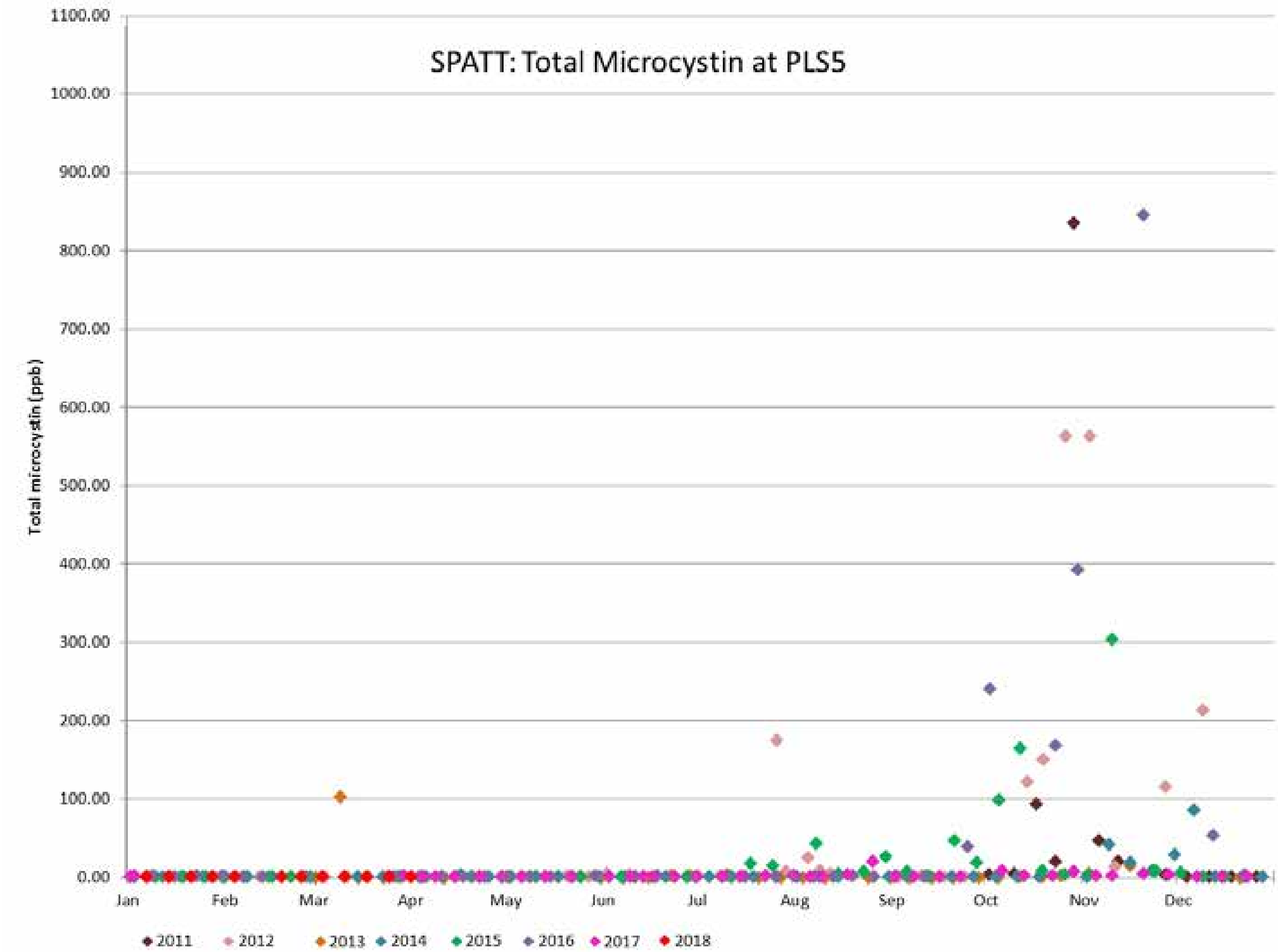


Figure 30 The total microcystin, spanning alum treatment, measured by Raphe Kudela at the Pinto Lake City Park dock (PLS5)

Sensitivity to collection of public data

As mentioned previously, some landowners communicated to the RCDSCC and the City that they were interested in implementing the identified practices, but were not interested in cost share assistance as part of grant agreement #14-424-253, due to a perceived liability associated with the pubic nature of on-site water quality and monitoring data that would be collected.

Value of stakeholder collaboration

This grant agreement provided a unique opportunity for Pinto Lake stakeholders to interact with each other whether through TAC meetings, outreach and education events, or through participation in technical assistance and implementation. These interactions assisted in building trust, increasing the effectiveness of individual projects, and supporting a consistent long-term approach to implementing pollution reduction strategies throughout the watershed.

A highlight of the project was engaging the community during outreach events. A particularly successful event was the iSpy Science event on May 19, 2018. The City had approximately 250 visit the lake to learn about water quality, wildlife and habitat. An important lesson from this event was the amount of interest in learning about the health of the lake. The community values this important free resource and would like to use it safely once the public health issues are resolved.

Managing public perceptions
The City has always been conscientious in regards to engaging and educating the community on restoration activities taking place in the watershed. Throughout the Project, the City was thoughtful in its approach to ensure that members of the public understood the importance of the project. This approach allowed the City to inform the community that alum treatment was only one of the selected management measures that was implemented in Pinto Lake. The City informed the public that this treatment would only work if there was continued long term efforts in the watershed to manage sediment and nutrient run off. In other words, the alum treatment would effectively stop blooms in the short-term, but stakeholders will need to continue to work together for the long term health of the lake and watershed.

Need for ongoing technical assistance
The City has learned through many years of working in the watershed with partners, such as the RCDSCC, that there is a need to provide ongoing technical assistance to growers, residents, and even other agencies. Going forward the City intends to continue to build upon work conducted as part of this agreement to implement additional pollution reduction strategies.

FOLLOW UP ACTIVITIES

Additional monitoring and well rehabilitation
Santa Cruz County Environmental Health will continue to sample TP/TKN in the watershed, perform source control monitoring from septic systems on the Amesti side of the lake, and attempt to rehabilitate the wells that were funded in the prior 319(h) planning and assessment grant. The rehabilitation of the wells would allow Santa Cruz County to sample for phosphorus constituents to rule out shallow groundwater influences into the lake.

Secure funding for additional implementation activities
Working with collaborating stakeholders, the City will continue to endeavor to secure funding to implement the priority projects that were identified as part of the previous 319(h) Planning and Assessment grant, that were not implemented during this grant agreement due to limited funds and time.

Continued public health monitoring
The City and Santa Cruz County will continue to monitor microcystin toxicity on a weekly basis as well as qualitatively categorize the algal species present.

APPENDICES

GLOSSARY OF ACRONYMS AND ABBREVIATIONS

Aluminum Sulfate	Alum
Best Management Practice	BMP
Central Coast Regional Water Quality Control Board	CCRWQCB
California Department of Fish and Wildlife	CDFW
California Environmental Quality Act	CEQA
City of Watsonville	The City
California State University San Marcos	CSUSM
Clean Water Act	CWA
Disadvantaged Community	DAC
Global Positioning System	GPS
Harmful Algal Bloom	HAB
Not Detected	ND
Non Point Source	NPS
Resources Conservation District of Santa Cruz County	RCDSCC
Solid Phase Adsorption Toxin Testing	SPATT
State Water Resources Control Board	SWRCB
Technical Advisory Committee	TAC
Total Kjeldahl Nitrogen	TKN
Total Maximum Daily Load	TMDL
Total Phosphorus	TP
Total Suspended Solids	TSS
University of California Santa Cruz	UCSC
United States Environmental Protection Agency	US EPA

LIST OF DELIVERABLES

Item A.1.1. HUC 12s for Project Site - Salsipuedes/Pinto Watershed

Item A.1.1. HUC 12s for Project Site - Salsipuedes/Pinto Watershed

Item A.1.1. HUC 12s for Project Site - Salsipuedes/Pinto Watershed (2).docx

Item A.1.2. Stream Reaches for Project Sites and Monitoring Locations

Item A.1.2. Stream Reaches for Project Sites and Monitoring Locations

Item A.1.2. Stream Reaches for Project Sites and Monitoring Locations.docx

Item A.2.1 Non Point Source Pollution Reduction Project Follow-up Survey Form - 2015 submittal

Item A.2.1 Non Point Source Pollution Reduction Project Follow-up Survey Form - 2015 submittal

Item A.2.1 PAEP_Revised_051716

Item A.2.1 Project Assessment and Evaluation Plan (PAEP)

Item A.2.1 Project Assessment and Evaluation Plan (PAEP)

Item A.2.1 Project Assessment and Evaluation Plan (PAEP).docx

Item A.2.2 Non Point Source Pollution Reduction Project Follow-up Form

Item A.2.2 Non Point Source Pollution Reduction Project Follow-up Form _2017 Load Reduction

Item A.2.2 Non Point Source Pollution Reduction Project Follow-up Form_DRAFT

Item A.2.2 NPS Pollution Red Form-Total Grant Summary-w corrections

Item A.3 Revised Monitoring Plan_FINAL_3.0

Item A.3 Monitoring Plan_jm 1-15-15_kw-JHmerged

Item A.3 Monitoring Report #3- 12-31-16

Item A.3 Monitoring Report #3- DepthSampling_12-5-16

Item A.3 Monitoring Report #3- PINTO_SPATT_1-2-17

Item A.3 Monitoring Report #3- TribSampling_12-15-16

Item A.3 Monitoring Report #3- TribSampling_12-8-16

Item A.3 Monitoring Report #4 - 4-20-17

Item A.3 Monitoring Report #4 - ID and Enumeration_11-4-16

Item A.3 Monitoring Report #4 - Pinto TAT Presentation 1 17 17

Item A.3 Monitoring Report #4 - PINTO_SPATT_3-25-17.xls

Item A.3 Monitoring Report #4 - TribSampling_1-3-17

Item A.3 Monitoring Report #5 - 7-20-17

Item A.3 Monitoring Report #5 - DepthSampling_4-27-17

Item A.3 Monitoring Report #5 - IDandEnumeration_11-4-16

Item A.3 Monitoring Report #5 - PINTO_SPATT_6-24-17

Item A.3 Monitoring Report #5 - RollingDips_Calculation

Item A.3 Monitoring Report #5 - TribSampling_3-24-17

Item A.3 Monitoring Report #5 - TribSampling_3-27-17

Item A.3 Monitoring Report #5 - TribSampling_4-13-17

Item A.3 Monitoring Report #5 - TribSampling_4-7-17

Item A.3 Monitoring Report #6 - 10-20-17

Item A.3 Monitoring Report #6 - PINTO_SPATT_10-17-17

Item A.3 Monitoring Report #7 - 1-20-18

Item A.3 Monitoring Report #7 - PINTO_SPATT_12-23-17

Item A.3 Monitoring Report #7 - TribSampling_11-16-17

Item A.3 Monitoring Report #8 - 3-31-18

Item A.3 Monitoring Report #8 - Data_3-27-18

Item A.3 Monitoring Report #8 - DepthSampling_2-26-18

Item A.3 Monitoring Report #8 - PL_SPATT_April2018

Item A.3 Monitoring Report #8 - TribSampling_1-8-18

Item A.3 Monitoring Report #8 - TribSampling_3-1-18_Amended

Item A.3 MonitoringPlan 2016_FINAL.pdf

Item A.3 Motioning Report #3- COC_CSUSM_11-4-16

Item A.3 Motioning Report #7- COC_CSUSM_12-19-17

Item A.3. Monitoring Plan (MP)

Item A.3. Monitoring Plan (MP)

Item A.3. Monitoring Plan (MP).docx

Item A.3. Monitoring Plan (MP)_SK.pdf

Item A.3.2 Monitoring Report #1_In-Lake Treatment_

Item A.3.2 Monitoring Report #1_In-Lake Treatment_COC_CSUSM_6-30-16

Item A.3.2 Monitoring Report #1_In-Lake Treatment_DepthSampling_4-27-16

Item A.3.2 Monitoring Report #1_In-Lake Treatment_SPATT DATA

Item A.3.2 Monitoring Report #1_In-Lake Treatment_TribSampling_1-19-16

Item A.3.2 Monitoring Report #1_In-Lake Treatment_TribSampling_1-5-16

Item A.3.2 Monitoring Report #2_In Lake Treatment

Item A.3.2 Monitoring Report #2_In Lake Treatment_COC_CSUSM_7-27-16

Item A.3.2 Monitoring Report #2_In Lake Treatment_COC_CSUSM_8-26-16

Item A.3.2 Monitoring Report #2_In Lake Treatment_COC_CSUSM_9-25-16

Item A.3.2 Monitoring Report #2_In Lake Treatment_PINTO_SPATT_8-13-16

Item A.4 Revised QAPP_FINAL Signed

Item A.4 Revised QAPP_FINAL_3.0

Item A.4. QAPP_kw-sk_JM edits

Item A.4. Quality Assurance Program Plan (QAPP)

Item A.4. Quality Assurance Program Plan (QAPP)

Item A.4. Quality Assurance Program Plan (QAPP).docx

Item A.5 Proof of Registration with CEDEN

Item A.6 CEQA NOE_Pinto Lake Alum Treatment

Item A.6. Pinto Lake Winter Preparedness Program CEQA NOE Filed 092917

Item A.6. Virgin Mary Road CEQA Concurrence Signed_082117

Item A.6.1 CEQA Concurrence Attachment - NOE - 15306 - In-Lake Monitoring

Item A.6.1 CEQA Concurrence Attachment - NOE - 15307 - Pinto Lake Alum Treatment

Item A.6.1 CEQA Concurrence Attachment - Project Location Map

Item A.6.1 CEQA Concurrence Project Location Map

Item A.6.1 CEQA Concurrence with FINAL signatures

Item A.6.1 CEQA Concurrence_Pinto Lake Alum Treatment_signed

Item A.6.1 CEQA NOE - 15306 - In-Lake Monitoring

Item A.6.1 CEQA NOE - 15307 - Pinto Lake Alum Treatment

Item A.6.2 Final CEQA_In-Lake Treatment

Item A.6.2 Final CEQA_Pinto Lake County Road Sediment Control Practice_2015 CEQA Renewal Document

Item A.6.2 Final CEQA_Pinto Lake County Road Sediment Control Practice_County Master Permit

Item A.6.2 Final CEQA_Pinto Lake County Road Sediment Control Practice_PIR Inital Study 2004

Item A.6.2 Pinto Lake County Road Sediment Control Practice_SWRCB_CEQA_Concurrence_FINAL Signed 092716

Item A.6.2_Virgin Mary Road Repairs_CEQA NOE_filing_2017-06-29

Item A.7 CADFW 1600 Final Agreement 2016-0362

Item A.7 CADFW 1600 Final Agreement_2016-0362 _signed

Item A.7 County-City MOU_Veg FilterStrip

Item A.7 Pinto Alum Application Memo LOA_County-City

Item A.7 Pinto Lake County Road Sediment Control Practice_CDFW_ 1600 Streambed Alteration Agreement_2016-0205 Final

Item A.7 Pinto Lake County Road Sediment Control Practice_R3_AmestiWaterQlty_34416WQ05_Cert_160630_final

Item A.7. CDFW 1600 Monitoring Report

Item A.7.1 10-06-2016_NPDES_Alum_Pinto_NoPermitReqrd

Item A.7.2 Right of Way Documentation_Pinto Lake County Road Sediment Control Practice_Landowner Access Agreement with SCCnty

Item A.7.2 Virgin Mary Road Repairs_Rights of Way Documentation

Item A.8 Pinto County Park_VirginMary_Sign

Item A.8 Pinto Creek Signs

Item A.8 Pinto Lake City Park Signage

Item A.B.1.1 Pinto Lake Kick-off Meeting Presentation Materials

Item A.B.1.1 Pinto Lake Kick-off Meeting Presentation Materials

Item A.B.2.1 TAC Mtg 1_081715_List of Pinto TAC Members and Affiliations

Item A.B.2.1 TAC Mtg 1_081715_List of Pinto TAC Members and Affiliations

Item A.B.2.2 TAC Mtg 1_081715_Agenda

Item A.B.2.2 TAC Mtg 1_081715_Agenda

Item A.B.2.2 TAC Mtg 1_081715_Agenda.docx

Item A.B.2.2 TAC Mtg 1_081715_Mtg Minutes

Item A.B.2.2 TAC Mtg 1_081715_Mtg Minutes

Item A.B.2.2 TAC Mtg 1_081715_Mtg Minutes.docx

Item A.B.2.2 TAC Mtg 1_081715_Summary of TAC Conclusions

Item A.B.2.2 TAC Mtg 1_081715_Summary of TAC Conclusions

Item A.B.2.2 TAC Mtg 1_081715_TAC Presentation Materials

Item A.B.2.2 TAC Mtg 1_081715_TAC Presentation Materials

Item A.B.2.2 TAC Mtg 1_081715_TAC Sign-In Sheet

Item A.B.2.2 TAC Mtg 1_081715_TAC Sign-In Sheet

Item A.B.2.3 Pinto Lake Restoration Project_TAC Mtg Agenda_020818

Item A.B.2.3 Pinto Lake Restoration Project_TAC Mtg Min_020818

Item A.B.2.3 Pinto Lake Restoration Project_TAC presentation EK_020818

Item A.B.2.3 Pinto Lake Restoration Project_TAC presentation LL_020818

Item A.B.2.3 TAC Agenda 1-17-17

Item A.B.2.3 TAC Meeting Notes and Attendees 1-17-17

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LIST OF SUB-CONTRACTORS

CSUSM - Dr. Rosalina Hristova. Note that Dr. Hristova was paid through Bioaccumulation Oversight Group (BOG) funding via the Surface Water Ambient Monitoring Program (SWAMP) of the SWRCB, and not through this grant.

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