APPENDIX H

ADDITIONAL HYDROLOGIC ANALYSIS

TOLAY LAKE REGIONAL PARK
INTERIM LAKE MANAGEMENT PLAN

SONOMA COUNTY, CA

Prepared by:
MIG, Inc.

Prepared for:
Sonoma County Regional Parks

May 18, 2018

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Introduction

This Interim Lake Management Plan (Plan) will be implemented by Sonoma County Regional Parks at Tolay Lake Regional Park (Park) beginning in 2018 and ending upon completion of the Tolay Lake Restoration Project, which is part of the larger Tolay Lake Regional Park Master Plan Project. The Tolay Lake Restoration Project is intended to restore the lake to near historic conditions, enhance wildlife habitat, and reduce flooding impacts in the Park without increasing flood risk to upstream landowners. The Project will significantly improve hydraulics of flood flows through Tolay Lake.

The goal of this Plan is to minimize the impacts of Tolay Lake formation (watershed runoff storage in the Tolay Lake basin) on agricultural operations on the private property immediately north of the Park while simultaneously limiting impacts to Tolay Lake habitat and Park operations during the interim period preceding full restoration of Tolay Lake.

Background

Tolay Lake was originally formed by a natural dam across Tolay Creek that was about 14 feet (ft) higher than the lake bed (KHE 2003). The natural dam was breached in the 1860s and the lake and creek were modified to create an artificial condition more favorable for farming and ranching (KHE 2003; Florsheim 2009). Modifications included digging drainage ditches along the lake perimeter, through the center of the lake, and through the location of the historic natural dam to the location where the Tolay Creek channel steepens.

Formation of the dam and lake is the natural hydrogeomorphic condition of the system. Because the historic natural dam location is a natural sediment deposition zone, the ditch through the location (from the "farm bridge" that exists today to about 1,000 ft downstream from the farm bridge) had to be periodically cleared of sediment by the previous landowners to maintain the artificial agricultural condition. During the spring months of wet years the previous land owners had to pump water from the lake to the location where the creek is sufficiently steep to facilitate lake drainage in time to plant their seasonal crops.

Setting and Objectives

Agricultural tilling operations in the Tolay Lake basin within the Park (former Cardoza Ranch) have been discontinued. During average and above average water years, the footprint of Tolay Lake extends beyond the Park property onto agricultural properties to the north, "upstream" from the Park. The private property that abuts the Park property to the north, APN 068-060-055 ("Impacted Property") is the most immediately impacted by Tolay Lake formation. In order to implement lake management measures to facilitate drainage of Tolay Lake to a level that does not impact agricultural operations on the Impacted Property, Sonoma County Regional Parks has developed this plan.

Because the channel downstream from the farm bridge is flat for about 1,000 ft, the energy in the Tolay Lake hydraulic system is insufficient to readily drain the lake below water-surface elevation (WSE) around 215 ft (it will drain to approximately 214.4 ft [NAVD88], the elevation of the channel high point under the farm bridge according to 2016 survey data, but will do so slowly). Because elevations on the private property to the north are in some places as low as 215 ft (according to 2016 Sonoma County LiDAR data), the lake should be drained to around 214 ft WSE to ensure

TOLAY LAKE REGIONAL PARK
INTERIM LAKE MANAGEMENT PLAN

Lake Management - Pre-restoration

This map is for illustrative purposes only and is not intended to be a definitive property description.

0 0.15 0.3 0.6 Miles

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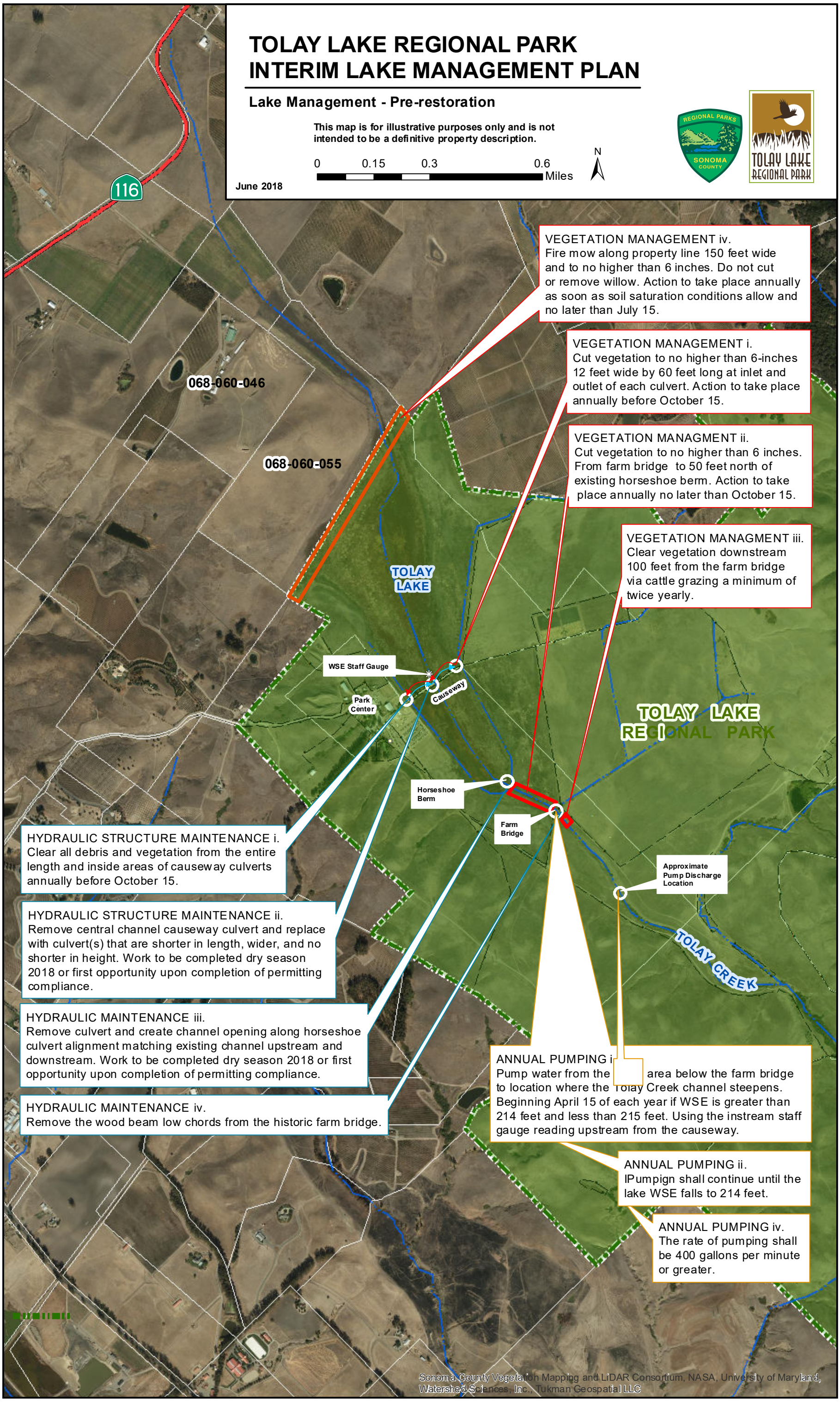
June 2018



VEGETATION MANAGEMENT iv.
Fire mow along property line 150 feet wide and to no higher than 6 inches. Do not cut or remove willow. Action to take place annually as soon as soil saturation conditions allow and no later than July 15.

VEGETATION MANAGEMENT i.
Cut vegetation to no higher than 6-inches 12 feet wide by 60 feet long at inlet and outlet of each culvert. Action to take place annually before October 15.

VEGETATION MANAGMENT ii.
Cut vegetation to no higher than 6 inches. From farm bridge to 50 feet north of existing horseshoe berm. Action to take place annually no later than October 15.

VEGETATION MANAGMENT iii.
Clear vegetation downstream 100 feet from the farm bridge via cattle grazing a minimum of twice yearly.

HYDRAULIC STRUCTURE MAINTENANCE i.
Clear all debris and vegetation from the entire length and inside areas of causeway culverts annually before October 15.

HYDRAULIC STRUCTURE MAINTENANCE ii.
Remove central channel causeway culvert and replace with culvert(s) that are shorter in length, wider, and no shorter in height. Work to be completed dry season 2018 or first opportunity upon completion of permitting compliance.

HYDRAULIC MAINTENANCE iii.
Remove culvert and create channel opening along horseshoe culvert alignment matching existing channel upstream and downstream. Work to be completed dry season 2018 or first opportunity upon completion of permitting compliance.

HYDRAULIC MAINTENANCE iv.
Remove the wood beam low chords from the historic farm bridge.

ANNUAL PUMPING i
Pump water from the area below the farm bridge to location where the Tolay Creek channel steepens. Beginning April 15 of each year if WSE is greater than 214 feet and less than 215 feet. Using the instream staff gauge reading upstream from the causeway.

ANNUAL PUMPING ii.
lPumpign shall continue until the lake WSE falls to 214 feet.

ANNUAL PUMPING iv.
The rate of pumping shall be 400 gallons per minute or greater.

agriculture operations on said property are not impacted. Because draining the lake impacts potential habitat within the lake basin and pumping is costly, the lake should not be drained via pumping more than is necessary to ensure impacts to agriculture on the northern private property are prevented. The management measures incorporated in this Plan aim to accomplish the following primary objectives:

- Improve conveyance of flood flows through the lake such that the frequency, extent, and duration of inundation of the properties to the north is reduced; e.g. such that the lake drains more readily (passively without pumping) and rapidly during and after large storms.

- Improve low-flow conveyance through the lake such that the lake readily drains to 214 ft WSE in a timely fashion after the wet season ends (within a few weeks following the last winter storm).

- Establish pumping criteria, protocol, and adaptive management strategies which ensure pumping is only conducted when the lake is not draining freely (i.e. not draining at a rate faster than the proposed minimum pumping rate) to the extent necessary to sufficiently drain the northern private property.

Some of the management measures provided herein are based on topographic survey data and hydraulic analyses of the Tolay Lake system. Because the Tolay Lake hydraulic system is a dynamic and complex system, this Plan will need to be adapted based on observed effectiveness of the Plan to account for changes in the system.

Interim Management Measures

This Plan requires implementation of the following interim management measures to minimize inundation of properties to the north of the Park prior to the start of agricultural activities. Parks shall keep sufficient record of all management measures performed.

<u>Hydraulic Structure Maintenance</u>

i. Clear all debris and vegetation from the entire length and inside areas of existing east and west channel and improved causeway culverts annually after August 15 and before October 15.

   This measure will enable optimized conveyance through the culverts, will accelerate lake drainage, and will simplify pumping until the structures can be improved as described below.

ii. Remove central channel causeway culvert and replace with culvert or culverts that are shorter in length, wider in width, and no shorter in height. Such replacement culvert(s) shall be installed during dry season 2018 or first possible dry season opportunity upon completion of CEQA/permitting compliance documentation.

   This measure, in combination with the measure below, will significantly accelerate the free-draining of the lake to below 215 ft WSE. The size of the replacement culvert(s) should be maximized to the extent space, budget, and permitting considerations allow but in no event shall be less than 36" in width or be set, at invert height, higher than 214 ft WSE. The culvert(s) shape (e.g. circular, elliptical, arch), material type (HDPE, CMP, concrete) and configuration (parallel pipes, box

culvert, etc.) should be appropriate for the open water setting and anticipated vehicle loadings along the causeway.

iii. Remove horseshoe culvert and create channel opening along horseshoe culvert alignment matching existing channel upstream and downstream of the horseshoe culvert during dry season 2018 or first possible dry season opportunity upon completed CEQA compliance documentation.

This measure, in combination with the measure above, will significantly accelerate the free-draining of the lake to below 215 ft WSE. Connecting the channels upstream and downstream of the horseshoe culvert with a channel of equal size will eliminate the horseshoe constriction. The new channel banks should be sloped back at 2:1 or less, compacted to roughly 85%, and seeded with native seed to ensure stability and prevent erosion.

iv. Remove the wood beam low chords from the historic wood farm bridge.

This measure would dramatically improve drawdown times during large flood events. The wood beam low chords (see image below) impede flows when the lake WSE is greater than ~216.5. These low chords are not part of the existing bridge and thus have no effect on the historical character, structural stability or load bearing capacity of the existing bridge.

Vegetation Management

i. Cut vegetation to no higher than 6 inches upstream and downstream from the existing causeway culverts annually as soon as soil saturation conditions allow and no later than August 30. The minimum area of vegetation management upstream and downstream of each culvert shall be 12 ft in width and 60 ft in length. Adaptive Management – the area of vegetation management may be reduced as effectiveness of other measures allows. Other approaches to vegetation management could be considered including goat grazing or prescribed fire.

This measure helps improve flow conveyance through the culverts, but may have limited effectiveness, especially after the proposed hydraulic structure improvements are complete. Vegetation removal incurs costs and habitat impacts and should thus be minimized to the extent possible without impacting drainage time/pumping time required to sufficiently drain the lake.

ii. Cut vegetation to no higher than 6 inches from farm bridge to 50 ft north from existing horseshoe berm annually as soon as soil saturation conditions allow and no later than June 1. Adaptive Management – the area of vegetation management may be reduced or eliminated as effectiveness of other measures allows.

This measure helps improve flow conveyance through the horseshoe and farm bridge, but likely will not be necessary after the proposed hydraulic structure improvements are complete. Vegetation removal incurs costs and habitat impacts and should thus be minimized to the extent possible without impacting drainage time/pumping time required to sufficiently drain the lake.

iii. Clear vegetation downstream 100 feet from the farm bridge via cattle grazing a minimum of twice yearly. Adaptive Management – the frequency of grazing may be reduced as effectiveness of other measures allows.

This measure helps improve flow conveyance downstream of the farm bridge, but may have limited effectiveness, especially after the proposed hydraulic structure improvements are complete.

iv. Fire mow/cut vegetation to no higher than 6 inches along the length of the Schaller- Park property line annually as soon as soil saturation conditions allow and no later than June 30. The minimum line shall be 150 ft. Any willow within the vegetation management area shall be preserved to the extent practicable. Adaptive Management – the area of vegetation management may be reduced or eliminated as effectiveness of other measures allows.

This measure helps improve flood flow conveyance from the northern private property onto the Park property, but might be more than is necessary, especially after the proposed hydraulic structure improvements are complete. Vegetation removal incurs costs and habitat impacts and should thus be minimized to the extent possible impacting drainage time/pumping time required to sufficiently drain the lake. This measure also provides a fire break between the two properties, the utility of which must be considered in adaptive management.

Annual Pumping

i. Pump water from the creek area below the farm bridge to approximately 1,000 to 1,500 ft downstream of the farm bridge (the location where the Tolay Creek channel steepens) beginning April 15 of each year if the lake water-surface elevation (WSE) is greater than 214 ft (NAVD88) and less than 215 ft, as determined by staff gauge readings.

This pumping approach is based on topographic data and hydraulic analyses and is designed to prevent pumping when the lake is draining freely (when the flowrate in the channel downstream from the farm bridge is greater than the proposed minimum pumping rate) and to prevent pumping beyond what is necessary to prevent impacts to agriculture on the northern private property.

To implement this pumping approach, Park staff will observe the central channel causeway staff gauge on April 15th and photo document the reading. The elevation of the "0" mark on that gauge is known to be 211.9 ft. So, when the gauge reading is between 2.1 and 3.1 feet, pumping at the farm bridge will begin. If the gauge reading is less than 2.1 feet, no pumping should be needed. See item ii below regarding when pumping can be delayed.

ii. If the lake WSE is greater than 215.3 ft on April 15 (i.e. following a large winter or series of storms leading up to April 15, or during a large storm on April 15), start of pumping shall be delayed until the lake drains down to 215.3 ft WSE and/or until the flow velocity in the Tolay Creek channel immediately downstream of the farm bridge drops below 0.5 ft per second (fps) and/or until the WSE differential between the central channel staff gauge immediately upstream from the causeway and the staff gauge immediately upstream from the farm bridge drops below 0.10 ft.

If the central channel causeway staff gauge reading is greater than 3.4 ft, Park staff will observe and photo document flow in the Tolay Creek channel downstream of the causeway and the staff gauge immediately upstream from the farm bridge. If the channel downstream of the causeway is clearly flowing, Park staff can delay pumping until the lake WSE drops to 215.3 ft or until the channel downstream of the causeway appears to be flowing very slowly[1], at which point Park staff will begin pumping. If the WSE differential between the central channel staff gauge immediately upstream from the causeway and the staff gauge immediately upstream from the farm bridge is greater than 0.10 ft, Park staff can delay pumping until the Lake WSE drops to 215.3 ft or until the WSE differential drops below 0.10' ft. Park staff will check the staff gauge reading at the central channel causeway staff gauge and at the upstream farm bridge staff gauge and check the flow at the farm bridge on a daily basis to initiate pumping as soon as the gauge reading drops to 3.4 ft elevation or as soon as flow velocity in the channel downstream of the farm bridge appears to be flowing very slowly (see footnote below) or until the WSE differential drops below 0.10 ft.

If Parks wishes to delay pumping to the maximum extent allowable (until the channel flowrate drops below the proposed minimum flowrate (~1cfs) and/or until the flow velocity in the channel downstream from the farm bridge drops below 0.5 fps), then flowrate or flow velocity measurements within the channel downstream from the farm bridge will be required (via portable meter) to ensure that the outflow rate (at the farm bridge) is greater than the inflow rate (measured at the Schaller - County property line). However, if Parks is amenable to pumping when the channel is slightly above the proposed minimum flowrate/flow velocity, then visual observation should be sufficient and no flowrate or flow velocity measurement should be needed. In either case, photo-documented staff gauge readings and photographs of the channel downstream from the farm bridge must be taken daily starting April 15th until pumping begins and any flowrate or velocity measurements must be recorded.

iii. Pumping shall continue until the lake WSE falls to 214 ft.

[1] *By the time the flow velocity drops below 0.5 fps, the flow in the channel downstream from the farm bridge will likely be reduced to a trickle and/or there may appear to be standing water in the channel. Pumping should begin before such a condition is observed, otherwise must begin as soon as possible upon observing such a condition.*

214 ft is one foot lower than the lowest point on the northern private property, according to 2016 Sonoma County LiDAR data. This elevation should therefore be sufficiently low to drain all standing water from said property. It should be noted that some "birdbaths" (isolated ponds of water) may remain on the northern private property for a number of days after the lake level reaches 214 ft WSE.

iv. The rate of pumping shall not be less 400 gallons per minute (gpm). A pumping rate of 1,000 gpm is recommended. A discharge hose should be installed from the pump to a downstream point where the creek velocity is not less than 2 fps, or a minimum distance of 1,000-feet downstream of the pump. Pumping will be done during daylight hours for a minimum of six hours per day.

A higher pumping rate is proposed to reduce the duration of pumping, thereby reducing burden on Park staff and accelerating the drainage of the lake from the northern private property.

Adaptive Management

- If the existing culverts are clogged, pumping upstream from the causeway in combination with pumping at the farm bridge shall be performed as necessary to drain the lake within a reasonable timeframe (by the end of May).

- If draining the lake to 214 ft WSE is insufficient to prevent impacts to agriculture on the Impacted Property, the "target" WSE at which pumping can be stopped shall be reduced to the extent necessary to prevent impacts to agriculture on said property.

- If draining the lake to 214 ft WSE is more than is necessary to prevent impacts to agriculture on the northern private property, the "target" WSE at which pumping can be stopped may be increased to as much as 214.5 ft or to the maximum WSE that does not cause impacts to agriculture on the Impacted Property.

- The criteria which governs initiation of pumping may be revised based on observation of Plan efficacy and associated data collected. For example, the "trigger" WSE of 215.3 ft may be adjusted upward if flow downstream from the farm bridge is observed to stop at a higher WSE, or downward if the flow downstream from the farm is observed to continue down to a lower WSE. Similarly, the "trigger" flow velocity of 0.5 fps and/or the "trigger" WSE differential (between the staff gauge immediately upstream from the causeway and the staff gauge immediately upstream from the farm bridge) can be adjusted upward or downward according to observation or eliminated as supplemental criteria if either are deemed unnecessary.

These adaptive management measures enable adaptation of pumping criteria and protocol based on observation of the effectiveness of the proposed criteria and protocol and to account for any changes to the lake system, thereby ensuring the goals of the Plan can be met.

Other Conditions

All aspects of implementation of this Plan shall be documented by Park staff, and maintained as

public records.

i. Park staff shall observe and record the central channel staff gauge immediately downstream from the causeway in addition to the central channel staff gauge immediately upstream from the causeway as part of the pumping protocol. The purpose of this measure is to provide data for analysis of the energy loss through the causeway culvert. This condition may be removed from the Plan if the data is not useful.

ii. Documentation shall include written descriptions and photo-documentation. All of the following shall be recorded and documented by Park staff:

- Hydraulic structure improvements (include as-built schematic drawings), repairs, and maintenance including extent, date, and method of culvert clearing and notes pertaining to any unaddressed culvert maintenance needs such as inability to clear culverts;

- Extent, date, and method of all vegetation management;

- Pumping information including location(s), pumping rate, start and ending date, start and ending time, starting and ending lake WSE (central channel causeway culvert staff gauge reading); and

- Daily visual observations of lake levels (staff gauge readings and flow in the channel downstream from the farm bridge) and any creek flowrate or flow velocity measurements taken starting on April 15th each year (<u>for years when the lake is still free-draining on April 15</u>).

This condition ensures adequate documentation will be available to assess the efficacy of the Plan and precisely determine changes necessary to refine the Plan.

iii. The Plan shall be reviewed on an annual basis to evaluate its efficacy in minimizing impacts of lake formation on agricultural operations on the property to the north in a fashion that limits impacts to Tolay Lake habitat and Park operations and resources during the interim management period, and shall be revised as needed.

This condition enables refining of the Plan on an annual basis based on observed efficacy of the Plan during the year prior to ensure the Plan is optimized.

iv. If non-grazing vegetation management cannot be conducted outside of bird nesting season (generally February 16 to August 14) due to fire break or other needs, then any required nesting bird surveys shall be conducted prior to initiating any mowing or fire management activities.

This condition ensures compliance with existing agreements and regulations.

References

Florsheim, J. 2009. Baseline Geomorphic Assessment of Tolay Creek, Sonoma County, California. Prepared for Sonoma Land Trust. Prepared by Joan Florsheim, Geology Department, University of California Davis.

KHE (Kamman Hydrology & Engineering, Inc.). 2003. Hydrologic Feasibility Analysis for the Tolay Ranch Property, Sonoma County, California. Report by Kamman Hydrology & Engineering, Inc., prepared for Sonoma County Agricultural Preservation & Open Space District, 18 p.

TOLAY LAKE PUMPING PROTOCOL FIELD GUIDE

for

TOLAY LAKE REGIONAL PARK

This field guide was developed for Tolay Lake Regional Park (Park) staff to ensure the Interim Lake Management Plan for the Park is followed. A hard copy of this Guide and the Tolay Lake Pumping Protocol Field Data Sheet should be made available to Park staff prior to April 15th of each year. On April 15th of each year, Park staff appointed to carry out the pumping protocol associated with the Interim Lake Management Plan shall perform the following:

1. Secure this Pumping Protocol Field Guide and the Pumping Protocol Field Data Sheet (Data Sheet) to a clipboard and acquire a charged camera for photographs.

2. Fill out the date, time, data collector name, and weather boxes on the Data Sheet.

3. Travel onto the causeway to the central channel (Tolay Creek channel) unless the causeway is under water. If the causeway is under water, complete Step 3.a only and repeat daily until the causeway is no longer under water. If the causeway is not under water, skip Step 3.a. and move to Step 4.

    3.a. When the causeway is under water on and/or after April 15th, perform the following:

        i. Take a photograph of the causeway and a photograph of the staff gauge immediately upstream from the causeway in the west channel (West channel staff gauge).

        ii. Estimate[1] (see footnote) the staff gauge reading on the West channel staff gauge.

        iii. Record the West channel staff gauge reading in the Data Sheet and add a note in the "Notes" column stating that the causeway is inundated.

4. Photograph the staff gauge immediately upstream from the causeway (Tolay channel upstream causeway staff gauge) and the staff gauge immediately downstream from the causeway (Tolay channel downstream causeway staff gauge).

5. Estimate[1] the Tolay channel upstream causeway staff gauge reading and the Tolay channel downstream staff gauge reading and record the values in the Data Sheet.

[1] To estimate staff gauge readings, observe the staff gauge and record the lowest visible measurement value on the staff gauge, i.e. the first measurement mark that is above the water level.

6. Compute the water surface elevations at the Tolay channel upstream causeway staff gauge and at the Tolay channel downstream causeway staff gauge per the directions shown in the Data Sheet. If the Tolay channel upstream causeway staff gauge water surface elevation is greater than 215.3 ft, stop here and repeat Steps 1-6 of this protocol daily until the Tolay channel upstream causeway staff gauge water surface elevation reaches 215.3 ft and then continue to Step 7. If the Tolay channel upstream causeway staff gauge water surface elevation is less than or equal to 214.0 ft, stop here and add a note in the "Notes" column stating that no pumping is needed.

7. Travel to the farm bridge.

8. Photograph the staff gauge immediately upstream from the farm bridge (upstream farm bridge staff gauge) and the channel downstream from the farm bridge.

9. Estimate[1] the upstream farm bridge staff gauge reading, record the value in the Pumping Protocol Field Data Sheet, and add a note in the "Notes" column describing the observed flow downstream from the farm bridge, i.e. "flowing quickly", "flowing slowly", or "not noticeably flowing". If the flow downstream from the farm bridge is not noticeably flowing, skip to Step 11. If the flow downstream from the farm bridge is noticeably flowing, continue to Step 10.

10. Compute the water surface elevation at the upstream farm bridge staff gauge and the water surface elevation differential between the Tolay channel upstream causeway staff gauge and the upstream farm bridge staff gauge per the directions shown in the Data Sheet. If the water surface elevation differential is greater than 0.10 ft, stop here and repeat this protocol daily until following this protocol leads to Step 11. If the water surface elevation differential is less than 0.10 ft, continue to Step 11.

11. Begin pumping. Pump from under the farm bridge to the location downstream where the Tolay Creek channel steepens (approximately 1,000 to 1,500 feet). Record the pumping start time, pumping rate, starting water surface elevation (at the Tolay channel upstream causeway staff gauge, obtained per Steps 5 and 6) and pump inlet and outlet locations on the Data Sheet.

12. Pump for a minimum of six hours or until the Tolay channel upstream causeway staff gauge water surface elevation (obtained per Steps 5 and 6) drops to 214.0 ft. Record the pumping stop time on the Pumping Protocol Field Data Sheet. Repeat this protocol daily until the Tolay channel upstream causeway staff gauge water surface elevation (obtained per Step 6) is less than or equal to 214.0 ft and record the final water surface elevation (from the Tolay channel upstream causeway staff gauge) on the Data Sheet.

TOLAY LAKE PUMPING PROTOCOL FIELD DATA SHEET

DATE:_____ TIME:_____

DATA COLLECTOR:_____

WEATHER:_____

Staff Gauge	Staff Gauge Reading	Conversion Value	Water Surface Elevation[1]	Photo Taken (Y/N)	Notes
West Channel[2]					
Tolay Channel Upstream Causeway					
Tolay Channel Downstream Causeway					
Upstream Farm Bridge					
Water Surface Elevation (WSE) Differential[3] = _____ feet					

[1]Water Surface Elevation = Staff Gauge Reading + Conversion Value

[2]West Channel data only required when the causeway is under water and the staff gauge can be safely read.

[3]WSE Differential = Tolay Channel Upstream Causeway Water Surface Elevation - Upstream Farm Bridge Water Surface Elevation

PUMPING DATA

START TIME:_____ START WATER SURFACE ELEVATION:_____

PUMP INLET LOCATION :_____ PUMP OUTLET LOCATION:_____

STOP TIME:_____ FINAL WATER SURFACE ELEVATION:_____

TOLAY LAKE
DRAFT COMPARISON REPORT

SONOMA COUNTY, CA

Prepared by:

Prepared for:
Sonoma County Regional Parks

March 7, 2018

Contents

Introduction

The purpose of this report is to summarize the physical condition of Tolay Lake prior to, during, and following historic agricultural use of the lake and surrounding land in order to provide a framework for developing interim lake management efforts and fine-tuning the future restoration and enhancement of Tolay Lake as part of the larger Sonoma County Regional Parks' (Parks) Tolay Park Master Plan. Future restoration of Tolay Lake is intended to restore the lake to near historic conditions, thereby enhancing wildlife habitat, protecting cultural resources, and reducing flooding impacts in the Park without increasing flood risk to upstream landowners.

Information for this report was gathered from existing documentation, aerial imagery, and interviews conducted with Park staff and adjacent landowners. Included in this effort was the installation of several staff gauges to measure the stage (water-surface elevation) of Tolay Lake and associated channels over time and the lake's response to any structural or operational changes implemented as part of the Parks' interim management efforts. This report can be updated throughout the interim (Pre Lake Restoration) period as data from the staff gauges are collected and more information on lake depths and inundation extents and duration relevant to storm events and water management efforts comes to light.

Parks took ownership of the property that contains most of Tolay Lake in 2005. At that time agricultural operations related to managing the ditch network and vegetation within the Tolay lakebed ceased. These operations included pumping and draining the lake. During the ensuing period, some property owners to the north (upstream of Tolay Lake) expressed concerns regarding their fields being seasonally inundated from lake backwater and oversaturation of the soils well into the growing season limiting their ability to farm as they had done prior to 2005. In order to try and mitigate these aspects of backwater inundation during the time period preceding full lake restoration and enhancement, it is helpful to have a framework of understanding of the lake's evolution from pre-historic natural condition, to historic agricultural setting, through more recent actively farmed and managed and onto today's management condition under Park ownership.

This report is broken out into three main parts, 1) a summary of lake condition and activities prior to, during, and following the long agricultural period based on written and oral information, 2) a comparison of mapped Tolay Lake extents over time including changes within the watershed, and 3) an overview of the staff gauge monitoring plan initiated in November 2017 and intended to be implemented throughout the interim management period.

Historic Lake Condition

The Tolay Lake Basin is an elevated depression located within the Tolay Creek watershed bordered by the Sonoma Mountains to the northeast and a low line of hills to the southwest. A natural drainage divide roughly 14 feet higher than the lake bed had existed downstream of the lake prior to human manipulation intended to drain the lake for farming (Kamman 2003).

Prior to European colonization, the native Alaguali tribe resided in the Tolay Valley for thousands of years. Tolay Lake is the southernmost lake in a chain of lakes through Sonoma County and according to tribal oral histories each lake served a specific ceremonial purpose, with Tolay Lake for "holding sickness and doctoring." With incredible views of mountains considered sacred including Mt Tamalpais, Mt Diablo, Mt. Burdell and Mt. St Helena, the lake and the valley were also known as a place for prayer and reflection. The Alaguali hosted ceremonial gatherings at Tolay Lake and visitors were said to have come to the gatherings from as far as Oregon and Mexico. The landscape was dominated by open grassland with stands of shrubs and oak groves on hillsides and there is evidence that the Alaguali actively managed the land through controlled burning, tending, weeding, pruning, and seed broadcasting (MIG 2017).

The historical record describes Tolay Lake as a feature roughly 500 feet wide by over 2 miles long. That feature was modified and drained for agriculture in the late 1800s. Illustrations in Figures 1 and 2 show a fairly prominent lake feature.

"Lakeville takes its name from a little lake mentioned by Padre Altimera in his Mission founding expedition as being called Tolay, after an Indian chief, and having an area of 150 to 200 varas in width and nearly a league in length. An American owner has drained the lake and it is now cultivated for potatoes." (Bell and Heymanns. 1988).

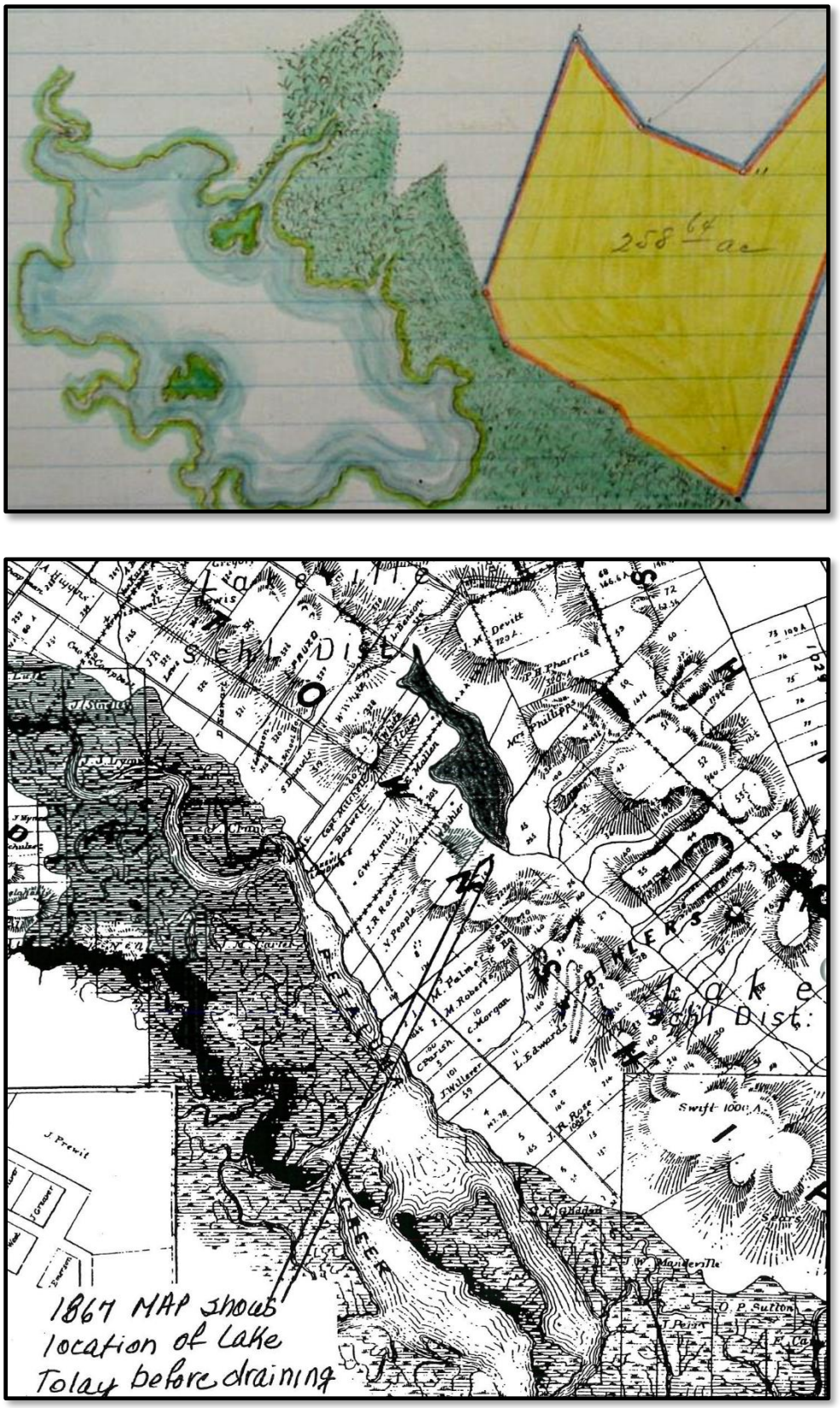
These measurements of Spanish origin convert to roughly 411 to 548 feet wide and nearly 2.6 miles long (Caldwell County 2018). (, which represent a narrower but much longer lake than is exhibited now.

"… The road from Lakeville over the mountain, between Petaluma and Sonoma creeks, passes the former Lake Tolay,--of which Padre Altimira, in his mission-founding expedition in 1823, said: "We found on said hillock, a little further on, the large lake of Tolay,--so-called after the chief of the Indians, who in former times settled there. Its width at some parts is, with little difference, one hundred and fifty varas,--at others two hundred varas, and at one point one-fourth of a league, which is also its length." This lake, from which Lakeville was named, was drained by its present owner (a utilitarian), and is now a potato patch." (Sonoma County History 2018)

"Father Altamira, who arrived from Spain in 1819 to assist at Mission San Francisco de Asis, promptly traveled north to explore sites for the new mission. Altamira's June 27, 1823 diary entry noted his visit to Laguna de Tolay while en route to found the new mission, so named after the Coast Miwok man who was chief of the tribelet from this area. At the time of his visit, Altamira estimated Tolay Lake's dimensions as 150-200 varas (415-500 feet) wide and 1,200 varas (3,500 feet) long." (ARG 2012)

"Altimira visited Lake Tolay, a large shallow pond named after the chief of the Petaluma Indians, but when he saw that it was too choked with tules to serve as an adequate water supply, he became convinced that the Petaluma Valley would not do as a site for the new mission." (Heig 1982)

"One of the earliest landing points on the Petaluma River was called Lakeville. The name was derived for a large lake, called Tolay, lying in the hills to the east, but which was soon drained so that its rich soil could be used to raise potatoes." (Miller 1967).



Figures 1 and 2. Survey illustration 1860 *(top, Source Sonoma County)*: 1867 Map (*bottom, Source: Hanson 1999)*

Active Agriculture Historic Lake Condition

The descriptions below reveal that the land encompassing the lake was originally purchased in 1834 by Lieutenant Mariano G. Vallejo as part of a 44,000 acre land grant (Rancho Petaluma) and used as rangeland. Over the next 145 years (through 1979) the land was further divided and sold to various owners with the land surrounding Tolay Lake purchased and used largely for ranching and farming.

According to the reports, Tolay Lake was first modified and drained for farming more than 150 years ago by William Bihler sometime after his purchasing the land in 1865. The 1877 map figure (Figure 3) still shows a somewhat prominent lake feature, however a new road crossing which appears to be in the location of the historic farm bridge on the southern end of the lake hints at the beginning of manmade modifications to the lake. The more complex irrigation and drainage system (i.e. network of drainage channels) was likely constructed by Arthur W. Foster who purchased the land in 1905 and inscribed the date of 1907 in some of the concrete work.

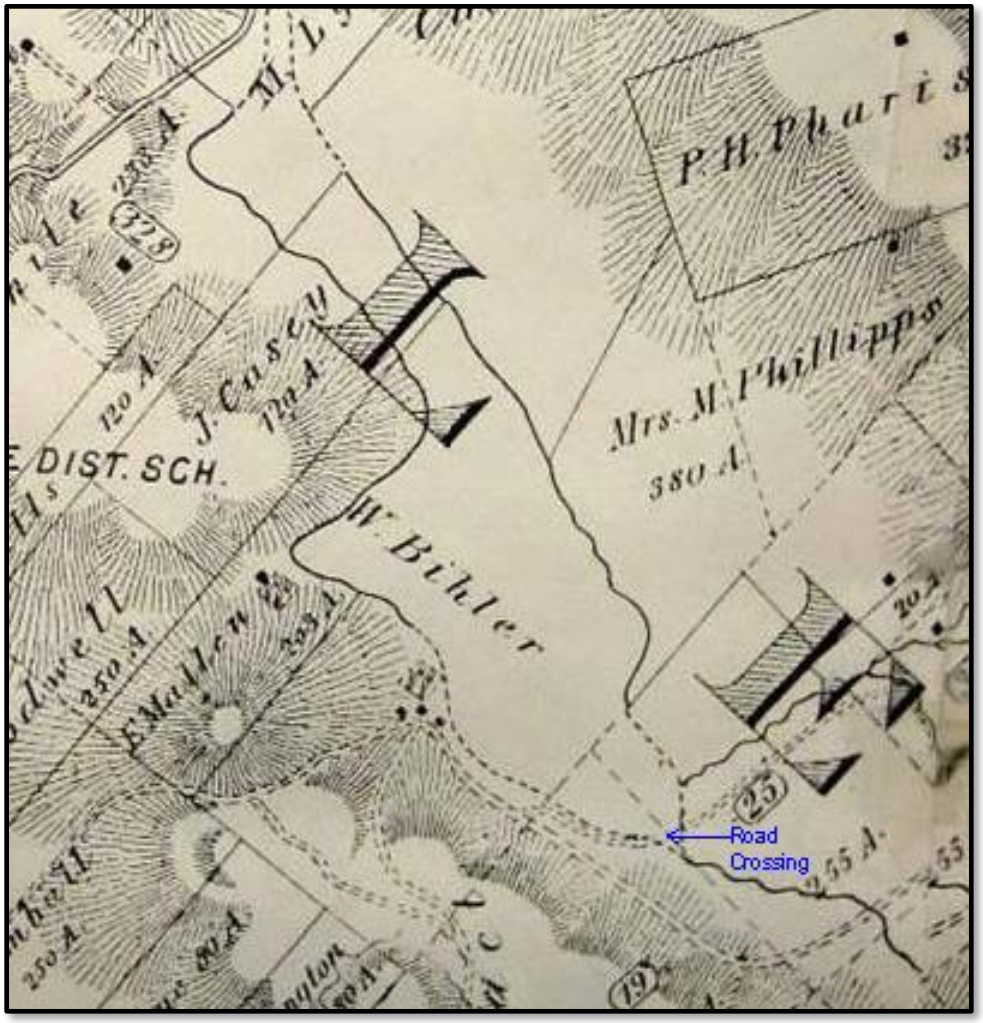


Figure 3. 1877 Map (Sonoma County 1877)

"In 1833, Lieutenant Mariano G. Vallejo was ordered by Governor Jose Figueroa to explore and settle the country north of Mission San Rafael, largely as a means to monitor the nearby Russian colony at Fort Ross. Vallejo applied for and received a 44,000-acre land grant for Rancho Petaluma, which encompassed Lake Tolay, from the governor in 1834. … The Tolay Lake margins and foothills would have served as rangeland for the large herds of cattle, horses, and sheep owned by Vallejo." (ARG 2012)

"William Bihler purchased the area that was to become the 1,737-acre Cardoza Ranch in 1865. …During his tenure on the property, Bihler reputedly drained Lake Tolay so that he could use it for farming the land. A decade later Bihler was still noted as a farmer, and residing with the same housekeeper (noted as Prussian at this time), a foreman, eight farm laborers, four milkers, a butcher, and a saddler. Ten Chinese farm laborers and one cook were residing in the adjoining household, and presumably working on the same ranch. That same year the Agricultural Production Census noted that Bihler's 430-acre ranch had produced 100 tons of hay, 2,000 bushels of wheat, 400 bushels of apples, 360 dozen eggs, and 300,000 pounds of grapes the previous year." (ARG 2012)

"The water would be dammed up every other year, allowing the rich silt and water from the watershed to gather on the valley floor. Then the water would be drained, allowing the water table to remain high enough underground to provide sub irrigation for the potatoes." (Cannard 1999)

"Unfortunately for all of us, German immigrant William Bihler had already dynamited the southern end of the lake, drained it, and planted potatoes." (Papp 1996)

"Bihler sold the ranch in the 1880s, and between approximately 1885 and 1894 it was owned by James G. Fair, who had amassed a fortune in the Comstock Lode and served as a United States senator. Fair raised thoroughbred horses and cattle, and operated a vast vineyard that produced prize-winning grapes and brandies, as well as operating the "first continuous brandy distillery on the Pacific Coast." The ranch was purchased from Fair's heirs by Arthur W. Foster in 1905, who operated it for the next two decades. Foster, president of the San Francisco North Pacific Railroad, operated the ranch as the Lakeville Stock Farm….Foster apparently constructed the elaborate irrigation and drainage system at the ranch, as the date "1907" is incised in some of the concrete work, although some of it may have been constructed earlier [likely Bihler as referenced above]." (ARG 2012).

Foster grew potatoes in the lake bottom but went bankrupt in 1948 and the ranch was sold and split into four properties, Cardoza (Marvin's Grandfather's ranch), Mengle (Roche Ranch), Denell (S/E of Cardoza), and Niemela Ranch which was further sold and broken up (Pers. Comm. Marcucci, January 6, 2018).

"The ranch was granted to the North Bay Farms Company in 1922, which retained ownership until 1943, the year that it was sold to John S. Cardoza, Sr., George S. Cardoza, and John S. Cardoza, Jr., natives of the Azores, who acquired the property in co partnership. John Cardoza, Sr. was a dairyman who also raised sheep and Hereford cattle on the ranch. According to descendant Marvin Cardoza, the ranch was in poor condition, undoubtedly due to absentee owners, when John Cardoza, Sr., purchased the property. During the late 1940s and early 1950s, John set about restoring the ranch as a viable livestock and dairy operation, demolishing many of the old buildings and using the timber, lumber, windows, and other architectural elements to build new structures and rebuild others, including barns, equipment sheds, and other amenities." (ARG 2012)

"…I am one of the owners of the property which is known by many as the "Lake Ranch". My father, brother and I and our wives bought the property approximately 1943. To my knowledge there has always been a lake on the property. When we bought the ranch, there used to be a levy almost all the way around the edge of the lake but we removed it about five years or so

after we moved here as it was in disrepair and wasn't needed. The lake used to flood all the way to Stage Gulch Rd. but that was way too much water so we always pumped out what we didn't need. (Cardoza 1999a)

"Before us, Fosters owned the ranch and from what we were told and saw, they grew corn and asparagus on the lake, which they sold in San Francisco. They grew lots of potatoes." (Cardoza 1999c)

Active Agriculture (Lake Ranch) Recent Lake Condition

An approximately 4.6 square mile drainage area (2,944 acres) feeds Tolay Lake via the main Tolay Creek channel originating from the west and northwest and the North Creek and Eagle Creek tributaries that flow into Tolay Lake just upstream of the historic farm bridge and are fed from headwaters to the north and northeast. The flow regime through Tolay Lake is controlled to a large degree by the network of irrigation channels and hydraulic structures that were built over a period of time (Figure 4).

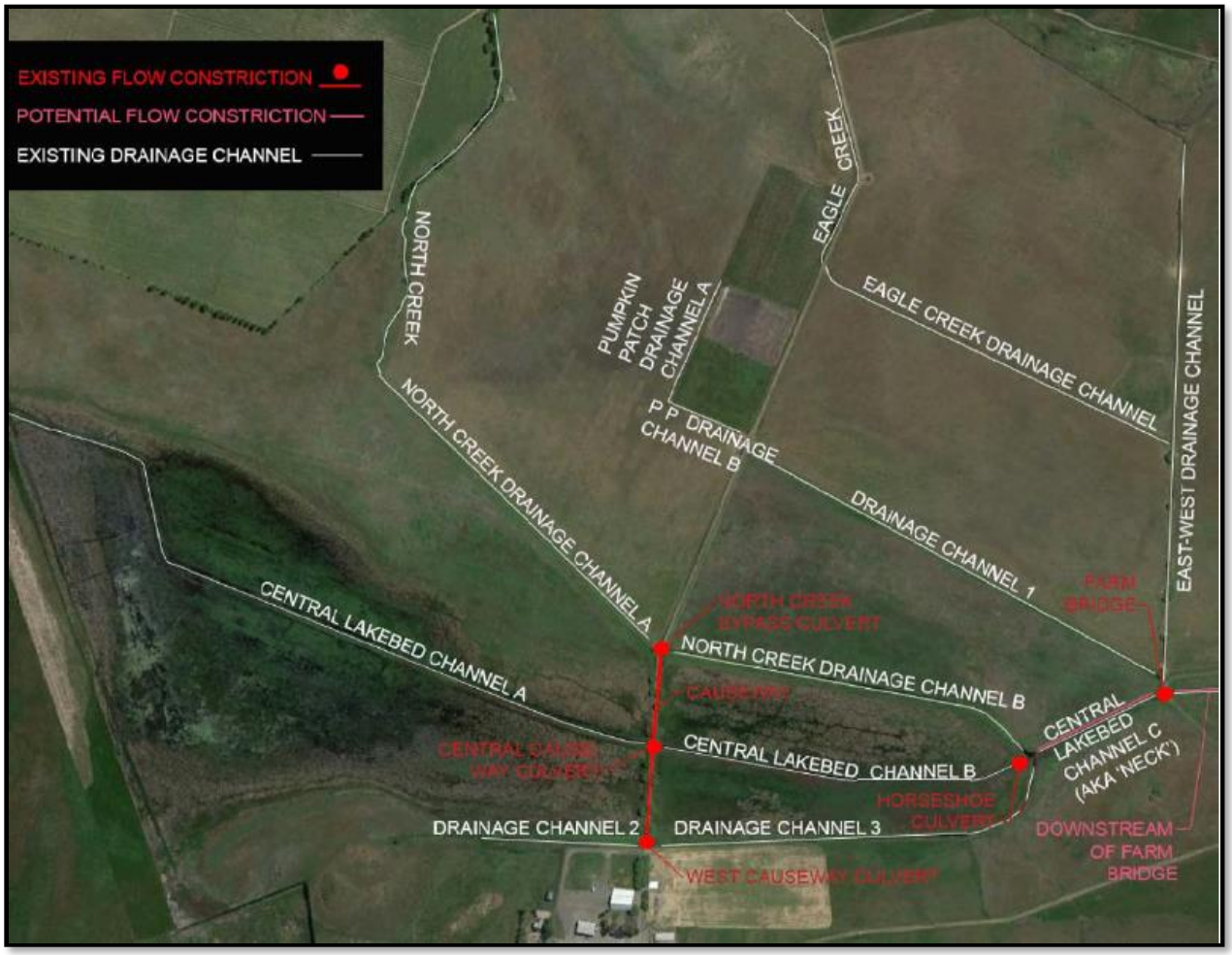


Figure 4. Existing Irrigation Channels and Hydraulic Structures in Tolay Lake Regional Park (WRA 2013).

The Cardozas had several agricultural operations running including cattle grazing, a 10-acre vineyard and the seasonal crops within the lakebed that eventually was utilized largely for cultivating pumpkins. In more recent years they ran a Pumpkin Festival that brought in an estimated 30,000 people annually including

school tours. As part of the land transfer, the Cardozas negotiated a leaseback period through September 2006 so that they could conclude their agricultural operations (Sonoma County Regional Parks 2006).

"Corn and wheat are the crops grown by the Cardoza brothers today. Except in an exceptionally dry year they still cannot use heavy equipment in the middle of the valley. Tractor work has to follow contours of two small streams which join at the southern end of the vast field to form Tolay Creek." (PAC 1958)

"In wet winters the water would come up quite close to the large hay barn which still stands. It would cover the levy road and we could not even get across it with a saddle horse. Instead, I would have to go all around the southern edge and cross the bridge near the duck shack. Usually the lake formed around December but I can remember once it formed as early as November, and sometimes as late as January or February…When we moved to the Lake Ranch, we grew corn, and sorghum mostly on the lake bottom, using the ditches and sub irrigation. Before us, the Foster Ranch grew potatoes and corn. They also grew asparagus and shipped it to San Francisco by railway. These things were all done using the water from Tolay Lake. Today, the lake still forms though I don't know if it is as large as it once was." (Cardoza 1999a)

"In 1979, George S. and Vera Cardoza granted the property to Rita and Marvin Cardoza, who sold the ranch to the Sonoma County Regional Parks Department in 2005." (ARG 2012)

"…the ranch has always been known at the "Lake Ranch" because of the lake that is made each year from the winter rains. I know that it has formed a lake each year from 1943 till now which is how long I have lived here. My husband, his brother and his parents and I bought the property and moved here at that time…As to the size of the lake, it has always been large – a couple hundred acres, I imagine. Sometimes it got up into the corral by the hay barn but on the average it would be in the field just next to it….I don't ever remember a time when the lake wasn't there, at least by January or February. It has always been a place that ducks and geese would visit each winter." (Cardoza 1999c)

"I do not ever remember a time when the lake did not form. Each year it floods about 100 to 200 acres of the valley floor. I have noticed that it has always formed by February 8th (my wife's birthday) even if it gets off to a slow start in a dry year. When I was about 15 years old I remember seeing the old remnants of a brick and wood floodgate put in the main drainage channel to control the flow of the lake….they blasted the neck of the lake in the 1850's, forming an annual rather than year round lake, they would hold water in the lake year round every other year. This was done to build up the soil…Today there is a pile of brick and dirt in the channel south of where we currently pump which is the remains of the old floodgate." (Cardoza 1999b)

"Although the lake which forms now must be smaller than the original, it still gets about six to ten feet deep in the middle portions. There are times when we have not been able to use the center levy road as the lake waters were too high over the top to get a tractor or horse across to feed the animals on the eastern hills. Our practice has been to begin to pump out the lake when the waters cease flowing on their own or slow to a point where pumping is needed to drain the waters to a level which allows us to plant our fields. We plant from the outer areas inward, using the moisture and sub irrigation to provide the necessary water for our crops. In the years I have operated the ranch we have grown corn, sunflowers, melons, safflower, silage crops, zucchini, barley, cucumbers, tomatoes, pumpkins and all types of winter squashes on the lake bottom. These are all spring crops and could not have been grown without irrigation from the lake waters. We do this by controlling the ditch water and keeping it high enough to bring water to the root zone of the crop. This is the same process used by my father and grandfather and the earlier owners, probably just enhanced by our use of powerful large pumps and greater control of ditch water. (Cardoza 1999b)

Mr. Allen Marcucci worked on the Cardoza Ranch directly under Marvin Mendoza from 1980 to 1994 while he also lived and worked on his own ranch adjacent to the Cardoza Ranch property. According to Mr. Marcucci, the Cardozas ran a beef herd mostly along the east side of the pasture and grew hay part of the

time. The Tolay Lake bottom was used to grow more seasonal crops such as corn and barley for cattle feed, safflower, and in the later years they started farming pumpkins. The lake would typically fill up during the winter and waters would recede in late February or March. In years where the lake bottom didn't drain adequately to grow crops they would start pumping in March or April. According to his recollection, they pumped to drain the lake less than half of the years during the time that he worked on the ranch (*Personal comm. Mr. Allen Marcucci on January 6th 2018*).

In comparing Mr. Marcucci's recollection with the annual precipitation recorded at the Petaluma Airport during that same time period, there appears to be a similar number of years at or above the median of 23 inches precipitation (i.e. 6 to 8 years out of 15) and a similar number of peak flows above the median peak flow event of 7,646 cfs for the nearby gauged Novato Creek (6 to 7 years out of 15) as shown in Figures 5 and 6 below.

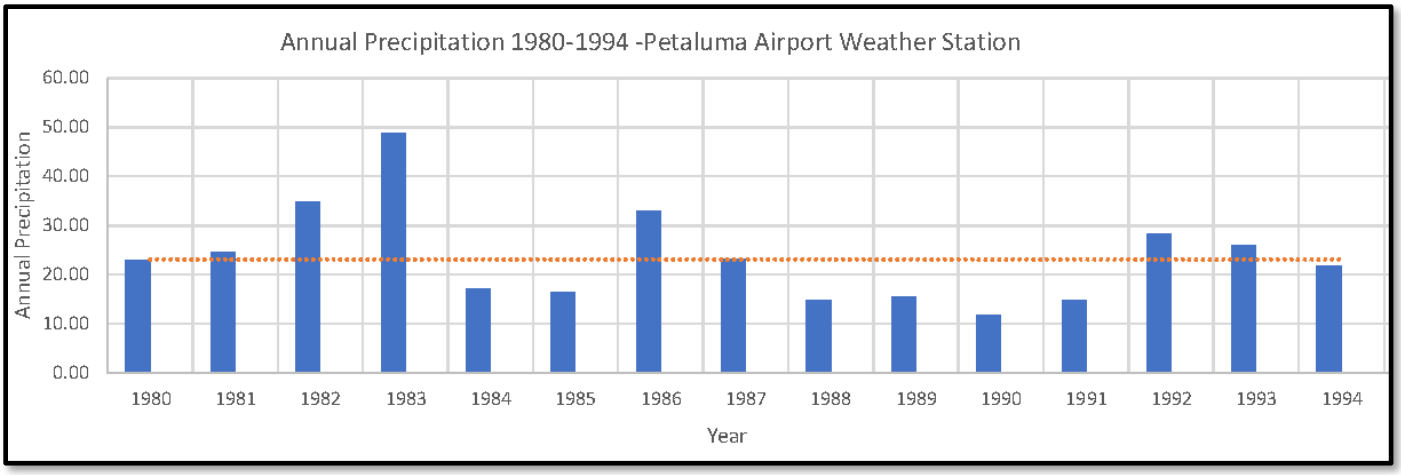


Figure 5. Annual Precipitation 1980-1994 measured at Petaluma Airport
(*orange line = median value 1980 - 2012)*

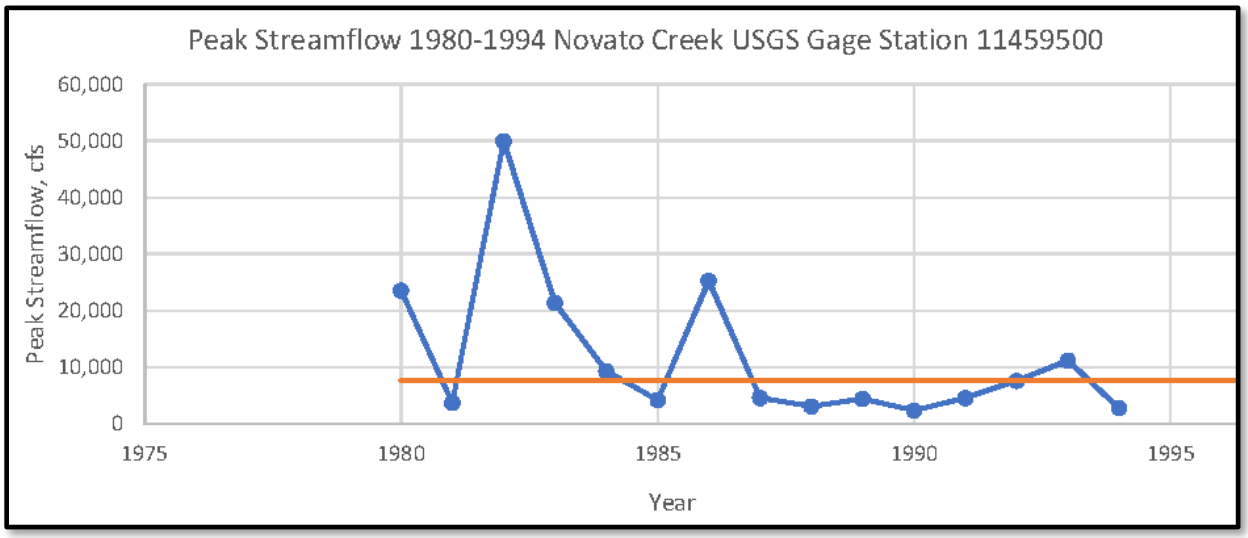


Figure 6. Novato Creek Peak Streamflow 1980 - 1994
(*orange line = median value 1980-2016)*

To drain the lake, they used a ditch pump powered by a tractor in the vicinity of the historic bridge and discharged via a 10 to 12 inch rubber hose to a location downstream where the channel was steep enough to carry the water away. They would make efforts to keep the ditches open and the water ponded at the historic bridge would last the longest. Pumping would run all day long for a few days up to a couple of weeks. They would start working the lakebed fields in late March, starting at the outside edges working inward aiming to essentially "push down" the top layer in order to preserve the moisture in the soil. Then they would till and plow the fields 1 to 2 feet deep depending upon the crops being planted. Every year they had to remove and burn what they called "Dry Land Kelp" which grew 3 feet tall in all the irrigation channels and lake bed (this is likely the same plant that continues to grow on site, Swamp smartweed or *Persicaria hydropiperoides* that is described in more detail in a later section). He also recalled the channel immediately below the historic bridge being further modified and bermed during the time he worked at the ranch (*Personal comm. Mr. Allen Marcucci on January 6th 2018*).

Mr. Marcucci mentioned in the late 1980s the City of Santa Rosa conducted groundwater studies on his land and the Cardoza's in order to determine the feasibility of using Tolay Lake as a reclaimed wastewater storage site. This option was ultimately rejected and replaced with the Geysers Recharge Project, completed in 2003 which pumps tertiary treated wastewater northward to be used as a water source to the Geysers geothermal field located in the Mayacamas Mountains of Sonoma and Lake Counties which in turn generates electricity for the City of Santa Rosa (Stark et. al 2005).

Jim and Lucy Mendoza, neighbors who have owned and ranched property to the north of Tolay Lake since 1979 also mentioned the City's desire to send reclaimed wastewater to Tolay Lake but that is was abandoned due to the concern over impacts to groundwater. The Mendozas reinforced that prior to Sonoma County Regional Parks (Parks) taking ownership of the land, the Cardozas would clear the ditches and burn the vegetation in the fall. They recalled that the lake would be drained in about two weeks' time during the spring even in the more significant rainfall years including 1982, 1986 and 1987 (*Personal comm. Mr. and Mrs. Mendoza on January 6th 2018*).

In 1984 the Mendozas entered into an agreement with the City of Petaluma to obtain reclaimed treated wastewater for irrigating their fields. As one of the requirements of the reclaimed water usage agreement, they constructed a small check dam within the drainage swale at the terminus of their property that borders Schaller property in order to retain and infiltrate any irrigation runoff from their fields. They shared photos from 2004 (Figure 7) that illustrate their property relative to the Cardoza and Schaller property and the check dam and ponded water at the terminus of their property. The Mendozas stated that prior to Parks taking ownership of the Cardoza Ranch their fields would drain immediately following rainstorms and they highlighted this with the third photo image in Figure 7 showing the fields readily drained following recent rains (*Personal comm. Mr. and Mrs. Mendoza on January 6th 2018*).

Mr. Dave Martinelli's family has owned the property that abuts Tolay Lake along the northeast for over 100 years. He doesn't recall any flooding or backwatering issues on his family's property since growing up there likely due to the higher topography (*Personal comm. Mr. Dave Martinelli on January 12th, 2018*).

In discussions with the Parks Supervising Ranger, Brandon Bredo, who has worked and resided on the Tolay Lake property since October 2005, in the years leading up to the land transfer the Cardozas used the entire lake bed, draining it every spring in order to grow pumpkins which were then sold during a month long Pumpkin Festival in the fall (*Personal comm. Mr. Brandon Bredo Sonoma Regional Parks on February 2nd, 2018*).

Figure 7. Mendoza Ranch 2004 photos showing the swale, berm and fields at the property terminus.

Post Agriculture (Parks Ownership) Lake Condition

Once the land was officially owned by Parks, efforts to actively manage lake inundation levels to facilitate farming were discontinued because of Parks' mission to restore the lake to a more natural condition and avoid any further disruption of buried cultural resources within the lakebed. According to the park ranger, the depth and extent of water inundation varied since 2005 depending on the water year, with some years the lake filling up early and more recently (2017) the lake was observed to be at its largest since Parks took ownership (*Personal comm. Mr. Brandon Bredo on February 2nd, 2018*).

A conservation easement was agreed to as a condition of a grant funded through the California Department of Fish and Game (CDFG) for purchase of the park property and intended to ensure the property would be retained in its natural condition. The easement requires restoration of Tolay Lake to a seasonal shallow water lake to primarily benefit wildlife species . The easement also specifies prohibited activities unless they become part of a CDFG approved plan; including grazing, vegetation removal, water impoundment, and recontouring or reshaping of the lake bed to enhance wildlife habitat (CDFG 2005).

Cattle grazing still occurs within the Park property, however per a 2011 grazing agreement certain areas deemed environmentally sensitive have been deemed off limits to grazing including Tolay Lake and an area that abuts North Creek Channel to the east just downstream of the causeway that is now reported to be full of unwanted invasives (*Personal comm. Mr. Brandon Bredo on February 2nd, 2018*).

Under existing conditions, flooding in the Park is common during the wet season, including overtopping of the causeway that divides Tolay Lake into upper and lower impoundment areas, with roughly two-thirds of the lake upstream of the causeway and one-third below (shown as a red line in Figure 4). The lake generally dries up during the summer (Wildscape 2016).

Parks developed a preliminary Interim Management Plan that specified pumping the southern portion of the lake in order to lower the water surface elevation along the northern property. Parks staff first pumped in late spring 2017 (Figure 8) from a single location within the central channel at the causeway rather than from the southern portion, due to high water levels and sediment clogging the hydraulic structures within the channel. The water surface at the start of pumping was roughly six inches below the causeway and pumping was done 5 to 6 hours per day, six days a week for around 7 weeks. The pumped water was discharged via a 2 to 3 inch hose into North Creek at roughly 1,000 gallons per minute (gpm). They observed that Tolay creek channel north of the lake needed to be sufficiently drawn down before the water levels receded on Dr. Schaller's property. Following the pumping regimen, Parks staff also cut vegetation on either side of the culverts 40 feet wide by 100 feet in length and cleared the sediment and debris from inside the culverts as best they could, although two of the primary culverts are still around 70% full of sediment. A gate on the horseshoe culvert was also removed (*Email comm. Karen Davis-Brown, Sonoma Regional Parks February 01, 2018*).

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Figure 8. Tolay Lake and central channel during active pumping, photos taken 04/28/17.

Dense vegetation growth now persists within the lakebed as a result of discontinued cultivation. The two prominent species within the lakebed are Swamp smartweed (*Persicaria hydropiperoides*), a North American native perennial that grows around 3 feet in height and prefers moist wet habitats and the introduced weed species Wild teasel (*Dipsacus follonum*), a biennial plant (rarely short-lived perennial plat) that can grow up to 8 feet tall. (*Personal comm. Mr. Brandon Bredo on February 2nd, 2018)*

The Mendozas reported since Park's purchase and abandonment of agricultural farming in 2005 they've observed water often extending up into their property. They added that the most significant impacts to their fields from water backing up occurred this past year (2017), which also happened to be a very wet year, when water extended up to their well and portions of their fields remained saturated through May (*Personal comm. Mr. and Mrs. Mendoza on January 6th 2018*).

Although he's never observed inundation on his property since Parks purchased the Tolay Lake property, Mr. Martinelli recently observed water backing up to within ten feet of his fence. He postulates that the original ranchers had the foresight to designate the property boundary and fence line above the natural waterline (*Personal comm. Mr. Dave Martinelli on January 12th, 2018*).

Figures 9 and 10 show the mean annual precipitation for the area and peak flows on the nearby gauged Novato Creek for a portion of the time period since Park's took ownership of the property. Unfortunately the precipitation data didn't extend through 2017, but the peak flows were recorded through 2016 and show events both above and below the median.

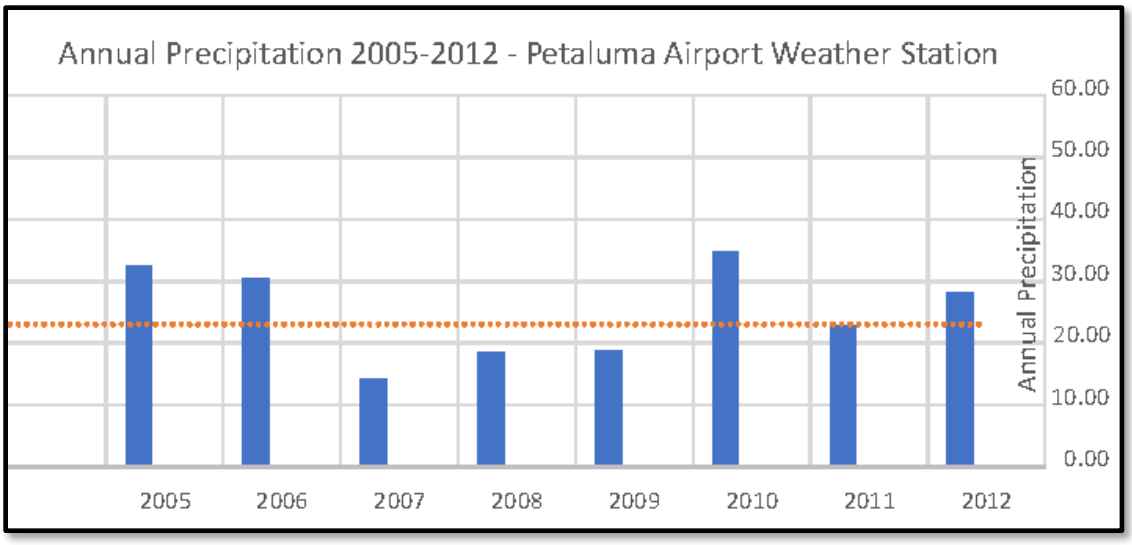

Figure 9. Annual Precipitation 2005 -2012 measured at Petaluma Airport
(*orange line = median value 1980 - 2012)*

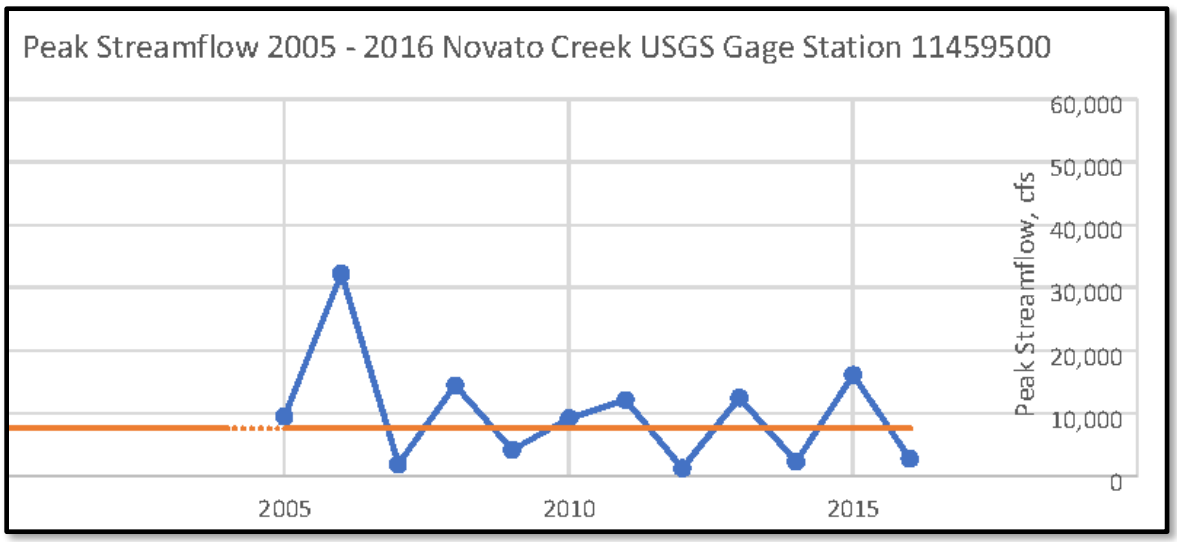

Figure 10. Novato Creek Peak Streamflow 2005-2012
(*orange line = median value 1980-2016)*

Mapped Tolay Lake Extents

A series of maps were assembled, which included historic schematic maps from the late 1800s to more recent Google aerial images. These maps were reviewed to see if there were any clear trends of lake inundation extents over time (Attachment 1). Even though we are unable to scale the older schematic maps (1887 and 1898) for direct comparison, they do provide a clear indication that the lake feature was prominent at that time and extended northward to where Tolay Creek now often inundates lands adjacent to it.

The 1993 to 2017 images were scaled with the approximate edge of water boundary delineated against the backdrop of the Tolay Lake extents taken from 2017. It is uncertain what month the 1993 image was taken, however it appears that the majority of the lake bed had been drained and pockets of standing water still appear in the northwest section and up into Tolay Creek. The May 2005 figure shows green fields and drier hillsides with a drained Tolay Lake and the May 2006 figure shows green vegetation on the hillsides and fields and a narrow band of standing water remaining along the northwestern property boundary. May 2007 shows ponded water on both sides of the lakebed and in Tolay Creek to the north. March 2008 and March 2016 clearly show a fully inundated Tolay Lake and Tolay Creek. March 2010 and February 2011 show a saturated lakebed with large pockets of standing water while in February 2012 there is much less water on the surface of the lake which is the same year peak flows in nearby Novato Creek dipped well below the median.

The May 2017 aerial image must have been taken after the Parks' pumping activities since we know that was a significant water year with extensive ponding, but in contrast the image shows the lakebed to be very green but largely drained. Given the lack of available scalable images prior to park ownership and the irregularity in which months these images were taken, no quantitative conclusions are possible. The series of images do however signal that since 2006 when the agricultural operations within the lake were discontinued the significant ponding in the late winter and early spring months during average and wet years likely extended into later spring.

The potential for increased runoff associated with increased anthropogenic impervious area was assessed by examining changes to the Tolay Lake watershed about the last fifty years. This period is associated with significant development in the Sonoma County region, albeit not necessarily to a similar degree within the Tolay watershed (Attachment 2) that might have impacted overall runoff volumes reaching Tolay Lake. Structures indicating increased impervious area and increased runoff potential plus any new or changed surface water reservoirs or ponds indicating increased storage and decreased runoff were demarcated and tallied to determine whether changes to the landscape over the watershed might have contributed to reported increases in lake inundation extent or duration.

The land area within Tolay Lake watershed remained fundamentally rural with an increase of only 4.26 acres in structure footprint from 1952 to present. This is only a 0.14 percent increase in anthropogenic impervious surfaces excluding any roads (2,944 acre watershed) and would not have any major impact on the volume or timing of water to Tolay Lake. The saturated soils during large storm events would be a greater contributor to overall runoff within the watershed.

A larger change, 32.93 acres of increased water storage was recorded, and is attributed largely to the construction of the North Creek Reservoir. The reservoir will have resulted in attenuated flows from its respective subwatershed to Tolay Lake since its construction prior to 1993. The reservoir contributes only a 1.1 percent increase in storage within the entire Tolay Lake watershed is has likely not been a major player in changes to the lake.

Hydrologic Monitoring Program

Eight staff gauges were installed in early November in targeted locations to develop a more complete picture of the hydrologic regime of Tolay Lake and its tributaries. Subsequent to installation of the staff gauges, digital camera were installed to allow for remote capture of water-surface levels during the winter

through early summer months. Continuously recorded data supplemented with manual field recordings of water surface levels at these key locations will provide important information on annual and seasonal lake levels, their effect on northern properties, and how the levels differ depending where they are spatially. Some of the gauges will be incorporated into the Interim Management Plan to aid in determining when to activate pumping to drain northern properties (i.e. when water surface levels reach a certain threshold) and how the system is performing as a result. Additionally, monitoring of the staff gauges during the interim management period will inform Parks as to how their overall efforts to improve conveyance and draining of northern properties, including any upgrades to conveyance structures and vegetation removal efforts are working in terms of increasing conveyance and reducing water surface levels where desired. Lastly, the staff gauges are a valuable tool for collecting pre- and post- restoration project hydrologic data in order to evaluate future project effectiveness in achieving targeted lake depths and extent of seasonal inundation.

The draft hydrologic monitoring protocol is provided in Attachment 3 and includes a map of the staff gauge locations and photos of the individual installations. The data will be collected and reviewed annually to determine overall results and overall indicators of how the system is performing and whether fine tuning is needed in specific locations.

In Summary

Tolay Lake was once a deeper and more expansive lake due to the natural dam that existed fourteen feet above the lake bed prior to being dynamited and drained for agriculture more than a hundred fifty years ago. Continued modifications including construction and maintenance of drainage ditches along the lake perimeter, through the center of the lake, and through the location of the historic natural dam to the location where the Tolay Creek channel steepens allowed for cultivation of the lake bed and production of seasonal crops that persisted from that time period through 2005 when Parks purchased the property. Because the historic natural dam location is a natural sediment deposition zone, the ditch through the location had to also be periodically cleared of sediment by the previous landowners to maintain the artificial agricultural condition. Furthermore, during the spring months of wet years the previous land owners had to pump water from the lake to the location where the creek steepens to facilitate lake drainage in time to plant their seasonal crops. Once Parks discontinued much of these activities neighbors to the north reported observing more extensive inundation, particularly during the wet year of 2017.

The Tolay Lake Restoration Project is intended to restore the lake to near historic conditions, enhance wildlife habitat, protect cultural resources, and reduce flooding impacts in the Park without increasing flood risk to upstream landowners. The natural condition for Tolay Lake is to persist as a lake that will likely aggrade (deposit sediment) along its southern (downstream) end ultimately rebuilding the natural divide over the long term, deepening the lake with waters extending further north during average to wet years.

The proposed measures for restoring Tolay Lake will significantly improve the conveyance of flood flows through Tolay Lake, however ongoing management measures will likely still be required into the indefinite future to prevent inundation of the Schaller property, which resides within the limits of the historic Tolay Lake footprint. In order to prevent excessive seasonal inundation on neighboring properties prior to restoration, Parks is also developing an Interim Management Plan that will aim to sustain standing water within the lakebed to a degree for wildlife habitat while providing for sufficient conveyance and drainage through the site to alleviate flooding to the north.

Continued monitoring of the staff gauges will provide key information on annual and seasonal lake levels to inform Parks on targeted management efforts during pre- and post-restoration periods that will provide for optimum wildlife habitat while preventing floodwater encroachment onto lands to the north.

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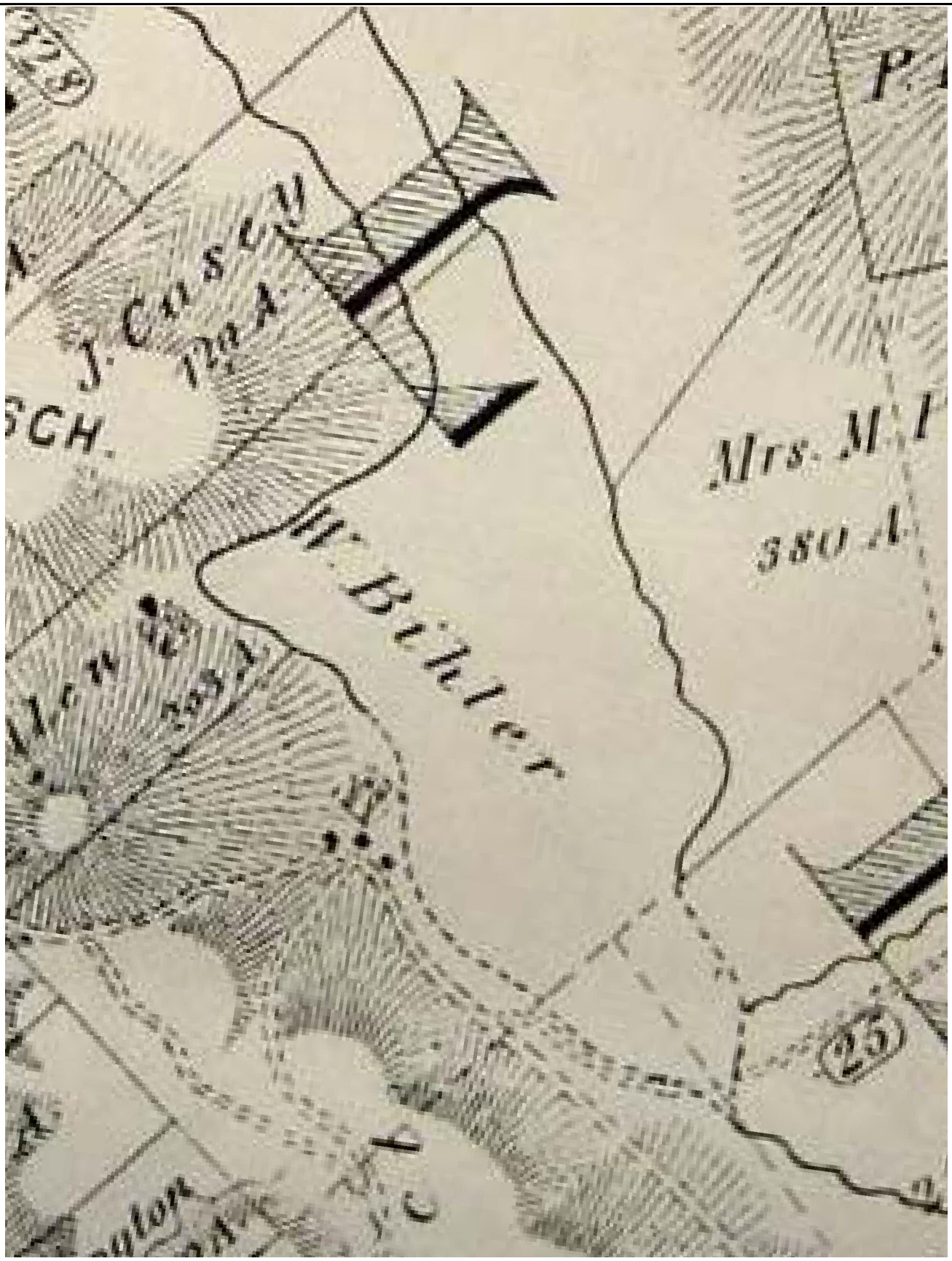
ATTACHMENTS

ATTACHMENT 1

Historic and Aerial Maps of Tolay Lake



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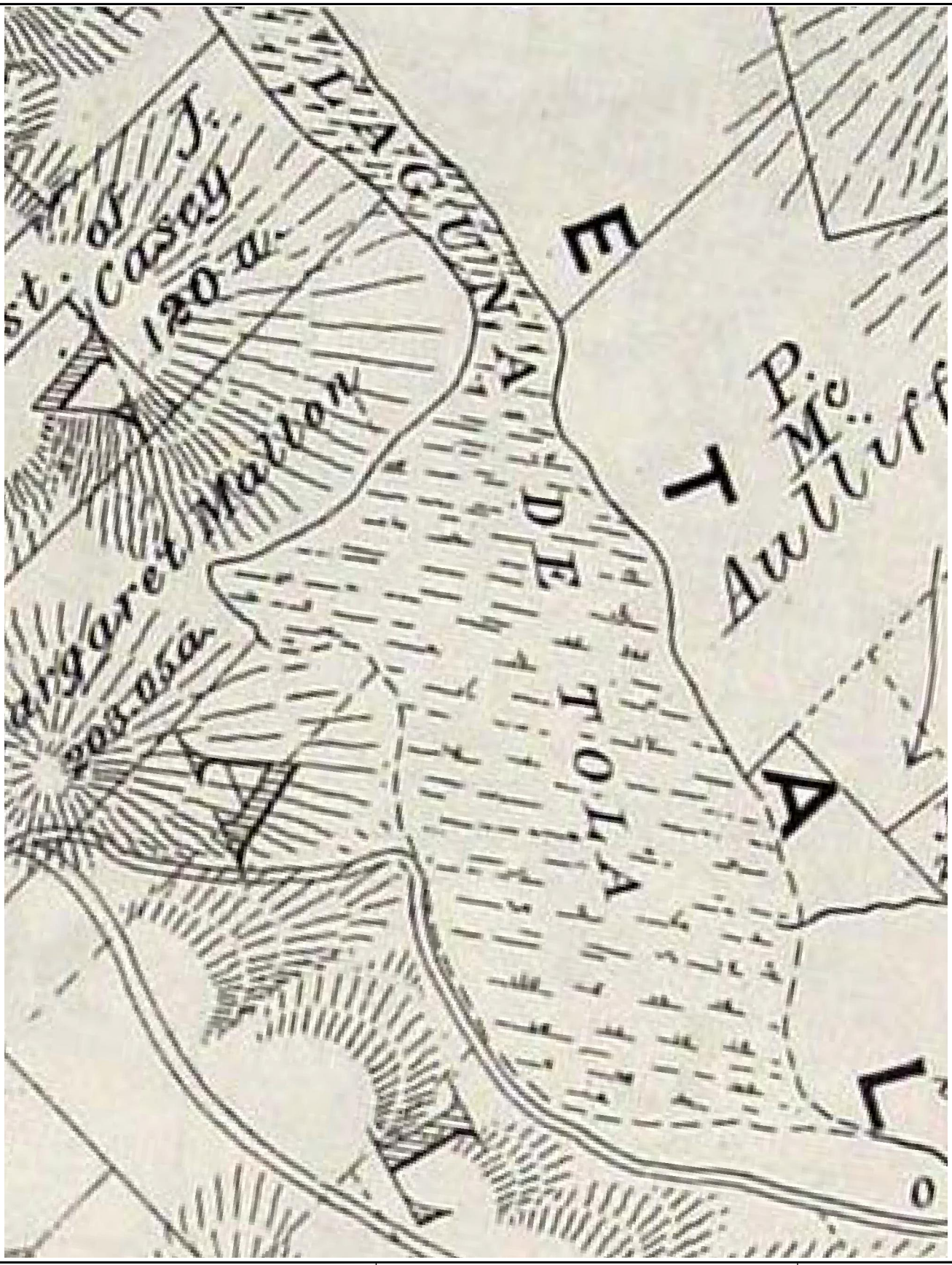
South Lake Tahoe, CA 96150
www.wildscape-engineering.com

Historical Map - 1887

Tolay Lake Regional Park
Petaluma, Sonoma County, CA

0 800

SCALE: feet



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Historical Map - 1898

Tolay Lake Regional Park
Petaluma, Sonoma County, CA

0 800
SCALE: feet

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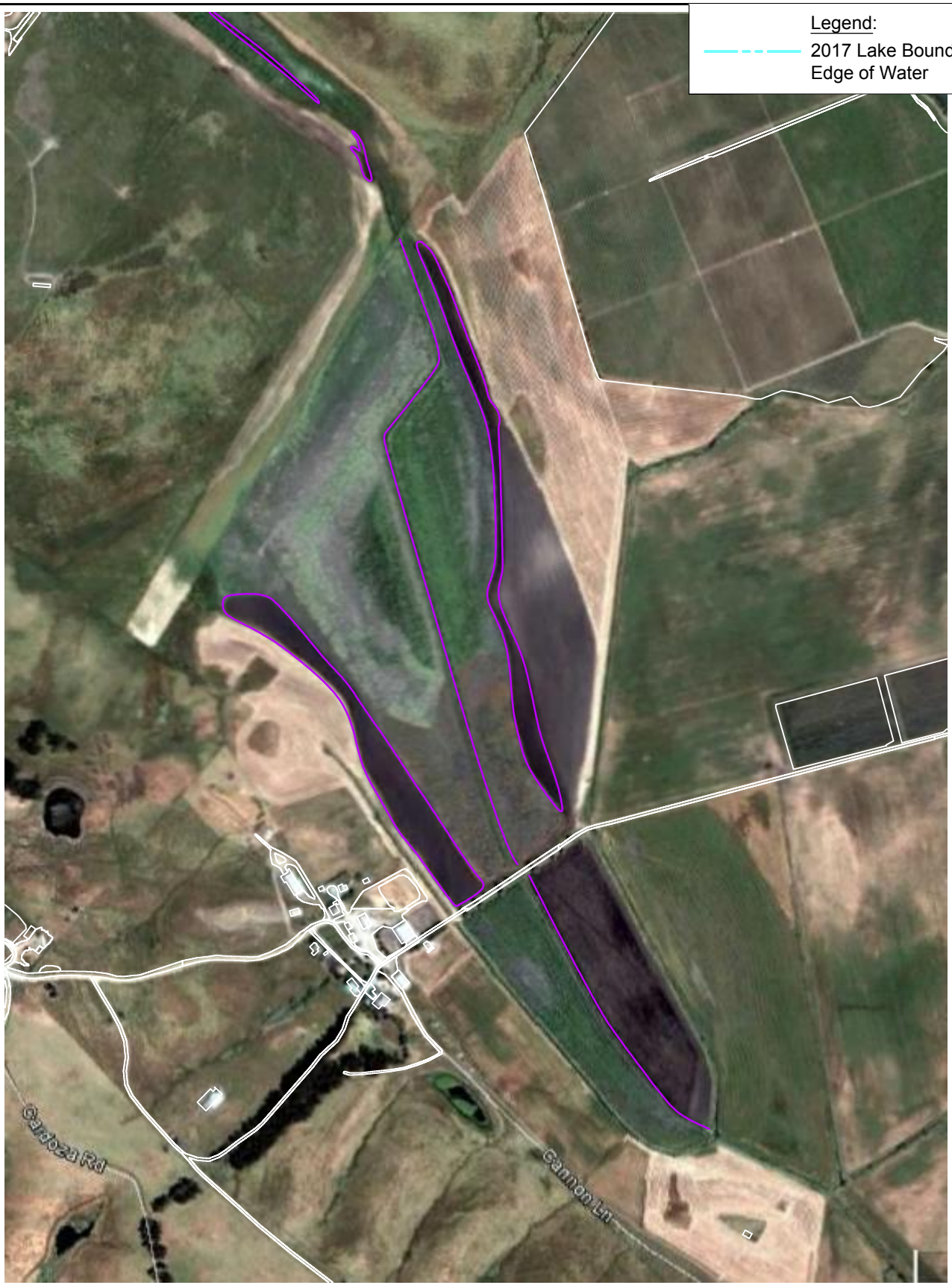
Aerial Photograph - 1993

Tolay Lake Regional Park
Petaluma, Sonoma County, CA

0 800
SCALE: feet



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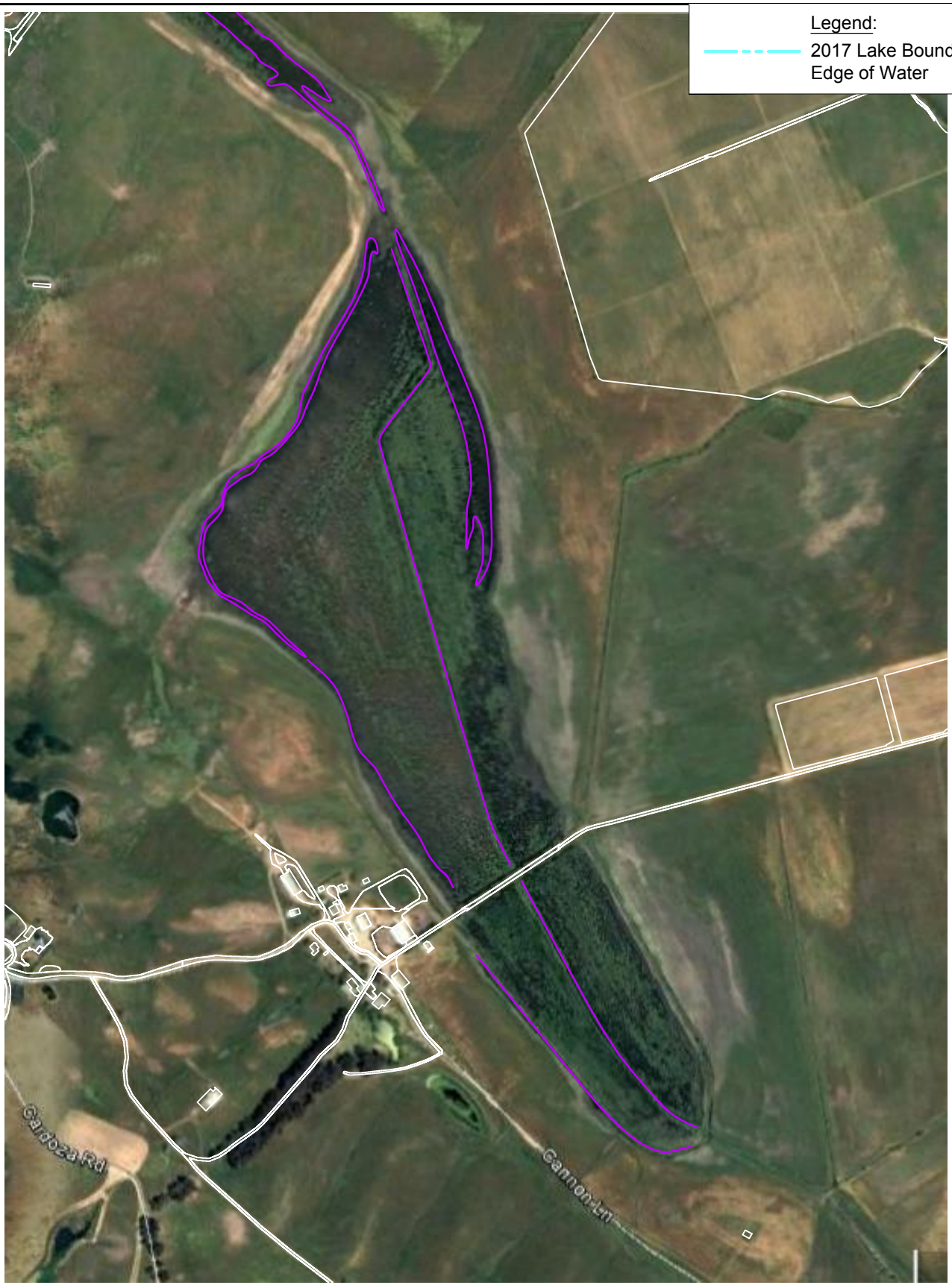
Aerial Photograph - May 2005

Tolay Lake Regional Park
Petaluma, Sonoma County, CA

0 800
SCALE: feet



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Aerial Photograph - May 2006

Tolay Lake Regional Park
Petaluma, Sonoma County, CA

0 800
SCALE: feet

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Aerial Photograph - May 2007

Tolay Lake Regional Park
Petaluma, Sonoma County, CA

0 800
SCALE: feet

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Aerial Photograph - Dec 2007

Tolay Lake Regional Park
Petaluma, Sonoma County, CA

0 800
SCALE: feet

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Aerial Photograph - Mar 2008

Tolay Lake Regional Park
Petaluma, Sonoma County, CA

0 800
SCALE: feet

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Aerial Photograph - Mar 2010

Tolay Lake Regional Park
Petaluma, Sonoma County, CA

0 800
SCALE: feet

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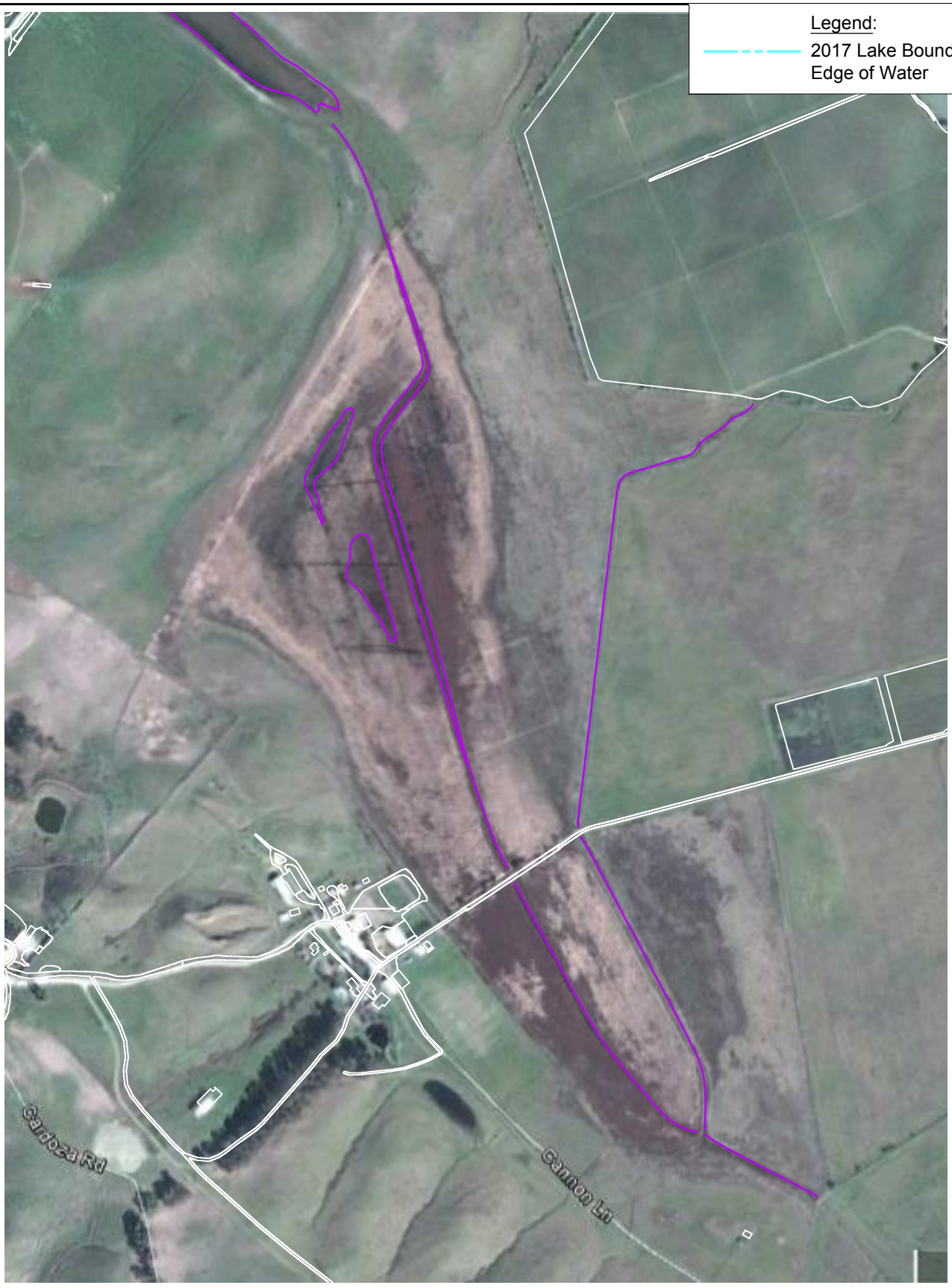
Aerial Photograph - Feb 2011

Tolay Lake Regional Park
Petaluma, Sonoma County, CA

0 800
SCALE: feet



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Aerial Photograph - Feb 2012

Tolay Lake Regional Park
Petaluma, Sonoma County, CA

0 800
SCALE: feet

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Aerial Photograph - Apr 2015

Tolay Lake Regional Park
Petaluma, Sonoma County, CA

0 800
SCALE: feet

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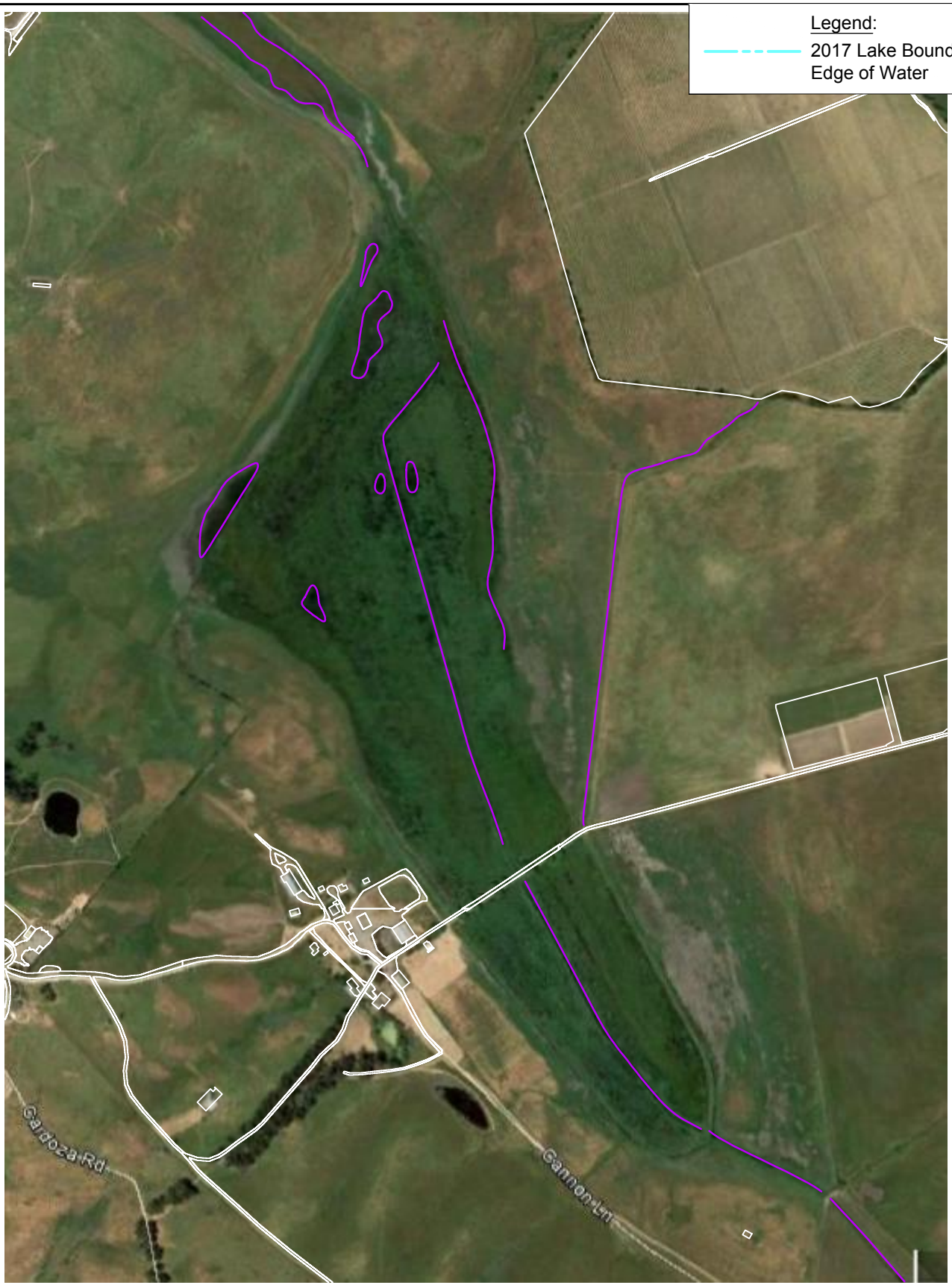
Aerial Photograph - Mar 2016

Tolay Lake Regional Park
Petaluma, Sonoma County, CA

0 800
SCALE: feet



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Aerial Photograph - May 2017

Tolay Lake Regional Park
Petaluma, Sonoma County, CA

0 800
SCALE: feet

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South Lake Tahoe, CA 96150
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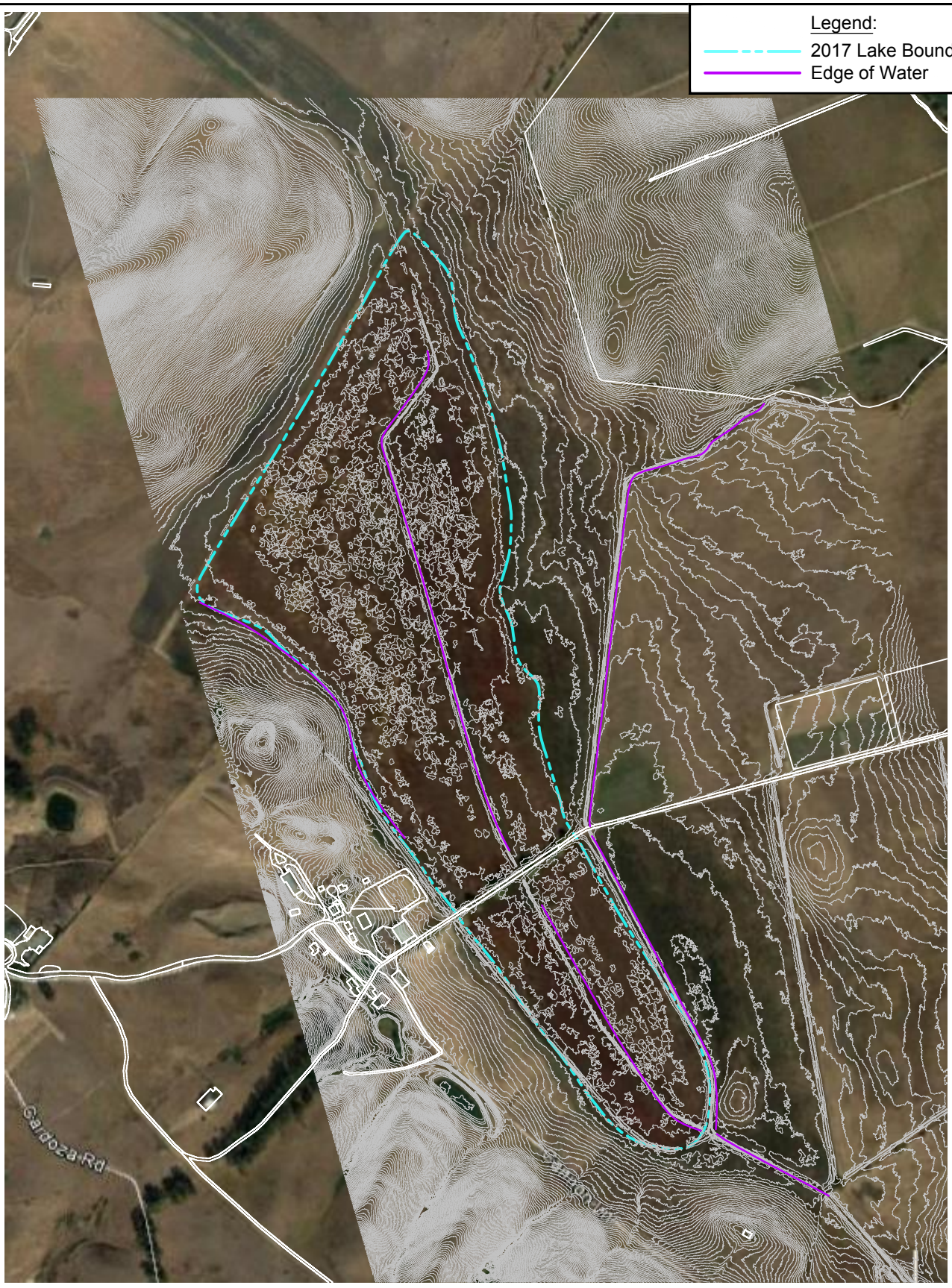
Aerial Photograph - Oct 2017

Tolay Lake Regional Park
Petaluma, Sonoma County, CA

0 800
SCALE: feet



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Aerial Photograph - Oct 2017 with Surface Topography

Tolay Lake Regional Park
Petaluma, Sonoma County, CA

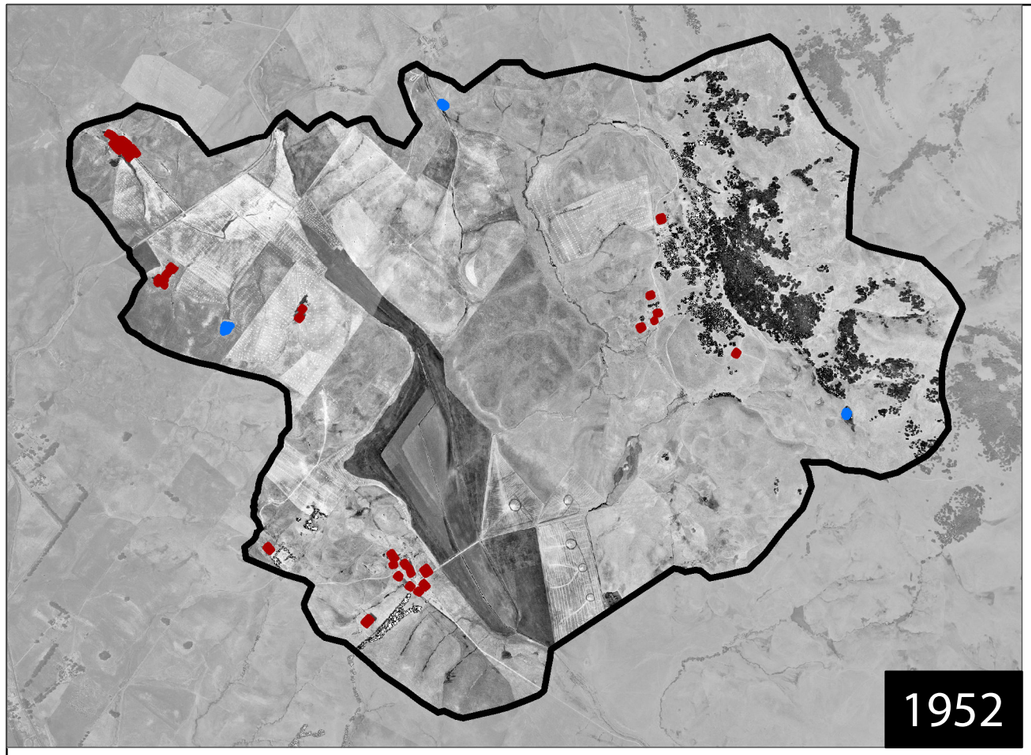
0 800
SCALE: feet

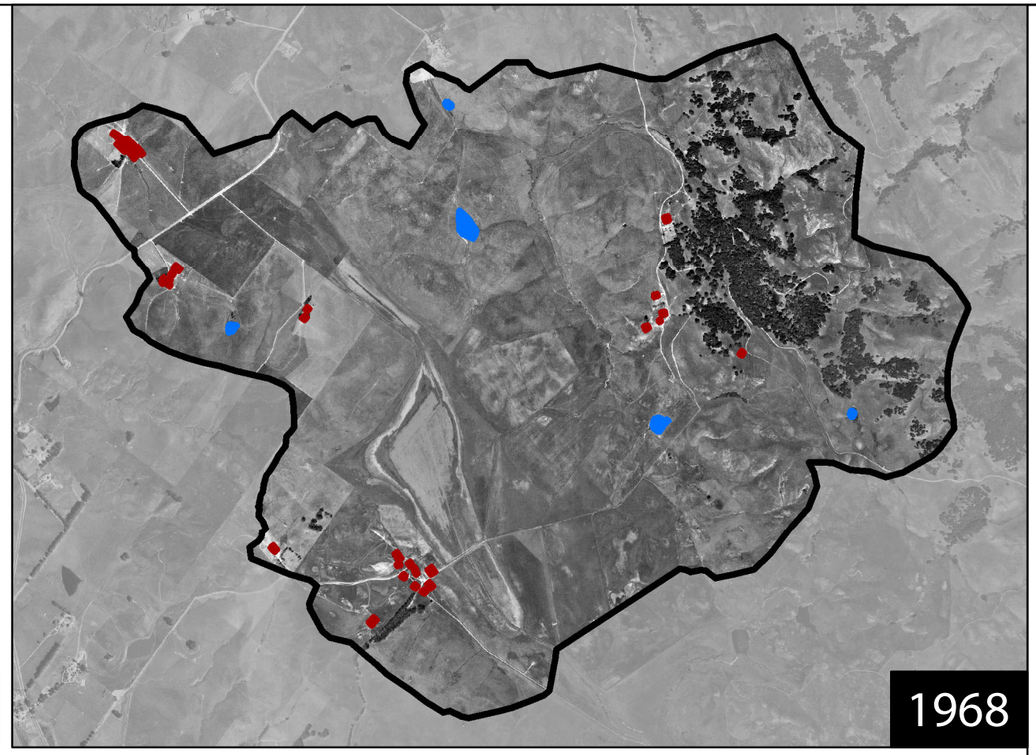
ATTACHMENT 2

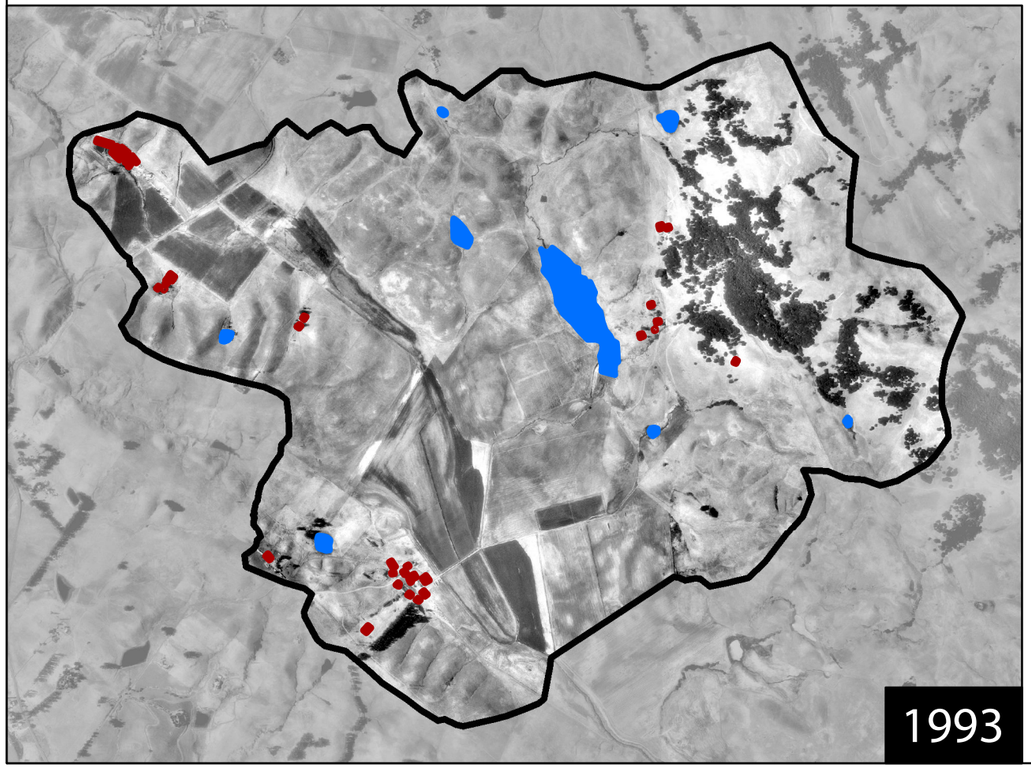
Time Series Figure Tolay Lake Watershed

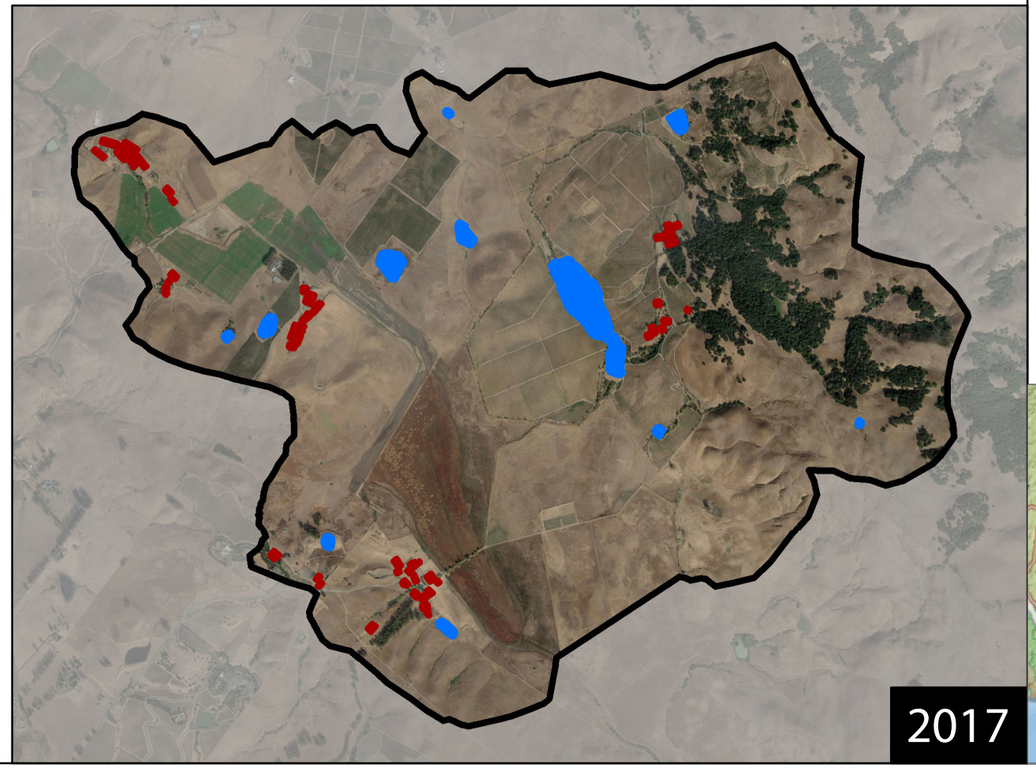
Figure 1
Time Series Analysis
Tolay Lake (1952-2017)

Tolay Lake Watershed, CA







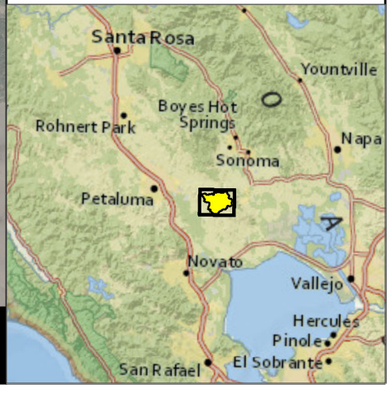


Watershed Boundary
Structure
Waterbody

Year	Structures (ac)	Change (ac)	Water (ac)	Change (ac)
1952	3.74	-	0.67	-
1968	3.74	0.00	3.87	+3.20
1993	4.25	+0.51	32.01	+28.14
2017	8.00	+3.75	33.60	+1.59

0 0.25 0.5 1 Miles

M I G



ATTACHMENT 3

Tolay Lake Draft Hydrologic Monitoring Report

Tolay Lake
Draft Hydrologic Monitoring Plan
February 2018

I. Introduction

This plan describes the monitoring protocol for short and long-term monitoring of the hydrologic regime of Tolay Lake.

The Tolay Lake Park Master Plan includes future enhancement of Tolay Lake that will encompass elimination of artificial drainage ditches within and adjacent to the lake bottom and installation of open arch culverts within the causeway and a larger spanning bridge or similar where the current historic bridge is located to improve overall conveyance. The goal for these measures is to create a longer lasting seasonal wetland without increasing flooding to adjacent private property.

In fall of 2017, eight (8) hydrology staff gauges were installed at strategic locations (Figure 1 and Attachment 1) and soon after remote cameras pointed at these gauges were also installed in order to record water surface level changes over time, particularly during the winter/spring season.

It order to develop a more comprehensive understanding of lake hydrology prior to and following restoration, it is recommended that groundwater monitoring wells (i.e. piezometers) be installed in strategic locations in order to assess groundwater levels over time and their relation to surface water levels. If piezometers are installed a protocol for measuring, recording, and assessing groundwater depths and their relationship to surface water levels will be incorporated into this plan as part of the overall hydrologic monitoring effort.

It is also recommended that a compact weather station be purchased and installed at Tolay Lake in order to record ambient temperature and precipitation accumulation. These data will allow for a greater degree of accuracy in determining how the lake system responds to large storm events or series of storms and annual and seasonal precipitation patterns. Upon purchase of a compact weather station for the site, protocol for acquiring, assembling, and recording the data will also be incorporated into this plan as part of the hydrologic monitoring effort.

II. Monitoring Methodology

The purpose of hydrologic monitoring is twofold;

1) **Pre-Restoration Implementation Monitoring –** Gain a better understanding of how water surface levels at various locations throughout Tolay Lake vary throughout the water year and how they are affected by any changes to the existing setting including active management efforts such as vegetation removal or trimming, cleaning of culverts, and active pumping. This information will also support final restoration design development.

2) **Post-Restoration Effectiveness Monitoring** – Data can continue to be collected following restoration implementation in order to evaluate changes in hydrology and measure project success in sustaining standing water in desired locations while providing for adequate flow conveyance and minimizing nuisance flooding in other locations.

Pre-Restoration Implementation Monitoring Protocol (Current)

Monthly Monitoring and Data Download: The following shall be done at each of the 8 staff gauges on a monthly basis:

1. Open the camera's waterproof case and toggle the interior switch to "Setup". Note, the staff gauge number (numeration as shown on Figure 1) is written on the label inside of the camera.
2. Remove the SD card by pushing gently into the camera. It should then spring out enough to slide the card fully out.
3. Copy the data onto a laptop into a dated folder and replace the memory card into the camera.
4. Check the battery status on the top left of the screen (battery bar). You may need to press the "Menu" button if the screen has gone dark. Replace the batteries if the battery life is low or if the batteries are dead.
5. Format the memory card. Start by pressing the "Menu" button to access the menu. Scroll up using the arrow buttons until you reach "Format". Enter the format menu by using the right arrow key and use the "OK" button to format the card.
6. Toggle the switch back to the "On" position, making sure the switch is fully clicked into that position, and close the case. The camera will resume shooting approximately 10 seconds after the switch is moved to the on position.
7. Take a photo of the gauge with your phone/camera and complete the gauge recording sheet (Attachment 2), including name of field monitor, date and time visual reading is recorded, condition of staff gage (i.e. still legible and stable, needs cleaning to see numbers easily, bent or damaged, etc.), whether photos are taken, etc.
8. Submit data results to the following address: carol@wildscape-engineering.com

For additional information related to camera operations or to troubleshoot any problems, see Camera Manual included as Attachment 3.

Storm Related Monitoring: The following shall be done every 24 hours prior to, during, and following a storm that is forecast to produce 0.25 inches or more of rain.

1. Record visual readings of water surface levels at each of the 8 staff gauges.
2. Complete field sheet.
3. Check condition of staff gauge and camera.

4. Repeat steps 1 and 2, every 24 hours until the storm clears for at least a 24-hour period.

Semi-Annual Visual Monitoring: The following shall be done every six months and integrated with the "monthly" staff gauge monitoring effort described above.

1. Observe and record culvert inlet and outlet conditions and take photos at the following locations (photos of 2017 condition provided in Attachment 1):
    a. Tolay Creek causeway culvert
    b. Horseshoe culvert
    c. West ditch causeway culvert
    d. North creek causeway culvert

Post-Restoration Implementation Monitoring Protocol (Future) -

Monitoring protocol for post-restoration should be developed in parallel with permitting and design development of the final restoration concept in order to incorporate targeted protocol that will measure project effectiveness and adhere to resource agency mitigation and/or success monitoring requirements.

Table 1. Proposed monitoring and recommended frequency and timing of monitoring activities.

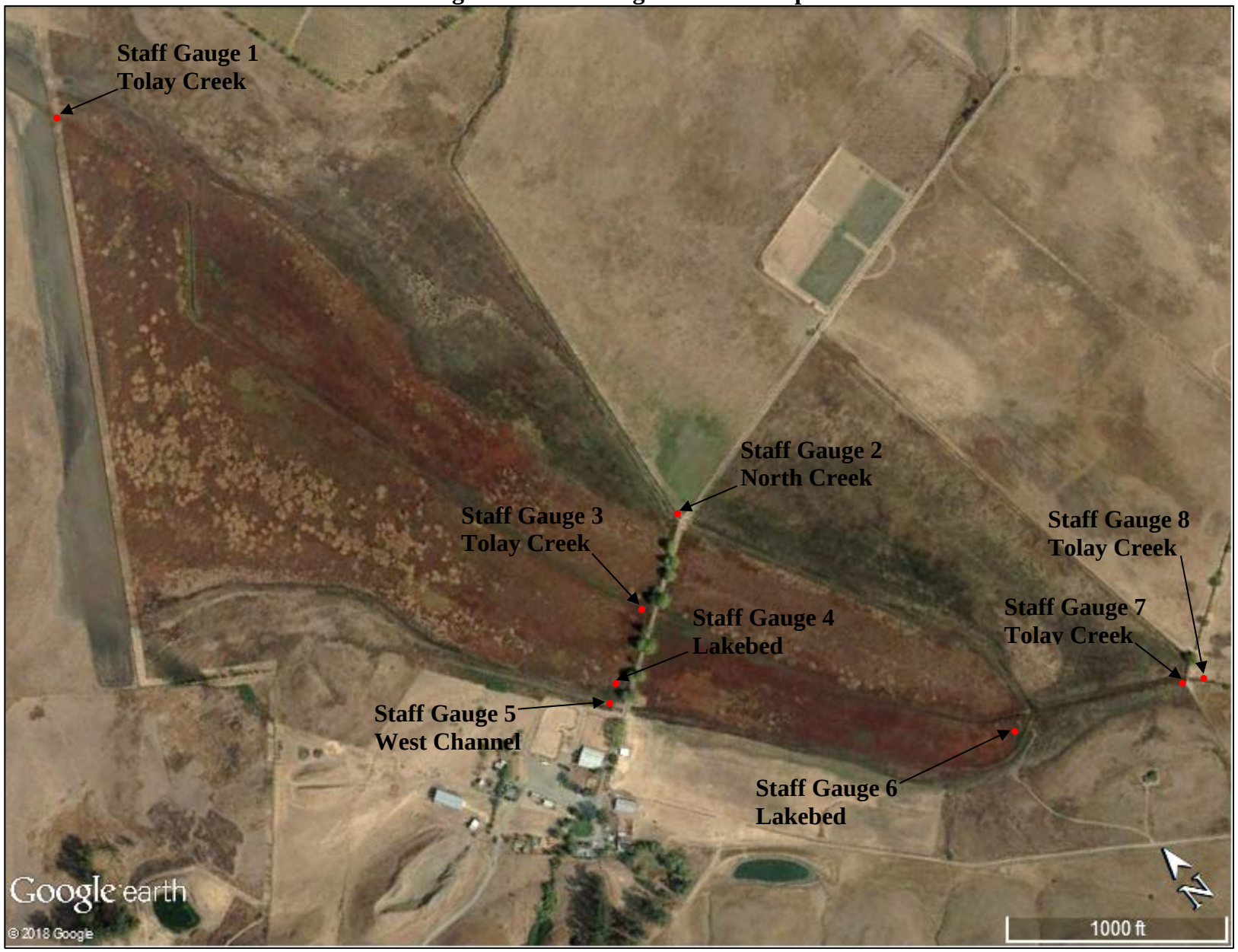
Monitoring Type	**Metric (units)**	**Method**	**Pre-project**	**Post-project**
Goal: Enhance wetland condition and improve flow conveyance.				
Hydrologic Staff Gauge	Height (0.0 Feet)	Visual Recording	Monthly from September to June (or until no surface water in Tolay Lake	Monthly from September to June (or until no surface water in Tolay Lake
Hydrologic Staff Gauge	Height (0.0 Feet)	Camera Recording	Download data monthly	Download data monthly
Culvert Condition	Observations	Visual recording	Semi-annually	Semi-annually
GW Monitoring Wells	TBD			
Weather Station	TBD			

III. Reporting

Annual monitoring activity for Pre-Restoration Implementation will be summarized and reported in an Annual Hydrologic Monitoring report. This report will describe the data collected each year, as well as a summary of any key findings and include observation photos.

Future annual monitoring activity for Post-Restoration will be summarized and reported in an Annual report the first two years and followed by reporting six years after project completion to allow for the 5-year post-project data to be fully analyzed and interpreted.

Figure 1: Staff Gauge Location Map



ATTACHMENT 1
Tolay Lake Regional Park
Staff Gauges and Culvert Inspection Photo Log
November 3, 2017

1. **Gauge #1 – within Tolay Creek channel just downstream of northern property boundary/fence line, looking north.**

2. Gauge #2 – within North Creek channel (right bank toe) just upstream of the causeway, looking northwest.

3. Gauge #3 - within Tolay Creek channel (left bank toe) just upstream of the causeway, looking northwest.

4. Gauge #4 – within lakebed northeast of west ditch just upstream of the causeway, and Gauge #5 – within west ditch (left bank toe) just upstream of the causeway, looking northeast.

5. Gauge #6 – within lakebed, just upstream and south of the horseshoe culvert, looking northwest.

6. Gauge #7 – within Tolay Creek channel (right bank) just upstream of the farm bridge, looking north.

7. Gauge #8 – within Tolay Creek channel (left bank toe) just downstream of the farm bridge, looking southeast.

8. Inlet of horseshoe culvert looking south, flow is "backwards" from southeast to northwest.

9. Tolay Creek causeway culvert inlet, looking southeast.

10. Looking southeast through Tolay Creek causeway culvert, ~70% full of sediment, but appears to be in good conditions.

11. West ditch causeway culvert, looking southeast.

12. North Creek channel causeway culvert, looking southeast; notice top of culvert concaving from vehicle loads.

ATTACHMENT 2
Staff Gauge Field Sheet

TOLAY LAKE HYDROLOGIC MONITORING

WATER SURFACE RECORDING FORM

DATE:_____

DATA COLLECTOR:_____

WEATHER:_____

Staff Gauge #	Time Reading Taken	Manual Staff Gauge Reading	Camera Data Downloaded (Y/N)	Any Staff Gauge or Camera Maintenance Issues or Needs	Photo Taken (Y/N)	Additional Comments/Observations
1						
2						
3						
4						
5						
6						
7						
8						