Prepared for

Mary Lake Restoration Preliminary Design Report

Redding, CA

Prepared by

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Geosyntec Project #: LA0443

February 2019

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1 INTRODUCTION

1.1 Background

As part of the Redding Stormwater Resource Plan (Geosyntec 2018), the City of Redding (City) identified an opportunity to capture, store, and treat wet weather and dry weather runoff to Mary Lake for discharge to the lake during dry weather months when the lake water levels are low (Project). Mary Lake Park is located on the west side of the City and includes approximately 29 developed acres of walking trails surrounding the man-made lake (Figure 1). Upstream of this area, an upper pond captures and treats runoff from an approximately 260-acre drainage area through emergent wetland vegetation and slowly discharges the water over a constructed spillway into Mary Lake. During summer months, it has been reported that algal growth accumulates on the lake banks due to decreasing water levels from evaporation and limited runoff to Mary Lake and may also be affected by elevated water temperatures, decreased flushing, and local nutrient input as well. This algae accumulation results in unpleasant odors for the surrounding community.

Figure 1. Mary Lake Existing Project Footprint

The proposed Project includes installing a cistern next to the upper pond to capture and store stormwater runoff, a pump to convey flow to the upper pond from the cistern during dry weather months, and a stop log weir to control flows into Mary Lake. The Project also includes installing a storm drain diversion, sedimentation basin, and constructed subsurface treatment wetland adjacent to Mary Lake to improve water quality, along with installing a small pump station to circulate lake water through the subsurface treatment wetland to sustain vegetation and reduce nutrient levels. The purpose of this report is to present the methodology and results of the preliminary design and sizing analyses performed to achieve the Project goals and recommend future actions to complete the Project design.

1.2 Preliminary Investigation

Geosyntec reviewed City-provided as-builts and utility shapefiles and additional utility information from the City's Electric Department. A site visit was conducted on Wednesday, May 24, 2018, to assess Project feasibility and existing site conditions and refine the proposed concept originally outlined in the City's Stormwater Resource Plan (Geosyntec 2018). One constant head infiltration test was conducted in the vicinity of the potential natural treatment system and demonstrated that infiltration may be limited and therefore a subsurface treatment wetland should be utilized.

The results of this preliminary investigation are included in the Mary Lake Restoration Field Feasibility Assessment Summary Memo (Appendix A) and were used to develop initial design sizing and layout as described in the following sections.

2 PRELIMINARY DESIGN OVERVIEW

This section presents a summary of the key design inputs and calculated values required to effectively size and implement the Project storage and treatment systems to meet the design goals of maximizing water stored during wet weather months and delivered to Mary Lake during dry weather months and to improve the water quality in Mary Lake.

Preliminary design calculations are provided in Appendix B. Appendix C includes a preliminary site plan and detail sheet, while Appendix D contains a preliminary project work plan, cost estimate, and schedule. Additional design details and analysis will be required during later stages of design as outlined in Section 3 below.

2.1 Storage System

To store wet weather and dry weather runoff, a cistern will be located southeast of the upper pond in an area that is currently undeveloped and free of known utility constraints, except for a sewer line that will need to be redirected around the cistern. A stop log weir will be installed on top of the existing spillway to promote additional ponding of water in the upper pond. Water will flow from the upper pond by gravity through a trench drain into the underground cistern. During dry weather periods, water will be pumped from the cistern into the upper pond and the stop log weir will be adjusted to allow flow from the upper pond into Mary Lake to increase the depth of water. Additional design details are described below.

2.1.1 Cistern Design Volume

The cistern was designed to maximize storage within the selected area for implementation, accounting for footprint constraints including nearby houses and utilities. The preliminary cistern design assumes a depth of 10 feet, which results in a volume of 280,000 cubic feet (6.4 acre feet) when accounting for the footprint space available. Subsequent structural and buoyancy calculations will need to be executed to determine whether this depth needs to be adjusted. From 2001 to 2014, the annual volume of potable water pumped from a nearby fire hydrant into Mary Lake to increase the depth of water varied from 3,800 cubic feet (0.087 acre feet) to 2,024,900 cubic feet (46 acre feet) with an average of 890,000 cubic feet (20 acre feet). The cistern design volume is therefore 31% of the average annual pumped volume. Preliminary cistern design parameter values are shown in Table 1, and calculations are provided in Appendix B.

Table 1. Preliminary Cistern Design Parameters

Parameter	Value
Depth (ft)	10
Footprint (acres)	0.64
Volume (acre-ft)	6.4
Average Pumped Volume from 2001-2014 (acre-ft/yr)	20
Cistern Volume Percent of Average Pumped Volume (%)	31

2.1.2 Spillway Modification and Cistern Inlet/Outlet Structures

The upper pond spillway will be retrofitted with a stop log weir or other adjustable weir/gate, installed above the existing spillway. During wet weather months, the weir will be raised 2 feet to allow more water volume to be captured by the cistern and the upper pond (additional flood control evaluations must be performed to determine whether increasing this depth will result in flooding of nearby houses). The cistern will be designed with a trench drain that allows stormwater to flow from the upper pond into the trench drain and then through a pipe into the cistern. Since water flows into the cistern by gravity, the water depth in the cistern will dictate whether flow enters the cistern or bypasses and stays in the upper pond (i.e., if the cistern and trench drain are full, water will not enter the trench drain by gravity). During dry weather months, the weir will be lowered, and a pump installed within the cistern will pump stored water from the cistern into the upper pond, allowing the water to flow to Mary Lake and increase the water depth. Depending on operation and maintenance desires, this pump can be initiated manually, or a timer could also be included to automate pumping cycles.

2.2 Treatment System

To capture and treat wet weather and dry weather runoff from 9.8 acres of residential development, a subsurface wetland treatment system will be installed in the southern portion of Mary Lake park, on the south side of the existing walkway path and north of Lakeside Drive. A diversion manhole and weir[1] will be installed in the nearby 24-inch storm drain to divert the tributary area 85th percentile 24-hour storm volume (16,000 ft^3) to a sedimentation basin. Stormwater will flow from the sedimentation basin to a subsurface treatment wetland. A small pump station will also be designed to circulate lake water through the sedimentation basin and maintain subsurface treatment wetland water levels during dry weather months. Preliminary sedimentation basin and subsurface treatment wetland design parameter values are shown in Table 2, and calculations are provided in Appendix B.

Table 2. Preliminary Sedimentation Basin and Subsurface Treatment Wetland Design Parameters

System Element	Parameter	Value
Project Drainage Area	85th percentile 24-hr storm depth (in)	0.91[2]
	Area (ac)	9.8
	Imperviousness (%)	46
	Runoff coefficient	0.50
	Design Runoff volume (ft^3)	16,000
Sedimentation Basin	Ponded surface area (ft^2)	3,600
	Bottom surface area (ft^2)	3,100
	Design ponding depth (in)	8
	Ponded volume (ft^3)	2,200
Subsurface Treatment Wetland	Ponded surface area (ft^2)	23,000
	Bottom surface area (ft^2)	22,000
	Design treatment ponding depth (in)	8
	Ponded volume (ft^3)	15,000
	Residence time (days)	3
	Flow rate through bed (CFS)	0.067
	Maximum change in bed depth (ft)	1.0
	Approximate length (ft)	300
	Approximate width (ft)	62
	Bed depth (in)	24
	Minimum bed hydraulic conductivity (ft/d)	14,000

[1] The diversion manhole and weir will be sized based on the design flowrate in future design iterations.

[2] City of Redding. *Post-Construction Standards Plan.*

2.2.1 Sedimentation Basin

A sedimentation basin is included to provide detention of wet weather flows and an opportunity for settling of sediment and particulate-bound pollutants prior to the subsurface wetland. This is essential to delay clogging of the subsurface wetland gravel layers. The sedimentation basin bottom surface area was designed to be approximately 10% of the subsurface treatment wetland bottom surface area. The preliminary bottom surface areas of the sedimentation basin and wetland are 3,100 square feet and 22,000 square feet, respectively, which were determined based on available land area within the proposed Project's footprint. The sedimentation basin outlet to the subsurface treatment wetlands contains an overflow structure for when the ponding depth has been reached and a low flow pipe to drain the sedimentation basin within 72 hours to minimize potential vector issues. Additionally, the sedimentation basin is bisected by a gabion basket filled with boulders to extend the flow path within the basin and promote settling and use of the full surface area.

2.2.2 Subsurface Treatment Wetland

A subsurface treatment wetland was selected as the natural treatment system for treating the neighborhood wet weather and dry weather runoff and recirculating lake water, because subsurface treatment wetlands typically achieve high nutrient removal and the associated vegetation can sustain prolonged inundation. The subsurface treatment wetland consists of a surface ponding area (2 ft including the freeboard), a wetland soil layer (8 inches), a pea gravel layer (3 inches), and a crushed stone layer (2 feet). The wetland's treatment ponding depth was sized to be 8 inches, which would provide a treatment ponding volume (17,000 ft^3) throughout the sedimentation basin and subsurface treatment wetland in excess of the 85^{th} percentile 24-hour storm volume.

Low flows into the subsurface wetland will be directly connected from the sedimentation basin to a horizontal perforated inlet pipe at the base of the gravel bed. The stormwater overflows (i.e., above the 8-inch ponding depth) from the sedimentation basin will enter at the surface of the subsurface wetland and then infiltrate down through the soil layer and vertical perforated riser pipes into to the horizontal perforated inlet pipe at the base of the gravel bed. To achieve a residence time of 3 days (consistent with vector control requirements), the subsurface treatment wetland bed flowrate was designed to be 0.067 CFS. Using a maximum bed elevation change of 1.0 foot, the minimum hydraulic conductivity though the gravel bed was designed to be 14,000 ft/d.

At the subsurface treatment wetland outlet, a perforated subdrain will convey flow from the base of the gravel bed to an outlet structure. A pipe elbow and orifice will allow the water to enter the outlet structure when the depth exceeds the depth of the pea gravel, which will maintain water beneath the wetland surface. An overflow grate will allow water above the treatment ponding depth to enter the outlet structure directly during larger storm events. A pipe from the outlet structure will then convey treated and bypassed flows to Mary Lake.

3 RECOMMENDED NEXT STEPS

This Report documents the preliminary design layout and sizing performed for the Project. Before implementation of the Project can be confirmed to be feasible and taken to final design, additional analyses and steps should be performed, including:

- A site topographical survey to obtain detailed elevation and constraint information;
- Utility investigation and potholing to determine if shallow utilities will impact the proposed design;
- Runoff and lake water quality sampling to see if nutrients are indeed an issue requiring treatment, what forms they're in (for treatability), and what the algae controlling nutrient is (to inform treatment wetland design);
- Additional calculations and/or hydraulic modeling to satisfy City drainage plan check requirements;
- Grading and drainage calculations to confirm all elevations of Project features in order to promote positive drainage;
- Structural design of the cistern and stop log weir in order to determine final depths, elevations, and materials;
- A flood control evaluation of the upper pond area to determine whether increasing the upper pond depth will negatively impact the surrounding properties;
- A lake water balance to determine the typical volume of water required to be added to Mary Lake to quantify the cistern's benefit;
- Pump station design to determine the size and type of pumps required;
- Subsurface treatment wetland ecological design to promote desired water quality performance including wetland plant selection;
- Development of a vector control plan and design of the trench drain to minimize vector concerns in the cistern as well as other provisions to minimize vector concerns within the sedimentation basin and the wetland; and
- Development of construction drawings including additional design details such as final elevations, sizes, and material types and quantities.

4 REFERENCES

City of Redding, 2016. *Post-Construction Standards Plan.* May 2016.

Geosyntec Consultants, 2018. *City of Redding Stormwater Resource Plan.* October 2018.

APPENDIX A

MARY LAKE RESTORATION

FIELD FEASIBILITY ASSESSMENT SUMMARY MEMO

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Memorandum

Date:	12 February 2019
To:	Mieke Sheffield; City of Redding
From:	Avery Blackwell, PE, Brandon Steets, PE, Adam Questad, PE, and Maia Colyar, Geosyntec Consultants
Subject:	Mary Lake Restoration Field Feasibility Assessment Summary Geosyntec Project: LA0443
Attachments:	Attachment A – Figure 1. Field Investigation Map, Field Logs and Calculations

INTRODUCTION AND BACKGROUND

The City of Redding (City) has identified a project to capture and treat surface runoff entering Mary Lake in the Jenny Creek watershed (Project). Stormwater and dry weather runoff carry pollutants from the surrounding neighborhoods into the lake and may be contributing to eutrophication issues, including algal buildup on the shoreline as water levels decrease during the summer months. As part of the Project, natural treatment systems are proposed at the western and eastern sides of Mary Lake to treat runoff from the surrounding residential stormdrain network. These natural treatment systems will re-circulate water from Mary Lake to provide additional water quality benefit. In addition, a portion of wet and dry weather runoff stored in the upper pond will be diverted into a cistern for storage during wet months and pumped back into the lake during dry months to increase the water depth in Mary Lake and reduce algal buildup on the shoreline. Mary Lake collects runoff from a 460-acre drainage area consisting mostly of open space and residential land uses and is located outside of the Redding groundwater basins, so direct aquifer recharge is not anticipated. Potential constraints identified during the desktop feasibility analysis included groundwater separation distance, limited percolation of the existing soils, and potentially insufficient space to install the natural treatment system and the storage tank.

This memorandum summarizes the field assessments performed to assess Project feasibility, constraints, necessary design modifications, and recommendations for next steps.

SITE ASSESSMENT

On May 24, 2018, Geosyntec staff visited the Project location to gather information to assess project feasibility and refine the proposed concept design based on identified constraints A site investigation map is included in Attachment A. The following key observations were made:

1) The western proposed natural treatment area is full of dense vegetation and trees and therefore likely not suitable for a treatment system. In addition, a stormdrain currently discharges to this area, which consists of wetland-like vegetation, so water quality benefit may already be provided.
2) A significant amount of irrigation runoff was observed entering one of the roadway inlets. This roadway inlet drains to a catch basin north of the proposed eastern natural treatment system, which represents a possible point for dry and wet weather diversion.
3) Dry weather flow was observed draining from the upstream bridge culverts, eventually draining to the upper pond.
4) A concrete and corrugated metal culvert were identified south of Mary Lake on the northern side of Lakeside Drive and near the location where the upper pond spills into Mary Lake. Approximate depth measurements were determined using a string and level, which concluded that these culverts were both approximately 50 inches below ground surface and 45 inches below the proposed eastern natural treatment area. As a result and due to their proximity to Mary Lake, it was determined that diverting stormwater from these stormdrains to the treatment systems would require a pump station.
5) The location of the cistern adjacent to the upper pond may be constrained by existing trees, the nearby residential parcels, and an existing sewer line (a sewer manhole was observed).
6) A flooding evaluation needs to be conducted to determine whether raising the upper pond’s spillway will result in excessive water depths that impact the adjacent residences.

As a result of this site assessment, the Project was determined to be feasible; however, it is not advised to implement the western natural treatment area due to the lack of usable area and because this area may currently be providing water quality benefit. In addition, the cistern should be sited to limit potential conflicts, but a relocation of the existing sewer line may be required. Finally, the only feasible location to divert stormwater by gravity was identified as a catch basin just north of the proposed eastern natural treatment area, where the roadway storm drain discharges. Stormdrain diversion should be proposed from this location, but not at the other identified storm drain locations due to their low invert elevations requiring pumping, which adds cost and maintenance requirements, and their proximity to Mary Lake potentially resulting in additional permitting concerns. Additional analyses should be conducted to confirm the feasibility of implementing all of the Project’s components including a flooding analysis to assess potential impacts to the residential properties adjacent to the upper pond, a hydrologic and hydraulic analysis to determine how much water can be diverted and would be available to supplement the volume of water in Mary Lake during the summer months, and a cost-benefit analysis to determine if the cistern's benefits justify the associated costs.

SOIL INVESTIGATION

To evaluate the Project's underlying soil types and infiltration potential, a soil investigation was performed on May 24, 2018. A soil investigation site was located within the Project's footprint and selected to characterize the type and infiltration potential of the soil type that may be present within the natural treatment system footprint. One boring (BH-ML-1) was dug using a hand auger and the soil types were logged in accordance with the Unified Soil Classification System (USCS). Water was encountered in the boring initially at 46 inches below ground surface, but then later filled up to 30 inches below ground surface, limiting the depth of the boring.

After the boring was complete, the bore hole was backfilled with cleaned gravel and used for infiltration testing. A constant head infiltration test was conducted in general accordance with the Well Permeameter Method, USBR 7300-89, from the US Bureau of Reclamation to estimate the saturated hydraulic conductivity or infiltration potential. Water was applied to the gravel until a constant head could be maintained. The volume and time elapsed were recorded and used to calculate the hydraulic conductivity summarized in the table below. The soil logs, infiltration test results, and hydraulic conductivity calculations can be found in Attachment A.

Table 1. Soil Infiltration Testing Summary

Boring ID	Latitude	Longitude	Ground Surface Elevation (feet AMSL[a])	Depth to Bottom of Boring (inches bgs[c])	Depth to Water (inches bgs)	Saturated Hydraulic Conductivity (inches/hour)
BH-ML-1	40.573675	-122.432182	737	53.5	30	0.314

a. above mean sea level
b. below ground surface

As shown on the boring logs presented in Attachment A, the subsurface soils generally consisted of silty, sandy, and gravely soil with a clayey layer about 30 inches below ground surface. Per the United States Department of Agriculture (USDA) Natural Resources Conservation Service (NRCS) soil classification, the rate shown in the above table is at the lower end of the typical range of saturated hydraulic conductivity values for the materials present (~0.15-1.52 inches per hour).[1]

[1] USDA NRCS. *Saturated Hydraulic Conductivity | NRCS Soils.* Retrieved on January 2, 2019 from https://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/survey/office/ssr10/tr/?cid=nrcs144p2_074846

The Los Angeles County *Low Impact Development Standards Manual*[2] recommends an infiltration rate greater than 0.3 in/hr for infiltration features to be feasible at a given site.

As a result of this soil investigation, it was determined that surface infiltration is likely infeasible at this location due to the low saturated hydraulic conductivities measured and the presence of shallow groundwater.

UTILITY REQUEST

A utility investigation was performed to identify potential utility constraints within the Project's footprint. The City provided utility shapefiles and as-builts by e-mail between June 7 – 8, 2018. Utility owner contact information was also acquired from the USA North 811 underground service alert of Northern/Central California and Nevada[3], and each identified owner with contact information was emailed and/or called on June 6, 2018 to request information about the type and location of utilities near the Project. Written utility information was received from the City of Redding Electric Department. The remaining utilities did not respond to the information requests. A summary of the requests and information received is provided in the table below.

Table 2: Utility Investigation Summary (potential constraints bolded)

Utility	Owner	Response received?	Data Provided	Description/ Location	Potential constraints?
Electricity	City of Redding Electric Department	Yes	Written description	Underground service near the upper pond	No
Electricity, Stormwater, Sanitary Sewer, Water	**City of Redding Public Works**	**Yes**	**Shapefiles, as-builts**	**Sanitary sewer near upper pond, storm drains near wetland**	**Yes, sewer may need to be relocated**
Telecommunications	Falcon CTV Redding	No	-	-	-
Telecommunications	Pacific Bell	No	-	-	-
Gas, Electricity	PG&E District Redding	No	-	-	-

[2] Los Angeles County. *Guidelines for Design, Investigation, and Reporting for LID Stormwater Infiltration.* 2014.
[3] https://www.usanorth811.org/

As a result of this utility investigation, the only potential utility constraint identified was the City of Redding Public Works Department's sanitary sewer lines. The sanitary sewer line located near the upper pond may interfere with installation of the cistern and may need to be relocated.

CONCLUSION

Based on the investigations performed, the Project was preliminarily determined to be feasible, but additional analyses are required to conclusively determine the feasibility of implementing all of the Project's components. These additional analyses include:

- A flooding analysis to determine whether increasing the upper pond's spillway may impact adjacent residences;
- A hydrologic and hydraulic analysis to evaluate the quantity of water that can be diverted to the cistern, the additional quantity that can be stored if the upper pond spillway is raised, and how this additional water will impact the water depth in Mary Lake; and
- A cost-benefit analysis to determine if the proposed cistern's benefits can justify the design, installation, and maintenance costs.

The Project should also be modified to only include the eastern natural treatment system and diversion of the stormdrain just north of this area due to the constraints identified. In addition, the soil investigation results suggest that infiltration may be limited and therefore a wetland or bioretention with underdrain is proposed as the natural treatment system so that the design does not rely on infiltration for water quality benefits. Finally, based on the utility information received, the sewer line identified near the upper pond may need to be relocated to accommodate the cistern installation.

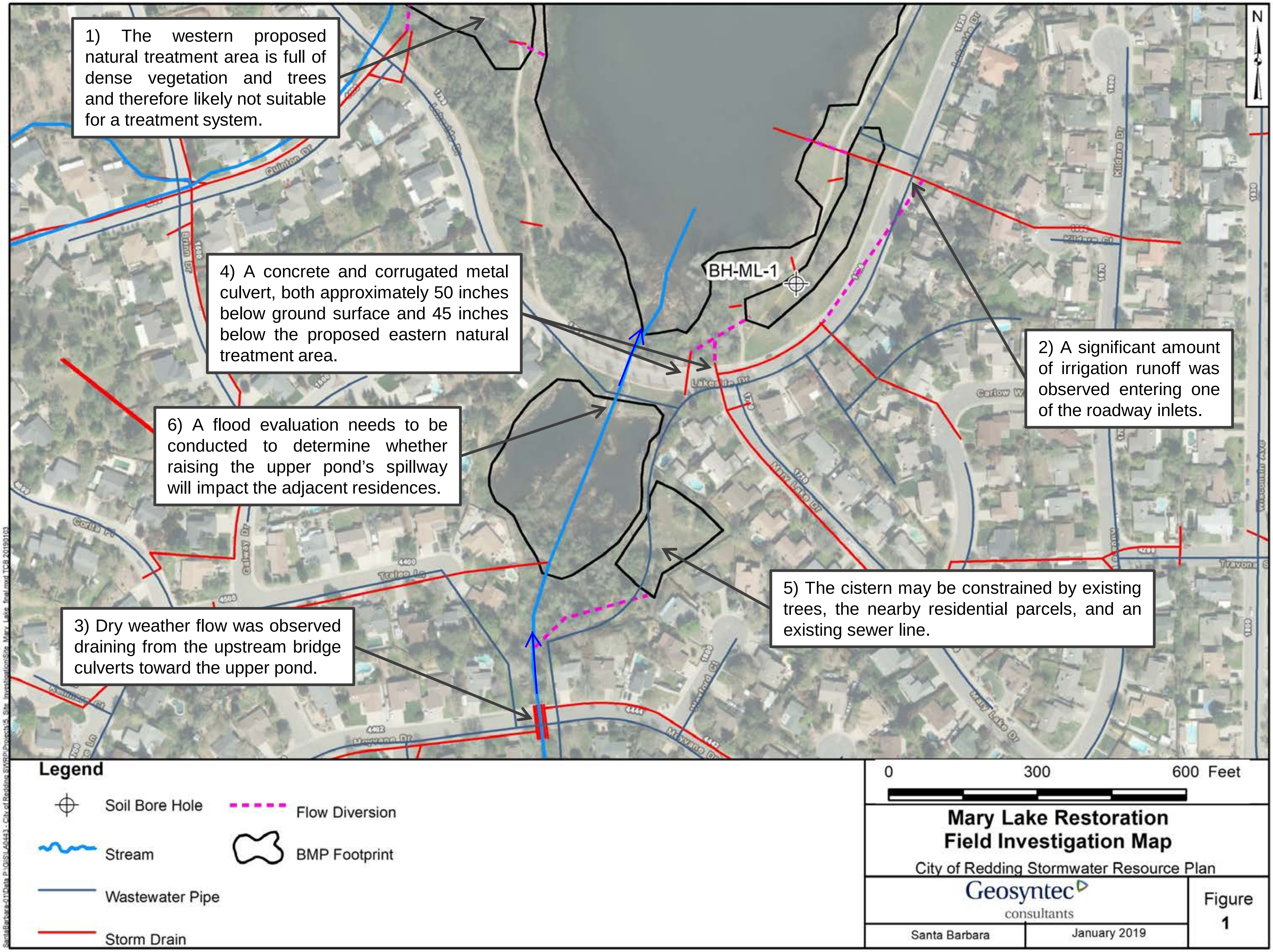
In addition, permitting conversations with applicable regulators (e.g., Regional Water Quality Control Board, California Department of Fish and Wildlife, Army Corps of Engineers, Flood Control, etc.) will be necessary to finalize the Project. These conversations will dictate future design requirements, therefore initial designs for this project should provide flexibility to accommodate future changes during subsequent design reviews.

* * * * *

ATTACHMENT A

FIGURE 1. FIELD INVESTIGATION MAP

FIELD LOGS AND CALCULATIONS


1) The western proposed natural treatment area is full of dense vegetation and trees and therefore likely not suitable for a treatment system.
BH-ML-1
4) A concrete and corrugated metal culvert, both approximately 50 inches below ground surface and 45 inches below the proposed eastern natural treatment area.
2) A significant amount of irrigation runoff was observed entering one of the roadway inlets.
6) A flood evaluation needs to be conducted to determine whether raising the upper pond's spillway will impact the adjacent residences.
5) The cistern may be constrained by existing trees, the nearby residential parcels, and an existing sewer line.
3) Dry weather flow was observed draining from the upstream bridge culverts toward the upper pond.
N
Legend
Soil Bore Hole
Flow Diversion
Stream
BMP Footprint
Wastewater Pipe
Storm Drain
0 300 600 Feet
Mary Lake Restoration
Field Investigation Map
City of Redding Stormwater Resource Plan
Geosyntec consultants
Santa Barbara
January 2019
Figure
1

Geosyntec consultants

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GS FORM: WELL BORE 01/04

BOREHOLE LOG

BORING BH-ML-1
START DRILL DATE 5/23/18
FINISH DRILL DATE
LOCATION Mary Lake
PROJECT Redding SWRP
NUMBER LA0443

SHEET OF

ELEVATION DATA: — —
GROUND SURF.
TOP OF CASING
DATUM

DEPTH (ft-bgs)	DESCRIPTION 1) Unit/Formation, Mem. 2) Soil/Rock Name 3) Color 4) Moisture 5) Grain Size 6) Percentage 7) Plasticity 8) Density/Consistency 9) Structure 10) Other (Mineralization, Discoloration, Odor, etc.)	GRAPHIC LOG	WELL LOG	GROUNDWATER OR STRUCTURE	ELEVATION (ft)	SAMPLE: SAMPLE NO.	TYPE		RECOVERY (%)	PID READING (ppm)	TIME (00:00)	COMMENTS 1) Rig Behavior 2) Air Monitoring
4"	topsoil/ silty sandy loam loose, moist, brown.											
10"	loam (clayey)? Small gravel, med. brown, moist											
20"												
30"	-31" wet clay (silty)											-31" thin wet layer
	-36" moist gravely loam/clay											
40"	-42" sandy/gravely clay tan/gray, wet											-44" becomes wet again
				46" DTW after 15 min								
50"				49.5" DTW when first measured								soil comes out moist water fills in hole
	-53" grey gravel w/some silt, moist			53" EOB								5/24 water 30" bgs
60"												

Margin notes: dark-ish brown; brown-tan; tan-grey; grey

CONTRACTOR
EQUIPMENT
DRILL MTHD
DIAMETER
LOGGER
REVIEWER

NORTHING
EASTING
COORDINATE SYSTEM:

NOTES:

SEE KEY SHEET FOR SYMBOLS AND ABBREVIATIONS

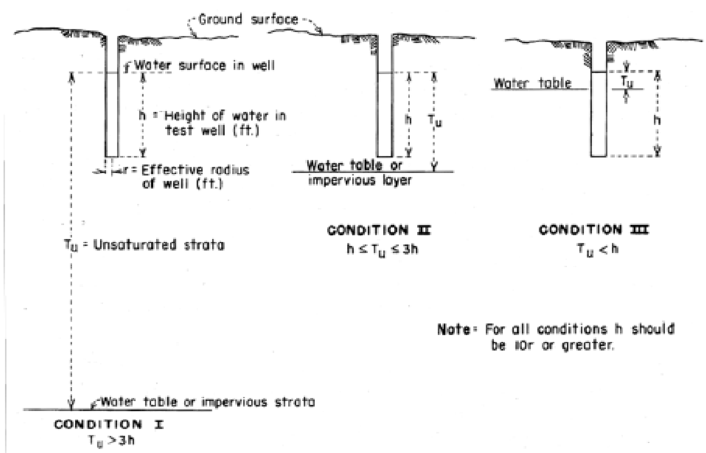
Borehole	Depth bgs	Soil Name	Color	Moisture	Grain Size	Percentage (Gravel, Sand, Silt)
BH-ML-1	0-10"	Silty Sand (SM)	Dark Reddish Gray (5YR 4/2)	Moist	Fine to medium sands with silt and gravel	5, 65, 30
	10-31"	Silty Sand (SM)	Weak Red (2.5YR 4/2)	Slightly moist	silts and fine to medium sands	0, 65, 35
	31-32"	Sandy clay (CL)	Dark yellowish brown (10YR 4/6)	Saturated	Clays, silts, fine to coarse sands	0, 30, 70
	32-36"	Sandy clay (CL)	Brown (10YR 4/3)	Moist	Clays, silts, fine to coars sands	0, 45, 55
	36-43"	Well graded gravels (GW)	Yellowish Brown (10YR 5/4)	Moist	Medium to coarse sands, gravels	55, 45, 0
	43-44"	Silty sand (SM)	Yellowish Brown (10YR 5/4)	Wet	Silts, fine to coarse sands w/ gravels	10, 60, 30
	44-53"	Poorly graded gravels	Light Yellowish Brown (2.5Y 6/3)	Moist	Gravels and coarse sands	65, 35, 0

Well Infiltration Test- Time and Volume Measurements

Project	LA0443	Ground Elev. (ft)	737	Notes:
Boring ID	BH-ML-1	GWT Depth bgs (ft)	2.5	
Date	5/24/2018	Depth to Botttom of Well (ft)	4.46	
Tested By	MC, AQ	Radius of Well (ft)	0.27	
Ground Temp (^{o}C)	20	Depth to water surface in well (ft)	0.25	
Flow Rate (gpm)	0.0897	Height of water in well (ft)	4.21	

Time		Totalizer Reading (gal)	Difference (gal)	Accum Flow (gal)	Water Temperature	
Clock	Accum (min)				Well	Tank
	-	10,322.68	0.00	0.00		
	0	10,325.57	2.89	2.89		
	5.5	10,325.75	0.18	3.07		
	10	10,325.99	0.24	3.31		
	15	10,326.07	0.08	3.39		
	20	10,326.48	0.41	3.80		
	26	10,327.04	0.56	4.36		
	30.25	10,327.34	0.30	4.66		
	36	10,327.73	0.39	5.05		
	40	10,328.10	0.37	5.42		
	47.5	10,328.74	0.64	6.06		
	50.5	10,329.01	0.27	6.33		
	56.5	10,329.53	0.52	6.85		
	60.5	10,329.89	0.36	7.21		
	65.25	10,330.26	0.37	7.58		
	80.5	10,331.52	1.26	8.84		
	85	10,331.97	0.45	9.29		
	90	10,332.39	0.42	9.71		
	100	10,333.27	0.88	10.59		

Boring ID	Flow Rate, q q gpm	 ft^3/hr	Temperature Correction V	Head h ft	Well Radius r ft	Water Surface to GWT Depth T_u ft	Saturated Hydraulic Conductivity k_{20} ft/hr	 cm/s	 in/hr	Condition
BH-ML-1	0.089744	0.720	1.00	4.2	0.271	2.3	2.6E-02	2.2E-04	0.314	3



Condition 1:

$$K_s = \frac{Q(\mu_T/\mu_{20})}{2\pi H^2}\left[\ln\left[\frac{H}{r}+\sqrt{\left(\frac{H}{r}\right)^2+1}\right] - \frac{\sqrt{1+\left(\frac{H}{r}\right)^2}}{\frac{H}{r}} + \frac{r}{H}\right]$$

Condition 2:

$$K_s = \frac{Q(\mu_{20}/\mu_T)}{2\pi H^2}\left[\frac{\ln\left(\frac{H}{r}\right)}{\frac{1}{6}+\frac{1}{3}\left(\frac{H}{T_u}\right)^{-1}}\right]$$

Condition 3:

Condition III:

$$k_{20} = \frac{gV}{2\pi h^2}\left[\frac{\ln\left(\frac{h}{r}\right)}{\left(\frac{h}{T_u}\right)^{-1} + \frac{1}{2}\left(\frac{h}{T_u}\right)^{-2}}\right]$$

Temp (C)	Dynamic Viscosity
0	1.787
5	1.519
10	1.307
11	1.2843
12	1.247
13	1.2111
14	1.1766
15	1.1435
16	1.1118
17	1.0815
18	1.0526
19	1.0251
20	1.002
21	0.9743
22	0.951
23	0.9291
24	0.9086
25	0.8895
26	0.8718
27	0.8555
28	0.8406
29	0.8271
30	0.815
31	0.8043
32	0.795

K_s = saturated hydraulic conductivity (infiltration rate, inches/hour)
H = height of water in well (inches)
Q = percolation flow rate from selected time interval (cubic inches/hour)
r = effective radius of well (inches)
μ_T = viscosity of water at water temperature, T
μ_{20} = viscosity of water at 20° C
T_u = unsaturated distance between the water surface and the water table or impervious strata

Temperature - t - (°C)	Dynamic Viscosity - μ - (Pa s, N s/m²) x 10^{-3}	Kinematic Viscosity - ν - (m²/s) x 10^{-6}
0	1.787	1.787
5	1.519	1.519
10	1.307	1.307
20	1.002	1.004
30	0.798	0.801
40	0.653	0.658
50	0.547	0.553
60	0.467	0.475
70	0.404	0.413
80	0.355	0.365
90	0.315	0.326
100	0.282	0.294

$u = 0.0007 t^2 - 0.0534 t + 1.7785$ $R^2 = 0.9993$

APPENDIX B

PRELIMINARY DESIGN CALCULATIONS

CISTERN CALCULATIONS

The cistern area was designed based on the amount of available land. The cistern depth was assumed to be 10 feet. The cistern volume, V_c, was calculated as

$$V_c = A_c d_c = (27{,}795\ ft^2)(10\ ft) = 277{,}950 ft^3$$

where A_c is the cistern area and d_c is the cistern depth.

The cistern volume as a percent of the average annual volume of water pumped into Mary Lake from 2001 to 2014 was calculated as

$$f = \frac{V_c}{V_p} = \frac{277{,}950\ ft^3}{887{,}036\ ft^3} = 31\%$$

where V_p is the average annual pumped volume.

TREATMENT SYSTEM

Treatment Design Volume

The sedimentation basin and subsurface treatment wetland were designed to capture the 85th percentile 24-hr storm from the nearby 24" storm drain. The drainage area was determined based on contours and the storm drain pipe network. The fraction of impervious area was estimated from aerial imagery. The runoff coefficient, C, was calculated as

$$C = 0.95 \cdot imp + C_p(1 - imp) = 0.95(0.46) + 0.12(1 - 0.46) = 0.50$$

where imp is the fraction impervious and C_p is the pervious coefficient for the watershed.

The sedimentation basin and subsurface treatment wetland design volume, V_w, was calculated as

$$V_w = CdA = (0.50)(0.91\ in)(426{,}017\ ft^2) = 16{,}263\ ft^3 = 121{,}649\ gal$$

where d is the 85th percentile 24-hour storm depth and A is the drainage area.

Sedimentation and Subsurface Treatment Wetland Sizing

The sedimentation basin and subsurface treatment wetland areas were determined based on physical constraints (sidewalk, path, storm drain) and a maximum 3:1 slope for grading work. The slopes of the sedimentation basin and subsurface treatment wetland ponding areas were also designed to be 3:1. The sedimentation basin base area was designed as 13% (approximately 10%) of the total treatment system area.

The treatment ponding depth in the sedimentation basin and subsurface treatment wetland was assumed to be 8 inches, and this depth was sufficient to capture the 85th percentile 24-hr storm volume. The treatment ponding volume, V_p, was approximated as

$$V_p = \left(\frac{A_{p,s}+A_{b,s}+A_{p,w}+A_{t,w}}{2}\right) \times d_p$$
$$= \left(\frac{3{,}575\ ft^2+3{,}122\ ft^2+23{,}351\ ft^2+21{,}795\ ft^2}{2}\right) \times 8\ in = \mathbf{17{,}281\ ft^3}$$

where $A_{p,s}$ is the sedimentation basin ponded surface area, $A_{b,s}$ is the sedimentation basin bottom surface area, $A_{p,w}$ is the subsurface treatment wetland ponded surface area, and $A_{t,w}$ is the subsurface treatment wetland bottom surface area.

The fraction f of the 85th percentile 24-hour design storm that is captured and stored in the sedimentation basin and subsurface wetland ponded area is

$$f = \frac{V_p}{V_w} = \frac{17{,}281\ ft^3}{16{,}263\ ft^3} = 1.1$$

Subsurface Treatment Wetland Flowrate

The subsurface treatment wetland was designed such that the treatment ponded volume would drain in 3 days.

The subsurface treatment wetland flowrate, Q, was calculated as

$$Q = \frac{V_p}{\tau} = \frac{17{,}281\ ft^3}{3\ d} = \mathbf{0.067\ CFS}$$

where τ is the residence time.

The subsurface treatment wetland was design for a maximum 1-foot change in bed depth to maintain plant life. The minimum bed hydraulic conductivity, k_{min}, was calculated as

$$k_{min} = \frac{LQ}{W\delta\Delta H_{max}} = \frac{(300\ ft)(0.067\ CFS)}{(62\ ft)(24\ in)(1\ ft)} = 13{,}936\ ft/d$$

where L is the approximate subsurface treatment wetland length, W is the approximate subsurface treatment wetland width, δ is the bed depth, and ΔH_{max} is the maximum change in bed height.

APPENDIX C

PRELIMINARY DESIGN SHEETS

LOCATION MAP:
SCALE 1" = 80'

CITY OF REDDING

MARY LAKE PRELIMINARY DESIGN

PROJECT LOCATION:
MARY LAKE DR AND LAKESIDE DR
REDDING, CA 96001

FEBRUARY 2019

PROJECT TEAM:

APPLICANT:
CITY OF REDDING
777 CYPRESS AVE
REDDING, CA 96001
(530) 224-6068

CIVIL ENGINEER:
GEOSYNTEC CONSULTANTS, INC.
924 ANACAPA ST, SUITE 4A
SANTA BARBARA, CA 93101
(310) 957-6100

PROJECT DESCRIPTION:

CONSTRUCT WETLAND TREATMENT SYSTEM, INSTALL CISTERN, RELOCATE SEWER, AND MODIFY SPILLWAY.

DRAWING INDEX

Z:\Project Folders\LA0443 - City of Redding SWRP\CAD\Mary Lake CAD\Drawings\MRLK-G-01.dwg
February 13, 2019 - 2:29pm AGrayStewart

REV	DATE	BY	CHK	APP	DESCRIPTION

DESIGNED BY
DRAWN BY
CHECKED BY
APPROVED BY
DATE

Geosyntec consultants
engineers | scientists | innovators

CITY OF REDDING CALIFORNIA

MARY LAKE DR AND LAKESIDE DR, REDDING, CA

CITY OF REDDING SWRP:
MARY LAKE
PRELIMINARY DESIGN
TITLE SHEET AND DRAWING INDEX

JOB NO. LA0443
DRAWING NO. G-01
SCALE AS SHOWN
SHEET NO. 01 OF 05

REV	DATE	BY	CHK	APP	DESCRIPTION

DESIGNED BY

DRAWN BY

CHECKED BY

APPROVED BY

DATE

Geosyntec consultants

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CITY OF REDDING CALIFORNIA

MARY LAKE DR AND LAKESIDE DR, REDDING, CA

CITY OF REDDING SWRP:
MARY LAKE
PRELIMINARY DESIGN

SITE PLAN

JOB NO.	LA0443
DRAWING NO.	C-01
SCALE	1"=40'
SHEET NO.	02 OF 05

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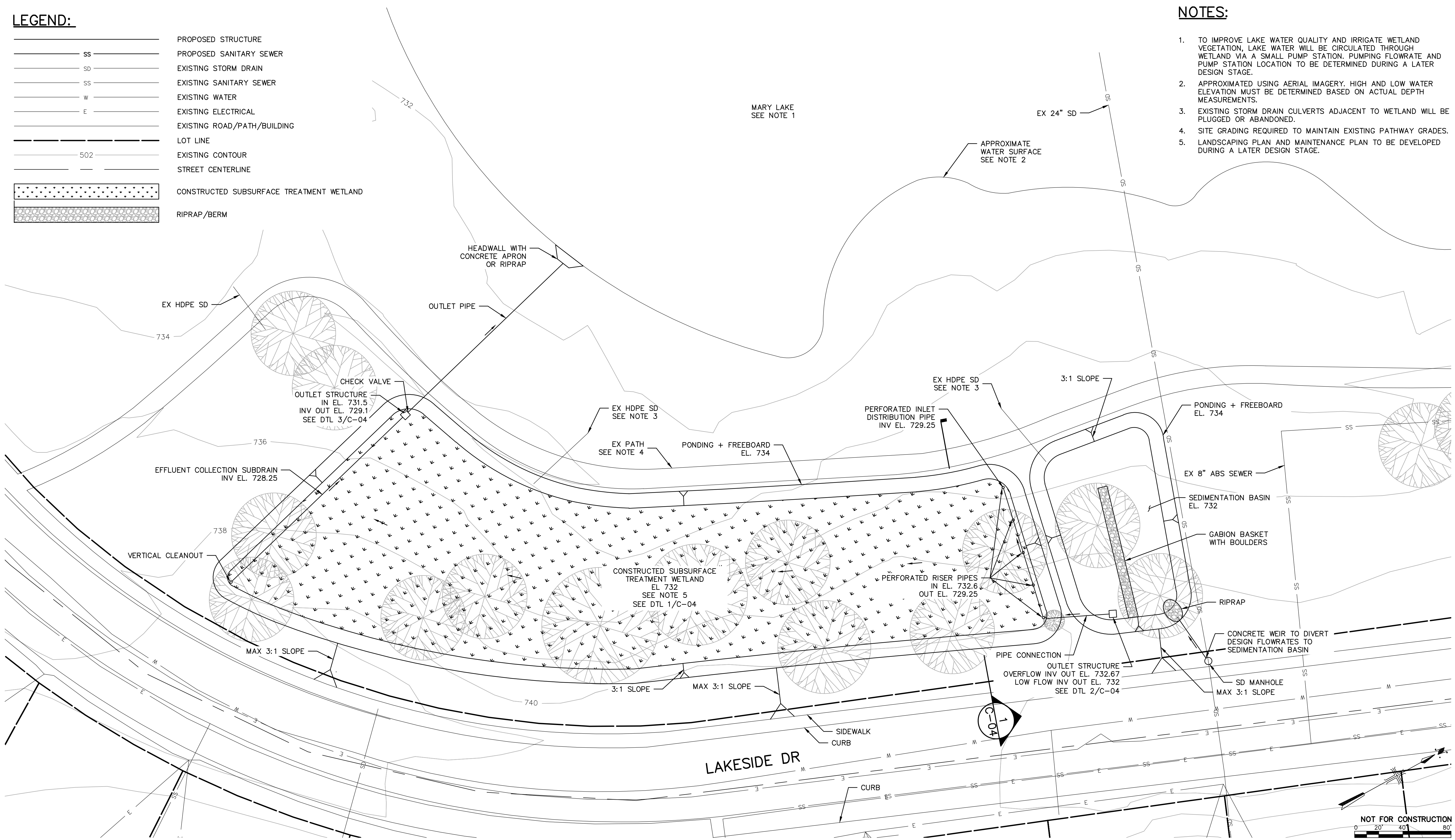
February 01, 2019 - 2:49pm AGrayStewart

LEGEND:

(solid line)	PROPOSED STRUCTURE
—— SS ——	PROPOSED SANITARY SEWER
—— SD ——	EXISTING STORM DRAIN
—— SS ——	EXISTING SANITARY SEWER
—— W ——	EXISTING WATER
—— E ——	EXISTING ELECTRICAL
(thin line)	EXISTING ROAD/PATH/BUILDING
(heavy dashed line)	LOT LINE
—— 502 ——	EXISTING CONTOUR
(long-short dashed line)	STREET CENTERLINE
(stippled pattern)	CONSTRUCTED SUBSURFACE TREATMENT WETLAND
(gravel pattern)	RIPRAP/BERM

NOTES:

1. TO IMPROVE LAKE WATER QUALITY AND IRRIGATE WETLAND VEGETATION, LAKE WATER WILL BE CIRCULATED THROUGH WETLAND VIA A SMALL PUMP STATION. PUMPING FLOWRATE AND PUMP STATION LOCATION TO BE DETERMINED DURING A LATER DESIGN STAGE.
2. APPROXIMATED USING AERIAL IMAGERY. HIGH AND LOW WATER ELEVATION MUST BE DETERMINED BASED ON ACTUAL DEPTH MEASUREMENTS.
3. EXISTING STORM DRAIN CULVERTS ADJACENT TO WETLAND WILL BE PLUGGED OR ABANDONED.
4. SITE GRADING REQUIRED TO MAINTAIN EXISTING PATHWAY GRADES.
5. LANDSCAPING PLAN AND MAINTENANCE PLAN TO BE DEVELOPED DURING A LATER DESIGN STAGE.



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February 01, 2019 - 2:54pm AGrayStewart

REV	DATE	BY	CHK	APP	DESCRIPTION

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DRAWN BY
CHECKED BY
APPROVED BY
DATE

Geosyntec consultants
engineers | scientists | innovators

CITY OF REDDING CALIFORNIA

MARY LAKE DR AND LAKESIDE DR, REDDING, CA

CITY OF REDDING SWRP: MARY LAKE PRELIMINARY DESIGN

WETLAND SITE PLAN

JOB NO.	LA0443
DRAWING NO.	C-02
SCALE	1"=20'
SHEET NO.	03 OF 05

LEGEND:

———	PROPOSED STRUCTURE
——— SS ———	PROPOSED SANITARY SEWER
——— SD ———	EXISTING STORM DRAIN
——— SS ———	EXISTING SANITARY SEWER
——— W ———	EXISTING WATER
——— E ———	EXISTING ELECTRICAL
———	EXISTING ROAD/PATH/BUILDING
— — —	LOT LINE
——— 502 ———	EXISTING CONTOUR
— — —	STREET CENTERLINE
(dotted box)	CISTERN
(hatched box)	RIPRAP/BERM

NOTES:

1. THE STOP LOG WEIR OR GATE WILL BE DESIGNED DURING SUBSEQUENT DESIGN STAGES AND AFTER A FLOODING EVALUATION HAS BEEN COMPLETED.
2. SITE GRADING REQUIRED TO ACCOMMODATE PROPOSED TRENCH DRAIN ELEVATION.
3. STRUCTURAL ANALYSIS MUST BE PERFORMED TO DETERMINE CISTERN SIZING REQUIREMENTS (I.E. DEPTH, MATERIAL, THICKNESS, ETC.). SIZE AND QUANTITY OF ACCESS MANHOLES TO BE DETERMINED BY ENGINEER.
4. GRADING DESIGN TO BE DETERMINED IN COORDINATION WITH VECTOR CONTROL REQUIREMENTS.
5. APPROXIMATED USING AERIAL IMAGERY. HIGH AND LOW WATER ELEVATION MUST BE DETERMINED TO FINALIZE DESIGN.
6. ADDITIONAL CALCULATIONS TO BE PERFORMED TO DETERMINE ALIGNMENT FEASIBILITY. IF REALIGNMENT IS INFEASIBLE, CISTERN CONFIGURATION WILL BE MODIFIED TO PROTECT SEWER IN PLACE (I.E. INSTALLING MULTIPLE CISTERNS).

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January 31, 2019 - 11:16am AGrayStewart

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						DESIGNED BY
						DRAWN BY
						CHECKED BY
						APPROVED BY
						DATE

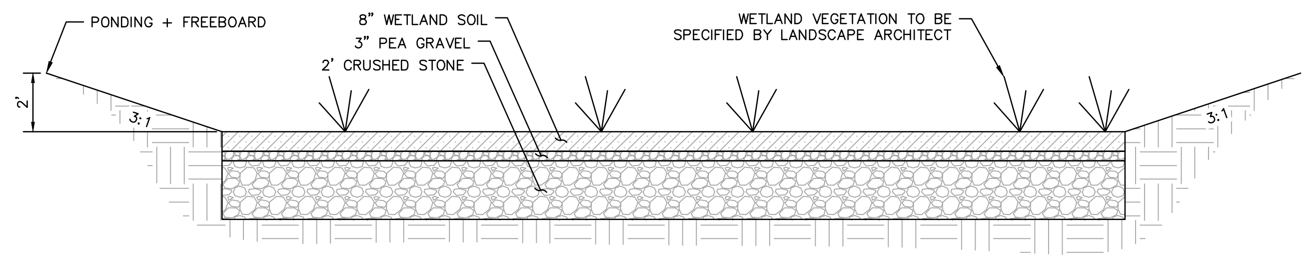
Geosyntec consultants
engineers | scientists | innovators

CITY OF REDDING CALIFORNIA

MARY LAKE DR AND LAKESIDE DR, REDDING, CA

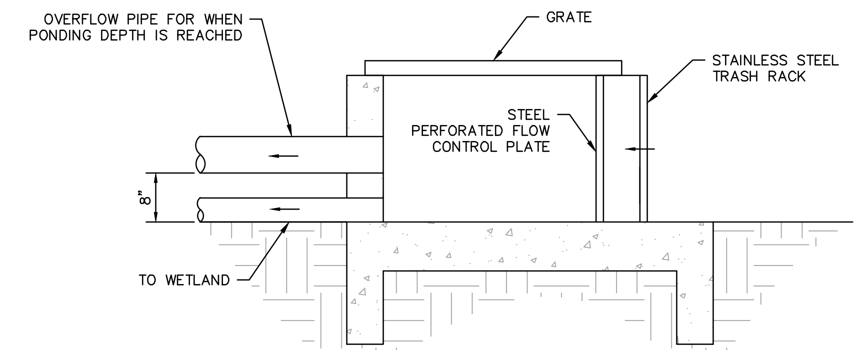
CITY OF REDDING SWRP:
MARY LAKE
PRELIMINARY DESIGN
CISTERN AND SPILLWAY SITE PLAN

JOB NO.	LA0443
DRAWING NO.	C-03
SCALE	1"=30'
SHEET NO.	04 OF 05



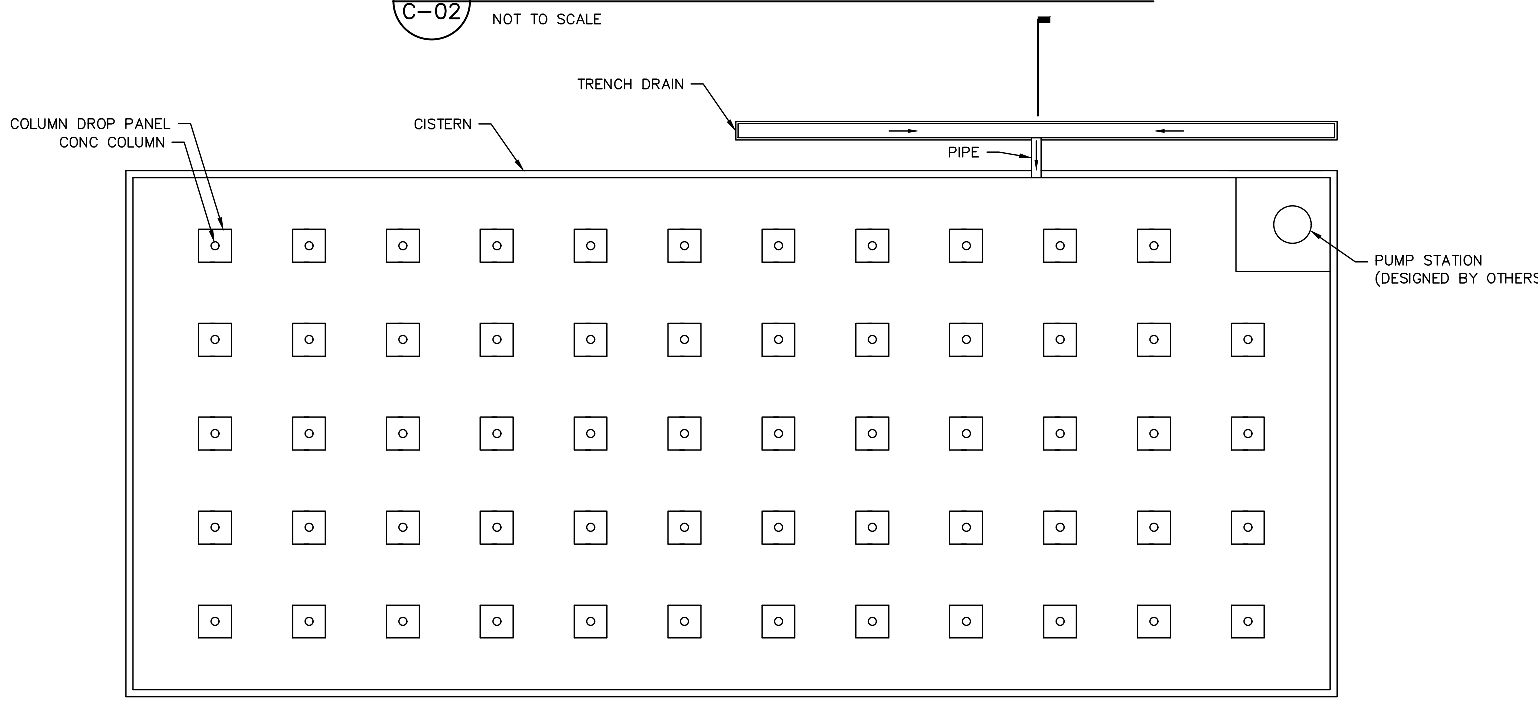
1 C-02 SUBSURFACE TREATMENT WETLAND SECTION

NOT TO SCALE



2 C-02 SEDIMENTATION BASIN OUTLET SECTION

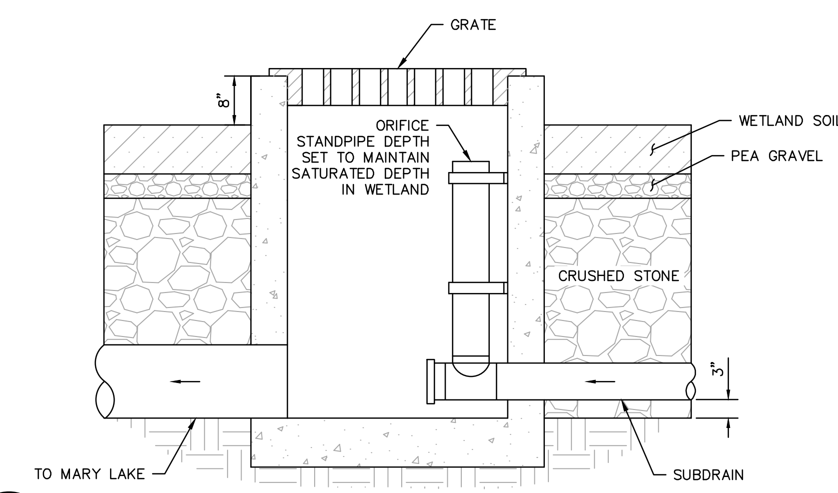
NOT TO SCALE



4 C-03 CISTERN ROOF PLAN

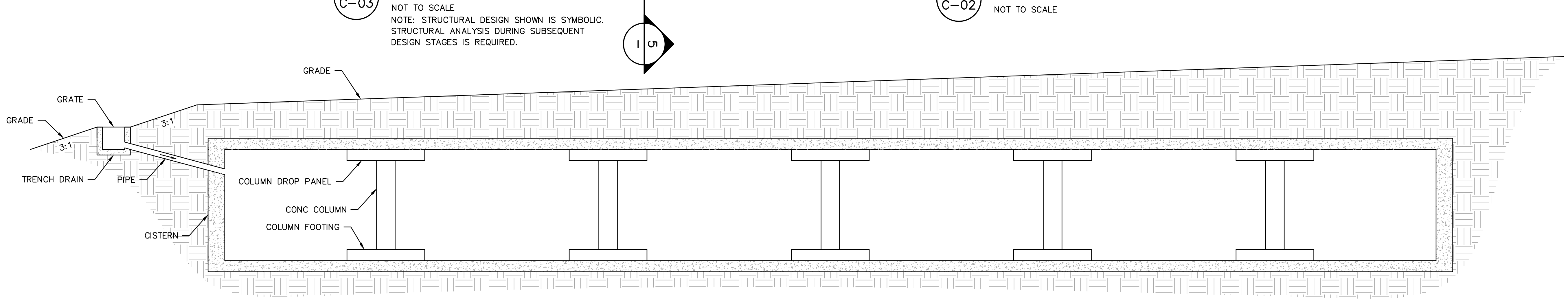
NOT TO SCALE

NOTE: STRUCTURAL DESIGN SHOWN IS SYMBOLIC. STRUCTURAL ANALYSIS DURING SUBSEQUENT DESIGN STAGES IS REQUIRED.



3 C-02 SUBSURFACE TREATMENT WETLAND OUTLET SECTION

NOT TO SCALE



5 – CISTERN SECTION

NOT TO SCALE

NOTE: STRUCTURAL DESIGN SHOWN IS SYMBOLIC. STRUCTURAL ANALYSIS DURING SUBSEQUENT DESIGN STAGES IS REQUIRED.

REV	DATE	BY	CHK	APP	DESCRIPTION

DESIGNED BY
DRAWN BY
CHECKED BY
APPROVED BY
DATE

Geosyntec consultants
engineers | scientists | innovators

CITY OF REDDING CALIFORNIA

MARY LAKE DR AND LAKESIDE DR, REDDING, CA

CITY OF REDDING SWRP: MARY LAKE PRELIMINARY DESIGN

DETAILS

JOB NO.	LA0443
DRAWING NO.	C-04
SCALE	NOT TO SCALE
SHEET NO.	05 OF 05

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February 07, 2019 - 3:13pm AGrayStewart

APPENDIX D

PRELIMINARY DESIGN WORK PLAN, COST ESTIMATE, AND SCHEDULE

924 Anacapa Street, Suite 4A
Santa Barbara, California 93101
PH 805.897.3800
FAX 805.899.8689
www.geosyntec.com

Memorandum

Date:	28 March 2019
To:	Mieke Sheffield; City of Redding
From:	Avery Blackwell, PE, Brandon Steets, PE, and Adam Questad, PE, Geosyntec Consultants
Subject:	Mary Lake Restoration Work Plan, Cost Estimate, and Schedule Geosyntec Project: LA0443
Attachments:	Attachment A – Preliminary Cost Estimate Attachment B – Preliminary Schedule

INTRODUCTION AND BACKGROUND

The City of Redding (City) has identified a project to capture and treat surface runoff entering Mary Lake in the Jenny Creek watershed (Project). Stormwater and dry weather runoff carry pollution from the surrounding neighborhoods into the lake and have contributed to eutrophication issues, including algal buildup on the shoreline as water levels decrease during the summer months. As part of the Project, a natural treatment system is proposed at the eastern side of Mary Lake to treat runoff from the surrounding residential stormdrain network. This natural treatment systems will re-circulate water from Mary Lake to provide additional water quality benefit. In addition, a portion of wet and dry weather runoff stored in the upper pond will be diverted into a cistern for storage during wet months and pumped back into the lake during dry months to increase the water depth in Mary Lake and reduce algal buildup on the shoreline. Mary Lake collects runoff from a 460-acre drainage area consisting mostly of open space and residential land uses and is located outside of the Redding groundwater basins, so direct aquifer recharge is not anticipated.

This memorandum describes the preliminary project work plan, cost estimate, and schedule developed for the Project, in a format consistent with the Proposition 1 Stormwater Grant Program (SWGP) Implementation Grant Proposal Templates[1].

PRELIMINARY PROJECT WORK PLAN

Task 1. Project Administration

The Project will be managed by the City, who will oversee all aspects of the Project, including but not limited to planning, permitting, design, construction, bid and award, monitoring, coordination with other entities, and project maintenance, to ensure that all tasks are completed on time and within budget. The following tasks are included under Project Administration and will be executed by the City:

- **Project Management:** To keep the Project on schedule and within budgetary limitations, this subtask includes overall project management to coordinate consultants and subcontractors, track schedule and progression of the Project, track expenditures and budget status, and time for internal City communication and meetings to discuss the Project with other departments.

- **Invoicing:** As required by the final agreement, this subtask includes time to develop invoices and the required backup and supporting information from all subconsultants and consultants.

- **Reporting:** This subtask includes time to develop quarterly and annual reports and other more frequent communication with the grant manager (if the Project receives grant funding).

Task 2. Planning/Design/Engineering/Environmental

The City will oversee the selection of an engineering consultant to develop 100% Construction design drawings and specifications based on the current preliminary designs with feedback from community stakeholders and regulatory agencies. A preliminary site investigation and design for the Project have been completed and are described in subsequent sections of the work plan. To

[1] https://www.waterboards.ca.gov/water_issues/programs/grants_loans/swgp/prop1/

develop the final design for the Project, the following subtasks will be completed by the City, engineering consultant, or subcontractor[2]:

- **Survey and Geotechnical Investigation:** To revise the current base plan shown in the preliminary design, a topographical survey will be executed to capture detailed elevation information of existing conditions and potential aboveground constraints. This subtask will also include utility investigation and potholing to identify shallow utilities that may impact the proposed design. Finally, additional geotechnical investigations including boreholes and possibly test pits will be executed to characterize subsurface conditions and further clarify the infiltration capacity of the soil.

- **Hydrologic and Hydraulic Analysis:** Additional calculations and modeling will be performed to finalize the final elevations, size, and material of the Project's required infrastructure. A water balance will be performed to determine the typical volume of water required to be added to Mary Lake each year to prevent algae buildup on the shores and whether the proposed cistern is capable of capturing and storing a sufficient percentage of this required volume. A flooding evaluation will be conducted to determine how the Project will impact the residential parcels surrounding the upper pond and identify mitigation strategies as needed. This task will also include a grading and drainage analysis to make sure positive drainage is achieved by the project and potential flooding is mitigated. Additionally, HEC-RAS modeling will be performed to satisfy the City's plan check requirements.

- **CEQA and Permitting:** The City, with the assistance of a consultant, will prepare the required CEQA documentation and develop the material required to obtain the applicable permits, which may include encroachment permits, building permits, grading permits, construction stormwater permits, and additional environmental permits as required by applicable regulators (e.g., California Department of Fish and Wildlife, Army Corps of Engineers, Regional Water Quality Control Board, etc.).

- **Final Design:** Based on the preliminary design and information gathered in the previous subtasks, a consultant will then advance the design and prepare a 100% construction plan

[2] The City may consider an alternative to the design-bid-build approach and instead establish a design-build contract with one consultant team. The design-build approach is typically lower cost due to the construction contractor being involved during final design and the removal of the construction bidding process. In addition, design-build contracts promote a partnership where all parties work together and are committed to the same goals, which can result in a more successful project and higher likelihood of achieving the Project's goals within the budget allotment.

set and technical specifications outlining the project's components with sufficient detail for the contractor to construct the project. This task will include additional structural and buoyancy calculations to design the cistern and the stop log weir. It will also include design of the cistern's pump station including wet well sizing, pump size and type selection, and operation requirements. In addition, a wetland ecologist may be required to finalize the wetland design to promote the desired pollutant reduction goals and select the appropriate wetland plants. This task will also include a revised cost estimate based on the final design's alignment and components as well as landscaping and operation and maintenance plans.

- **Vector Control Plan:** Based on the final design, a vector control plan will be developed for areas where standing water may persist (cistern and trench drain, sedimentation basin, wetland). This vector control plan may include establishing maintenance and observation procedures or specify the application of specific products to prevent vector introduction or proliferation within the areas identified above.

- **Bid Documents and Construction Award:** Upon completion of the final design, the City or a consultant will prepare the construction bid package and solicit competitive construction bids from qualified contractors unless a design-build approach is selected. The City will then award the Project to a qualified contractor and provide notice to proceed once all contract documents are in place.

Task 3. Construction/Implementation

The following subtasks are included for the administrative management of construction:

- **Contract Administration:** The City will serve as Project Manager throughout construction and the Engineer of Record or qualified engineering consultant(s) will be contracted by the City to provide engineering support during all phases of construction. The City and consultant(s) will coordinate activities with the contractor, review and approve contractor submittals, and make project decisions as required when conflicts or discrepancies are identified in the field. The City will be responsible for all external reporting requirements as necessary to fulfill the needs of any applicable grants.

- **Construction Management:** The City will contract a qualified construction manager to oversee construction activities and contractor coordination including conducting tailgate meetings, reviewing the contractor's execution of tasks, communication of progress and concerns to the City or consultant through daily and/or weekly reporting, and performing other general construction management responsibilities.

The following subtasks are expected to be executed by the construction subcontractor as part of this Project although the following tasks may be revised after the final design is complete:

- **Contractor mobilization –** After the contractor is provided with the notice to proceed, they will begin mobilization to the site, which may include establishing cost tracking tools and metrics, ordering material and assembling their crews, establishing a staging area if not provided by the City, and equipment rentals.
- **Clearing and grubbing –** The area within and adjacent to the cistern's footprint and the proposed wetland will be cleared of vegetation and other debris after mobilization is complete.
- **Excavation and Utility Relocation –** Excavation with proper shoring will be implemented to prepare for installation of the cistern. This excavation will also require dewatering and possible construction of a coffer dam to prevent water from entering the cistern's footprint during construction. Excavation of the proposed wetland and stormdrain pipe connections will also be executed under this task. Finally, it is anticipated that the existing sewer line currently running through the proposed cistern's footprint will need to be relocated according to the final design plans as part of this task. Excavated material will be stockpiled as needed and hauled offsite for proper disposal.
- **Cistern, Weir, and Wetland construction –** After completion of excavation and utility relocation, the cistern system (trench drain, storage tank, pump station, distribution piping), stop log weir, and wetland system (subsurface gravel and wetland planning soil, connector and discharge piping, sediment forebay, re-circulating pump and piping within Mary Lake) will be installed according to the final design plans and specifications. After completion, a stormwater diversion weir plate (or alternative means of stormwater diversion) will be installed in the existing manhole adjacent to the wetland to divert dry and wet weather flows through the wetland. All trenches and excavated areas will then be backfilled and surface grading will be provided as needed and according to the plans. The wetland system will be landscaped with plants to promote aesthetics and pollutant removal. Paths will be replaced along with any other structures affected by project construction and permanent educational signage will be installed.
- **Punch list completion –** Throughout construction, the engineer of record, City, or construction manager will maintain a punch list of items that need to be corrected by the contractor. After completion of the subtasks above, the contractor will be required to address all punch list items before a certificate of occupancy can be issued by the inspector.
- **Demobilization –** After construction is complete the contractor will remove any equipment or facilities used specifically for this project and clean up the site as needed.

Task 4. Monitoring/Performance

To assess the Project's performance the following monitoring/performance subtasks will be implemented:

- **Monitoring Plan and Quality Assurance Project Plan (QAPP):** A consultant will develop a detailed monitoring plan to outline the required monitoring procedures and methods for collecting post-construction data and evaluating data collected to determine the effectiveness of the Project and whether the multiple benefit goals have been achieved. In addition, this plan will include a Quality Assurance Project Plan (QAPP) outlining the quality assurance, quality control requirements to prevent sample contamination and produce reliable results.
- **Dry and Wet Weather Monitoring:** After completion of construction, a consultant will adhere to the monitoring plan developed and collect dry and wet weather samples and measurements for the Project. It is anticipated that the consultant will collect depth measurements within the cistern during a determined frequency (e.g., monthly), depth and flowrate measurements over the stop log weir during wet weather events, and influent and effluent samples from the wetland during dry and wet weather events (a total of four wet weather and two dry weather events will be targeted). Water quality samples will be analyzed by a lab subcontracted by the City. If any equipment other than sample bottles are required to collect samples, an equipment blank will be collected for 20% of the samples.

Task 5. Education/Outreach

Three public outreach meetings were held in 2018 during the project selection phase and additional education/outreach subtasks will include:

- **Public Communication:** During all stages of the project, the public will be notified of the project's progression through e-mail communication and possibly through an established website. In addition, temporary signage will be placed during construction to educate the public on the importance of the project and the expected goals. After construction, a permanent sign will be installed to describe the project and the multiple benefits it provides including reduced pollutant loading to Mary Lake, reduced eutrophication and nuisance concerns within Mary Lake, and improved aesthetics.

- **Public Meetings:** Two (2) public meetings are planned during the duration of the Project. After kickoff of the final design subtask, a public meeting will be held to discuss the preliminary design concepts and solicit additional feedback from the community. The feedback will be incorporated into the final design as feasible. Prior to construction, an additional public meeting will be held to present the final design and provide information regarding impacts expected during construction.

PRELIMINARY PROJECT COST ESTIMATE

The Project's preliminary cost estimate (Attachment A) has been assembled to match the five major tasks described above. Each task has a number of subtasks which represent various deliverables or stages of the project. The following is a summary of each category and task:

Project Administration: These costs are associated with grant administration and reporting labor and miscellaneous expenses (e.g., communication, photo copies, etc.) necessary to manage and operate a successful grant project.

Planning/Design/Engineering/Environmental: These costs were developed based on similar costs incurred during previous consultant stormwater improvement projects. Subtasks include deliverables necessary to analyze, design and produce engineering documents that are used in the permitting, bidding, construction and completion of the Project.

Construction/Implementation: The construction costs were developed according to the size and material of infrastructure outlined in the preliminary design layout for the Project. The construction cost is estimated to be $4.6 million USD. These costs are based on recent 2018 regional stormwater improvement projects, professional experience and judgment, and construction cost indexes (BNi cost books, R. S. Means). Assumptions used to develop the construction costs include:

- Excavated materials from the project area are considered clean and do not require special sampling, waste handling or disposal. The disposal costs assume that the material will be transported to a nearby facility within 15 miles of the project.
- Stormwater Pollution Prevention Plan monitoring requirements are not included since the Project is not expected to disturb more than one acre of land.
- Landscape vegetation will include wetland plants that require initial irrigation during establishment.

Monitoring/Performance: These costs are based on developing and implementing a plan to evaluate the performance of the Project. The costs associated with these tasks were determined based on previous experience with monitoring programs developed under Proposition 1 and 84 grant projects.

Education/Outreach: The costs associated with these tasks, including providing community and direct and web-based outreach and education to support the Project were based on education/outreach experience during past projects.

PRELIMINARY PROJECT SCHEDULE

The Project's preliminary schedule (Attachment B) includes tasks consistent with those described in the preliminary project work plan. Task durations were established based on prior experience with design and construction of similar projects and are expected to be sufficient for completion of each task. Timely completion of these tasks will be facilitated by the Project being managed solely by the City, who will coordinate all aspects of the Project. Based on the preliminary analyses performed, no significant obstacles are expected to hinder completion of the tasks.

The design drawings for the Project have been developed to approximately the 30% level, with the concept fully described including locations of all key infrastructure, and project effectiveness evaluated through both hydrologic calculations and a geotechnical investigation to estimate site-specific infiltration rates, expected infiltration volumes, and resulting pollutant load reductions. The first phase in the Project includes additional surveying, geotechnical investigations, and hydrologic and hydraulic analysis to confirm the proposed layout is feasible or if modifications are required to avoid environmental, grading, or utility constraints in order to meet the stormwater diversion goals of the Project. This phase is expected to last approximately three (3) months.

The next phase will include the development of the design to the 100% level, as well as submittal of applications for appropriate local permits (grading, etc.), and is expected to last approximately six (6) months. Development of a monitoring plan will be completed concurrently with the final designs.

During the last month of design and permitting, the construction contractor selection process will be initiated, and is expected to be completed within four (4) months. As soon as the construction contractor has been selected, construction of the project will commence. Construction is expected to be complete within seven (7) months. Once construction is complete, performance monitoring will be conducted, in accordance with the monitoring plan that was developed at the start of the Project.

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ATTACHMENT A

MARY LAKE RESTORATION

PRELIMINARY COST ESTIMATE

Prop 1 STORMWATER GRANT PROGRAM - BUDGET DETAIL

Applicant: City of Redding **FAAST PIN:**

Project: Mary Lake Restoration

Budget Category	Percent of Cost	Labor Costs			Consulting/Materials/Equipment				TOTALS
		Rate	# of Hours	Total Labor	Unit Cost	Units	# of Units	Total Cost	
1. Direct Project Administration Costs	**1.1%**								**$54,800**
Project Management		$100.00	232	$23,200				$0	$23,200
Invoicing		$100.00	116	$11,600				$0	$11,600
Reporting		$100.00	200	$20,000				$0	$20,000
2. Planning/Design/Engineering/ Environmental	**7.9%**								**$410,000**
Design Survey				$0	$25,000.00	LS	1	$25,000	$25,000
Geotechnical Investigation				$0	$20,000.00	LS	1	$20,000	$20,000
Hydrology & Hydraulics				$0	$25,000.00	LS	1	$25,000	$25,000
Preliminary Design Report				$0	$60,000.00	LS	1	$60,000	$60,000
Construction Documents				$0	$180,000.00	LS	1	$180,000	$180,000
Environmental Approvals/Construction Permits				$0	$100,000.00	LS	1	$100,000	$100,000
3. Construction/Implementation	**89.6%**								**$4,627,760**
General Conditions/General Requirements				$0	$400,000	LS	1	$400,000	$400,000
Clearing and grubbing				$0	$15,000	LS	1	$15,000	$15,000
Grading				$0	$30,000	LS	1	$30,000	$30,000
Excavation & Export				$0	$35	CY	14700	$514,500	$514,500
Relocate existing 8" sewer				$0	$80	LF	440	$35,200	$35,200
Cosntruct sewer manholes				$0	$10,000	EA	3	$30,000	$30,000
Construction of stop log structure				$0	$15,000	LS	1	$15,000	$15,000
Construction of headwall				$0	$20,000	LS	1	$20,000	$20,000
Install subdrain				$0	$60	LF	190	$11,400	$11,400
Install outlet pipe				$0	$120	LF	280	$33,600	$33,600
Install perforated pipe				$0	$60	LF	170	$10,200	$10,200
Construct outlet structure				$0	$8,000	EA	2	$16,000	$16,000
Construct concrete weir				$0	$5,000	LS	1	$5,000	$5,000
Construct stormdrain manhole				$0	$10,000	LS	1	$10,000	$10,000
Crushed stone (2')				$0	$75	CY	1614	$121,050	$121,050
Pea gravel (3")				$0	$75	CY	202	$15,150	$15,150
Wetland soil (8")				$0	$70	CY	538	$37,660	$37,660
Install gabion baskets				$0	$100	LF	90	$9,000	$9,000
Pump station & appurtenances				$0	$200,000	LS	1	$200,000	$200,000
Install trench drain				$0	$600	LF	165	$99,000	$99,000
Install Cistern				$0	$3,000,000	LS	1	$3,000,000	$3,000,000
4. Monitoring/Performance	**1.1%**								**$55,000**
Monitoring Plan and Quality Assurance Project Plan				$0	$15,000	LS	1	$15,000	$15,000
Dry and Wet Weather Monitoring				$0	$40,000	LS	1	$40,000	$40,000
5. Education/Outreach	**0.4%**								**$19,000**
Public Communication		$100.00	80	$8,000	$1,000	EA	2	$2,000	$10,000
Public Meeting #1		$100.00	20	$2,000	$2,500	EA	1	$2,500	$4,500
Public Meeting #2		$100.00	20	$2,000	$2,500	EA	1	$2,500	$4,500
Grand Total:	**100%**								**$5,166,560**

ATTACHMENT B

MARY LAKE RESTORATION

PRELIMINARY SCHEDULE

Mary Lake Restoration

City of Redding

Work Tasks	Start (month)	Duration (months)
Task 1. Project Administration		
Project Management	1	32
Invoicing	1	32
Reporting	1	32
Task 2. Planning/Design/Engineering/Environmental		
Survey and Geotechnical Investigation	1	2
Hydrologic and Hydraulic Analysis	2	2
CEQA and Permitting	1	9
Final Design	4	6
Vector Control Plan	9	1
Bid Documents and Construction Award	10	4
Task 3. Construction/Implementation		
Contract Administration	13	8
Construction Management	14	7
Mobilization	14	1
Clearing and Grubbing	15	1
Excavation and Utility Relocation	15	2
Cistern, Weir, and Wetland Construction	15	4
Complete punch list	19	1
Demobilization	20	0.25
Task 4. Monitoring/Performance		
Monitoring Plan and Quality Assurance Project Plan	6	6
Dry and Wet Weather Monitoring	21	12
Task 5. Public Education and Outreach		
Public communication	1	32.00
Public meeting #1	2	0.25
Public meeting #2	13	0.25