COUNTY OF SAN MATEO
PUBLIC WORKS

# CSA 7 - Water System Feasibility Study and Seismic Retrofit Project

## Water System Improvement Recommendation Report

WATERWORKS ENGINEERS

**Prepared For:**
**COUNTY OF SAN MATEO**
**PUBLIC WORKS DEPARTMENT**
**Project # 12-075, October 2015**

# County of San Mateo
# CSA No. 7 – Water System Feasibility Study and Seismic Retrofit Project
# Water System Improvement Recommendation Report

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# Abbreviations

| | |
|---|---|
| AC | Asbestos Cement Pipe |
| ARV | Air-Release Valve |
| AZI | Andy Zdon Inc |
| BEI | Bracewell Engineering Inc. |
| Bromoform | Tribromomethane |
| Cal Water | California Water Service Company |
| CDPH | California Department of Public Health |
| Chloroform | Trichloromethane |
| CIP | Capital Improvement Program |
| County | County of San Mateo |
| CSA 7 | County Service Area No. 7 |
| CT | Contact Time |
| DBP | Disinfection Byproduct |
| DDW | Division of Drinking Water |
| DIP | Ductile Iron Pipe |
| GAC | Granular Activated Carbon |
| Gpd | Gallons Per Day |
| Gpm | Gallons Per Minute |
| GSP | Galvanized Steel Pipe |
| GW | Groundwater |
| GWUDI | Ground Water Under the Direct Influence |
| HAA5 | Haloacetic Acids |
| HDPE | High Density Polyethylene Pipe |
| Master Plan | CSA 7 La Honda Water System Master Plan, 1998 |
| MCL | Maximum Contaminant Level |
| NOM | Natural Organic Matter |
| PRV | Pressure Regulating Valve |
| PVC | Polyvinyl Chloride Pipe |
| PUE | Public Utility Easement |
| RAA | Running Annual Average |
| ROW | Right-of-Way |
| SJWC | San Jose Water Company |
| SLR | Surface Loading Rate |
| SWRCB | State Water Resources Control Board |
| TOC | Total Organic Carbon |
| UST | Underground Storage Tank |
| TTHM | Total Trihalomethane |
| WTP | Water Treatment Plant |
| WWE | Water Works Engineers |

# 1. Background & Problem Description

In 1998, the County of San Mateo (County) prepared a comprehensive water system master plan (Master Plan) for the County Service Area No. 7 (CSA 7), also referred to as the "La Honda" Water System. The Master Plan elaborated on the condition of the existing Water Treatment Plant (WTP); concerns over the raw water source; age and remaining lifespan of the water storage tanks; and the durability of existing water distribution system. In October 2014, WaterWorks Engineers (WWE) was contracted by the County to re-examine and evaluate the findings and recommendations made in the 1998 Master Plan. WWE prepared this Recommendation Report (Report) to detail recommended improvements to the La Honda Water System and to provide an approach to prioritize them.

This report discusses and summarizes WWE's evaluation of the listed project objectives for the La Honda Water System that follow:

- Examine and evaluate current water treatment facilities, treatment processes, distribution systems, raw water intake sources, chemical containment, and the seismic integrity of raw and treated water tanks;
- Recommend a reliable method of achieving disinfection byproduct regulation compliance;
- Prepare an GIS industry standard water distribution system in GIS using existing data provided by the County and produce an updated system map;
- Determine additional sources of raw water to resolve the standing water rights issue and explore potential consolidation with new owners/operators;
- Design a seismic retrofit inlet/outlet pipe connection at the raw and treated water tanks;
- Provide chemical containment and an associated electrical retrofit within the Water Treatment Plant;
- Identify potential capital improvement projects for addressing pressure issues and frequent leaks within the distribution systems, and additional storage needs.
- Discuss proposed rate increases and identify sources of funding for recommended improvements

## 1.1 Project Location

The County operates the CSA 7 water system (or "La Honda" water system) and serves potable water to about 69 residential connections in the La Honda Creek and Alpine Creek drainage areas on the Pacific coast side of the County. It also supplies water to two County facilities, Camp Glenwood and Sam MacDonald Park. The County has a domestic water supply permit issued by the California Department of Public Health (CDPH) in 2013, which is renewed every 10 years.

The existing La Honda Water System includes a raw water intake, raw water pipeline, and a 70,000-gallon raw water storage tank; the Camp Glenwood Water Treatment Plant (WTP) with integral treated water pumping; one 500,000-gallon treated water storage tank; and distribution mains or pipelines. In 1994, the WTP was constructed and then upgraded in 1998 to incorporate coagulation/microfiltration and chlorine disinfection treatment processes. The existing water distribution system, however, was constructed and continuously expanded by private developers from the 1920s until the County inherited the system in 1958. Figure 1 shows the location of CSA 7, the existing WTP and project area.

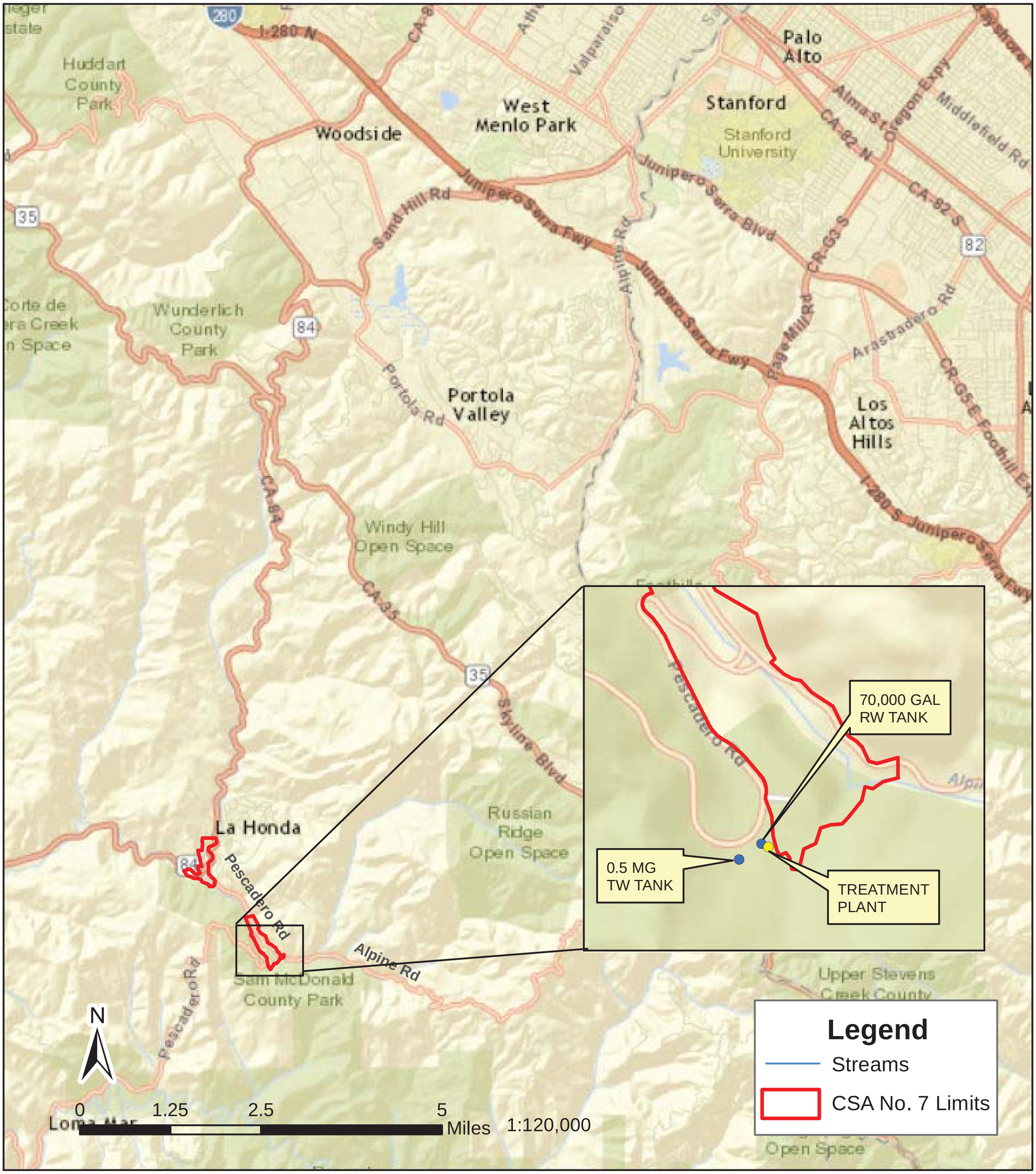


**FIGURE 1: COUNTY SERVICE AREA NO. 7**
**PROJECT LOCATION MAP**

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## 1.2 Existing Water Source, Treatment & Quality

At present, the system raw water intake is located in Alpine Creek near Pescadero Creek Road Bridge. Raw water is pumped from Alpine Creek via one (1) 7.5 HP pump through approximately 1,800 linear feet (LF) of 2½ -inch diameter Galvanized Steel Pipe (GSP) to a 70,000-gallon raw water storage reservoir on the WTP site adjacent to Pescadero Creek Road. Water is then pumped from the reservoir in to the WTP nearby.

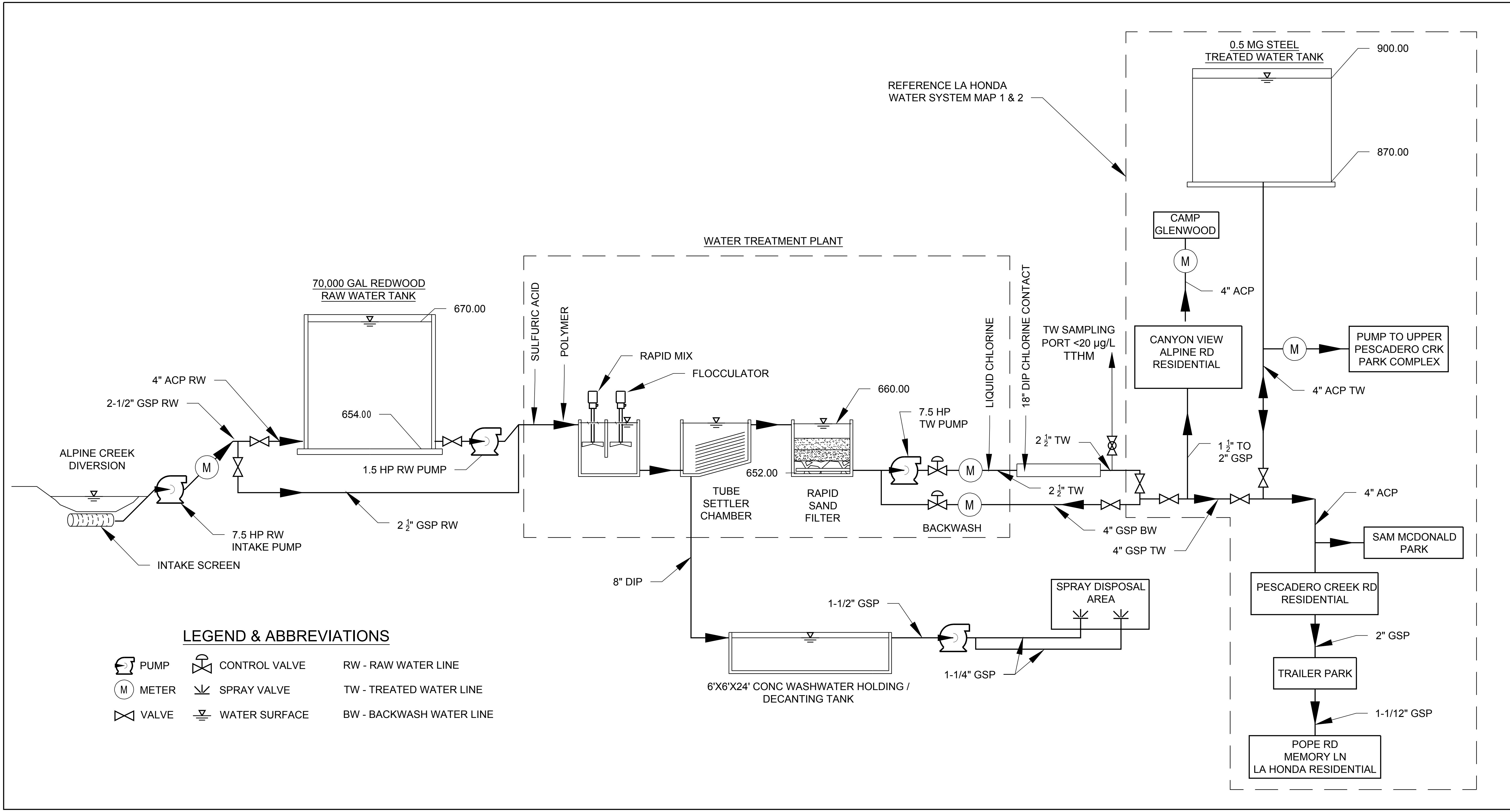
### 1.2.1 Water Treatment Plant Processes

The WTP treats raw water from Alpine Creek using full conventional treatment up to the rate of 50 gallons per minute (gpm). The treatment process consists of rapid mixing with chemical injection; flocculation; tube settling; rapid sand filtration; chlorine disinfection; backwashing; and storing treated water in a 500,000 gallon tank (See Section 1.3 for additional details on water storage). The raw water from Alpine Creek is pumped to the raw water tank and then to the WTP. Polymer is added for flocculating the solid particles in the flocculating chamber. From the flocculation chamber, water travels to the tube settler where the solids are re-routed into the underground backwash water tank. From the tube settler, water goes through the rapid sand filter for extended particle removal before it enters into the chlorine contact pipe for disinfection. Finished water is pumped to the treated water tank and subsequently to the distribution system. Table 1 summarizes the WTP processes and Figure 2 shows the WTP flow schematic and process flow diagram.

Excess water from the backwash tank is discharged via sprinkler irrigation on adjacent woodlands. A septic tank maintenance firm periodically removes and disposes of settled solids in the backwash tank.

**Table 1: Camp Glenwood CSA No.7 Water Treatment Plant Characteristics & Processes**

| Process Order | Description | Purpose | Existing Equipment |
|---|---|---|---|
| 1 | Raw Water Intake | ➢ Diverts raw water from Alpine Creek to WTP | ➢ Gravel bed intake structure<br>➢ (1) 7.5 HP vertical multi-stage centrifugal intake pump |
| 2 | 70,000-gallon Raw Water Tank | ➢ Causes pretreatment settling<br>➢ Reserves raw water during local rain events | ➢ 70,000-gal Redwood tank<br>➢ 27' diameter & 16' high<br>➢ Sits on concrete grade beam foundation with NO anchor |
| 3 | (3) Chemical Injection Tanks | ➢ Stores polymer for coagulation<br>➢ Stores liquid chlorine for disinfection<br>➢ Stores sulfuric acid for pH stabilization | ➢ (1) 30-gal drum of Polymer<br>➢ (1) 45-gal drum of Liq Chlorine<br>➢ (1) 35-gal drum of Sulfuric Acid<br>➢ All three drums have 0.92 gph peristaltic chemical feed pumps<br>➢ No secondary spill containment for drums |
| 4 | Rapid Mixer/Flocculator | ➢ Uniformly mixes polymer<br>➢ Neutralizes particle surface charges, causes flocculation, improves filtration | ➢ Vertical Paddle type in a flocculation chamber |
| 5 | Tube Settler | ➢ Settles large particles into a washwater holding tank | ➢ 60° inclined settling chamber |
| 6 | Rapid Sand Filter | ➢ Filters out small diameter particles | ➢ Filter Area = 16.7 SF |
| 7 | Chlorine Contact Pipe | ➢ Extends chlorine contact time and promotes efficient disinfection | ➢ 100 LF 18" chlorine contact pipe |
| 8 | Backwash water Holding/Decanting Tank | ➢ Collects and disposes of waste generated from filter backwashing procedures | ➢ (1) 6,000-gal Concrete Sludge Holding tank |
| 9 | Spray Irrigation | ➢ Discharges filter backwash water | ➢ 7,000 SF area of woodlands |
| 10 | Treated Storage Tank | ➢ Stores finished water in a steel tank | ➢ 500,000-gal Steel Tank<br>➢ Sits on concrete ring foundation with sand base and NO anchor |

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# FIGURE 2: PROCESS FLOW DIAGRAM
# CSA NO.7 LA HONDA WATER SYSTEM

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### 1.2.2 Raw Water Quality & Water Rights

Raw water is currently diverted from Alpine Creek near Pescadero Creek Road Bridge over 1,800 LF of 2½ -inch GSP into a 70,000-gallon raw water tank. The intake piping consists of 2-inch diameter GSP with a well screen at the end of the suction side of the piping submerged in the creek. The intake pipe is connected to the inlet side of a (1) 7.5 HP pump. Figure 3 shows the suction piping in Alpine Creek. The County has observed that the turbidity of the raw water increases during the heavy rainfall events, and is not effectively treated by the WTP during such events.

Figure 4 shows the average and peak raw water turbidity results for 2013 and 2014.

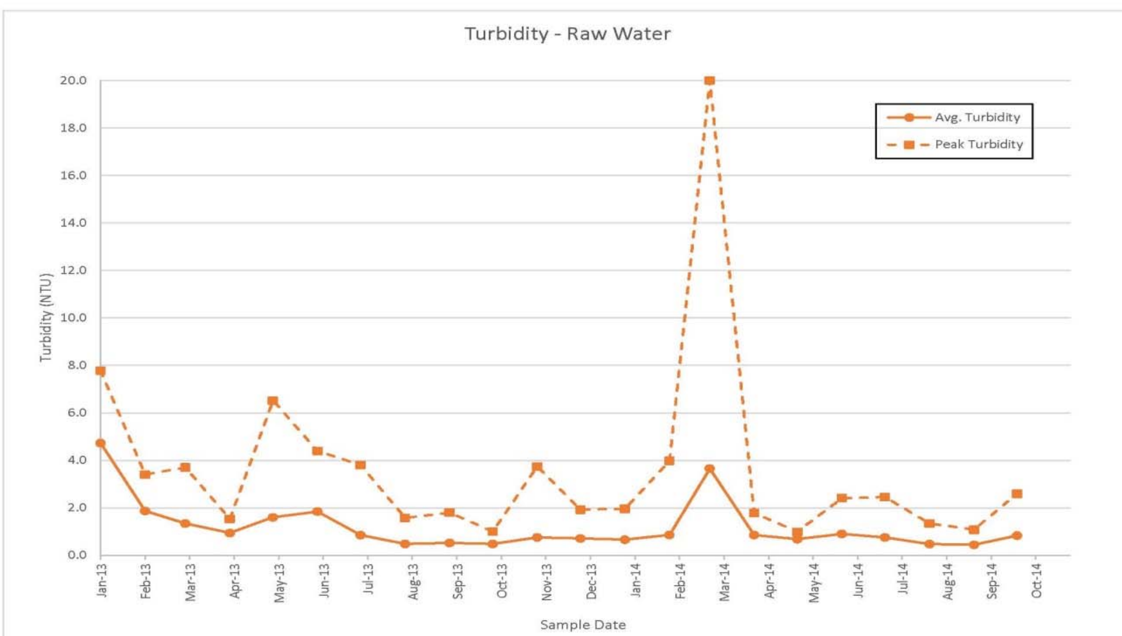
The 1998 Master Plan states that per California Superior Court Decree No. 355792, issued on January 29, 1993; CSA 7 must either establish a new point of diversion along La Honda Creek or otherwise provide its customers with holding riparian water rights from La Honda Creek with raw water source other than Alpine Creek. WWE and Andy Zdon & Associates (AZI) further reviewed the water rights of La Honda Creek/Alpine Creek using California State Water Resources Control Board's Electronic Water Rights Information Management System (eWRIMS). The surface water rights in the La Honda Creek / Alpine Creek area are adjudicated under the San Gregorio Creek Adjudication (California State Water Resources Control Board, 1989).

According to Superior Court of the State of California, County of San Mateo Decree No. 355792: *"In order to continue to serve those of its customers who hold decreed riparian rights to water from La Honda Creek, San Mateo County Service Area No. 7 (CSA 7) shall establish a new point of diversion on La Honda Creek or provide them with water from another source under other rights."*

At the time of this report, Alpine Creek intake was the only raw water source for the La Honda Water System. WWE identified and recommends additional raw water sources later in this report. In conjunction with identifying additional water sources, WWE summarizes discussions held with outside water system operators/owners who could potentially add CSA 7 to their existing systems through a purchase. The effect of consolidation and providing an additional source of water to the La Honda Water System could potentially resolve the water rights issue.

**Figure 3: Suction Piping in Alpine Creek**

**Figure 4: Raw Water Turbidity Data**



### 1.2.3 Water System Demands

Based on correspondence with the current system contract operator (Bracewell Engineering Inc. - BEI), the WTP flow meter does not consistently produce accurate data, thus it was not used to quantify current La Honda Water System demands. As such, WWE relied on the average-daily, maximum-day and peak-hour water demands of the system based on billing records between 1993 through 1997 that were presented in the Master Plan, and shown in Table 2. The County and BEI agreed that this water demand data is representative of current usage based on the historical billings showing water consumption of 10,000 to 20,000 gallons per day (gpd).

**Table 2:** Estimated Water Demand for La Honda Water System[1]

| Customer | Average Daily | Maximum Daily | Peak Hourly |
|---|---|---|---|
| | gpm | gpm | gpm |
| Residential (69 Connections) | 5.0 | 7.5 | 15.0 |
| Camp Glenwood | 4.3 | 6.5 | 12.9 |
| Sam MacDonald Park | 4.3 | 6.5 | 12.9 |
| Trailer Park | 4.3 | 6.5 | 12.9 |
| TOTAL | 17.9 | 27.0 | 53.7 |

1. Data generated from 1998 Master Plan

A combined capacity of the existing WTP (50 gpm) and treated water storage tank (0.5 MG), meets the current system peak hourly flow demand. Based on these values and as per California Division of Drinking Water (DDW) requirements, the La Honda Water System would require a treated water storage capacity greater than its maximum daily demand or MDD (27 gpm MDD = 38,880 gallons), not including fire flow demand requirements. However, due to the source water quality issue (turbidity during high creek flow events) as described above, the La Honda Water System includes a 500,000 gallon treated water storage tank used as long term emergency storage in case of raw water quality issues for extended period of time. This can lead to treated water quality issues that are discussed in the subsequent sections of this report.

As noted above, the estimated water demand for the La Honda Water System does not include fire flow demand requirements. It was determined in the 1998 Master Plan that La Honda Water System had sufficient storage but the system lacks sufficiently sized distribution piping to deliver fire flows and pressures consistent with current industry standards. It is assumed that fire hydrants and properly sized piping to accommodate rural fire demands would be constructed as part of the long-term future system-wide replacement.

### 1.2.4 Primary Water Source, Treatment & Quality Concerns

The following are current water source, treatment and quality deficiencies that are known by the County:

#### *1.2.4.1 Disinfection Byproducts:*

On December 31, 2012, the State Water Resources Control Board Division of Drinking Water (DDW) (formerly the California Department of Public Health) issued Citation No. 02-17-13C-033 to CSA 7 due to Total Trihalomethane (TTHM) Running Annual Average (RAA) exceeding the maximum contaminant level (MCL) of 80 ug/L for the four quarterly samples in 2012. BEI, who is contracted by the County to operate and maintain the CSA 7 water system, has employed various strategies to attempt to address DBP compliance as described in the

WWE DBP technical memorandum (See Appendix A). The DBP technical memorandum suggests that TTHM formation is generally occurring in the storage tank and recommends various treatment options for DBP compliance, which are further discussed in this report.

### 1.2.4.2 Chemical Storage Tank Containment:

The County uses three primary chemicals at the WTP. Liquid chlorine is used for disinfection, sulfuric acid for pH adjustment, and polymer for flocculation. The liquid chlorine is stored in a 45-gallon drum, sulfuric acid in a 35-gallon drum and polymer in a 30-gallon drum. These chemicals are refilled weekly with a 5-gallon utility bucket. The three chemical drums do not have secondary spill containment and are not anchored down. In addition, the peristaltic pumps rest on top of the chemical drums and are not secured. WWE also observed surface corrosion and deterioration of the steel electrical wiring gutter located behind the chemical storage and pumping area. Figure 5 shows the chemical storage tanks and electrical gutter.

**Figure 5: Chemical Containment & Electrical Gutter**


### 1.2.4.3 Corrosion Resistant Coating:

During a January 23, 2015 site visit, WWE observed that the corrosion resistant coating in the WTP flocculation chamber was cracking and chipping off. These cracks in the paint are shown in Figure 6.

**Figure 6: Flocculation Chamber Corrosion Resistant Paint**

### *1.2.4.4 Raw Water Quality:*

The existing raw water intake is from Alpine Creek for the entire La Honda Water System. SWRCB has permitted diversion rate from Alpine Creek to approximately 15 gpm or 22,600 gallons per day. During summer 2014 (third consecutive year of drought), the water level in Alpine Creek has lowered to just 5-inches above the suction pipe.

As displayed in Figure 4 the County has observed the turbidity of the raw water increase during heavy rainfall events when the water level is high in the Alpine Creek. Thus, removal of high turbidity is essential in improving the water quality for the customers of CSA 7.

### *1.2.4.5 Water Rights:*

Currently, Alpine Creek intake is the only raw water source for the La Honda Water System. According to Superior Court of the State of California, County of San Mateo Decree No. 355792, the northern area of La Honda Water System has decreed riparian water rights to La Honda Creek and not Alpine Creek. Thus, a new raw water source is required to serve the northern area of the La Honda Water System from La Honda Creek. The existing Alpine Creek intake should be solely used by the southern area of the La Honda Water System customers.

### 1.2.5 Project Objectives

The primary objectives of the County to address existing deficiencies for the Water Source, Treatment and Quality are as follows:

- Determine a reliable method of achieving disinfection byproduct regulation compliance;
- Utilize chemical containment and secondary containment that is seismically secure and utilize electrical wiring and associated conduits that are corrosion-resistant;
- Utilize corrosion-protection coating for the flocculation chamber;
- Identify additional water sources and analyze the feasibility of connecting them into the system, including having the La Honda Water System be incorporated by potential new owners/operators and how these options would resolve the water rights issue.
- Combine WTP upgrades with other necessary system upgrades (i.e., new raw water storage and/or DBP compliance) to ensure efficient expenditure of capital dollars and how this potentially supports the sale of the system to the new system owner/operator to benefit La Honda customers and County.

Section 2 of this report summarizes alternatives to meet these objectives; Section 3 compares each alternative against various factors and Section 4 recommends the improvements.

## 1.3 Existing Water Storage Facilities

The La Honda Water System consists of two water storage tanks, a 70,000-gallon raw water tank (Redwood tank) and a 500,000-gallon treated water tank (Steel tank). Both tanks are located in a close proximity to the WTP.

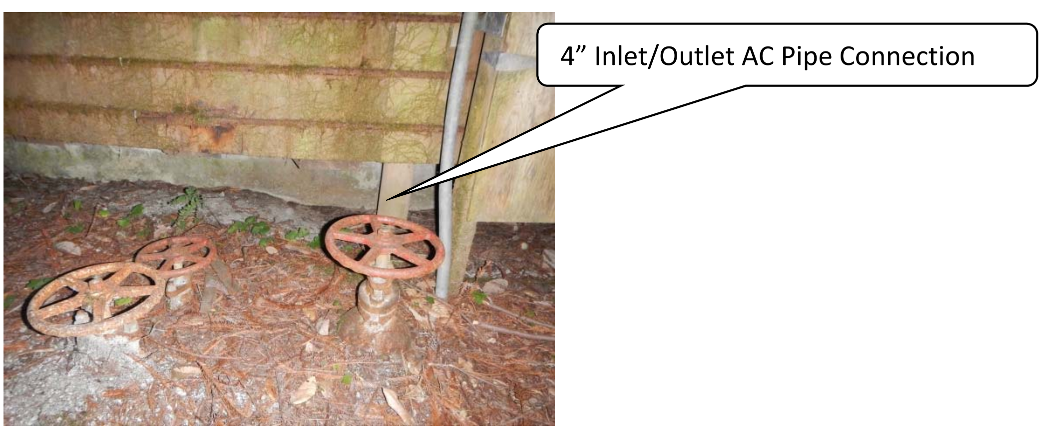
### 1.3.1 Raw Water Tank & Condition

The existing 70,000- gallon Redwood tank is approximately 27 feet in diameter with a maximum water depth of approximately 16 feet. The exact construction year is unknown, but it is suspected to be around 60 years old. The redwood tank wall consists of vertical redwood staves wrapped in galvanized steel cables. The wall supports a pitched redwood roof system. The roof uses openings at the top of the wall and around the entire perimeter for ventilation and is equipped with a roof vent at the center. The tank bottom consists of redwood planks over redwood joist framing which is supported by independent concrete grade beams. The foundation beneath the concrete grade beams is assumed to be compacted granular material. The tank piping is comprised of 4-inch Asbestos Cement Pipe (ACP) serving as both inlet and outlet (draw/fill) piping, which is routed through the bottom of the tank; and a 4-inch Polyvinyl Chloride (PVC) overflow pipe routed out the side of tank near the roof interface. There is no flexibility in the piping connections at the inlet and outlet pipeline. Such flexibility is particularly important during seismic events since the reservoir and connecting piping are likely to move independently. The Redwood tank and pipe connection are shown in Figure 7.

WWE and LiquiVision Technology Diving Services conducted underwater inspection of the redwood tank on October 24, 2014. The standards used to evaluate the condition of the redwood and steel tanks include Standard Method of Evaluating Degree of Rusting on Painted Steel Surfaces – SSPC-Vis 2-82, ASTM D 610-85 NACE Standard RP0196-96 & RP0388-2001 and Condition of Concrete In-service – ACI 201.1R-92. The redwood tank inspection noted the roof, ceiling and interior ladder are in extensive deteriorating condition. The redwood tank floor and its walls are in moderately deteriorating condition.

WWE conducted a thorough site inspection on November 12, 2014 and performed a structural evaluation of the redwood tank. A technical memorandum summarizing the evaluation was prepared and is included in Appendix B.

**Figure 7: Raw Water Redwood Tank & Inlet/Outlet Pipe Connection**


Inlet/Outlet Pipe Connection

### 1.3.2 Seismic Retrofit of Inlet/Outlet Piping of Raw Water Tank

On January 23, 2015, WWE inspected the 4-inch AC inlet/outlet piping connection at the bottom of the raw water tank. It does not have any seismic event resistance flexible couplings at the piping connection. Such flexibility is particularly important during seismic events since the reservoir and connecting piping are likely to move independently. WWE measured all necessary dimensions required for designing a flexible pipe connection required during the seismic event and details them in Section 2.

### 1.3.3 Treated Water Tank & Condition

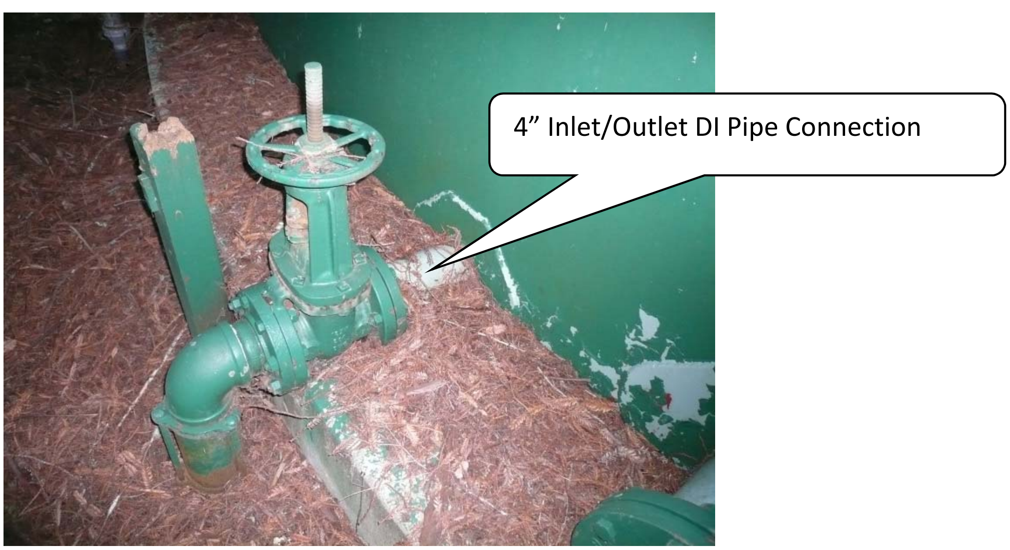
The existing 500,000-gallon Steel tank was constructed in 1967. The tank is sitting on a concrete ring foundation with a sand base. Based on the Master Plan, the tank bottom lip sits about 2 inches below the top of the concrete ring. There is an asphalt seal over the sand around the tank base. The ratio of tank diameter to height indicates it is unlikely that the tank will overturn in a major earthquake. Recently the tank had been coated externally. WWE observed the tank to be in good condition during the January 23rd, 2015 site visit. The treated water tank and inlet/outlet pipe connection is displayed in Figure 8.

WWE and LiquiVision Technology Diving Services conducted underwater inspection of the steel tank on October 25, 2014. The steel tank inspection noted that the coal tar coating on the interior wall, ceiling and floor appear to be in a good condition with minor deterioration. The steel tank overflow and 4-inch capped off penetration appear to be in fair condition with minor deterioration.

### 1.3.4 Seismic Retrofit of Inlet/Outlet Piping of Treated Water Tank

The 4-inch inlet/outlet ductile iron pipe (DIP) connection is located at the base of the Steel tank. It consists of a 4” Gate Valve (GV), a 90-degree elbow turning down, a flexible coupling connecting to the existing 4-inch pipe in the ground. WWE inspected the inlet/outlet piping connection on January 23, 2015, and found it does not have any seismic-resistant connections. The connection details are described in Section 2.

**Figure 8: Treated Water Tank & Inlet/Outlet Pipe Connection**



### 1.3.5 Project Objectives

The primary objectives of the County to address existing deficiencies for the existing storage tanks are to:

- Utilize flexible pipe connections at the steel treated water tank inlet/outlet pipe connections to enhance reliability of the tank connection during a seismic event;
- Utilize an above-ground cover to protect the new flexible pipe connections;
- Evaluate the feasibility of similar flexible connection at Raw Water Storage tank and determine if the tank can be retrofitted to enhance reliability during a seismic event.

WWE summarizes alternative improvements to meet the project objectives in Section 2, compares each alternative under several categories in Section 3, and recommends improvements in Section 4.

## 1.4 Existing Water Distribution System

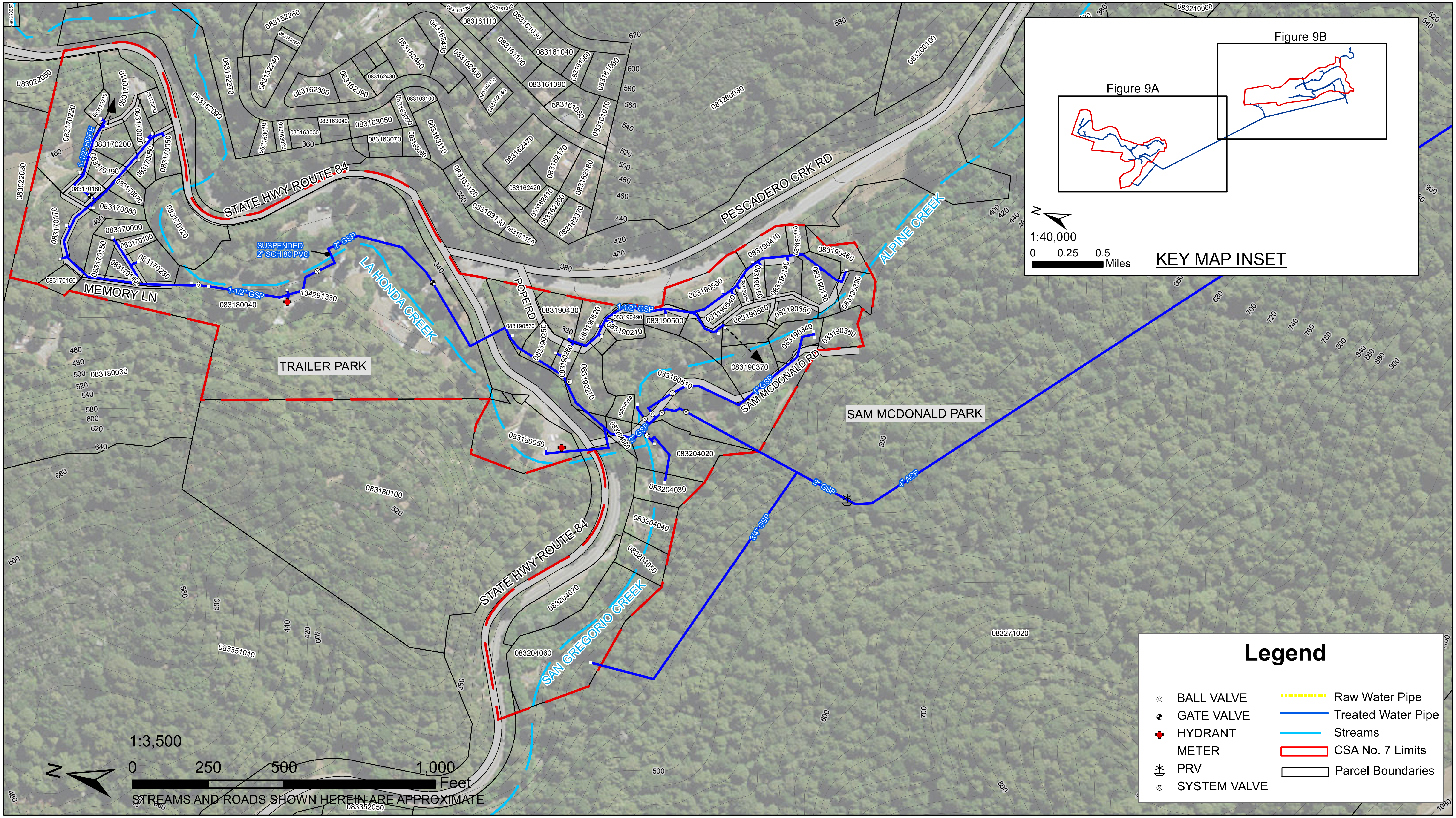
The existing distribution system is a dead-end, branched network of pipelines with no system redundancy or looping that serves residential customers along Alpine Creek and La Honda Creek. The distribution lines (pipelines) were installed over heavily-wooded, rugged terrain with numerous elevation changes, yet the system is not divided into pressure zones. The system was constructed with no "master planned" concept and was expanded as needed to serve new connections as they were built. It is made up of varying pipe diameters and materials, very few of which are consistent with current best practices for potable water system design and construction. In most cases, the pipelines were installed outside of public Right-Of-Way (ROW) in private roads and on private properties with limited access for maintenance. Improvements to the distribution system consist of reactive measures to fix leaks resulting from an aging infrastructure reaching to the end of its useful life.

In addition, the small diameter pipelines and relatively non-existent "looping" of the system result in significant pressure supply issues at the far reaches or northern end of the system, in particular along Memory Lane.

### 1.4.1 System Map

On November 18, 2014, WWE conducted a survey using a hand-held portable satellite GPS survey device that was rated to sub-meter horizontal accuracy. Due to the heavy tree cover and rugged terrain, the GPS device rarely achieved good satellite coverage during the survey. Once WWE determined that only 5% of the surveyed data had the desired sub-meter accuracy, the data was discarded. In lieu of utilizing GPS survey results, WWE created a GIS mapping of the entire system based on the existing mapping from the 1998 Master Plan, County records, and local and contract operator mapping archives. Additionally, WWE conducted three separate site visits of the La Honda system. The first site visit utilized a windshield overview with supervision and input from BEI and County staff; and the remaining two visits where conducted by WWE staff walking the majority of pipeline alignments in the La Honda system. WWE's research for development of mapping also included verbal communication and review of the mapping documents with BEI and local previous operator of the system.

La Honda Water System is divided into two areas, the northern and southern distribution systems. The northern area serves Memory Lane residential, Trailer Park, Pope Road and SR 84 & Pescadero Creek Road residential. The southern area includes Canyon View Road, Loop Road, Alpine Road, La Honda, Camp Glenwood and Sam McDonald park areas. Figure 9 shows the aerial view of La Honda's existing water distribution system.

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# FIGURE 9A
# LA HONDA WATER SYSTEM MAP
## County Service Area No. 7

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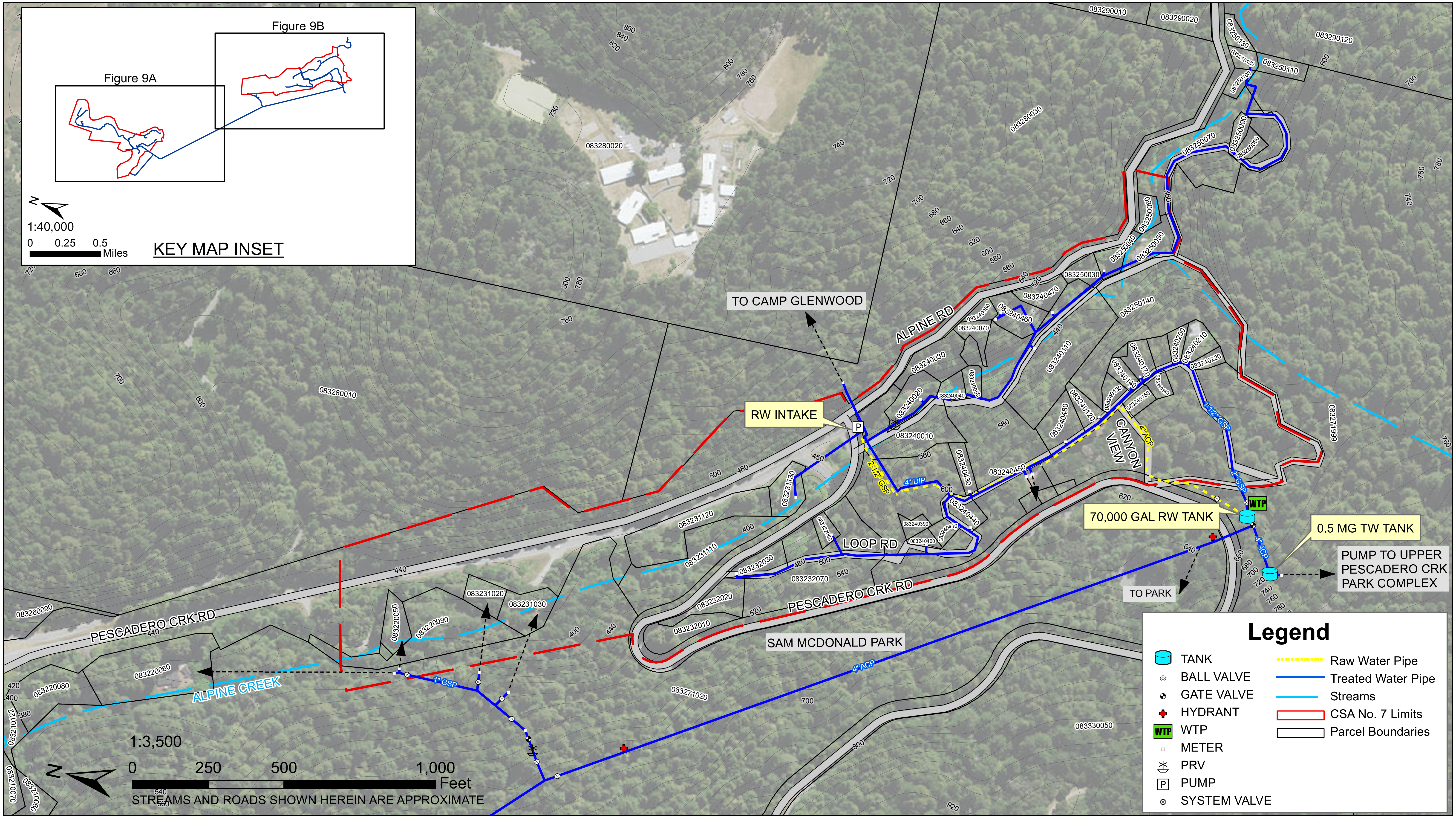


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# FIGURE 9B
# LA HONDA WATER SYSTEM MAP
## County Service Area No. 7

COUNTY OF SAN MATEO PUBLIC WORKS

### 1.4.2 Condition of Existing Water System

The majority of the existing La Honda water distribution system was constructed in the 1920s' using AC and GS pipe materials ranging from 3/4- to 4-inches in size. During the construction of the WTP in 1994, some of the existing distribution system was replaced with the DIP. In 1996, the distribution system on Upper Memory Lane was replaced with HDPE pipe material. Limited portions of the pipeline are buried in public roads but the majority is buried on private property and roads with limited segments exposed above grade. A large segment of 4-inch AC pipe connecting the two northern and southern areas is routed through Sam McDonald park area over difficult to access steep terrain.

After reviewing the master plan, conducting site reconnaissance and communicating with BEI, WWE summarizes the condition of the CSA 7 water system in the following list:

#### *1.4.2.1 Raw Water Pump to Redwood Tank:*

- The exposed raw water pipeline from the raw water pump connection at Alpine Creek to a bend in Loop Road is 2½ -inch GSP. The rest of the pipeline up to the tank is 4-inch ACP. The pipe appears to be in fair condition, and it has had minimal breakages and/or leaks based on limited available maintenance records.
- The buried existing raw water pipeline at Redwood tank connection is ACP. This pipe is unrestrained and was constructed in the 1920s'. Section 2.3 of this report describes additional details relating to this.

#### *1.4.2.2 Steel Tank to Abandoned Redwood Tank:*

- The exposed treated water pipeline from the Steel tank to an abandoned redwood tank is GSP, while the buried pipeline is ACP. Based on the review of available maintenance records, these pipes show limited history of breakages and/or leaks. It appears to be in relatively fair condition.

#### *1.4.2.3 South Distribution System Area:*

- The majority of the water system on Canyon View Road, Loop Road and on private roads near Alpine Road is DIP. Based on the review of available maintenance records, these pipes show no history of breakages and/or leaks. This pipeline appears to be in relatively good condition.

#### *1.4.2.4 North Distribution System Area:*

- The majority of the water distribution system on Memory Lane, in the Trailer Park, and on Pope Road has a documented maintenance history of breaks, leaks and low-pressure conditions within the pipes. This localized distribution system is in poor and deteriorated condition.

The 1998 Master Plan did not have any specific maintenance or service disruptions records for the water system but mentioned that there were pipe clamps at various undisclosed locations where the pipe had broken or leaked. WWE requested access to any available maintenance records, and BEI responded with a document detailing complaints and incidents from 2010 onwards. The county-provided system map notes at several locations where clamps were used to fix leaks or breaks, but the earliest note only dates back to 2006. WWE describes the areas where frequent disruptions have occurred in the following section.

### 1.4.3 Frequency of Water Shutdown

Table 3 describes the complaint and incident log for past three years as per DDW requirements. It is not a complete representative of all communications with the community regarding system operations and maintenance. Table 3 indicates that the majority of the breakage and leaks has occurred in the northern area water system on Memory Lane, Pope Road and Trailer Park areas. The northern area resides on a higher elevation than the rest of the system with relatively low water pressure and aged infrastructure. The existing pipe materials are GS and HDPE pipes.

The southern area water system consists of GS and DI pipe materials and has minimal complaints for breakage or leakages. The distribution system from the existing WTP connecting the northern and southern areas is of AC and GS pipe materials. There is very limited access to these pipes because of heavy vegetation, tree cover, and relatively steep slopes through which the pipe traverses.

### 1.4.4 Project Objectives

The primary objectives of the County to address deficiencies and disruptions in service related to the La Honda Water System infrastructure are to:

- Identify deficiencies in the existing water system and quantify capital improvements to address them;
- Prioritize improvements that will address the increased maintenance and low-pressure conditions on northern area of the system;
- Prepare a GIS-standard water system mapping and attribution database that logs current assets for future maintenance and planning efforts.

Section 2 of this report summarizes alternatives to meet these objectives; Section 3 compares each alternative against various factors and Section 4 recommends the improvements.

## Table 3: La Honda Water System – Complaint & Incident Log

| CSA 7 Complaint & Incident Log thru 2015 | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Date | Time | Name | Phone Number | Location | Type of Issue | Operator | Problem | Resolution |
| | | | | | | | | |
| 4/23/2015 | 16:55 | Kim | N/A, Contacted by CSM | 15005 Pescadero Creek Road | Leak | JE | CSA 7 Service Line Leak | Found Box Full of water, hose running on property, went back later found service line leak on CSA 7 side, Repaired Leak |
| 4/1/2015 | 10:30 | Ms. Randi Boice | N/A, Contacted by CSM | 14251 Pescadero Creek Road | Leak | TR | Customer Service Line Leak | Notified County |
| 1/17/2015 | 12:00 | Various | N/A | Pope Road, Memory Lane, Trailer Park | Low Pressure | TA | Main Line Valve at PRV Shut Off | Turned valve back on pressure returned |
| 11/19/2014 | 16:51 | Jeffrey Magni | Contacted Via Email | 64 Pope Road | HIgh Pressure | RC, TA | Failed PRV | Replaced PRV |
| 10/23/2014 | N/A | Various | Contacted Via Email | Near 58 Pope Road | Leaks - 3 | RC, AR | 3 leaks | Repaired leaks, Replaced section of service line |
| 10/1-10/192014 | N/A | Various | Contacted Via Email | Memory Lane | Leaks - 3 | RC, AR | 3 leaks | Repaired leaks |
| 9/22/2014 | N/A | Various | Contacted Via Email | Main Line, Logging Yard | Leak | RC, AR | Main line leak between Pope and Trailer Park | Repaired main in logging yard |
| 6/29/2014 | 16:58 | Heather McAvoy | (650) 969-5195 | Memory Lane | Low Pressure | RC | Low Water Pressure | No Issue Found, High Usage |
| 2/26 & 4/30/2014 | | | Contacted Via Email | #1 and #10 Memory Lane | Leak | TA | Water Running from Retaining Wall | |
| 5/14/2013 | 21:31 | Patricia O'Neil | Contacted Via Email | Memory Lane | Leak/Low Pres | RC | Leak in Trailer Park | Let Heather know it needs to be fixed |
| 12/23/2012 | 21:13 | Patricia O'Neil | Contacted Via Email | Trailer Park Bridge | Leak | RC & CH | Main Line Broken by Creek | Re-ran main going accross bridge |
| 11/14/2012 | 14:33 | America Sanchez | Contacted Via Email | By Raw Water Storage Tank | Leak | DG | Leak on RW Tank Feed Line | Repaired Leak |
| 7/5/2012 | N/A | America Sanchez | Contacted Via Email | Near 58 Pope Road | Leak | DG | Leak on previously repaired service line | Repaired Leak |
| 4/9/2012 | 7:12 | Mark Chow | Contacted Via Email | Pope Road, Memory Lane, Trailer Park | Leak/Low Pres | DG, CH | Leak on Pope Road, Customer Irrigation Line | Shut off valve to irrigation line. pressure restored. |
| 2/22/2012 | N/A | ? | Contacted Via Email | Memory Lane | Leak | N/A | Leak on Main | Leak Repaired |

# 2. Investigation of Alternative Solutions

WWE determined various alternative improvements to the La Honda Water System that would address the stated project objectives in Section 1. The following sections describe improvements to each component of the water system. Please note that a majority of Section 2.1.1 was adapted from the Disinfection Byproduct Formation Assessment technical memorandum and addendum submitted by WWE to the County on February 27th, 2015. To see the full report and addendum, please reference Appendix A.

## 2.1 New Water Source, Treatment & Quality Alternatives

This section will evaluate and discuss alternatives to fulfill project objectives that are listed in Section 1.2. The following components of the La Honda Water System are discussed further:

- DBP compliance to current DDW regulations;
- Available chemical containment in WTP building;
- Coating repairs within the WTP flocculation chamber;
- Finding an alternative raw water source;
- Other WTP upgrades for future sale of the La Honda Water System.

### 2.1.1 Disinfection Byproduct (DBP) Compliance

On December 31, 2012, the State Water Resources Control Board Division of Drinking Water issued Citation No. 02-17-13C-033 to CSA 7 due to TTHM running annual average exceeding the maximum contaminant level of 80 µg/L for the four quarterly samples in 2012.

After conducting a site reconnaissance on November 18, 2014, several options were suggested in making the existing WTP DBP compliant. Upon the request from WWE, BEI took several treated water samples from the WTP and at the sampling point on the distribution system. The results of these test samples are summarized in the technical memo in Appendix A. Overall, the data suggests that TTHM formation is generally occurring in the storage tank, which is the basis for the recommendations of this section.

#### *2.1.1.1 Air Stripping*

One of the recommended methods of TTHM removal that is applicable for the La Honda Water System is to have a recirculating spray system installed in the treated water tank. A recirculating spray system can provide the necessary air to water droplet surface area interface to volatilize ("strip") TTHMs from the treated water. This system can be fixed (attached to the tank wall or roof) or floating (affixed to a raft). With sufficient ventilation (typically through a roof mounted vent fan), a typical removal efficiency rate is in the range of 50 to 90%. Below are the TTHM removal spray test results that were completed by BEI. Additional chemical processes and design considerations of spray system air stripping equipment is described in Appendix A.

TTHM REMOVAL PILOT STUDY

WWE recommended performing a TTHM removal pilot (spray) test using a spray nozzle at varying heights and spraying the treated water from the steel tank in a parabolic manner in a bucket. This pilot test was conducted by BEI, and consisted of collecting three samples from varying heights comparing against the fourth sample that had not been administered through the spray nozzle. The summary of the results of this pilot test that was taken on March 4th, 2015 are displayed in Table 4.

Sample one was collected from the steel tank representing an initial measurement of TTHM level of the existing treated water. Sample two, three and four were taken after the treated water was aerated at one, three and five feet in height respectively. TTHM levels were measured from these three samples and reported below.

**Table 4: TTHM Removal Pilot Test for La Honda Water System**

| Sample # | Sample 1 | Sample 2 | Sample 3 | Sample 4 |
|---|---|---|---|---|
| Sample Location | Water Tank | LHW Spray @ 1’ | LHW Spray @ 3’ | LHW Spray @ 5’ |
| Sample Time | 12:00 PM | 12:45 PM | 1:30 PM | 2:30 PM |
| TTHM Measured (µg/L) | 90.78 | 34.04 | 34.18 | 31.84 |
| % TTHM Removal | - | 63 | 62 | 65 |

The data indicates that TTHM was volatilized during the pilot test, with a range of 62 to 65% removal observed. This data further supports the potential efficacy of a recirculating spray system in removing TTHMs in the La Honda Water System.

### *2.1.1.2 TOC Removal:*

Another alternative solution to TTHM removal is to remove Total Organic Carbon (TOC) through granular activated carbon (GAC) adsorption following the filtration process. Removing TOC will reduce the amount of organic content that is available to react with free chlorine to form TTHMs. The use of GAC for TOC removal as a control strategy is most effective when implemented in conjunction with air stripping. The majority of the TTHM removal will occur during the air stripping and the GAC process provides finishing removal for high TTHM levels resulting from long periods of elevated water age. Air stripping ahead of the GAC extends the life of the GAC media, and the GAC provides a more robust TTHM removal process.

### *2.1.1.3 Chloramine as Secondary Disinfectant:*

Some water utilities use chloramine for their secondary (residual) disinfectant, with primary disinfection still being achieved using free chlorine. Following primary disinfection, ammonia can be added to the water to produce chloramines (the ammonia is added at a 4:1 ratio to the chlorine residual). The use of chloramines for secondary residual can be effective, but with long water age, issues of nitrification and destruction of chloramine residual problems with minimum chlorine residuals compliance in the distribution system can occur. Additionally, La Honda water system customers have expressed to the County staff an extreme concern regarding the use of chloramine as a disinfectant.

### 2.1.2 Chemical Storage Tank Containment

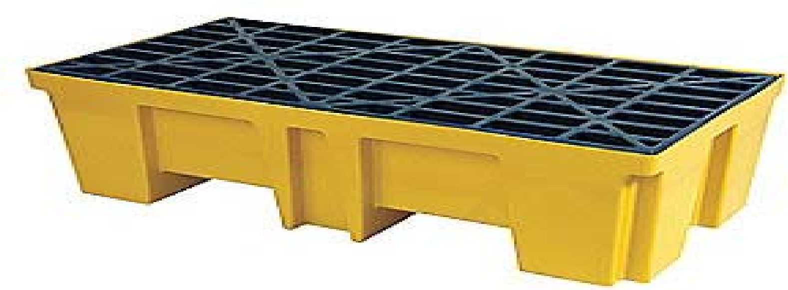
The WTP uses three chemicals in its treatment process; polymer as a coagulant, liquid chlorine as a disinfectant and sulfuric acid for pH adjustment. The chemicals are stored in 30 to 45-gallon drums and are pumped via peristaltic pumps into the WTP. Currently, the chemical drums have no secondary spill containment and are not secured or anchored to the WTP wall or ground floor.

#### *2.1.2.1 Chemical Containment:*

During January 23rd, 2015 site visit, BEI and WWE evaluated the condition of existing chemical drums and noted the absence of secondary spill containment. According to BEI, the existing chemical drums are in poor conditions and they should be replaced.

The recommended chemical containment for the chemical drums will be similar to Brady SPC Absorbents Spill containment pallet made of HDPE material. The containment size is 17"H x 26"W x 52"L providing up to 68-gallon capacity, which is double the volume of the chemical containers. Figure 10 shows the spill containment pallet for chemical containment. A seismic stainless steel strap similar to a household water heater strap should be used to anchor the chemical drums to the WTP wall.

**Figure 10: Chemical Containment**



#### *2.1.2.2 Electrical Modification:*

WWE observed extensive corrosion to the electrical gutter, receptacles, and switches behind the chemical containers. Replacement of the existing gutters and receptacles is needed, whereas the existing conduits are in fair condition and do not require immediate replacement. Waterproof Ground Fault Circuit Interrupter (GFCI) receptacles should be used and NEMA 4X pull boxes where needed. Covers should be waterproof and made out of a thermoplastic material.

### 2.1.3 Flocculation Chamber Coating

As shown in Figure 6, the WTP flocculation chamber coating is cracking and is discolored likely due to rust from the tank corroding. The recoating of the flocculation tank will require redirecting the flow to a temporary flocculation tank of similar size during the duration of the recoating operation. The recoating and curing operation may take approximately ten (10) days including all prep work (draining, cleaning and sand blasting the old coating) and recoating the flocculation tank. A temporary flocculation tank may need to be outside of the WTP or more likely (and more cost effective) the system will be fed from the treated water storage tank during this WTP down period.

### 2.1.4 Sources of Raw Water

WWE investigated two possible raw water sources for La Honda Water System and discusses them in this section. One of the options that was researched and analyzed by AZI was for multiple potential groundwater sites. The second option was discussed in the Master Plan of building new intake facility on La Honda Creek.

WWE investigated selling the La Honda Water System to other water systems that may have more raw water. However, none of the other water systems had extra water sources. Therefore, this alternative was not investigated further.

#### *2.1.4.1 Groundwater Well Sites & Supporting Infrastructure:*

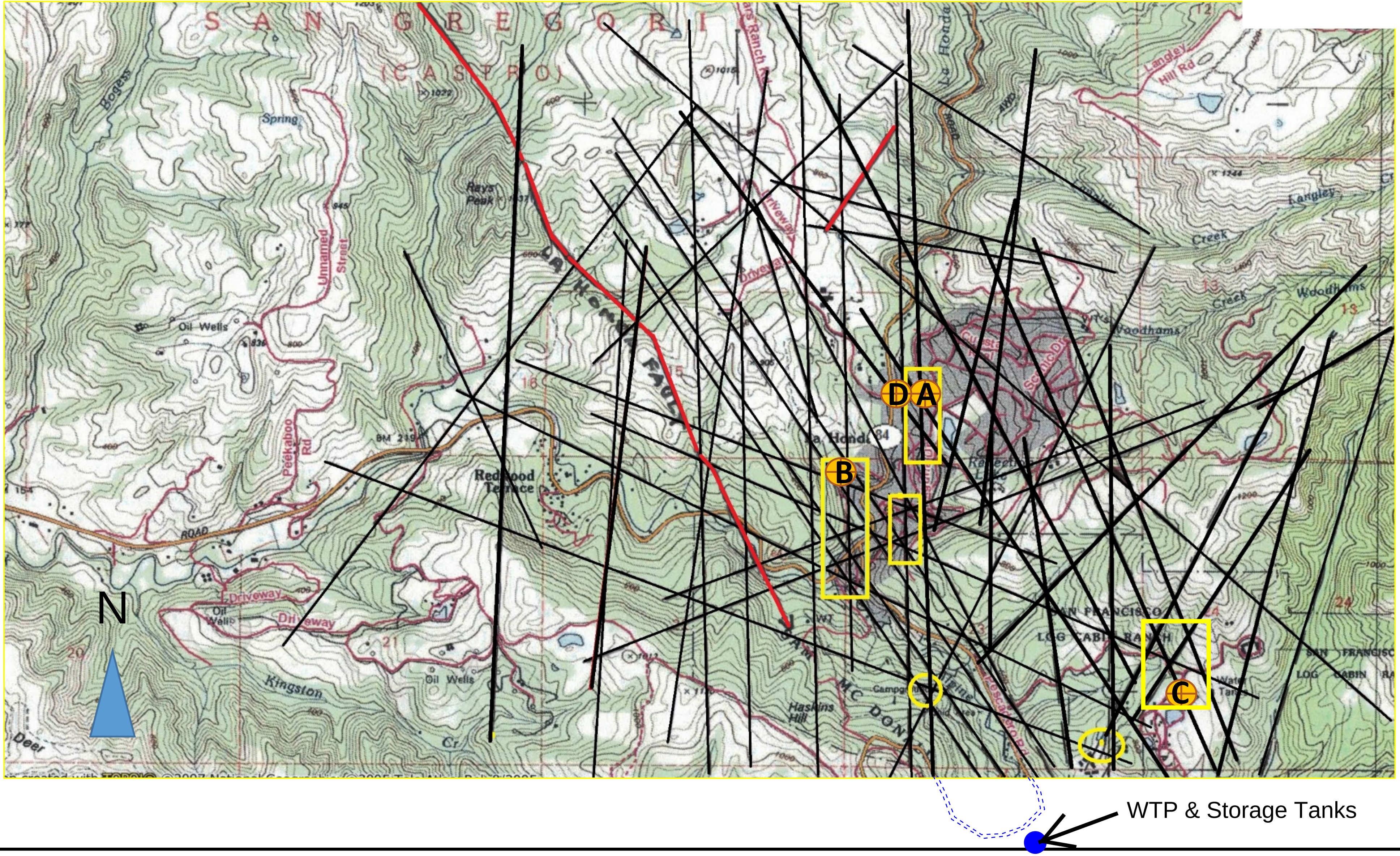
The County has water rights to serve properties near Alpine Creek from the Alpine Creek, and serve properties near La Honda Creek from the La Honda Creek as their raw water source. Currently, the entire La Honda Water System is only supplied from Alpine Creek. Thus, an additional raw water source and supporting infrastructure is required to serve the northern area residence near La Honda Creek.

WWE contracted with AZI to evaluate the potential feasibility of a new GW source well as described in detail in Appendix C. AZI researched and analyzed potential groundwater sites for additional raw water sources for the northern area residences in La Honda Water System. AZI assessed several sources of water using fracture trace analysis and existing geologic data regarding geologic structures in combination with locating natural linear features on aerial/satellite imagery and topographic maps. These linear features, or “fracture traces,” are surface expressions of joints and zones of joint concentration, or faults as described in detail in Appendix C of this report. Figure 11 shows key fracture and fault traces as thick lines, whereas pertinent lineaments are presented by the more numerous thinner lines. The yellow rectangles are areas in which intersecting lineaments are most numerous. These areas would likely provide the most successful well sites. The most prominent area of intersecting alignments is in the area immediately west and east of La Honda Creek. Any groundwater well sites would likely require that the raw water be pumped back to the water treatment plant. Consequently a new raw water pipeline is needed. AZI has identified potential four sources of raw water as described below.

- APN 083-092-180 (11 Entrada Way, La Honda, CA – East of County Corp Yard);
- APN 083-170-090 to 092 (17 Memory Lane, La Honda, CA – Memory Lane);
- APN 083-280-020 (500 Log Cabin Ranch Road, La Honda, CA – Glenwood Boys Camp);

- APN 083-092-200 (59 Entrada Way, La Honda, CA – County Corp Yard)

These four well sites are remotely located with respect to the existing WTP site. These sites are depicted individually in Figure 12 and are shown in detail in Appendix C of this report. Below is the brief description of each of these four sites.




**Well Sites**

A - East of County Yard
B - Memory Lane Site
C - Glenwood Boys Camp Site
D - San Mateo County Yard Site

Legend:

Reported Faults
Pertinent Lineaments
Potential Well Site Area
Potential Well Site

# Fracture Trace Analysis & Recommended Well Site Areas

Date: January 16, 2015
Project: La Honda
Image Source: TOPO!

Figure 11

ANDY ZDON & ASSOCIATES, INC.

I. APN 083-092-180 (11 Entrada Way, La Honda, CA – East of County Corp Yard):

A vacant parcel east of County Corp Yard is one of the preferred sites for a potential production well based on the geological analysis and favorable site conditions. It has ample space for drilling equipment and support vehicles, has electrical power at the site, and existing facilities if need be nearby at the adjacent County yard. Given the elevation of the site relative to La Honda Creek, it is likely that groundwater would be relatively shallow, likely reducing drilling costs. The proximity of the creek may also lead to stricter permitting requirements (e.g., a waste discharge permit). The site is on the private property and will require a permanent easement and possibly property acquisition, an option that the County does not favor. The site is located outside of CSA 7.

A 2.5-mile long 4-inch water line will be required to transfer the raw water up to WTP. Alignment of the raw water pipeline is further discussed in this Section under V.

II. APN 083-170-090 to 092 (17 Memory Lane, La Honda, CA – Memory Lane):

The second preferred site is located on the Lower Memory Lane, which is on a private land adjacent to several residences. With the elevation of the site being relatively higher than La Honda Creek and the subsidiary creek that feeds it, the total depth of drilling and any associated costs may be higher than the site east of County Corp Yard. The site is on the private property and it will require a permanent easement and possibly property acquisition. The site is also located within CSA 7, which makes it more favorable to the County.

A 2.0-mile long 4-inch water line will be required to transfer the raw water up to WTP. Alignment of the raw water pipeline is further discussed in this Section under V.

III. APN 083-280-020 (500 Log Cabin Ranch Road, La Honda, CA – Glenwood Boys Camp):

While the Glenwood Boys Camp site is geologically favorable with several intersecting lineaments identified, it is located at a significantly higher elevation. This site will lead to higher drilling and well development costs than the Memory Lane site.

A 1.0-mile long 4-inch water line will be will be required to transfer the raw water up to WTP. Alignment of the raw water pipeline is further discussed in this Section under V.

IV. APN 083-092-200 (59 Entrada Way, La Honda, CA – County Corp Yard):

The County Corp Yard site is a large parcel owned by the County for storing construction and road maintenance equipment. The County has stored gasoline supplies in an existing underground tank and had an above-ground fueling station on-site. It is also located adjacent to the La Honda Creek. Due to the close proximity of petroleum hydrocarbons and the La Honda Creek being in close proximity, this site is the least favorable to the County.

A 2.5-mile long 4-inch water line is required to transfer the raw water up to the WTP Alignment of the raw water pipeline is further discussed in this Section under V.

**Figure 12: Individual Well Site Location**

**East of County Corp Yard Site**

**Memory Lane Site**

**Glenwood Boys Camp Site**

**County Corp Yard Site**

V. New Raw Water Pipeline:

Figure 11 depicts that the four groundwater well sites are located relatively far away from the existing WTP site and thus, a connecting raw water pipeline is required to pump to the WTP. The two furthest raw water well sites are on County Corp Yard and just east of County Corp Yard. These sites will require approximately 2.5 miles of pipeline running west along Entrada Way; south on SR 84; south on Pescadero Road; and on to the existing WTP. The new 4-inch water line can be constructed along the roadside public right-of-way in the shoulder area. The design and construction of this pipeline alignment may include up to two bore and jack constructions, a 4-inch water line and required appurtenances, environmental permitting, a Caltrans encroachment permit, and road repaving.

The Memory Lane site is approximately 2.0 miles away from the existing WTP site. It will consist of a 4-inch water line running south on Memory Lane; south on SR 84; south on Pescadero Road; and on to the existing WTP. The new 4-inch water line can be constructed along the roadside and within the Public Utility Easement (PUE) on Memory Lane in the shoulder area. The design and construction of this pipeline alignment may include up to two bore and jack constructions, a 4-inch water line and required appurtenances, environmental permitting, Caltrans encroachment permit, and road repaving. Additional access easement and PUE may be required for the pipeline.

The Glenwood Boys Camp site is located at a site that is about 400 feet higher in elevation than Pescadero Road. The site is approximately 1.0 mile away from the existing WTP site. The new pipeline will travel west on privately owned Log Cabin Ranch Road; west on Pescadero Road; and on to the existing WTP. The design and construction of this pipeline alignment may include up to one bore and jack construction, a 4-inch water line and required appurtenances, environmental permitting, and road repaving. Additional access easement and PUE may be required for the pipeline.

VI. Groundwater Quality Implications:

In case the groundwater quality is tested and found to be in a good enough quality that it may simply require a sand filtration and chlorination, than the treated groundwater could directly be pumped into the existing distribution system in the northern area. This may eliminate the need for a new raw water pipeline as described above.

However, the potential for such a high level of water quality is unlikely, especially from the groundwater well sites located adjacent to La Honda Creek, due to a Groundwater under the Direct Influence (GWUDI) of surface water. The GWUDI will require a very similar treatment to the surface water treatment, with the distinction that it has been filtered through subsurface formations. Due to these facts, it can make a higher quality and easier to filter. This groundwater will still need to be filtered to achieve 3-log Giardia removal and disinfected for 4-log virus inactivation.

#### *2.1.4.2 Raw Water Intake on La Honda Creek:*

As discussed in the Master Plan, one of the additional sources of raw water for the La Honda Water System is to have a new raw water intake on La Honda Creek. A new raw water intake will be located near La Honda Road Bridge on La Honda Creek. It will consist of 6" stainless steel well screen embedded in a granular bedding material that is wrapped in a geotextile fabric material. The suction pipe will be laid at the bottom of the creek. The intake will also consist of a new 7.5 HP intake pump similar to the Alpine Creek intake and a 4-inch pipeline with appurtenances.

The new intake on La Honda Creek will also require an approximately 2.5 mile long 4-inch raw water pipeline up to the existing WTP, similar to what is required for the individual groundwater well site.

#### *2.1.4.3 New System Owner/Operator:*

WWE contacted several local water systems to discuss the potential purchase or operation of the La Honda Water System. WWE communicated with San Jose Water Company (SJWC), Cuesta La Honda Guild and California Water Service Company (Cal Water). The following is the summary of various discussions, telephone conversations, and meetings with these agencies:

I. San Jose Water Company:

WWE had an informal discussion with SJWC regarding a potential purchase of the system in which SJWC responded that they were not interested. WWE did not pursue any further conversations with SJWC.

II. Cuesta La Honda Guild:

WWE discussed the potential combination of the systems (Cuesta La Honda Guild & CSA 7) with Mr. Peter Lyon on November 21st, 2014 by phone. He stated that the Board of Directors had little interest in consolidating the two water systems because of the poor CSA 7 infrastructure condition. Furthermore, the Cuesta La Honda Guild system is currently understaffed and does not have the operational workforce to maintain CSA 7. Also, Cuesta La Honda Guild system is in need of a raw water source and CSA 7 does not have excess capacity to offset this need. In summary, Cuesta La Honda Guild was concerned CSA 7 is not sufficiently funded to meet their current system upgrade liabilities or identify, develop and build a new raw water source. The consolidation was not discussed further.

III. California Water Service Company:

WWE facilitated several phone correspondence with Cal Water representatives regarding the potential purchase of the system (Cal Water expressed no interest in contract operations only purchase.) Cal Water previously considered purchase of the system in 1996. Cal Water provided the County with a list of items to be repaired before a purchase would be considered further. The County and WWE met with Cal Water on March 24th, 2015 to further discuss options. Cal Water continues to be interested in pursuing a purchase and/or consolidation with other systems but communicated several constraints that would need to be addressed to confirm feasibility. The major items are listed below.

- If Cal Water purchased the system, the system would have to be improved to a design standard consistent with current PUC requirements for level of service similar to what they are providing in their other systems. The County's current infrastructure condition; ongoing system upgrade and replacement program; and design standards do not meet the typically required level of service. For example, "looping" of entire system would be required; all pipes (and appurtenances) would be sized to provide rural (or potentially urban residential) fire flow demands, meters and service lines would need to be upgraded to meet Cal Water standards.
- Before the system was purchased, the total funds required for the improvements to bring the system up to an acceptable standard would need to be quantified and the funding source and/or plan to meet this total identified, including ongoing long term infrastructure rehabilitation and replacement funding for distribution and treatment infrastructure. Acquiring the County system cannot be a financial burden to the existing Cal Water customers. Any rates, fees and/or alternate funding source (grants, loans, etc.) would transfer to Cal Water at time of purchase.
- The acquisition would require approval from the California Public Utilities Commission (PUC), Local Area Formation Commission (LAFCO), and DDW, as well as CSA-7, County and Cal Water governing bodies. The review and approval process for PUC, LAFCO and DDW is at minimum a one year from the date of filing for approvals with these agencies.
- Cal Water would require all CSA7 customers transfer their water rights to Cal Water with the purchase.

The County provided system operating and budget data to Cal Water for their review and use in preliminarily evaluating feasibility. Cal Water is awaiting a final version of this feasibility report, with particular emphasis on the Capital Improvement Plan, to complete their planning level financial feasibility analysis.

### 2.1.5 Additional WTP Modifications

In order to resolve the issue of DBP compliance and reducing turbidity from the existing raw water source, WWE has evaluated several alternatives that are discussed in this section and remainder of this report.

#### *2.1.5.1 Replace Existing Sand Media & Recoating:*

A sand filter media should be replaced periodically, as it is subject to permanent mechanical degradation due to backwashing/flushing events, and fouling over time. The existing sand media is approximately 12 years old. The typical service life of the sand media is approximately 8 to 10 years. During the process of changing the sand media, the new media and filter should be disinfected before being placed back into service.

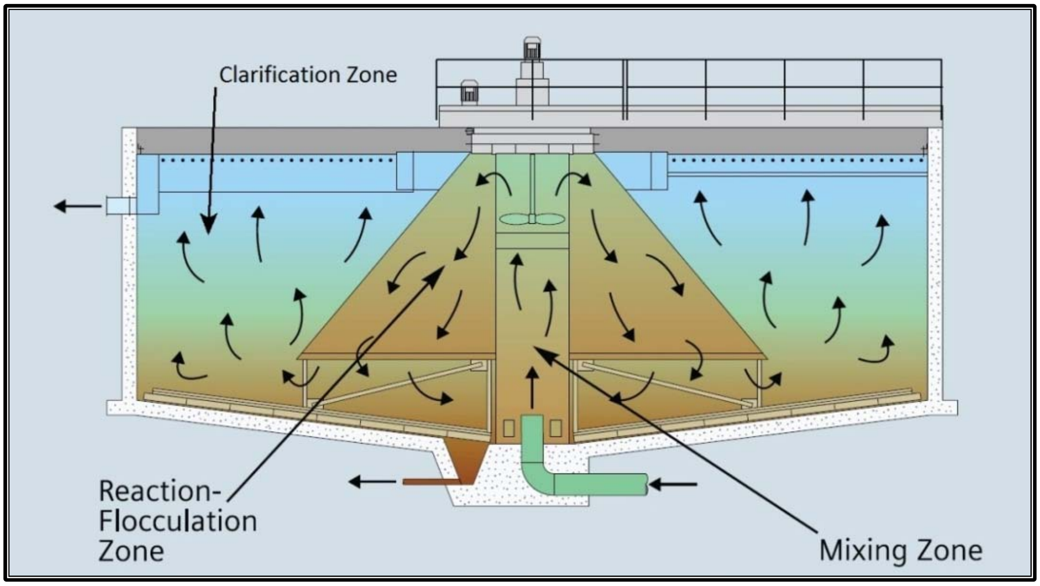
The existing interior tank coating was re-coated in 2009. Removing the existing coating and recoating the sand filter tank will extend the life of the filters and new media.

#### *2.1.5.2 Solids Contact Clarifier:*

WWE analyzed the solids contact upflow clarifier as an option to provide raw water storage and complying with DBP requirements. The solids contact clarifier combines flash mixing, flocculation, and clarification in a single unit process. Raw water, coagulant, and recycled solids are blended in the mixing zone of the clarifier, which is a draft tube in the center of the tank with flow driven upward by a propeller. Floc particles collide with one another to form larger floc in the reaction-flocculation zone, which is separated from the clarification zone by an inverted cone shaped barrier. A portion of the flocculated water is recycled from the reaction-flocculation zone back into the mixing zone to increase collisions with particles just forming in the coagulated raw water inflow. Flocculated water flows at a rate equivalent to the rate of incoming raw water flow upward through the solids blanket and enter the upflow clarification zone. The clarification zone provides a quiescent area where solids are separated from the clarified water, and settle back into the solids blanket. Clarified water overflows in to an effluent launder. A typical surface loading rate (SLR) for the clarification zone is 0.3 gpm per square foot. A lower surface loading rate for clarification will result in a higher treatment quality. The target residence time in the mixing zone and flocculation zone is 30 minutes. A canopy style metal cover may also be required to protect the solids contact clarifier from the surrounding trees and vegetation falling into the clarifier. Figure 13 shows a typical solids contact clarifier configuration.

A solids contact clarifier will remove natural organic matter (NOM) from the raw water content in an effective manner. Due to the effectiveness of removing NOM from the raw water is high, the solids contact clarifier will help reduce DBPs typically in the range of 10 to 20% and increase the longevity of a filter system at the WTP. Section 3.3 describes the cost comparison of solids contact clarifier.

**Figure 13: Solids Contact Clarifier**




A solids contact clarifier consists of a concrete ring foundation, coating and lining, and required electrical and instrumentation for motor controls. A coagulator will be fed in to the clarifier for coagulation/flocculation process to occur and a waste line is required to connect with existing washwater holding decanting tank. A pump will be required to pump out the raw water from clarification zone into the sand filters of WTP. Table 5 summarizes the sizing of the new raw water tank.

**Table 5: Sizing of Solids Contact Clarifier**

| Diameter | Height | SLR | Volume |
|---|---|---|---|
| ft | Ft | gpm/sf | gallon |
| 30 | 15 | 0.11 | 80,000 |

### *2.1.5.3 Pressure Filter Vessel:*

Sand media of the existing sand filter should be replaced every 8 to 10 years. According to BEI, the sand filter media was last replaced approximately 12 years ago. WWE considers that the existing sand filter has reached the end of its serviceable life.

Thus, WWE evaluated new pressure filter vessels to replace the existing sand filters. The pressure filter vessel is a simple flow through filter system, with reverse flow for backwash and a surface wash assembly to supplement backwash. A "water-only" backwash system is recommended for high quality raw water sources, and it is recommended for this application if a pre-treatment step such as solids contact clarifier will precede filtration process. The design criteria for the new pressure vessel system are included in Table 6 below. WWE considered replacing the existing multi-cell filter with (2) parallel vertical pressure vessels tanks.

**Table 6:** Pressure Filter Vessel Design Criteria

| Parameter | Design Value |
|---|---|
| # of Parallel Vessels | 2 (1 Active & 1 Redundant) |
| Media Type | Dual Media (Sand/Anthracite) |
| Diameter | 5'-0" |
| Height | 6'-0" |
| Surface Wash Flow Rate | 58 gpm per vessel |

## 2.2 Water Storage Tanks

The 70,000-gallon Raw Water Tank and a 500,000-gallon Treated Water Tank are located in a close proximity to the WTP. This section summarizes the findings of the condition of Redwood tank, its seismic retrofit options and pipeline connection at the tank. This section will also evaluate various options of seismically retrofitting the pipeline connection at the Steel tank and an option of a new raw water storage tank.

### 2.2.1 Existing Raw Water Tank

The seismic retrofit evaluation of the raw water Redwood tank includes analyzing how to secure the tank and its inlet/outlet pipe connection during a seismic event. WWE conducted several site visits to determine its condition and assess its seismic durability.

#### *2.2.1.1 Seismic Analysis:*

A stability analysis of the tank was completed using ASCE 7-10, Minimum Design Loads for Buildings and Other Structures, Section 15.7.6, which includes the design requirements for ground-support storage tanks for liquids. The seismic stability analysis of the raw water tank indicated that it does not have sufficient resistance to resist sliding and overturning during a seismic event. The tank also lacks an anchorage, sliding resistance, roof to wall shear transfer, and has insufficient freeboard. WWE has determined that the existing roof is in poor condition and has likely exceeded its useful life and is in need of replacement. WWE has investigated and evaluated condition of the existing Redwood tank, which are summarized in Appendix B.

In the event that the existing Raw Water Tank is no longer safe to use before it can be replaced, the County may have the option to bypass the tank using existing fittings and pump directly to the WTP. One negative consequence of this action, however, is that the County would lose the storage capacity of the Raw Water Tank, necessitating a coordinated shut-off of the intake pumps if the WTP reaches capacity. Bypassing the Raw Water Tank might introduce other unforeseen challenges and WTP operation, such as increased solids loading (turbidity) at the WTP that could negatively impact the ability of the WTP in producing regulatory compliant water.

#### *2.2.1.2 Pipeline Connection @ Tank Bottom:*

The existing raw water pipeline connection at the tank bottom is 4-inch ACP inserted through the tank without any coupling or fitting. The pipe connection through the tank is unrestrained and inflexible. WWE is of the opinion that this connection will be damaged and possibly fail during a seismic event. Thus, a new flexible pipeline connection is needed, which is further discussed in the following section.

#### *2.2.1.3 Inlet/Outlet Pipeline Connection:*

In order to secure the remaining existing 4-inch inlet/outlet AC pipeline of the raw water tank, WWE analyzed several possibilities using flexible couplings. Two options that were reviewed are shown. Each option begins at the tank bottom connection with an ACP to DIP flexible restrained coupling. New 4-inch restrained DIP and fittings will be used until it transitions back to ACP.

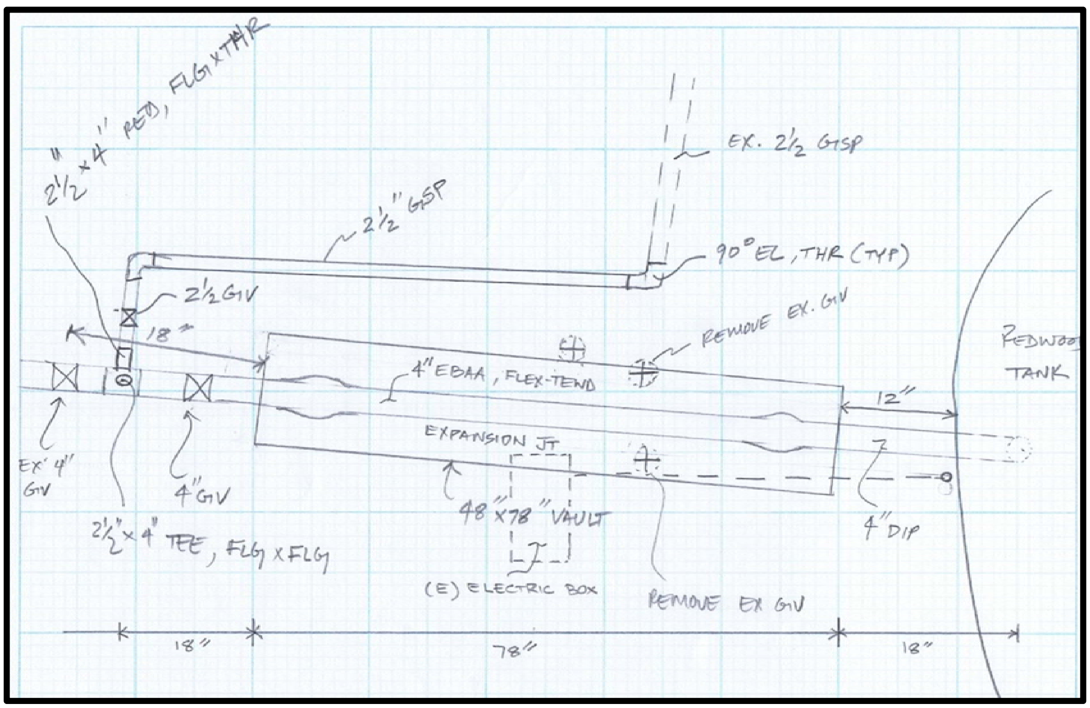
**Option 1:**

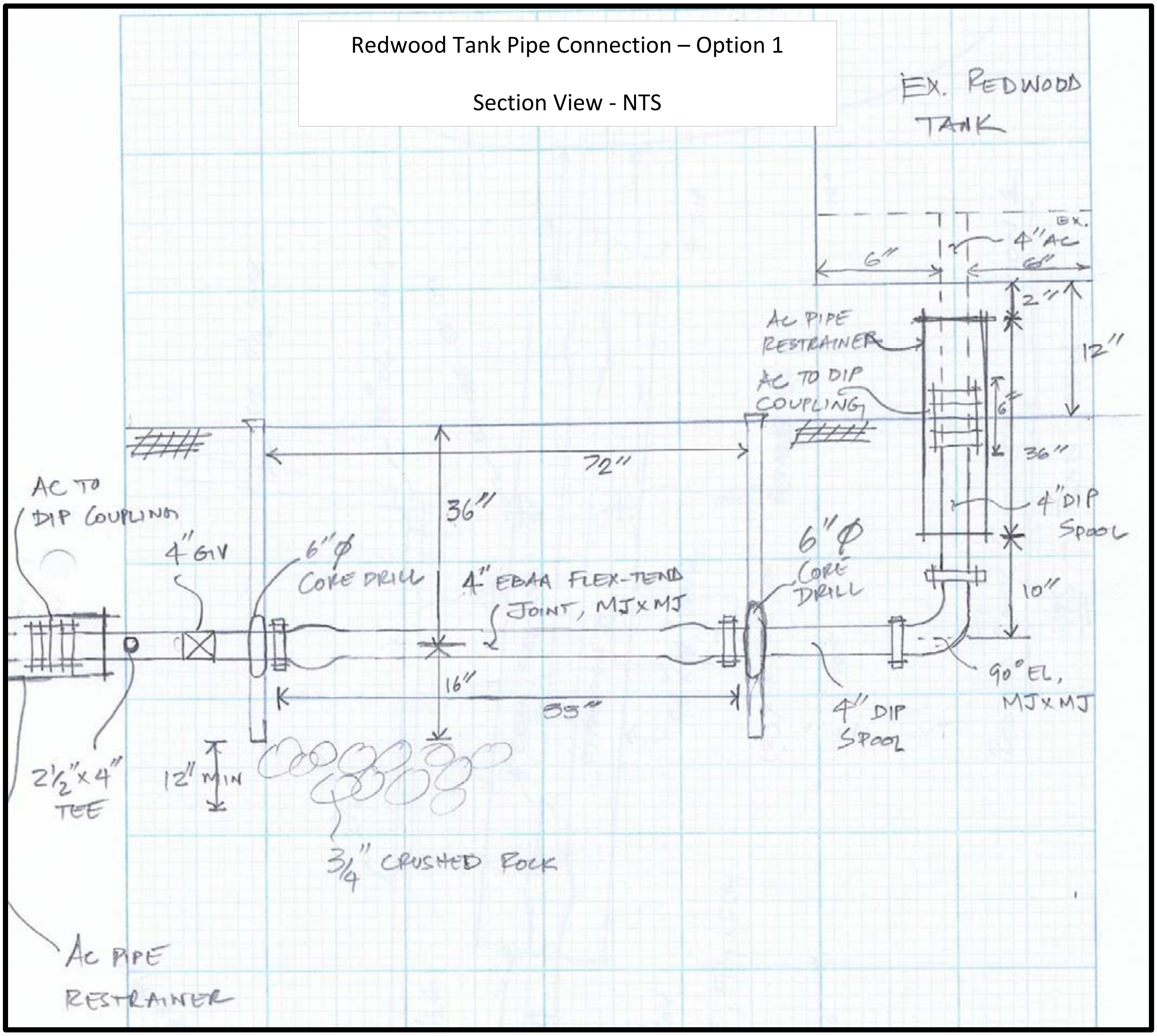
Option 1 incorporates an EBAA Iron force-balanced Flex Tend coupling that has an ability to deflect up to 20 degrees in all directions and can move laterally or horizontally for up to 8-inches. Sufficient room for the force-balanced Flex Tend coupling movement shall be provided. Generally, it is placed above ground or in a concrete vault. As shown in **Figure 14**, the EBAA Iron force-balanced Flex Tend coupling is located in a 48" x 72" concrete vault. Other existing pipelines, valves and connection will be relocated and replaced. With this option, the existing electrical box and conduits for the raw water tank level controls will also be relocated.

**Figure 14: Raw Water Tank – Pipe Connection**

Redwood Tank Pipe Connection – Option 1

Plan View - NTS



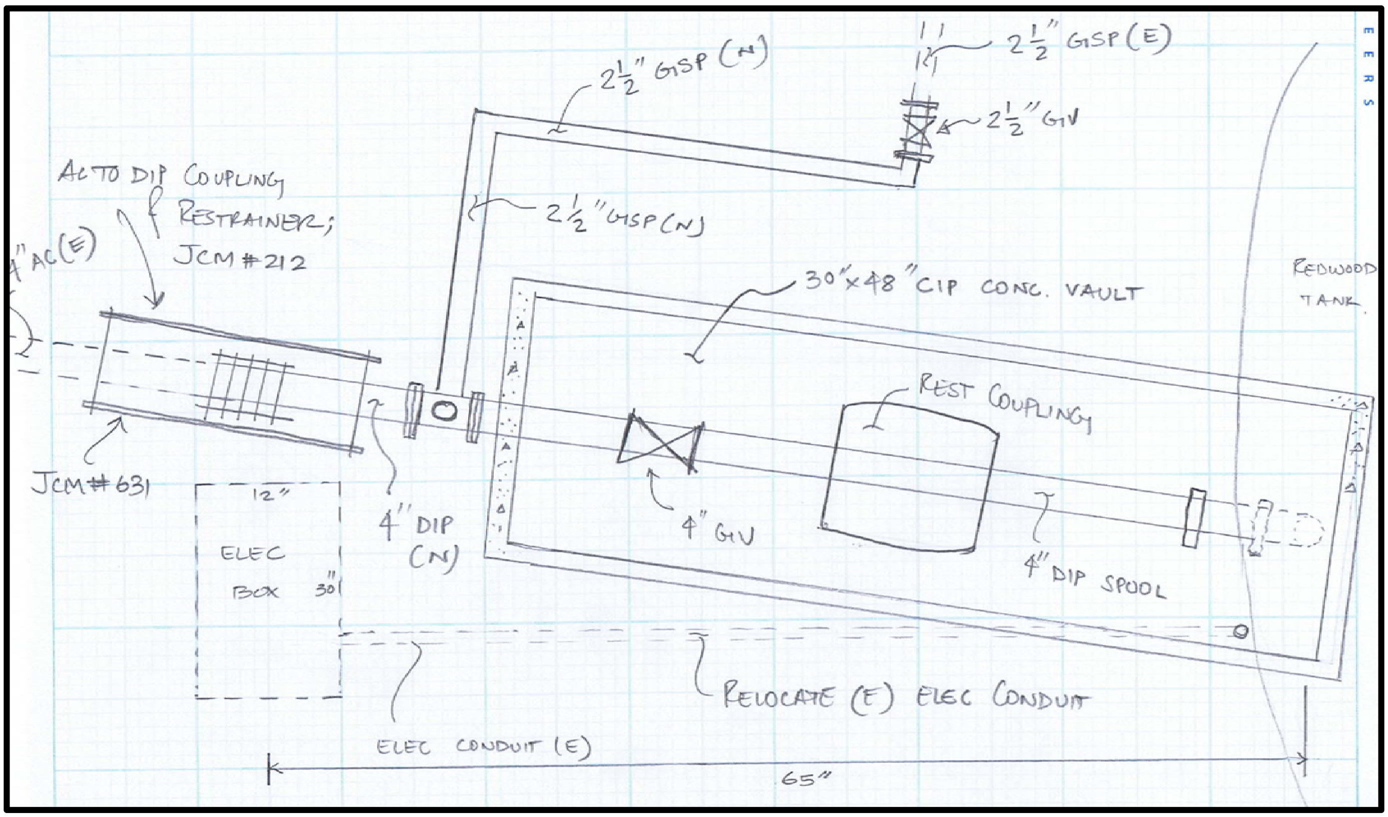

Redwood Tank Pipe Connection – Option 1
Section View - NTS
EX. REDWOOD TANK
EX. 4" AC
6"
6"
2"
12"
AC PIPE RESTRAINER
AC TO DIP COUPLING
6"
36"
4" DIP SPOOL
10"
72"
36"
AC TO DIP COUPLING
4" GV
6" Ø CORE DRILL
4" EBAA FLEX-TEND JOINT, MJ x MJ
6" Ø CORE DRILL
90° EL, MJ x MJ
4" DIP SPOOL
16"
33"
2½" x 4" TEE
12" MIN
3/4" CRUSHED ROCK
AC PIPE RESTRAINER

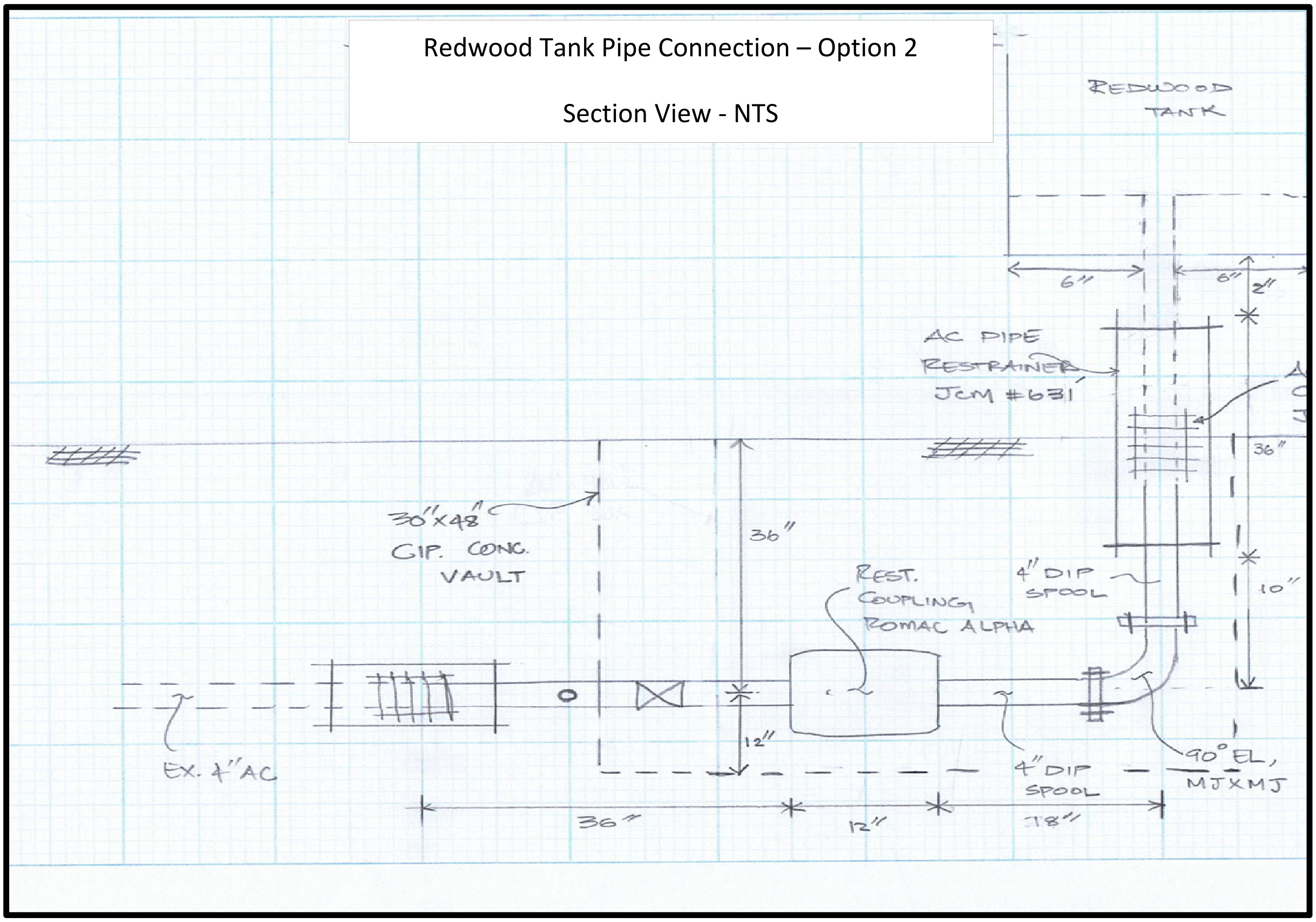
**Option 2:**

Option 2 uses a Romac Alpha coupling that has an ability to deflect up to 8 degrees in all direction but the lateral and horizontal movement is limited to only 8 degrees of deflection. Sufficient room for the movement in Alpha coupling shall be provided. Generally, it is placed in a concrete vault as depicted in the figure. The existing pipelines, valves and connection will also be relocated and replaced. The existing electrical box and conduits for the tank level controls may not have to be relocated.

Redwood Tank Pipe Connection – Option 2

Plan View - NTS






Redwood Tank Pipe Connection – Option 2

Section View - NTS

### 2.2.2 Existing Treated Water Tank

The Treated Water Tank is welded steel (painted and coated), seated on a ring foundation resting on compacted sand without anchorage. A visual inspection of the water tank and appurtenant connections indicates that the likely point of failure during a seismic event is at the tank to pipe connection interface. This interface is a semi-rigid unrestrained connection that requires improved restrained flexibility to enhance seismic reliability of the facility.

#### *2.2.2.1 Flexible Expansion Joint:*

The existing 4-inch DIP inlet/outlet connection is connected to a welded steel flange located on the North side of the tank. The existing pipe connection has a 4-inch gate valve and a flexible coupling that connects with the existing 4-inch ACP underground. In order to provide a restrained flexible coupling that can enhance reliability to withstand a seismic event, WWE identified the following alternatives as described below.

#### *2.2.2.2 Inlet/Outlet Pipeline Connection:*

WWE evaluated two possible options to secure the existing 4-inch inlet/outlet DIP and GSP using flexible couplings. The two options generally rely on a EBAA Iron force-balanced Flex Tend or a Romac Alpha couplings. Each of these couplings will connect to the 4-inch DIP and an additional coupling is required for transitioning to existing ACP. This connection will be restrained and new 4-inch DIP will be used. **Figure 15** shows both of the inlet/outlet pipe connection options:

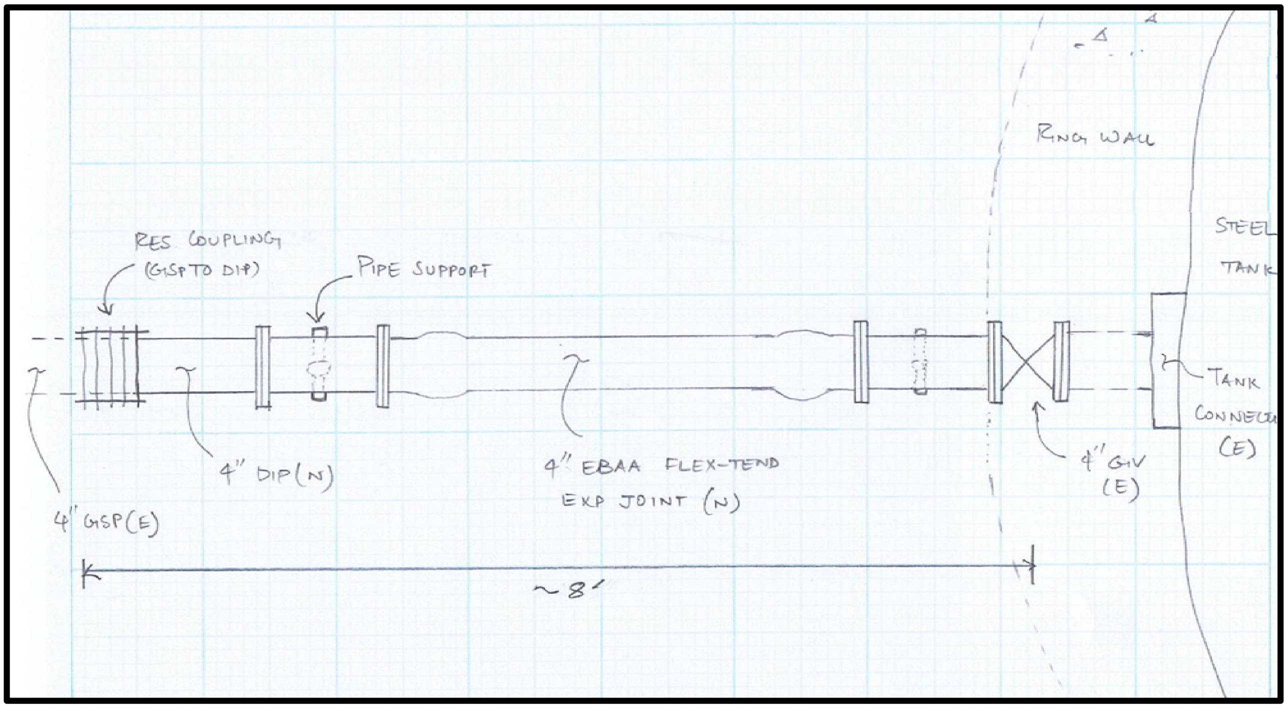
**Option 1:**

Option 1 uses a EBAA Iron force-balanced Flex Tend coupling that can deflect up to 20 degrees in all direction and can move laterally or horizontally for up to 8-inches. Sufficient room for the force-balanced Flex Tend coupling movement shall be provided. Generally, it is placed above ground or in a concrete vault. As shown in the figure, the EBAA Iron force-balanced Flex Tend is above ground with a minimum of 16-inches of clearance between the Flex Tend and existing ground. The new 4-inch DIP will be connected to the existing valve and to the Flex Tend coupling. The new 4-inch DIP will transition to existing 4-inch ACP using a flexible coupling with restraint rods.

**Figure 15: Treated Water Tank – Pipe Connection**

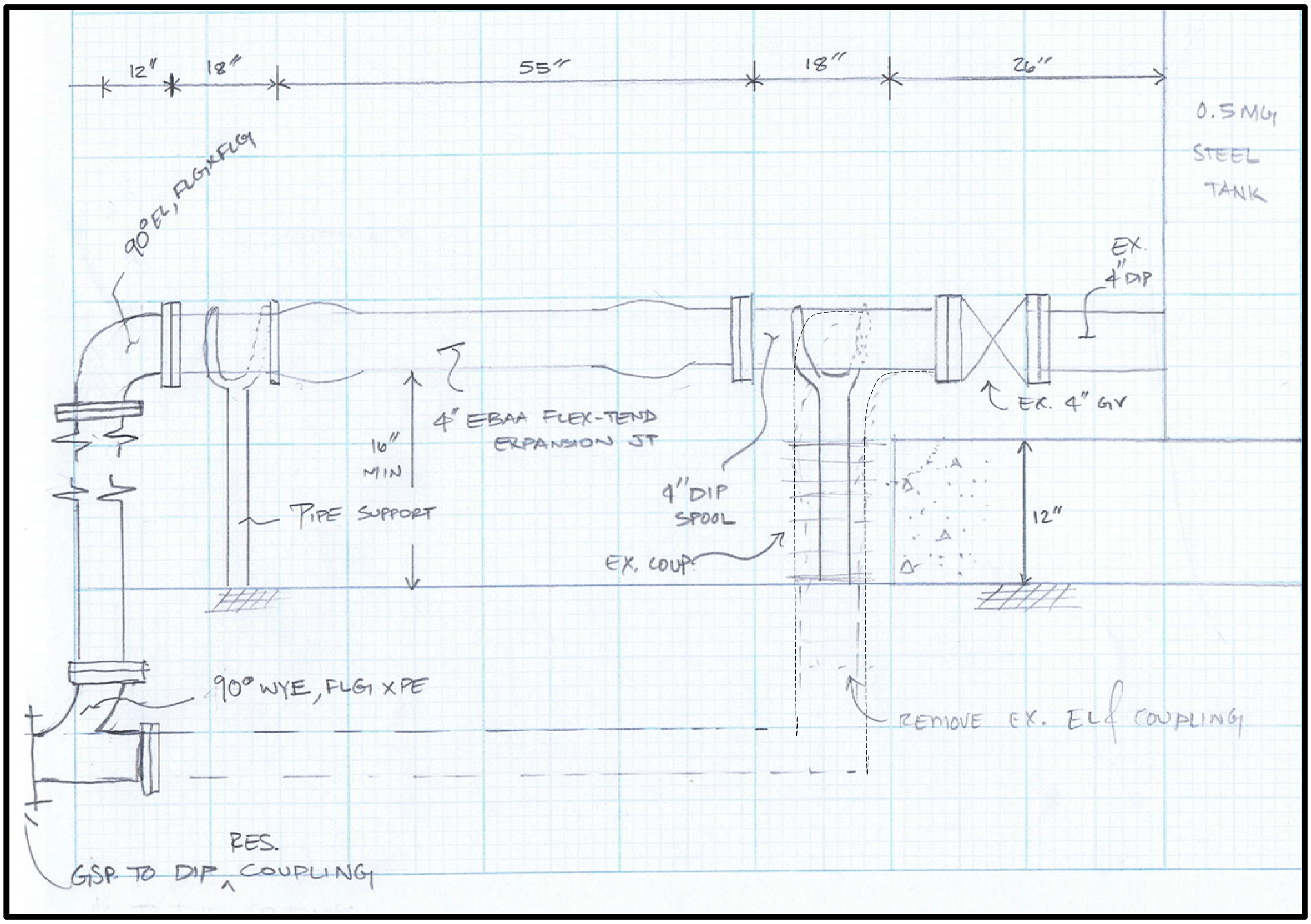
Steel Tank Pipe Connection – Option 1

Plan View - NTS



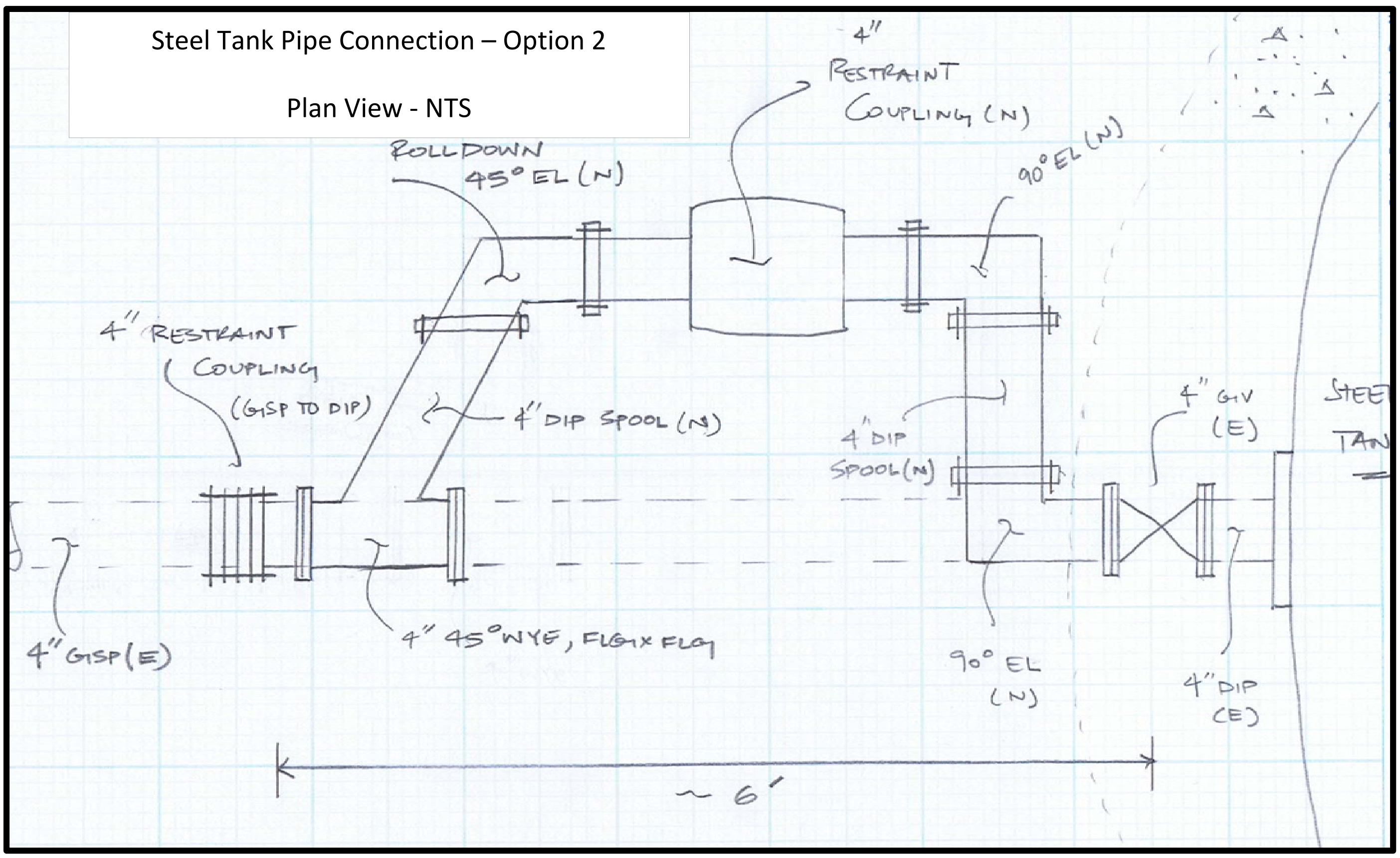
Steel Tank Pipe Connection – Option 1

Section View - NTS



**Option 2:**

Option 2 uses a Romac Alpha coupling that has an ability to deflect up to 8 degrees in all directions but lateral and horizontal movement is limited to only 8 degrees deflection. The new piping will have two 90-degree elbows and a 45-degree elbow to provide additional flexibility. The alpha coupling is placed approximately 16-inches above ground to provide sufficient room for deflection. Generally, it is placed in a concrete vault but it can be aboveground.

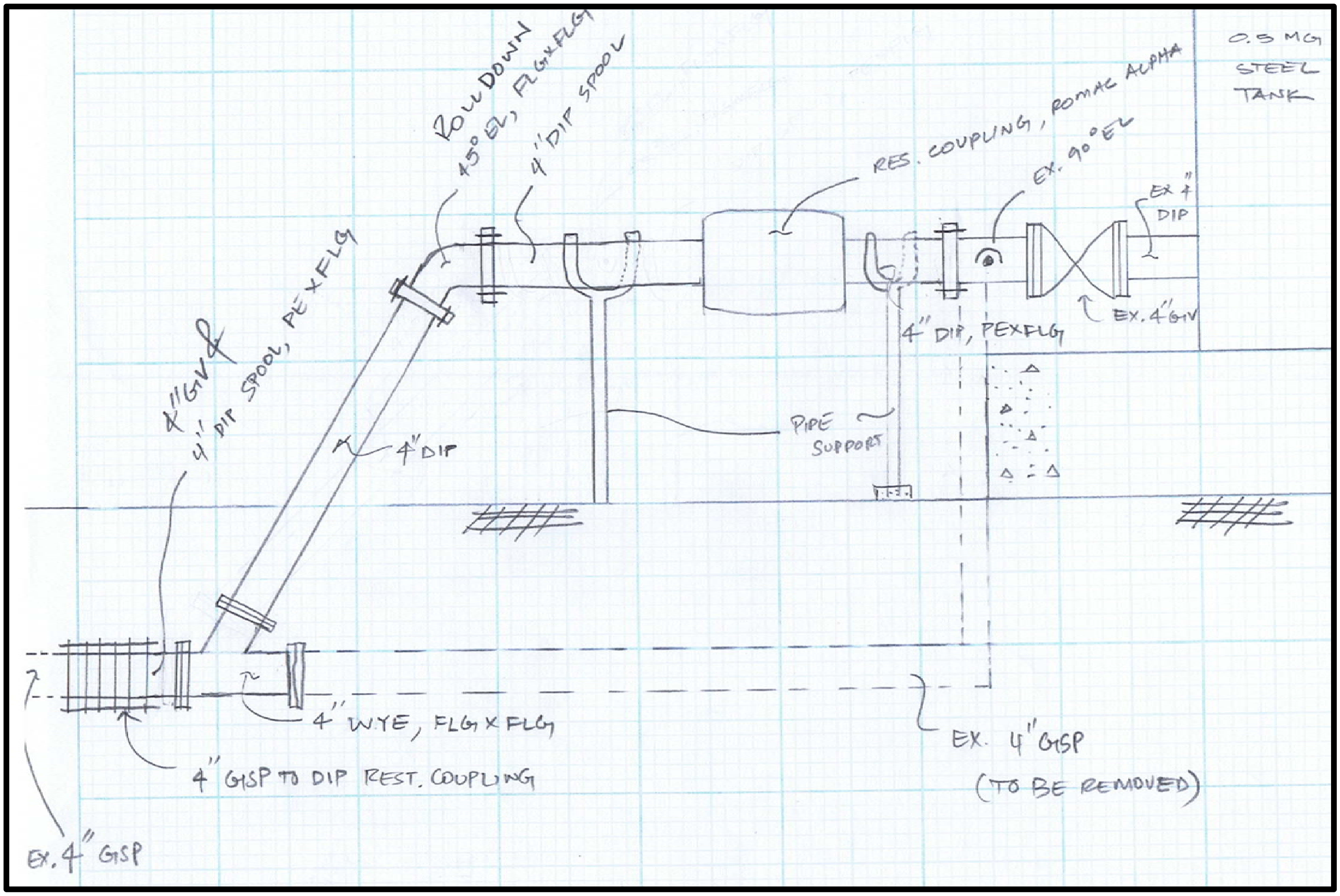



Steel Tank Pipe Connection – Option 2

Plan View - NTS

Steel Tank Pipe Connection – Option 2

Section View - NTS




### *2.2.2.3 Aboveground Cover:*

An aboveground cover with hollow structural steel (HSS) components is placed over the seismically-retrofitted pipe connection to protect it from falling object hazards (i.e., tree limbs, etc.).

### 2.2.3 New Raw Water Tank

Based on the seismic analysis of the existing Redwood Tank presented in Appendix B, WWE has considered replacing the existing raw water tank. The tank sits on unanchored concrete beams and based on the calculated seismic base shear, does not have sufficient resistance to sliding during a seismic event. It also has a high potential for overturning during a seismic event. In order to secure the existing raw water tank and its inlet/outlet pipe to tank connection, WWE reviewed several options for both retrofitting the existing tank and building a new tank.

In addition, WWE evaluated one possibility of replacing the existing redwood tank with a new combined raw water tank and solids contact clarifier which provides storage and pre-treatment for the existing WTP.

#### *2.2.3.1 Retrofit Existing Redwood Tank:*

The existing Redwood tank sits on unanchored concrete beams. Based on the calculated seismic base shear, the tank does not have sufficient resistance to sliding during a seismic event. It also has a high potential for overturning during a seismic event. In order to anchor the tank for overturning and sliding resistance a new ring foundation would be required. Installing a ring foundation would require moving the tank or shoring the tank in place while the existing grade beams were modified to allow the placement of a ring foundation. Attaching the anchorage system to the tank walls would require unique detailing to individually anchor each vertical stave to prevent the staves from sliding vertically when the tank was subjected to overturning forces.

If the tank was to be retrofitted, the capacity of the staves and cables should be verified, and strengthened as required, to support hydrodynamic forces.

#### *2.2.3.2 New Raw Water Steel Tank:*

A new 70,000-gallon AWWA D103-09 Factory-Coated Bolted Carbon Steel Tank for the raw water storage was also evaluated as an option for the raw water tank. It will be located in place of the existing redwood tank and the existing tank will be removed. This tank will reside on a concrete ring-wall footing that is placed over compacted sand.

This 70,000 gallons steel tank will be approximately 15’ in height by 30’ in diameter. Features of the new raw water steel tank will include an access manway, an above grade side inlet/outlet pipe connection, access ladder, telemetry, and vent.

#### *2.2.3.3 Solids Contact Clarifier:*

Another alternative for raw water storage is to have a solids contact clarifier, which combines flash mixing, flocculation, clarification and storage in a single unit process. The 80,000-gallons of solids contact clarifier will provide storage and primary treatment of the raw water.  A canopy style metal cover may be required to protect the clarifier from falling trees and vegetation. The clarifier was described in detail previously in Section 2.1.

## 2.3 Water Distribution System Upgrades

The majority of the existing La Honda water distribution system was constructed in the 1920s' using AC and GS pipe materials ranging from 3/4- to 4-inches in size. In past, regular pipe breakage and leakage occurred throughout the system. The repairs were made using temporary fittings and clamps to keep the system in operation with a minimum downtime. WWE identified deficiencies in the existing water system, quantified necessary capital improvements, and analyzed various alternatives in the next section.

### 2.3.1 New Water Distribution Pipeline Design Criteria

All new and rehabilitated pipelines shall be in accordance with minimum state requirements as located in California Code of Regulations (CCR), Title 22, Chapter 16, and Article 4. In order to protect and maintain the integrity of the pipe material, it is industry standard to have a minimum of 36-inch cover for buried water lines. The new and rehabilitated pipeline and appurtenances must meet the following requirements listed in Table 7:

**Table 7: CCR Standards for New & Rehabilitated Water line[1]**

| Pipe & Appurtenances | Minimum Size | Material | Others |
|---|---|---|---|
| Pipeline | 4" | PVC, DIP, HDPE | ➢ Install below Frost line<br>➢ Protect against crushing under loads |
| Air Release Valve | 2" | N/A | ➢ Vent shall be above grade<br>➢ Located at every high point |
| Isolation Valve | 4" | N/A | ➢ Required at 1,320 LF or less<br>➢ Required at each Tee, Cross, Fire Hydrant |
| Minimum Pressure | 20 psi | N/A | ➢ Minimum pressure at the user service line |

1. CCR, Title 22, Chapter 16, Article 4 & 8

### 2.3.2. Pipe Size & System Pressure

A minimum of 2 fps and maximum of 10 fps pipe velocity is assumed for new pipeline, with an average pipe velocity of 4.5 fps. As per Table 2, the average water demand per household is 5 gpm, maximum daily demand is 7.5 gpm and peak hourly demand is 15 gpm. WWE calculated flows for various pipe sizes and estimated a maximum number of households that it can serve. The required water demand is depicted below in Table 8.

**Table 8: Pipe Size vs. Deliverable Flows**

| Pipe Size | Assumed Pipe Slope | Pipe Velocities | Deliverable Flows | Max # of Households Served | | |
|---|---|---|---|---|---|---|
| *In* | % | *fps* | *gpm* | Ave Water Demand | Max Water Demand | Peak Water Demand |
| 1” | 5 | 2.5 | 5 | 1 | 0 | 0 |
| 1 ½” | 5 | 3.3 | 17 | 3 | 2 | 1 |
| 2” | 5 | 4.0 | 36 | 7 | 4 | 2 |
| 2 ½” | 5 | 4.8 | 70 | 14 | 9 | 4 |
| 4” | 5 | 6.5 | 256 | 51 | 34 | 15 |

The existing smaller diameter pipes (i.e. 1” and 1 ½”) are undersized for serving multiple residences. To meet the maximum anticipated water demand, a minimum of 2” diameter pipe is required to serve up to 4 households and 4” pipe is required to serve up to 34 households. As per Table 7, the minimum diameter of a new water pipe is 4-inch; although, a waiver to Title 22 may be submitted to allow the use of a smaller pipe size if larger pipe results in insufficient pressure and/or velocity. The layout and operation of the new distribution system piping may benefit from some segments of smaller diameter pipe at the furthest reaches of system to maintain velocity and limit water age. For the purpose of preliminary design, WWE has assumed a minimum 4” diameter for all new piping. A 4” diameter piping will substantially improve water delivery within La Honda Water System. WWE recommends further analysis of system layout during replacement design to determine the operational feasibility and cost effectiveness of 2” diameter variance from DDW.

### 2.3.3 Deficiencies in Existing Water Distribution System

For the past three years, BEI has kept a good record on the type and location of the breakage and leakages occurring with the distribution system. The findings of the breakage are summarized in Table 3, indicating the majority of pipe failures have occurred in the northern part of the distribution system.

The northern area resides on a higher elevation than the rest of the system with relatively low water pressure and aged infrastructure. Additionally, the small diameter pipelines and relatively non-existent “looping” of the system resulted in significant pressure supply issues at the far reaches or northern end of the system, in particular along Memory Lane.

#### *2.3.2.1 Northern Area of Water Distribution System:*

The existing water line in the northern part of the distribution system includes 1, 1½, and 2-inch pipe sizes and is located on private properties and easement roads. The existing water line in the northern area travels from Memory Lane and serves adjacent private properties; then travels to the trailer park area via crossing private property; then crosses La Honda Creek and Hwy 84 towards Pope Road and serves properties adjacent to it; and then connects to the existing 4-inch ACP in the Sam McDonald Park area.

Based on the GIS mapping, approximately 5,500 LF of existing water line on Memory Lane, Pope Road and Trailer Park areas is in deteriorating shape, which should be replaced with the new 4-inch pipes. The new 4-inch pipeline should be located within public ROW and utility easements, and avoid traveling through the private properties if possible.

#### *2.3.2.2 “Looping” Water Distribution System:*

The northern and southern areas of La Honda Water System are not looped and possess no redundancy. Currently, the water is being delivered from the southern area of the La Honda Water System via a single 4-inch AC pipe that runs across a significant length of the Sam McDonald Park. A looped system will provide greater capacity to maintain service in remote locations during the unexpected failure of pipeline or equipment. Additionally, circulating water within the distribution system will reduce its water age and improve the water quality.

Based on the GIS mapping, a new 4-inch diameter looping water main would be approximately 6,500 LF long and run along Pescadero Road between the La Honda Road near the Trailer Park and the Alpine Creek Bridge.

#### *2.3.2.3 Entire Water Distribution System Replacement:*

The majority of the existing La Honda water distribution system was constructed in the 1920s’ using AC and GS pipe materials ranging from 3/4- to 4-inches in size. Intermittently, some of the northern area pipeline was replaced at later times with HDPE pipe material. The majority of the water line is in a deteriorating condition and has experienced numerous breakages and leaks throughout the system. County staff and BEI have been repairing the breakages using temporary fittings, bends and clamps. The entire water distribution system should be replaced with new pipes and appurtenances that will meet current industry standards.

The existing Water Distribution System pipeline characteristics are summarized below:

- The northern area of La Honda water distribution system includes 1, 1 ½, and 2 – inch sized pipes with a total length of approximately 5,500 LF (measured from GIS mapping);
- The southern area consists of 1, 1 ½, 2, 3 and 4 – inch pipe sizes with a total length of approximately 11,500 LF (measured from GIS mapping);
- The water line connecting the WTP to the Trailer Park area is 4-inch in size with a total length of approximately 6,000 LF (measured from GIS mapping).

# 3 Comparison of Alternatives

WWE has identified various alternative improvements for the WTP, water storage tanks, and water distribution system. WWE has evaluated and compared these improvements for each component of the La Honda Water System by comparing them based on ease of constructability, operability and maintenance, and capital costs.

## 3.1 Constructability

The constructability category is a basis for comparison that includes such factors as industry standard design practices, available area for construction, long-term reliability, accessibility, regulatory compliance, permitting, geology, hydrogeology and other construction related parameters.

### 3.1.1 Water Source, Treatment & Quality

Comparing alternative solutions for complying with DBPs, corrosion in flocculation chamber, providing chemical containment, investigating additional sources of raw water and water rights issues are discussed in this section. Each of these components is evaluated for its constructability and their advantages and disadvantages are listed below.

#### *3.1.1.1 DBP Alternatives for WTP:*

Three options for DBP removal were discussed previously in this report. The constructability of these options vary significantly and all have their respective advantages and disadvantages as listed below:

**Air stripping:**

A custom-made spray system can be constructed in various ways. One such custom-built spray system consists of a submersible pump that supplies water from the bottom of the tank to a floating sprayer at the tank water level. Another system consists of an exterior mounted recirculation pump with fixed spray nozzles. Both of these custom-built systems utilize headspace exhaust fans, as ventilation of the tank is important in reducing corrosion potential and prohibiting the reaching of equilibrium between TTHMs in air and water. This point of equilibrium would thereby reduce or stop the air stripping process altogether. Based on the recent spray pilot test results (discussed previously in this report), a minimum of five feet of aeration space (freeboard between spray system and water surface) should be maintained so as to promote TTHM removal.

Commercially produced (or pre-manufactured) air stripping systems for the purpose of TTHM removal are available as well. Medora/GridBee and PAX are two companies that make NSF-61 certified air stripping systems. These systems include recirculating spray system and headspace ventilation equipment. More information on all systems can be found in Appendix A.

Construction Challenges:

- Custom-built air stripping system is simpler to build using spray nozzles, plastic piping, a pump located at tank elevation, and blower mounted on the roof;
- Pre-manufactured air stripping systems may require additional retrofit of the tank piping, and include spray nozzles and bars, piping, a pump located at tank elevation, and blower mounted on the roof;
- Adequate area for construction and accessibility is needed;
- 5 feet of freeboard is needed.

**TOC Removal:**

Due to the WTP being a packaged system, it is anticipated that the County might not be able to modify the current set-up to incorporate a GAC adsorption system without significant construction activity and cost. Based on WWE site review it is unlikely that the existing packaged WTP system could be retrofitted with a GAC adsorption system. In addition, it would likely be necessary to expand the size of the compact building in which the WTP currently resides to accommodate this process. Therefore, the constructability of a GAC adsorption system is not a favorable option for the La Honda Water System.

Construction Challenges:

- The GAC adsorption system will require retrofitting existing WTP piping within the WTP building, making room for the adsorption unit, constructing a backwash system, and removing existing media.

**Chloramine as Disinfectant:**

The use of chloramines for secondary residual can be effective, however, with long water age, issues of nitrification and destruction of chloramine residual can cause issues with compliance. In addition, the use of chloramines at plants that are run intermittently has also been shown to be problematic. Both of these conditions are typical for the La Honda Water System. Additionally, the County has made it very clear that the La Honda community has strongly voiced their opinion against the use of chloramine as a disinfectant. In light of all of this information, a change in residual disinfectant is not recommended at this time. Thus WWE did not analyze this option further.

#### 3.1.1.2 Chemical Containment:

Currently, the chemical drums have no secondary spill containment and are not secured or anchored to the WTP wall or ground floor. WWE recommended chemical containment for each of the three chemicals similar to Brady SPC Absorbents Spill containment pallets made of HDPE material. The containment size is 17"H x 26"W x 52"L providing up to 68-gallons of capacity, which is approximately double the size of the chemical drums. Some of the construction challenges are listed below:

Construction Challenges:

- Existing chemical drums, peristaltic pumps, tubing and some of the electrical wiring will need to be removed and relocated temporarily;
- Seismic anchors will be used to tie the new chemical drums against the wall;
- Existing peristaltic pumps and new tubing will be reconnected to the new chemical drums and power outlets and would be placed in a stable location.
- WWE observed extensive corrosion to the electrical gutter, receptacles, and switches behind the chemical containers. The electrical modification will include removal of electrical gutter, receptacles, switches and replacing them with GFCI receptacles and NEMA 4X pull box. The construction challenges are similar to the above listed challenges.

#### 3.1.1.3 Corrosion Resistant Coating:

As shown in Figure 6, the WTP flocculation chamber coating is cracking and is discolored likely due to rust from the tank corroding. Some of the construction challenges with the recoating of the flocculation tank are listed below:

Construction Challenges:

- It will require to redirect the flow to a temporary flocculation tank of similar size;
- Removal of existing paint and coating will be conducted using sand blasting or similar process;
- If existing flocculation chamber tank is damaged during the sand blasting process, the tank will need to be repaired or replaced.

#### 3.1.1.4 Sources of Raw Water:

WWE evaluated four new groundwater well sites and a new La Honda Creek intake as additional sources of raw water for the La Honda Water System. These alternatives are further evaluated under the construction category.

**New Groundwater Site:**

AZI researched and analyzed four potential groundwater sites for additional raw water sources for the northern area residences in La Honda Water System. As shown in Figure 11 and Figure 12, these four sites are located in the northern area of CSA 7. Construction challenges with these four sites vary significantly and they are analyzed below.

I. APN 083-092-180 (11 Entrada Way, La Honda, CA – East of County Corp Yard):

A vacant parcel east of County Corp Yard is the preferred site for a potential production well based on the geological analysis and site conditions. The site is located on a private property, which will require property acquisition and easement. Following are several construction challenges related to developing this site:

Construction Challenges:

- Potential production well site is located on a private property, thus PUE and property acquisition is required;
- Due to close vicinity of La Honda Creek, there is a potential of concurrent stream flow gaging during groundwater pumping from the well site. An aquifer test would be needed with a concurrent stream flow gaging to evaluate the effect of groundwater pumping on streamflow trends;
- Well site is located outside of the La Honda Water System area and within the Cuesta La Honda Guild water system, which will require additional water agreements between the water district and the County;
- 2.5 mile of 4-inch pipeline is required with the majority of it located within County and State ROW, which will require permitting. Two crossings (one highway and one creek) are anticipated.

II. APN 083-170-090 to 092 (17 Memory Lane, La Honda, CA – Memory Lane):

This preferred well site is located in a residential area surrounded by private properties and in the northern area of the existing La Honda Water System. The site elevation is relatively higher from the La Honda Creek, which has the potential for a deeper production well depth compared to the site adjacent to the County Corp Yard. The following are several construction challenges related to developing this site:

Construction Challenges:

- Potential production well site is located on a private property, thus PUE and property acquisition is required;
- Well site is relatively higher in elevation than La Honda Creek, thus a deeper production well may be required;
- Relatively narrow access road and steeper climb for the construction equipment;
- Tree lines are lower and several branches may be in the way;
- Overhead power lines are nearby but away from the well site;
- 2.0 mile of 4-inch pipeline is required with the majority of it located within private roads and County and State ROW, which will require easement acquisition and permitting. Two crossings (one highway and one creek) are anticipated.

III. APN 083-280-020 (500 Log Cabin Ranch Road, La Honda, CA – Glenwood Boys Camp):

The Glenwood Boys camp site is geologically suitable for developing a raw water source well but is located well above Alpine Creek. It is likely to require a significantly deeper well, which will have significantly higher construction costs than the other development sites. Some of the construction challenges with developing this site are listed below:

Construction Challenges:

- Potential production well site is located on a private property, thus easement and property acquisition is required;
- Well site is located at significantly higher elevation than the Alpine Creek;
- Log Cabin Ranch road is at steep elevation, which will be challenging for the well driller to mobilize the equipment;
- Utility coordination may be required;
- 1.0 mile of 4-inch pipeline is required with the majority of it located within private properties and County ROW, which will require easement acquisition and permitting. One creek crossing is anticipated.

IV. APN 083-092-200 (59 Entrada Way, La Honda, CA – County Corp Yard):

The least favorable alternative well development site is located on the County Corp Yard near the La Honda Creek. The advantages of this site are additional easements may not be required because of the County property and the depth of the raw water source well will be relatively shallow as it is located few feet higher than the La Honda Creek elevation. Some of the construction challenges with developing this site are listed below:

Construction Challenges:

- County owned site has an underground storage tank (UST) for an onsite fueling station, which could be a potential source of hydrocarbon groundwater contamination;
- Due to close proximity of La Honda Creek, there is a potential of concurrent stream flow gaging during groundwater pumping from the well site. An aquifer test would be needed with a concurrent stream flow gaging to evaluate the effect of groundwater pumping on streamflow trends;
- Utility coordination may be required;
- Well site is located outside of the La Honda Water System area and within Cuesta La Honda Guild water system, which will require additional water agreements between the water district and the County;
- 2.5 mile of 4-inch pipeline is required with the majority of it located within County and State ROW, which will require permitting. Two crossings (one highway and one creek) are anticipated.

**New Raw Water Intake on La Honda Creek:**

A new raw water intake will be located near La Honda Road Bridge on La Honda Creek. It will consist of a 6" stainless steel well screen embedded in a granular bedding material that is wrapped in a geotextile fabric material. The new intake on La Honda Creek will also require an approximately 2.5 mile long 4-inch raw water pipeline up to the existing WTP. Some of the construction challenges with a new raw water intake are listed below:

Construction Challenges:

- ❖ Environmental and construction permits are required from Federal, State and local agencies (U.S Army Corp of Engineers, CDFW, CDPH, County DPW);
- ❖ Additional ROW and easement is required from Federal & State agencies;
- ❖ A temporary creek diversion is required during the construction of an intake;
- ❖ 2.5 mile of 4-inch pipeline is required with the majority of it located within County and State ROW, which will require permitting. Two crossings (one highway and one creek) are anticipated.

#### *3.1.1.5 Additional WTP Modifications:*

In order to resolve the issue of DBP compliance and reduce turbidity from the existing raw water source, WWE has evaluated several potential WTP modifications and its construction challenges as described below.

**Replacing Sand Media & Recoating Sand Filters:**

The existing sand media is approximately 12 years old and the tank has been re-coated in 2009. Below is a construction challenge with replacing sand media and recoating the sand filters:

Construction Challenge:

- ❖ Flows to the filters should be temporarily bypassed during the media replacement.

**New Solids Contact Clarifier:**

A solids contact clarifier will provide storage of raw water and additionally it will remove NOM from the raw water content in an effective manner. Typically, it will reduce DBPs in the range of 10% to 20% and it will increase the longevity of a filter system at the WTP. The solids contact clarifier will replace-in-place the existing redwood tank. Below are the construction challenges with a new solids contact clarifier:

Construction Challenges:

- ❖ Existing Redwood tank will be removed;
- ❖ Temporary raw water storage may be required during the construction period;
- ❖ Additional chemical feed system, filtered raw water pump and inlet/outlet pipe will be required;
- ❖ Existing 4-inch ACP removal and replacement is required;

- Existing Rapid Mixer and Flocculation chamber will be removed and additional WTP piping will be modified and replaced;
- A canopy style cover is required to protect clarifier from surrounding trees and vegetation.

**New Pressure Filter Vessel:**

The pressure filter vessel is a simple flow through filter system, with reverse flow for backwash and a surface wash assembly to supplement backwash. The new filters will replace-in-place the existing sand filters that are in fair to poor condition. Some of the construction challenges with the new pressure filter vessel are listed below:

Construction Challenges:

- Existing sand filters will be removed;
- A redundant pressure filter vessel is required to produce peak hour water demand;
- Additional WTP piping will be modified and replaced to its greater extent than solids contact clarifier;
- Additional space may be required for pressure vessel installation.

### 3.1.2 Water Storage Tanks

Several options of retrofitting the existing raw water tank, pipe connections at the raw and treated water tanks, and a new steel tank were evaluated. The construction challenges with each of the options are listed in this section.

#### *3.1.2.1 Raw Water Tank:*

In order to secure the existing raw water tank and its inlet/outlet pipe to tank connection, WWE reviewed several options for retrofitting the existing tank and its connection. Some of the construction challenges that will be encountered are listed below.

**Retrofit Existing Raw Water Tank:**

Following are the construction challenges with code compliant retrofit of the raw water tank:

Construction Challenges:

- The existing raw water tank will be temporarily moved or shored during the construction of a new concrete ring foundation;
- A new concrete ring foundation will have to be constructed;
- Condition of the staves and cables would need to be investigated further and any existing corrosion and rot should be removed;
- The area under the tank and concrete beams is minimal and it will require structural support during construction;
- Existing roof will need to be anchored to the staves and cables of the tank wall.

**New Raw Water Steel Tank:**

Following are the construction challenges with a code compliant new raw water tank are as follows:

Construction Challenges:

- The existing raw water tank will be temporarily moved or new tank location will be chosen when constructing a new concrete ring foundation;
- Construction of a new flexible restrained expansion joint for the pipe to tank connection may require removing and relocating existing pipelines and electrical conduits;
- Extreme care shall be taken for any fire hazards during the welding and construction of the new steel tank.

**Inlet/Outlet Pipe to Tank Connection:**

Retrofitting the existing inlet/outlet piping of the raw water tank connection includes two options. Option 1 includes installing an EBAA Iron flexible restrained coupling expansion joint in a 48" x 72" concrete vault. Option 2 includes installing a Romac flexible restrained coupling in a 36" x 48" concrete vault. The following are the construction challenges with both options.

Construction Challenges:

- Inlet/outlet pipe connection is a push-on type fitting entering at the tank bottom; and the tank bottom is only 12-inches from the ground;
- The area under tank and concrete beams is minimal and will require structural support during construction;
- Existing inlet/outlet pipeline is AC and the seismic retrofit to the pipe will not protect the tank due to its push-on type fitting;
- Existing electrical and instrumentation conduits for the level control and an electrical box will have to be relocated;
- Existing water line and two gate valves will have to relocated;
- Approximately 5 feet deep excavation is needed to place an underground concrete vault to install a flexible expansion joint;
- Options 1 and 2 will not secure the existing redwood tank from damage during a seismic event because the existing redwood tank sits on an unanchored concrete beams and can tip over;

Installation of the flexible connection on the existing raw water tank will only marginally increase the seismic reliability of the connection because the raw water tank is not secured.

#### *3.1.2.2. Treated Water Tank:*

The 4-inch DI inlet/outlet pipe enters on the Northeast side of the steel tank, which is approximately 16-inches above ground. This existing configuration allows for placement of an above ground piping structure that will provide a more reliable connection during a seismic event. In order to secure the inlet/outlet pipe to tank connection, WWE reviewed two options. Option 1 includes installing an aboveground EBAA Iron flexible restrained coupling along the alignment of existing pipeline. Option 2 includes installing an aboveground Romac flexible restrained coupling and two 90-degree elbows placed horizontally to provide sufficient deflection in enhancing the reliability of the connection. The following are the construction challenges with both options.

Construction Challenges:

- Existing inlet/outlet pipeline is DI connected to a welded steel plate on the tank and it enters on the Northeast side of the tank, so the tank will be off-line during the tie-in;
- Connection to the existing pipeline will require abandonment in place of some segments and disinfection of others;
- All new piping will be aboveground and covered, thus additional protection is required;

- New pipeline will connect with existing pipeline at approximately 3.5 feet deep, so excavation in relatively close proximity of the tank is required.

### 3.1.3 Water Distribution System Upgrades

The majority of the existing La Honda water distribution was constructed in the 1920s' using AC and GS pipe materials ranging from 3/4- to 4-inches in size. The northern area of La Honda Water System has relatively low water pressure and its infrastructure is in poor condition. Additionally, there is no "looping" of the system present, which could result in significant pressure supply issues at the far reaches of the system. In order to correct these deficiencies in the La Honda water distribution system, WWE has proposed system upgrades that have several construction challenges.

#### *3.1.3.1 Northern Area Water Distribution System:*

The majority of the breakages in the existing small diameter (1", 1 ½" and 2") water line have occurred in the northern area on Memory Lane, Pope Road and in Trailer Park. Approximately 5,500 LF of existing water line on Memory Lane, Pope Road and in Trailer Park is in deteriorating shape, which should be replaced with the new 4-inch pipes. The new 4-inch pipeline should be located within public ROW and utility easements, and avoid traveling through the private properties if possible. Below are the construction challenges related to the replacement of the existing water line.

Construction Challenges:

- ❖ Existing water lines are located on private properties, which will require private property access for tie-in and testing with the new water line;
- ❖ Existing underground and overhead utilities could be in conflict with the new water line;
- ❖ Additional environmental compliance and permitting from public agencies (Caltrans, DPW) is required;
- ❖ New water line may cross a creek and/or highway via trenchless or above grade "exposed" pipe.

#### *3.1.3.2 Looping Existing Water Distribution System:*

Currently, the water is being delivered from the southern area of the La Honda Water System via a 4-inch ACP located across Sam McDonald Park and it is not "looped". A new 4-inch diameter looping water main of approximately 6,500 LF along the Pescadero Road between the La Honda road near Trailer Park and the Alpine Creek Bridge would provide redundancy. Some of the construction challenges with the construction of a new water main for looping are as follows:

Construction Challenges:

- ❖ A new water line may require additional easements from private property owners;
- ❖ Additional environmental compliance and permitting from public agencies (Caltrans, DPW) is required;
- ❖ New water line may cross a creek and/or highway via trenchless or above grade "exposed" pipe;
- ❖ Existing underground and overhead utilities could be in conflict with the new water line.

#### *3.1.3.3 Entire Water Distribution System Replacement:*

Replacing an entire water distribution system could be a major project that may require dividing it into multiple phases. Some of the construction challenges with the construction of an entire water distribution system are as follows:

Construction Challenges:

- A new water line may require additional easements from private property owners;
- Additional environmental compliance and permitting from public agencies (Caltrans, DPW) is required;
- New water line may cross a creek and/or highway via trenchless or above grade “exposed” pipe;
- Existing underground and overhead utilities could be in conflict with the new water line;
- Construction access could be difficult in heavily wooded areas present all over CSA 7 boundaries.

## 3.2 Operation & Maintenance

The O&M category is a basis for comparison that includes such factors as accessibility, preventive and long-term maintenance, water supply downtime, and failure response time with the proposed infrastructure. The County has currently contracted the O&M of La Honda Water System with Bracewell Engineering. This section evaluates the O&M requirements with various components of the project.

### 3.2.1 Water Source, Treatment & Quality

WaterWorks compares and discusses alternative solutions for DBP compliance, floc chamber corrosion control, chemical containment, additional raw water sources and water rights. Each of these components are evaluated under the O&M category and their advantages and disadvantages are listed below.

#### *3.2.1.1 DBP Alternatives for WTP*

Three options for DBP removal were discussed earlier in this report. The O&M-related components for each of these options are briefly described below:

**Air stripping:**

Water age is of particular concern during the winter months when TTHM reaches above the required limits due to limited demand and excessive storage. The recirculating spray system must be in service during these periods. It is likely that the full 5-ft of freeboard required to operate the spray system will be necessary during winter months, even when high turbidity raw water conditions limit operation of the treatment plant. The anticipated O&M activities are as follows.

O&M requirements:

- Periodic testing and maintenance (once a month) of the pump, the sprayer(s), and the exhaust fan(s);
- Testing of the components of a recirculating spray system will ensure that all parts are functional, while the maintenance of the components will help to extend their service life;
- Whether the County decides to utilize a submersible or exterior mounted pump, both options are expected to be accessible for maintenance;
- As the roof of the steel storage tank is accessible by ladder, the sprayer(s) and exhaust fan(s) are expected to be accessible as well. The County could schedule for these periodic testing and maintenance activities to occur during the perceived low-TTHM months so as to avoid negatively affecting the TTHM levels when taking the recirculating spray system offline.

**TOC Removal:**

For a GAC adsorption system at the WTP, the anticipated O&M activities are as follows.

O&M requirements:

- Periodic replacement or regeneration of the GAC media is the primary O&M activity to be performed. GAC media replacement commonly occurs in two to three year cycles;
- The County must account for the disposal of old GAC media via landfill, incineration, or other methods. In lieu of disposing it, the GAC media could be regenerated offsite, but it may have a shorter lifespan than new GAC.
- Placement of GAC adsorption system in a way such that it is easily accessible.

#### *3.2.1.2 Chemical Containment:*

The three chemicals used at the WTP should be positioned above containers similar to the Brady SPC Absorbents Spill containment pallet made of HDPE material and securely strapped to the WTP wall. The following are the O&M requirements with this option:

O&M requirements:

- Periodic visual inspection (once a month) of the chemical tanks, pumps, tubing and containment pallets is the primary O&M activity to be performed;
- Moving the chemical tank at all would require that the wall strap be disengaged.
- In the event of chemical spill into the containment pallets, a small pump can be used to pump out the spilled material from the containment.

#### *3.2.1.3 Corrosion Resistant Coating:*

The recoating of the flocculation chamber will have the following O&M requirements as listed below:

O&M requirements:

- Periodic visual inspection (once a month) of the flocculation tank, condition of coating, and any leaks shall be performed.

#### *3.2.1.4 Sources of Raw Water:*

Two raw water source alternatives were discussed earlier in this report. They consist of developing a new groundwater well in four possible locations, and building a new La Honda Creek intake.

**New Groundwater Site:**

AZI and WWE assessed alternative source of raw water and evaluated O&M requirements that may occur with each sites and 4-inch raw water line. These challenges are summarized below:

I. APN 083-092-180 (11 Entrada Way, La Honda, CA – East of County Corp Yard):

Since this site is on a private property, an access easement may be required or County may have to purchase portion of the vacant parcel. Following are several O&M requirements related to the vacant parcel located east of County Corp Yard site:

O&M requirements:

- For an access route to the well site, an access easement and an access road may be required;
- Due to the close proximity of La Honda Creek, continuous monitoring for stream flow gaging would be conducted to evaluate existing conditions and streamflow trends;
- Regular geochemical testing of both water produced from the well and surface water will be required for analyzing any cross contamination;
- Groundwater quality monitoring must be conducted to assure that groundwater entering the well is not impacted by gasoline or other petroleum hydrocarbons from the existing fueling station located on the neighboring County Corp Yard parcel;
- The 2.5-miles of 4-inch Water line will have in-line valves and ARVs that will require routine O&M.

II. APN 083-170-090 to 092 (17 Memory Lane, La Honda, CA – Memory Lane):

The Memory Lane is a private road and has public utility easement for placement of water utilities. The well site is on a private property off Memory Lane, which presents several O&M requirements.

O&M requirements:

- For accessing the well site, an access easement and utility easement for raw water line are required on Memory Lane and from private property;
- Regular geochemical testing of water produced from the well will be required;
- Due to narrow (~10 feet wide) private road with no room for the utility vehicles to turn around, routine access for O&M activities may be challenging. County may need additional access easement from the private property owners to turnaround their vehicles. ;
- The 2.0-miles of 4-inch Water line will have in-line valves and ARVs that will require routine O&M.

III. APN 083-280-020 (500 Log Cabin Ranch Road, La Honda, CA – Glenwood Boys Camp):

The Glenwood Boys Camp site is located relatively higher than the La Honda Creek, which requires the well depth to be significantly deeper. Additionally, an unnamed seasonal creek flows through the private property, which might require additional testing and monitoring. Below is the summary of the O&M requirements related to this well site.

O&M requirements:

- For accessing the well site, an access and utility easement for the raw water line are required on the Log Cabin Ranch Road and from private properties;

- Due to the close proximity of the unnamed creek, continuous monitoring for stream flow gaging would be conducted to evaluate existing conditions and streamflow trends;
- Regular geochemical testing of both water produced from the well and surface water will be required;
- 1.0-mile of 4-inch Water line will have in-line valves and ARVs that will require routine O&M.

IV. APN 083-092-200 (1-59 Entrada Way, La Honda, CA – County Corp Yard):

The County Corp Yard site will not require any property acquisition. Below is the summary of the O&M requirements:

O&M requirements:

- Continuous monitoring for stream flow gaging would be conducted to evaluate existing conditions and streamflow trends, due to close proximity of La Honda Creek;
- Regular geochemical testing of both water produced from the well and surface water will be required for analyzing any cross contamination;
- Groundwater quality monitoring must be conducted to assure that groundwater entering the well is not impacted by gasoline or other petroleum hydrocarbons from the existing fueling station located on this parcel;
- The 2.5-miles of 4-inch water lines will have in-line valves and ARVs that will require routine O&M.

**New Raw Water Intake on La Honda Creek:**

A new raw water intake will be located near La Honda Road Bridge on La Honda Creek and it will also require an approximately 2.5 mile long 4-inch raw water pipeline up to the existing WTP. Some of the O&M requirements with a new raw water intake are listed below:

O&M requirements:

- Routine maintenance (once a month) of the well screen, suction pumps and pipeline will be required;
- The 2.5-miles of 4-inch Water line will have in-line valves and ARVs that will require routine O&M.

#### *3.2.1.5 Additional WTP Modifications:*

In order to resolve the issue of DBP compliance and reduce turbidity from the existing raw water source, WWE has evaluated several potential WTP modifications and its O&M requirements as described below.

**Replacing Sand Media & Recoating Sand Filters:**

The existing sand media is approximately 12 years old and the rapid mix tank was recoated in 2009. Below are the O&M requirements with replacing sand media and recoating the sand filters:

O&M requirements:

- Backwash system for the sand filters should be in place and operational during WTP operation;

- Periodic inspection (once a month) of the media and coating of the sand filters should be conducted.

**New Solids Contact Clarifier:**

A solids contact clarifier will provide storage of raw water and additionally it will remove NOM from the raw water content in an effective manner. Below are the O&M requirements with a new solids contact clarifier:

O&M requirements:

- Periodic visual inspection (once a month) of the chemical feed system, pump, components of the clarifier, sludge discharge and other routine maintenance are required;
- Initially, it takes time to monitor and adjust the sludge discharge rate in order to maintain the solids blanket level in the clarifier. This may require a daily inspection of the sludge formation and monitoring the controls for removing the sludge into the washwater holding tank;
- A yearly inspection of the clarifier is recommended, which includes emptying the entire clarifier and conducting a thorough inspection of its components;
- Routine maintenance (once every six months) of the impeller pump and its gear box may be required, such as oiling the gears for maintaining its longevity;

**New Pressure Filter Vessel:**

The existing sand filters shall be replaced-in-place with a pressure filter vessel. Some of the O&M requirements with the new pressure filter vessel are listed below:

O&M requirements:

- Periodic visual inspection (once a month) of the backwash system, pump, components of the filter and other routine maintenance are required;
- A regular scheduled backwash of the sand/anthracite media is required;
- The manufacturer of the pressure filter recommends that its dirty media should be replaced and disposed every 5 years;
- A routine inspection (once every six months) of the valves is required.

### 3.2.2 Water Storage Tanks

Several options of retrofitting the existing raw water tank, inlet/outlet pipe connections at the raw and treated water tanks, and a new steel raw water tank were evaluated. The O&M requirements with each of these options are listed in this section.

#### *3.2.2.1 Raw Water Tank:*

In order to secure the existing raw water tank and its inlet/outlet pipe to tank connection, WWE reviewed several options for retrofitting the existing tank, new steel tank and its connection. Some of the O&M requirements and needs are listed below.

**Retrofit Existing Raw Water Tank:**

The following are the O&M requirements and needs with a code compliant retrofit of the raw water tank:

O&M requirements:

- Routine access to inspect the flexible inlet/outlet coupling in an underground concrete vault
- Periodic inspection and maintenance (once a month) of the raw water tank base, walls, and roof.

**New Raw Water Steel Tank:**

The following are the O&M requirements and needs related to a code compliant new raw water tank:

O&M requirements:

- The new steel raw water tank will require to be coated every 20 years.

**Inlet/Outlet Pipe to Tank Connection:**

Options 1 and 2 of seismic retrofit of the redwood tank are located underground in front of the tank and are easily accessible. Both of these options possess similar challenges from O&M perspective, and they are summarized below:

- Both options will require an underground concrete vault to place the flexible expansion joint, which are accessible;
- There is a potential of surface water collecting in these vaults and may need to be pumped out;
- For Option 1, the flexible expansion joint is approximately 5 feet deep may require confined space entry during its access;
- In a seismic event, both flexible expansion joint will deflect and displace as per the manufacturers specifications. The flexible expansion joints should be reset to manufacturer specifications and it may require disassembling the entire units. Option 2 has a slight advantage over Option 1 since it is easier to disassemble and reset per manufacturer standards.

#### *3.2.2.2 Treated Water Tank:*

Both Options 1 and 2 flexible expansion joints are aboveground and have similar O&M requirements. An aboveground cover will be placed to protect the flexible expansion joints from falling objects. Below is the summary of O&M requirements for both of the options:

O&M Needs for both Options:

- Option 1 has the straighter alignment, which will limit the area needed for improvements and accessibility;
- Option 2 has two 90-degree elbows that will encumber a larger area and slightly limiting access for improvements and accessibility;
- In a seismic event, both flexible expansion joint will deflect and displace as per the manufacturer specifications. The flexible expansion joints should be reset to manufacturer specifications and it may require disassembling the entire units. Option 2 has a slight advantage over Option 1 since it is easier to disassemble and reset per manufacturer standards.

### 3.2.3 Water Distribution System Upgrades

As explained in previous parts of this report, the majority of the existing La Honda water distribution was constructed in the 1920s' using AC and GS pipe materials ranging from 3/4- to 4-inches in size. Table 3 indicates that the majority of the breakage and leaks have occurred in the northern area water system on Memory Lane, Pope Road and Trailer Park. The northern area resides on a higher elevation than the rest of the system with relatively low water pressure, small pipe diameter and aged infrastructure. The following are the O&M requirements and needs related to the water distribution system.

#### *3.2.3.1 Northern Area of Water Distribution System:*

Approximately 5,500 LF of existing small diameter (1", 1 ½" and 2") water line on Memory Lane and in Trailer Park area is in deteriorating shape, which should be replaced with new 4-inch pipes. The new 4-inch pipeline should be located within public ROW and utility easements, and avoid traveling through the private properties if possible. Below are the O&M requirements and needs with the replacement of existing water line.

O&M requirements:

- Existing and new water lines will be located on private narrow roads, which will require access through private property and additional space for utility trucks to turnaround during their O&M operation;
- Periodic maintenance (once every six months) of the new water line and its appurtenances will be required.

#### *3.2.3.2 Looping Existing Water Distribution System:*

A new 4-inch diameter looping water main of approximately 6,500 LF along the Pescadero Road between the La Honda road near Trailer Park and the Alpine Creek Bridge is required. Some of the O&M requirements and needs with the construction of a new water main for looping are as follows:

O&M requirements:

- Some portion of the new water line may require additional easements from private property owners for future access;
- An encroachment permit from the public agencies (Caltrans, DPW) is required for routine O&M operations;
- Periodic maintenance (once every six months) of the new water line and its appurtenances will be required.

#### *3.2.3.3 Entire Water Distribution System Replacement:*

Replacing an entire water distribution system could be a major project that may require dividing it into multiple phases. Some of the O&M requirements with the construction of an entire water distribution system are as follows:

O&M requirements:

- A new water line will require access through private properties and easement roads to maintain the pipeline and its appurtenances;
- Periodic maintenance (once every six months) of the new water line and its appurtenances will be required.

## 3.3 Opinion of Probable Construction Cost

WWE communicated with several manufacturers and vendors in order to better estimate project construction costs. A 10% design contingency and a 15% construction contingency were used. WWE presents the calculated opinion of probable construction costs (OPCC) below:

### 3.3.1 Water Source, Treatment & Quality

WWE has calculated OPCC for various components of the WTP, such as the DBP alternatives, chemical containment, corrosion resistant coating for flocculation chamber, additional sources of raw water and other WTP modifications.

#### *3.3.1.1 DBP Alternatives for WTP:*

The OPCC for a recirculating spray system depends on whether a custom-built or pre-manufactured system is chosen. The OPCC for a recirculating spray system and GAC adsorption contractor system is based on prior project experience and knowledge within WWE. Table 9 summarizes and compares the costs for below.

Table 9: Cost Estimation – DBP Alternatives

| Item No. | Item Description | Custom-build Spray System | Pre Manufactured Spray System | GAC Adsorption System |
|---|---|---|---|---|
| 1 | Materials, Installation & Labor for DBP System | $25,000 | $80,000 | $100,000 |
| 2 | Materials, Installation & Labor for Piping | $20,000 | $20,000 | $50,000 |
| 3 | DDW Report Requirements | $50,000 | $50,000 | $50,000 |
| 3 | Sub-Total | $95,000 | $150,000 | $200,000 |
| 4 | Design Contingency (10%) | $9,500 | $15,000 | $20,000 |
| 5 | Construction Contingency (15%) | $15,700 | $24,800 | $33,000 |
| **6** | **Total Construction Cost (Rounded to $1,000)** | **$120,000** | **$190,000** | **$253,000** |

#### *3.3.1.2 Chemical Containment:*

The OPCC for the chemical containment includes replacing four new 35-gallon chemical drums, four containment pallets, new electrical and instrumentation equipment, and removal of existing wiring and chemical drums within the existing WTP. Table 10 summarizes the OPCC for the chemical containment.

**Table 10: Cost Estimation – Chemical Containment**

| Item No. | Item Description | Total Cost |
|---|---|---|
| 1 | Materials, Installation & Labor | $16,100 |
| 2 | Sub-Total | $16,100 |
| 3 | Design Contingency (10%) | $1,610 |
| 4 | Construction Contingency (15%) | $2,660 |
| **5** | **Total Construction Cost (Rounded to $1,000)** | **$21,000** |

### *3.3.1.3 Corrosion Protection Coating:*

The OPCC for recoating of the flocculation chamber, setting a temporary flocculation chamber and bypass piping for the setup is summarized in the below Table 11:

**Table 11: Cost Estimation – Corrosion Protection Coating**

| Item No. | Item Description | Total Cost |
|---|---|---|
| 1 | Materials, Installation & Labor | $7,500 |
| 2 | Sub-Total | $7,500 |
| 3 | Design Contingency (10%) | $750 |
| 4 | Construction Contingency (15%) | $1,240 |
| **5** | **Total Construction Cost (Rounded to $1,000)** | **$10,000** |

### *3.3.1.4 Alternative Source of Raw Water:*

AZI and WWE prepared the construction cost estimation for four different groundwater sites including well construction, testing, reporting, new 4-inch raw water pipeline, which are summarized in Table 12.

**Table 12: Cost Estimation – Raw Water Production Well & Raw Water Pipeline**

| Item No. | Item | East of County Yard | Memory Ln | Camp Glenwood | County Corp Yard |
|---|---|---|---|---|---|
| | | | | | |
| 1 | Materials, Installation & Labor for Wells | $139,000 | $141,000 | $171,000 | $139,000 |
| 2 | Materials, Installation & Labor for RW Pipeline | $1,126,000 | $915,000 | $510,00 | $1,126,000 |
| 3 | Sub-Total | $1,265,000 | $1,056,000 | $681,000 | $1,265,000 |
| 4 | Design Contingency (10%) | $126,500 | $105,600 | $68,100 | $126,500 |
| 5 | Construction Contingency (15%) | $208,800 | $174,200 | $112,300 | $208,800 |
| **6** | **Total Construction Cost (Rounded to $1,000)** | **$1,600,000** | **$1,336,000** | **$861,000** | **$1,600,000** |

In addition to these four production wells, WWE evaluated the OPCC of a new intake on La Honda Creek as an alternative source of raw water. Table 13 shows construction cost estimation for the new intake, which includes pipe material, trenching, backfilling, permitting, testing, trenchless construction, and pipe appurtenances. The OPCC does not include environmental and permitting costs and delays in the schedule.

**Table 13: Cost Estimation – New Intake on La Honda Creek**

| Item No. | Item Description | Total Cost |
|---|---|---|
| 1 | Materials, Installation & Labor for New Intake | $125,000 |
| 2 | Materials, Installation & Labor for RW Pipeline | $1,126,000 |
| 3 | Sub-Total | $1,251,000 |
| 4 | Design Contingency (10%) | $125,100 |
| 5 | Construction Contingency (15%) | $206,000 |
| **6** | **Total Construction Cost (Rounded to $1,000)** | **$1,583,000** |

### *3.3.1.5 Additional WTP Modifications:*

The OPCC of changing the sand media of the existing sand filters, solids contact clarifier and pressure filter vessel is based on prior project experience and knowledge within WWE. The OPCC for changing the sand media for an existing sand filter is summarized in Table 14.

**Table 14: Cost Estimation – Changing Sand Media & Recoating Sand Filter**

| Item No. | Item Description | Total Cost |
|---|---|---|
| 1 | Materials, Installation & Labor for Sand Media | $15,000 |
| | Materials, Installation & Labor for Recoating | $5,000 |
| 2 | Sub-Total | $20,000 |
| 3 | Design Contingency (10%) | $2,000 |
| 4 | Construction Contingency (15%) | $3,300 |
| **5** | **Total Construction Cost (Rounded to $1,000)** | **$25,000** |

The OPCC for 15 feet height by 30 feet diameter solids contact clarifier and 40' by 40' canopy style steel cover are summarized in Table 15 and for two (2) 5 feet diameter by 6 feet height pressure filter vessels are shown in Table 16.

**Table 15: Cost Estimation – Solids Contact Clarifier**

| Item No. | Item Description | Total Cost |
|---|---|---|
| 1 | Materials, Installation & Labor for Clarifier | $420,000 |
| 2 | Canopy Style Metal Cover | $60,000 |
| 3 | Sub-Total | $480,000 |
| 4 | Design Contingency (10%) | $48,000 |
| 5 | Construction Contingency (15%) | $79,200 |
| **6** | **Total Construction Cost (Rounded to $1,000)** | **$607,000** |

**Table 16: Cost Estimation – Pressure Filter Vessels**

| Item No. | Item Description | Total Cost |
|---|---|---|
| 1 | Materials, Installation & Labor for two (2) New Filter | $140,000 |
| 2 | Materials, Installation & Labor for Bypass & Piping | $15,000 |
| 3 | Sub-Total | $155,000 |
| 4 | Design Contingency (10%) | $15,500 |
| 5 | Construction Contingency (15%) | $25,600 |
| **6** | **Total Construction Cost (Rounded to $1,000)** | **$196,000** |

### 3.3.2 Water Storage Tanks

The OPCC for the water storage tanks include costs for the seismic retrofit of the existing raw water tank, the seismic retrofit of the pipe connections at existing raw and treated water tanks; and a new code compliant steel tank with new pipe connections.

#### *3.3.2.1 Raw Water Tank:*

**Retrofit Existing Raw Water Tank:**

OPCC for retrofitting the existing raw water tank includes roof replacement and anchorage; tank wall cleaning, anchorage and shoring; and construction of ring foundation, and seismic retrofit new and existing pipe connection using Option 1. Table 17 summarizes the OPCC of the existing raw water tank retrofit.

**Table 17: Cost Estimation – Code Compliant Retrofit of Existing Raw Water Tank**

| Item No. | Item Description | Total Cost |
|---|---|---|
| 1 | Materials, Installation & Labor for Tank | $102,400 |
| 2 | Materials, Installation & Labor for Pipes | $34,300 |
| 3 | Sub-Total | $136,700 |
| 4 | Design Contingency (10%) | $13,700 |
| 5 | Construction Contingency (15%) | $22,600 |
| **6** | **Total Construction Cost (Rounded to $1,000)** | **$173,000** |

**New Raw Water Steel Tank:**

The OPCC for a code compliant new steel tank includes removing existing raw water tank and its concrete beams; installing a new steel tank and ring foundation; and installing new pipe connection using EBAA joints. Table 18 summarizes the OPCC of new raw water steel tank.

**Table 18: Cost Estimation – Code Compliant New Raw Water Steel Tank**

| Item No. | Item Description | Total Cost |
|---|---|---|
| 1 | Materials, Installation & Labor for Tank | $68,000 |
| 2 | Materials, Installation & Labor for Pipes | $25,000 |
| 3 | Removal & Disposal of Existing Tank | $15,000 |
| 3 | Sub-Total | $108,000 |
| 4 | Design Contingency (10%) | $10,800 |
| 5 | Construction Contingency (15%) | $17,800 |
| **6** | **Total Construction Cost (Rounded to $1,000)** | **$137,000** |

**Seismic Retrofit of Existing Inlet/Outlet Pipe Connection for Raw Water Tank:**

The OPCC for seismic retrofit of the existing inlet/outlet pipe connection consists of two options, which includes flexible expansion joints, pipe and appurtenances, relocation of existing piping and electrical equipment, and concrete vault boxes. Table 19 summarizes the cost for seismic retrofit of existing inlet/outlet pipe connection.

**Table 19: Cost Estimation – Seismic Retrofit of Existing Inlet/Outlet Pipe Connection for Raw Water Tank**

| Item No. | Item | Option 1 – EBAA Exp Jt | Option 2 – Romac Exp Jt |
|---|---|---|---|
| 1 | Materials, Installation & Labor | $34,300 | $22,000 |
| 2 | Sub-Total | $34,300 | $22,000 |
| 3 | Design Contingency (10%) | $3,400 | $2,200 |
| 4 | Construction Contingency (15%) | $5,700 | $3,600 |
| **5** | **Total Construction Cost (Rounded to $1,000)** | **$44,000** | **$28,000** |

The OPCC of Option 1 is much higher than Option 2 due to installation of the EBAA expansion joint in a large underground concrete vault. Option 1 also requires existing utility relocation.

### *3.3.2.2 Treated Water Tank:*

WWE evaluated two options for seismic retrofit of the inlet/outlet pipe connection to the treated water tank, which includes flexible expansion joints, pipe and appurtenances, aboveground cover and other pipe fittings. Table 20 shows the OPCC comparison of both options.

**Table 20: Cost Estimation – Seismic Retrofit of Existing Inlet/Outlet Pipe Connection for Treated Water Tank**

| Item No. | Item | Option 1 – EBAA Exp Jt | Option 2 – Romac Exp Jt |
|---|---|---|---|
| 1 | Materials, Installation & Labor | $22,600 | $18,600 |
| 2 | Sub-Total | $22,600 | $18,600 |
| 3 | Design Contingency (10%) | $2,260 | $1,860 |
| 4 | Construction Contingency (15%) | $3,730 | $3,070 |
| **5** | **Total Construction Cost (Rounded to $1,000)** | **$29,000** | **$24,000** |

The estimated cost of Option 1 is slightly higher than Option 2 because of the higher cost of the EBAA expansion joint. It is important to note that the EBAA expansion joint offers more flexibility than the Romac expansion joint, meaning that Option 1 offers superior seismic protection than Option 2 does.

### 3.3.3 Water Distribution System Upgrades

The northern area of La Honda Water System has relatively low water pressure and its infrastructure is in poor condition. Additionally, there is no "looping" of the system present, which could result in significant pressure supply issues at the far reaches of the system. This section describes the OPCC for the two proposed distribution system upgrades.

#### *3.3.3.1 Northern Area of Water Distribution System:*

Based on the GIS mapping, approximately 5,500 LF of existing small diameter (1", 1 ½" and 2") water line on Memory Lane and in Trailer Park should be replaced with the new 2- and 4-inch pipes. The new 2 and 4-inch pipeline should be located within public ROW and utility easements, and avoid traveling through private properties. The OPCC for the northern area pipeline work is listed in Table 21.

**Table 21: Cost Estimation – Northern Area Water Distribution System**

| Item No. | Item Description | Total Cost |
|---|---|---|
| 1 | 4" W - Materials, Installation & Labor | $550,000 |
| 2 | Sub-Total | $550,000 |
| 3 | Design Contingency (10%) | $55,000 |
| 4 | Construction Contingency (15%) | $90,750 |
| **5** | **Total Construction Cost (Rounded to $1,000)** | **$696,000** |

#### *3.3.3.2 Looping Existing Water Distribution System:*

Based on the GIS mapping, a new 4-inch diameter looping water main of approximately 6,500 LF along the Pescadero Road between the La Honda road near Trailer Park and the Alpine Creek Bridge is required. OPCC for the looping water main is listed in the below Table 22:

**Table 22: Cost Estimation – "Looping" Water Distribution System**

| Item No. | Item Description | Total Cost |
|---|---|---|
| 1 | 4" W - Materials, Installation & Labor | $650,000 |
| 2 | Sub-Total | $650,000 |
| 3 | Design Contingency (10%) | $65,000 |
| 4 | Construction Contingency (15%) | $107,300 |
| **5** | **Total Construction Cost (Rounded to $1,000)** | **$822,000** |

#### *3.3.3.3 Entire Water Distribution System Replacement:*

Replacing an entire water distribution system could be a major project that may require dividing into multiple phases. As per Table 7, the minimum diameter of a new water pipe is 4-inch; although, a waiver to Title 22 may be submitted to allow the use of a smaller pipe size if larger pipe results in insufficient pressure and/or velocity. For the purpose of preliminary design, WWE has assumed a minimum 4" diameter for all new piping. A 4-inch diameter pipeline of approximately 11,500 LF for the southern area and 6,000 LF of pipe connecting the southern and northern areas of La Honda Water System shall be replaced; not including the northern area and a "looping" system. The OPCC of entire water distribution system replacement is listed below in Table 23.

**Table 23: Cost Estimation – Entire Water Distribution System Replacement**

| Item No. | Item Description | Total Cost |
|---|---|---|
| 1 | 4" W - Materials, Installation & Labor | $1,750,000 |
| 2 | Sub-Total | $1,750,000 |
| 3 | Design Contingency (10%) | $175,000 |
| 4 | Construction Contingency (15%) | $288,800 |
| **5** | **Total Construction Cost (Rounded to $1,000)** | **$2,214,000** |

# 4 Recommendation & Conclusion

WWE analyzed the La Honda Water System based on our understanding of the County's project objects. We then identified improvement alternatives to meet these objectives and develop cost estimates (OPCCs) for each. In this section, WWE compares competing improvement alternatives and presents recommended upgrades based on ease of constructability, O&M requirements, and "best value to customer" OPCC. In addition to providing recommendations, WWE prioritizes each improvement by categorizing them as immediate, intermediate, or long-term projects. At the conclusion of this section, WWE presents a funding and rate analysis and summary final recommendation.

## 4.1 Summary of Improvements & Prioritization Approach

WWE has recommended various alternative solutions to improve the existing La Honda Water System. This section summarizes these alternative solutions for each components of the La Honda Water System and assigns them a priority level.

The listed County's project objectives as follows the following:

- Examine and evaluate current water treatment facilities, treatment processes, distribution systems, raw water intake sources, chemical containment, and the seismic integrity of raw and treated water tanks;
- Recommend a reliable method of achieving disinfection byproduct regulation compliance;
- Prepare an GIS industry standard water distribution system in GIS using existing data provided by the County and produce a current system map;
- Determine additional sources of raw water to resolve the standing water rights issue and explore potential consolidation with new owners/operators;
- Design a seismic retrofit inlet/outlet pipe connection at the raw and treated water tanks;
- Provide chemical containment and an associated electrical retrofit within the Water Treatment Plant;
- Identify potential capital improvement projects for addressing pressure issues and frequent leaks within the distribution systems, and additional storage needs.

### 4.1.1 Water Source, Treatment & Quality

The primary objectives of the County to address existing deficiencies in Water Source, Treatment and Quality are to provide a reliable method of achieving disinfection byproduct regulation compliance; utilize chemical containment and secondary containment that is seismically secure; utilize electrical wiring and associated conduits that are corrosion-resistant; utilize corrosion-protection coating for the flocculation chamber; analyze the feasibility of an alternative water source; analyze additional WTP upgrades to ensure efficient expenditure of capital dollars; and determine what improvements or efforts would meet the conditions that are required by new potential buyers.

#### *4.1.1.1 Disinfection Byproduct (DBP) Compliance:*

As summarized in a previous section and detailed in Appendix A, it is likely that the addition of a GAC adsorption system for TOC removal will not be necessary to achieve consistent regulatory compliance because CSA 7 system's TTHM levels are just above the Maximum Contaminant Level (MCL). Air stripping is likely adequate to perform this task of achieving compliance. For a recirculating spray system, the estimated cost of custom-build is much lower than the pre-manufactured spray systems' proprietary design and/or materials. The County and WWE also communicated with DDW regarding the air stripping custom-build system for CSA 7. Below is the brief summary of this communication:

**TTHM/DBP Current Regulatory Compliance Status & Effects on Recommended Alternative:**

On May 20th, 2015, the State Water Resources Control Board - Division of Drinking Water sent a letter to the County regarding County Service Area 7, Water System No. 4100509 proposal to install a custom-built aeration system in response to ongoing disinfection byproduct formation. Generally DDW approved the County to move forward with a custom-built system but added significant additional requirements that will affect the design, construction, operation, and subsequent cost of the system. DDW's letter enumerates requirements that are significantly more restrictive than those assumed by WWE in the previously submitted TTHM compliance memo, addenda, and discussion herein. In past TTHM reduction efforts approximately $20-25k was spent in planning, design and construction support. This did not include detailed plans and specifications, as now required by DDW, but were approached as collaboration with County staff and material suppliers to identify and purchase equipment, and provide sketches to support client construction of the system. In these instances, County will spend $20-25k in materials with its staff performing construction and start-up.

As DDW now requires that an engineering report, complete plans and specifications, and an O&M Plan (along with the review and approval of these documents), the new expected engineering cost of this project has increased into the $40-50k range. A letter from DDW is included in Appendix D. The additional requirement that the engineering report "discuss the expected performance of the specific aeration system chosen and the calculations and other supporting documents demonstrating that the proposed design and operation will consistently and reliably reduce the TTHM levels to below standards.", will drive the Engineer and the County to design and install a system which is somewhat conservative (and therefore likely to be more expensive than the previous project costs of $20-25k in materials). Because the behavior of each tank is different (system performance has to do with water quality, tank cycling, temperatures, etc.), previous approaches have been to install a system, test the functionality of the system, and provide additional spray recirculation if the initial system is not effective. This has allowed for optimization of costs.

The custom-built system remains the most cost effective option for the La Honda Water System TTHM / DBP compliance effort and is still the preferred alternative recommended by WWE. However, the compliance cost budget for this project should be increased to $100k-125k range. This still assumes significant construction labor is performed by County or County approved Contractor (e.g. BEI or other). Every effort should be made to meet DDW requirements in the most cost effective way, including communicating with DDW to take an approach, which optimizes cost while meeting regulatory requirements.

WWW recommends a custom-made recirculating spray system for DBP compliance at an OPCC of **$120,000**.

#### *4.1.1.2 Chemical Storage Tank Containment:*

Currently, the chemical tanks have no secondary spill containment and are not secured or anchored to the WTP wall or ground floor. WWE recommends four (4) chemical containment pallets and four (4) new chemical drums with existing peristaltic pumps. A seismic stainless steel strap similar to a household water heater strap should be used to anchor the chemical tanks to the WTP wall. WWE also recommends replacing the existing gutter, and receptacles, and reuse existing conduits for wiring. Simplex, waterproof GFCI receptacle will be provided for each drum and pump. Two duplex, waterproof GFCI receptacle will also be provided for operator use. One 6"x10"x12" NEMA 4X fiberglass pull box will also be provided, which will minimize the conduit runs to the receptacles. All covers will be waterproof and made out of a thermoplastic material. This recommendation will also have minimum construction challenges and O&M requirements.

The OPCC for this portion of the project is **$21,000** and WWE has already submitted 90% design drawings and specifications to the County.

#### *4.1.1.3 Flocculation Chamber Coating:*

WWE recommends removal of all existing coating and blasting the surface to remove rust to provide a clean surface for re-coating. The recommended coating shall comply with NSF-61 requirements for potable water. A polyamidoamine epoxy coating designed for steel or other ferrous metals such as Tnemec series 140, Potapox Plus, will be recommended. During the recoating of the flocculation chamber, the existing flows will be bypassed to a temporary flocculation chamber. The OPCC for recoating the flocculation chamber is **$10,000**.

#### *4.1.1.4 Sources of Raw Water:*

WWE investigated two possible raw water sources for La Honda Water System, which included researching four potential groundwater sites near the northern area of the water system and a new intake facility on La Honda Creek.

AZI and WWE have evaluated four groundwater sites based on ease of constructability, O&M, property acquisition, proximity to La Honda Creek, and vehicular accessibility. Two sites that are located on and near the County Corp Yard are in close proximity of La Honda Creek and an underground fuel storage tank (UST). These two sites could have a potential of concurrent stream flow gaging during groundwater pumping from the well site. Due to the close proximity of the creek and the UST, these two sites are less favorable when compared to other sites via the construction and O&M criterion. The Camp Glenwood site is located at relatively high elevation and it could have higher drilling and well development cost. It is also located on a steep slope and might be negatively affected by surface water from a seasonal stream. Thus, this site is less favorable than the other sites. WWE favors developing the Memory Lane site for a new well because it has fewer constructability challenges and O&M requirements than other sites. In addition, the site is within the CSA 7 boundary already and if the groundwater quality is good, it could be minimally-treated and pumped directly into the northern area system that needs it the most.

Comparatively, a new intake facility on La Honda Creek is likely to require significant environmental planning, study and permitting from various federal and state agencies. A new intake will require more infrastructure then the well; will be harder to maintain; and harder to construct compared to the well. In addition, the new intake has a higher OPCC then the new well.

WWE recommends a new groundwater well on the Memory Lane site. The OPCC of the Memory Lane site, **$1,336,000**, includes well development and approximately 2-miles of raw water pipeline to the existing WTP.

Should the well water be of sufficient quality to minimize the need for on-site groundwater treatment (potentially filter and disinfection only), connecting directly into the potable water system could significantly reduce costs. Direct connection with the northern area of La Honda Water System would provide an immediate relief to the pressure and flow constraints experience by customers in that area and will address the water rights issues. The construction cost of the onsite groundwater treatment varies significantly based the treatment required and is not included in this report. However, well-head treatment in lieu of the raw water pipeline back to the WTP should be evaluated as during well development when water quality is known.

#### *4.1.1.5 Additional WTP Modifications:*

In order to resolve the issue of DBP compliance and to reduce turbidity from the existing raw water source, WWE evaluated several WTP modification options. WWE evaluated changing the sand filter media, solids contact clarifier and pressure filter vessels to meet project objectives.

The existing sand filter media was last replaced approximately 12 years ago, and is due for replacement based on a recommended 10 year replacement cycle. WWE recommends replacing the existing sand media and recoating the sand filter, with an OPCC of **$25,000**.

For a long-term capital improvement project, WWE recommends installing a solids contact clarifier and pressure filter vessels at the WTP. A solids contact clarifier will provide storage of raw water and efficiently remove NOM from the raw water. A new pressure filter vessel will replace existing sand filters and it can be installed in its place in the WTP building. The OPCC for a solids contact clarifier is **$607,000** and for a pressure filter vessel is **$196,000**.

The Solids Contact Clarifier and Pressure Filter Vessel could be built in-lieu of the changing sand media and filter, constructing the new raw water steel tank and recoating a flocculation chamber. CSA 7 could realize a long term savings by doing this, but it would require a larger near term investment. Another option would be building the Solids Contact Clarifier alone in-lieu of the new raw water steel tank. CSA 7 could realize a long term savings by doing this as well, but it would still require a larger near term investment than the raw water tank alone.

### 4.1.2 Water Storage Tank

WWE evaluated the existing condition and structural stability of the raw water Redwood tank and treated water Steel tank. WWE identified several seismic retrofit options for the pipeline connections at the tanks and also the option of replacing the raw water storage tank. A detailed analysis of the condition and structural stability of the redwood tank is included in Appendix B of this report. WWE presents its recommendations for improving the storage tanks in this section.

#### *4.1.2.1 Raw Water Tank:*

WWE evaluated several options to retrofit the existing Redwood tank and its pipe to tank connection. WWE recommends replacing the existing raw water tank with a new code compliant AWWA D103 Steel tank and with an aboveground flexible expansion joint at the inlet/outlet pipeline connection. The OPCC for the new Steel tank is **$137,000**.

#### *4.1.2.2 Treated Water Tank:*

Two inlet/outlet pipeline-to-tank connection options were evaluated. Both options have similar construction challenges and O&M requirements. WWE recommends utilizing Option 1 for retrofitting the existing inlet/outlet piping with an aboveground cover. WWE considers the EBAA coupling to be a better option because it provides lateral and longitudinal mobility that the Romac coupling does not. The OPCC for Option 1 is **$29,000** and WWE has prepared a 90% design drawings and specification for the County with the expectation that these improvements will be built in the near term.

### 4.1.3 Water Distribution System

The northern area of La Honda Water System resides on a higher elevation than the rest of the system with relatively low water pressure and aged infrastructure. Additionally, the small diameter pipelines and relatively non-existent "looping" of the system resulted in significant pressure supply issues at the far reaches or northern end of the system, in particular along Memory Lane. WWE recommends replacing the existing 5,500 LF of existing pipeline with a 4-inch pipe using restraint joints. An HDPE pipe material is recommended for the small-diameter water line that can be restrained via electrofusion or butt fusion pipe joining methods. In-line gate valves, air-release valves (ARV), and a pressure regulating valve (PRV) may also be required to control flow and pressure. The OPCC for the replacement of northern area pipeline is **$696,000**.

WWE also recommends looping the entire system, which has the potential to decrease water age, provide system redundancy against point failures in the distribution system, improve operational reliability, and provide additional fire protection. The 6,500 LF of new looping water main should be located within public ROW and acquired easements. Further design and hydraulic analysis of the system is recommended during the replacement of the existing water distribution system. The OPCC for the new looping water main is **$822,000**.

The 1998 Master Plan had generally recommended replacing the entire water system and WWE confirms this recommendation as a long-term project, in addition to the looping of the entire system, with an OPCC of **$2,214,000.**

## 4.2 Prioritization of Capital Improvement Program (CIP)

Based on the analysis presented in this report, WWE recommended a Capital Improvement Program (CIP) with a list of improvement projects separated into three priority categories.

Priority 1 improvement projects require immediate action in order to meet the current regulatory requirements and provide improved reliability in the water system. Priority 2 improvement projects provide operational reliability and redundancy to the system that are considered intermediate projects. Priority 3 improvement projects are for long-term projects that will provide redundancy and replacement of the aging infrastructure. The cost for each project is obtained from Section 3 represents present value. Table 24 lists the complete CIP list and provides a total sum for reference purposes.

**Table 24: CIP and Project Prioritization for CSA 7**

| Priority | Facility Type | Item Description | Total Cost |
|---|---|---|---|
| *Regulatory & Improved Reliability Repair (Immediate List)* | | | |
| 1 | Water Treatment | Chemical Containment | **$21,000** |
| | Water Treatment | DBP Compliance – Custom-Built Spray System | **$120,000** |
| | Water Tank | Seismic Retrofit of Pipe Connection of Steel Tank | **$28,000** |
| *Operational Reliability & Redundancy for Aging Infrastructure List (Intermediate List)* | | | |
| 2 | Water Source | Additional Source of Raw Water | **$1,336,000** |
| | Water Treatment | Change Sand Media of Sand Filters[1] | **$25,000** |
| | Water Storage | New Code Compliant Raw Water Steel Tank[1, 2] | **$137,000** |
| | Water Treatment | Flocculation Chamber Recoating[1] | **$10,000** |
| | Water Distribution | Northern Area Water Distribution System | **$696,000** |
| *Redundancy & Replacement of Aging Infrastructure (Long-Term List)* | | | |
| 3 | Water Treatment | Pressure Filter Vessels[1] | **$196,000** |
| | Water Storage | Solids Contact Clarifier[1, 2] | **$607,000** |
| | Water Distribution | "Looping" Water Main | **$822,000** |
| | Water Distribution | System-wide Replacement[3] | **$2,214,000** |
| | | **TOTAL COST =** | **$6,212,000** |

Notes:

1. If funding were available immediately, the Solids Contact Clarifier and Pressure Filter Vessel under priority 3 could be built in-lieu of the changing sand media and filter, constructing the new raw water steel tank and recoating a flocculation chamber listed under priority 2. CSA 7 could realize a long term savings of approximately $172,000, but at the expense of $803,000 capital investment now.
2. If funding were available immediately to construct only the Solids Contact Clarifier under priority 3 in-lieu of the new raw water steel tank listed under priority 2. CSA 7 could realize a long term savings of approximately $137,000, but at the expense of a $607,000 capital investment now.
3. This total does not includes $696,000 for Northern Area Water Distribution System piping, which is assumed to be constructed under priority 2 work. If northern area water distribution system is not replaced under priority 2, the cost for system-wide replacement under priority 3 will increase by the amount of replacing the northern area water distribution system ($696,000).

## 4.3 Funding & Rate Analysis

WWE completed a planning level review of available funding as compared to CSA No. 7 water system financial liabilities and identified potential sources to meet the liabilities, with particular emphasis on increase to rates needed to implement the prioritized Capital Improvement Plan.

### 4.3.1 Revenue Sources

In order to implement the identified CIP projects for the CSA No. 7 water system, the County requires additional funds. The ultimate source of such revenue is user fees (rates and connection fees) and public funding (County General Fund, Grants, Bonds, and/or Loans).

Based on review of five fiscal years of budget and anecdotal summaries from County staff, CSA No. 7 revenues (user fees) cover only routine operation and maintenance costs with basically no reserve or long-term capital replacement funding available. This break-even point was only just reached with the most recent rate increase that went into effect in 2013. On March 26, 2013, Board adopted Resolution No. 072416 and 04652 setting FYs 2012-13 through FYs 2014-15 water rates and meter service charges for CSA-7. These rates are summarized in Table 25.

**Table 25: Approved Rate Increase for CSA No. 7**

| Water Service Description | Current Rates (1999) | Proposed Rates | | |
|---|---|---|---|---|
| | | FY 2012-13 | FY 2013-14 | FY 2014-15 |
| Monthly Meter Service Charge | $20.00 | $33.20 | $44.16 | $58.73 |
| Water Rate per Unit (1 Unit = 748 gallons) | $4.80 | $7.97 | $10.60 | $14.10 |

Currently, there is a revenue transfer from the General Fund to the CSA No.7 budget, which represents the water service rate payment to CSA No.7 for County owned facilities served by water from the CSA 7 system. The County General Fund supports programs across the entire County and is not a potential long-term funding source.

While the County continues to research, identify and apply for available Grant funding, the County has basically one feasible option to support the CSA No. 7 water system CIP, i.e., borrow money and simultaneously raise user rates to pay the loan. While several of the lower cost Priority 1 and 2 projects could be funded out of the existing CSA No.7 budget and General Fund transfers, more comprehensive projects that mitigate more important regulatory, reliability and aging infrastructure issues in the system can only be done with additional funding. This requires a bond or loan from local, state and/or federal government, and the only likely source for this is the Drinking Water State Revolving Fund.

#### *4.3.1.1 Drinking Water State Revolving Fund:*

Administered by the SWRCB, Division of Financial Assistance, the Financial Assistance Application is designed to help determine your eligibility for funding through the Drinking Water State Revolving Fund (DWSRF). An overview of the financing process and the DWSRF Policy can be found at http://www.waterboards.ca.gov/drinking_wate r/services/funding/SRF.shtml. The DWSRF provides various types of assistance for Public Water Systems, including projects that: (1) address public health risk problems, (2) are needed to comply with the SDWA, and (3) assist those most in need on a per household affordability basis.

A Comprehensive List is prepared by SWRCB to identify potentially eligible future projects and prioritize the marketing, assistance, and application review efforts of SWRCB staff and management. A project must be on the current Comprehensive List to be considered for financing. Placement of a project on the Comprehensive List does not constitute a commitment to provide financing. As SWRCB receives DWSRF application packages from applicants, it will assign to each project a category from DWSRF Policy. To the maximum extent practicable, priority will be given to projects which: 1) address the most serious risk to human health, 2) are necessary to ensure compliance with the requirements of the SDWA, and 3) assist systems most in need on a per household basis. Projects are ranked by the categories established to achieve these objectives.

Any loan requires a rate increase to cover the principal and debt service, thus requiring CSA No.7 raise rates.

#### *4.3.1.2 Rate Increases*

For the purposes of the planning level feasibility assessment, WWE completed an estimate of the affect a DWSRF Loan to meet the obligations of each priority CIP category would have on rates. For the example below a 20-year term and 2% loan is assumed. For the purposes of this analysis it is assumed that the 69 residential connections in the La Honda Creek and Alpine Creek drainage areas will be responsible for 50% of the costs and the two County facilities, Camp Glenwood and Sam McDonald Park, will be responsible for the other 50%. To accommodate the assumption, it is assumed that there are 69 x 2 = 138 connections.

**Table 26: Proposed Rate Increase for CSA No. 7**

| Water Service Description | FY 2014-15 Rates | Required Rate Increase for Debt Obligation by CIP Priority Category | | | |
|---|---|---|---|---|---|
| | | Priority 1 | Priority 2 | Priority 3 | **Total** |
| CIP Cost | | $169,000 | $2,204,000 | $3,839,000 | **$6,212,000** |
| Monthly Meter Service Charge Increase (per connection per month) | $58.73 | $6.20 | $106.31 | $252.03 | **$364.54** |

Note: These potential rate increase calculations are based on an effective total connections of 69 x 2 = 138, which includes an assumed connection "value" for Sam McDonald Park and Camp Glenwood of 69. If only 69 connections are assumed, the total Monthly Meter Service Charge Increase (per connection per month) would be double than shown in above table.

WWE recommends County Staff continue to work with the CSA 7 Advisory Committee to evaluate the financial liabilities of CSA No. 7 and recommend rates to meet these financial obligations; however, based on the extreme cost of these improvements it is likely going to be a significant struggle to obtain ratepayer acceptance.

## 4.4 Conclusion

Given the fiscal constraints of CSA7 weighed against the regulatory and reliability concerns related to its existing water system infrastructure, WWE recommends Priority 1 projects be funded and implemented within a 1-2 year horizon; Priority 2 projects be funded and implemented within a 3-10 year horizon; and Priority 3 projects be funded and implemented within a 10-20 year horizon.

CSA7 and County should investigate and pursue Grant funding and begin the process of applying for and securing DWSRF loans.

CSA7 and County should immediately provide Cal Water a copy of this report and pursue their purchase of the system and all potential ways to upgrade system to a level of service acceptable to them.

# Appendix A – La Honda Disinfection Byproduct Formation Assessment TM

WATERWORKS ENGINEERS

# County of San Mateo
# County Service Area No. 7 – La Honda
# Disinfection Byproduct Formation Assessment

Date: December 11, 2014

Prepared by: Sami Kader, PE
Anthony Baltazar, EIT

REGISTERED PROFESSIONAL ENGINEER SAMI A. KADER No. C56653 Exp: 6-30-15 CIVIL STATE OF CALIFORNIA 2/27/15

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# Abbreviations

| | |
|---|---|
| BEI | Bracewell Engineering Inc. |
| Bromoform | Tribromomethane |
| Chloroform | Trichloromethane |
| County | County of San Mateo |
| CSA 7 | County Service Area No. 7 |
| CT | Contact Time |
| DBP | Disinfection Byproduct |
| DDW | Division of Drinking Water |
| GAC | Granular Activated Carbon |
| HAA5 | Haloacetic Acids |
| MCL | Maximum Contaminant Level |
| RAA | Running Annual Average |
| TOC | Total Organic Carbon |
| TTHM | Total Trihalomethane |
| WTP | Water Treatment Plant |

# Background

The County of San Mateo (County) Public Works Department operates the County Service Area No. 7 (CSA 7) water system to serve potable water to approximately 70 residential customers in the La Honda community. The water system also provides potable water to two County operated facilities: Camp Glenwood and Sam McDonald Park. This system consists of a surface water source, raw water intake pump, a 70,000 gallon raw water storage tank, a water treatment plant (WTP) (pressure filters followed by chlorine disinfection), a 500,000 gallon treated water storage tank, and a distribution system. The WTP was constructed in the early 1990s, while portions of the distribution system were constructed as long ago as the 1920s.

Currently, disinfection byproduct (DBP) formation (specifically formation of total trihalomethanes, TTHMs) is a concern for the County. On December 31, 2012, State Water Resources Control Board Division of Drinking Water (DDW), formerly the California Department of Public Health, issued Citation No. 02-17-13C-033 to CSA 7 due to TTHM Running Annual Average (RAA) exceeding the maximum contaminant level of 80 ug/L for the four quarterly samples in 2012. Bracewell Engineering Inc. (BEI), who is contracted by the County to operate and maintain the CSA 7 water system, has employed the following various strategies to attempt to address DBP compliance:

- In February of 2013, the coagulant was switched from a polymer to ferric sulfate and then back to a polymer because the ferric sulfate presented problems with the filtration bed and reduced the efficiency of the WTP.
- In March of 2013, BEI reviewed WTP operating times before the collection of TTHM samples in the distribution system. It should be noted that treated water can be distributed to the system in one of two ways: either directly from the WTP when it is operating to fill the storage tank or directly from the storage tank when the WTP is off. BEI's observations showed that the longer the WTP had been consistently supplying treated water directly to the distribution system, the lower the TTHM level was at the sampling site. At the same time, samples were collected at the WTP downstream of the chlorine contact pipe. The results confirmed that the WTP, when operating normally, produces treated water with TTHM levels comfortably below the maximum contaminant level (MCL). The data therefore suggests that TTHM formation is occurring in the piping and/or storage tank in the distribution system.
- During April and May 2013, samples were collected at the WTP, a sampling point in the distribution system, and at the storage tank. Taking into consideration the WTP operating times before these samples were collected, the data indicates that the primary source of TTHM formation is occurring in the storage tank.
- From June of 2013 to May of 2014, BEI proposed and attempted to implement modifications to allow BEI to run the WTP 50-67% of the time. The goal of this strategy was to ensure that the water in the distribution system, and therefore at the TTHM sampling site, was directly coming mostly from the WTP. This would hopefully result in a significant drop in average distribution system TTHM levels. However, BEI was only able to operate the WTP 43% of the time in May of 2014. This was due to low water consumption by the La Honda residents, which did not allow the WTP to be running for more than 43% of the time without causing the storage tank to overflow.

- In June and July of 2014, the DDW rejected a proposal from the County/BEI to conduct a study to analyze a blending method of treated water from the WTP and storage tank water to comply with the running annual average (RAA) TTHM requirement.

The graphs seen below in Figure 1 and Figure 2 show data for haloacetic acids (HAA5) and TTHM formation in the CSA 7 water system.

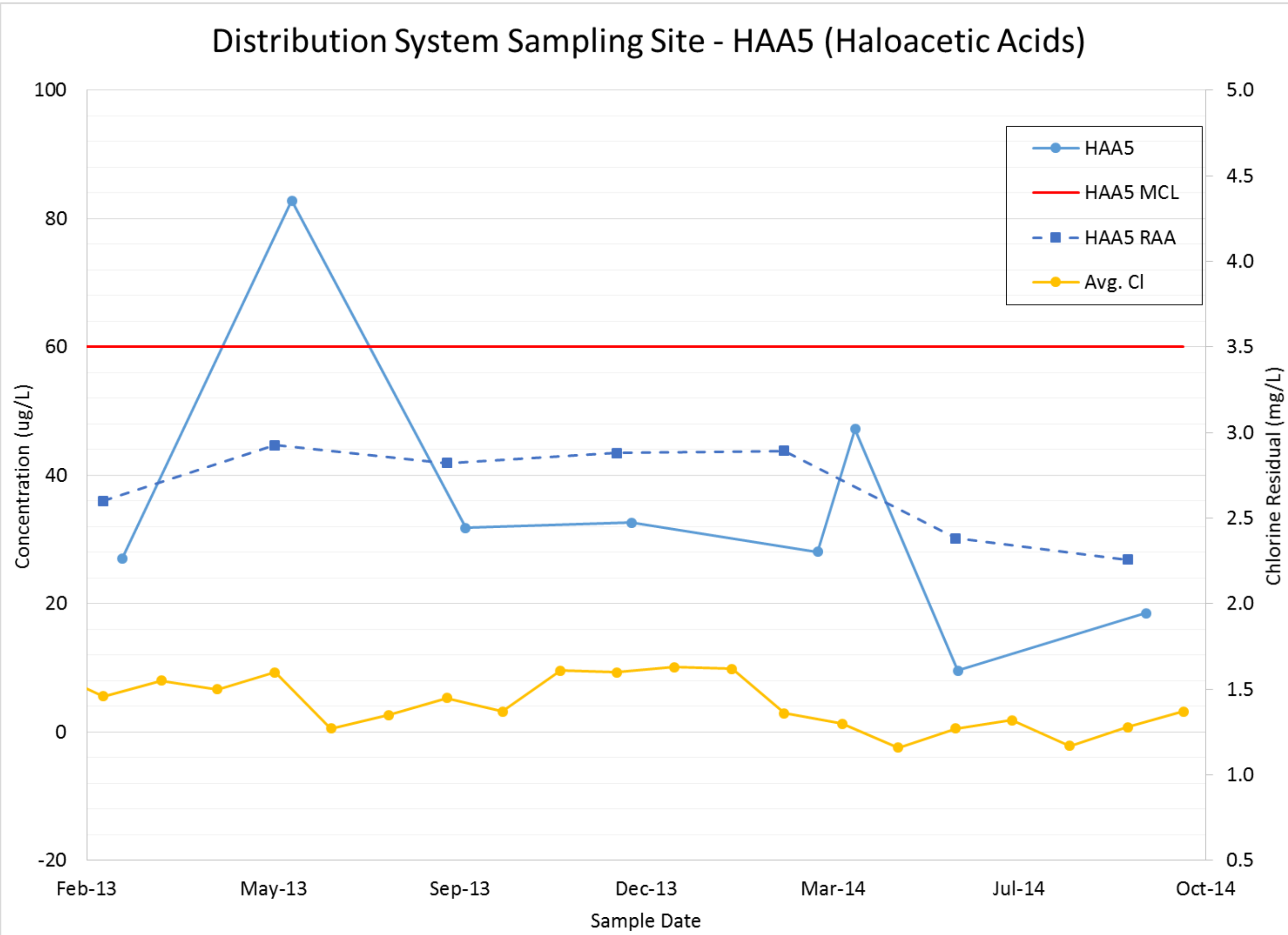



**Figure 1. HAA5 Formation in CSA 7 Water System**

As can be seen in Figure 1, one sample was above the HAA5 MCL of 60 ug/L. However, the HAA5 RAA has never been in violation of the MCL.

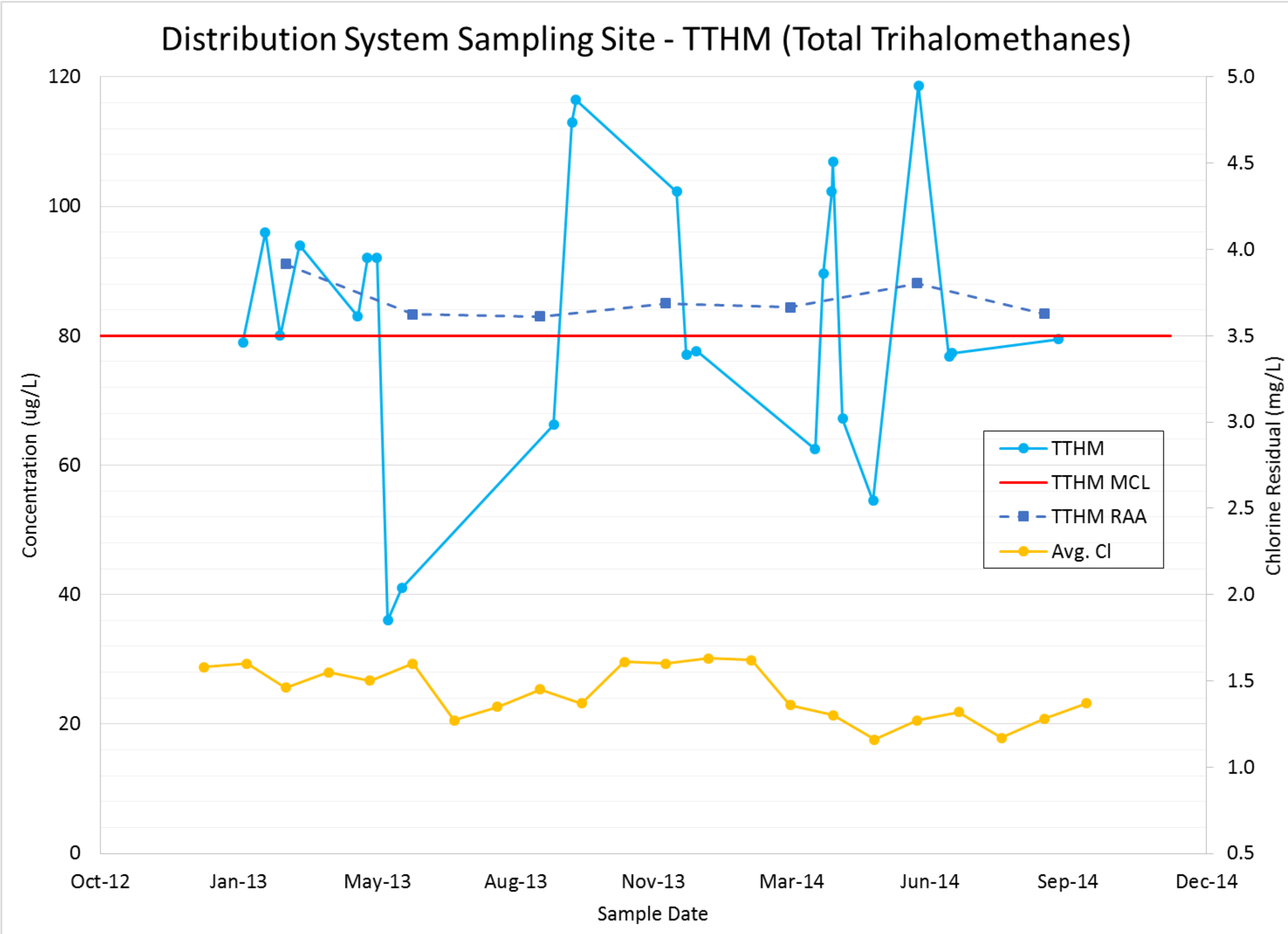



**Figure 2. TTHM Formation in CSA 7 Water System**

As shown in Figure 2, the TTHM RAA has been consistently hovering just above the regulatory MCL of 80 ug/L. In order to lower the RAA below the MCL, another TTHM strategy must be employed.

As mentioned earlier, treated water can be distributed to the system in one of two ways: either directly from the WTP when it is operating to fill the storage tank or directly from the storage tank when the WTP is off. Due to this two-pronged approach, it is hard to pinpoint exactly how much TTHM formation may be occurring within the piping of the distribution system as opposed to the storage tank. However, test results from when the WTP had been operating for over 24 hours prior to the time of sampling show that minimal TTHM formation had occurred in the piping upstream of the sampling site in the distribution system. One test result even showed that the TTHM concentration was lower at the sampling site than at the WTP. Overall, the data suggest that TTHM formation is generally occurring in the storage tank, which is the basis for the recommendations of this report. It is recommended, however, that more sampling be performed in order to confirm this assumption and ascertain how much of the TTHM formation is occurring in the storage tank and in the distribution system piping.

# Treatment Approach

## Air Stripping

TTHM removal through air stripping has proven to be a successful control strategy for many water systems. Although there are various methods to implement air stripping, the method most applicable to the CSA 7 water system is to install tank recirculating spray systems. Judging by experiences of other agencies who have implemented tank recirculating spray systems for TTHM control, a spray system will likely have the most significant impact at the treated water storage tank. The spray system is a simple way to get the necessary air/water interface surface area to allow the trihalomethanes to volatilize and be removed from the water after they are formed. This system can be fixed (attached to the tank wall or roof) or floating (affixed to a raft).

### Air Stripping Process Chemistry

TTHM is a measurement of four species of trihalomethane. Each species has different characteristics, including different tendencies to volatilize. The tendency for a compound to volatilize is reflected in the compound's Henry's Law Coefficient – the higher the Henry's Law Coefficient, the higher the tendency for the compound to volatilize. Water quality test results, from about 25 samples over the last two years, show the different species of TTHM found in the water at the sampling site in the distribution system. Table 1 shows each species' average percentage of the total trihalomethane content, along with their respective Henry's Law Coefficient:

**Table 1. TTHM Average Species Percentage in Distribution System and Henry's Law Coefficient**

| TTHM Species | Average Percentage of TTHM | Dimensionless Henry's Law Coefficient |
|---|---|---|
| TCM – Trichloromethane (Chloroform) | 40% | 0.1525 |
| BDCM – Bromodichloromethane | 33% | 0.1317769 |
| DBCM – Dibromochloromethane | 23% | 0.03254931 |
| TBM – Tribromomethane (Bromoform) | 4% | 0.02556555 |

The two species with the highest Henry's Law coefficients (the easiest to volatilize through air stripping) make up 73% of the TTHM formed, on average. Figure 3 illustrates this point. With the exception of one sample, the sum of the concentrations of the more volatile chloroform and bromodichloromethane, represented by the green line, is much greater than the sum of the concentrations of the less volatile dibromochloromethane and bromoform, represented by the orange line.

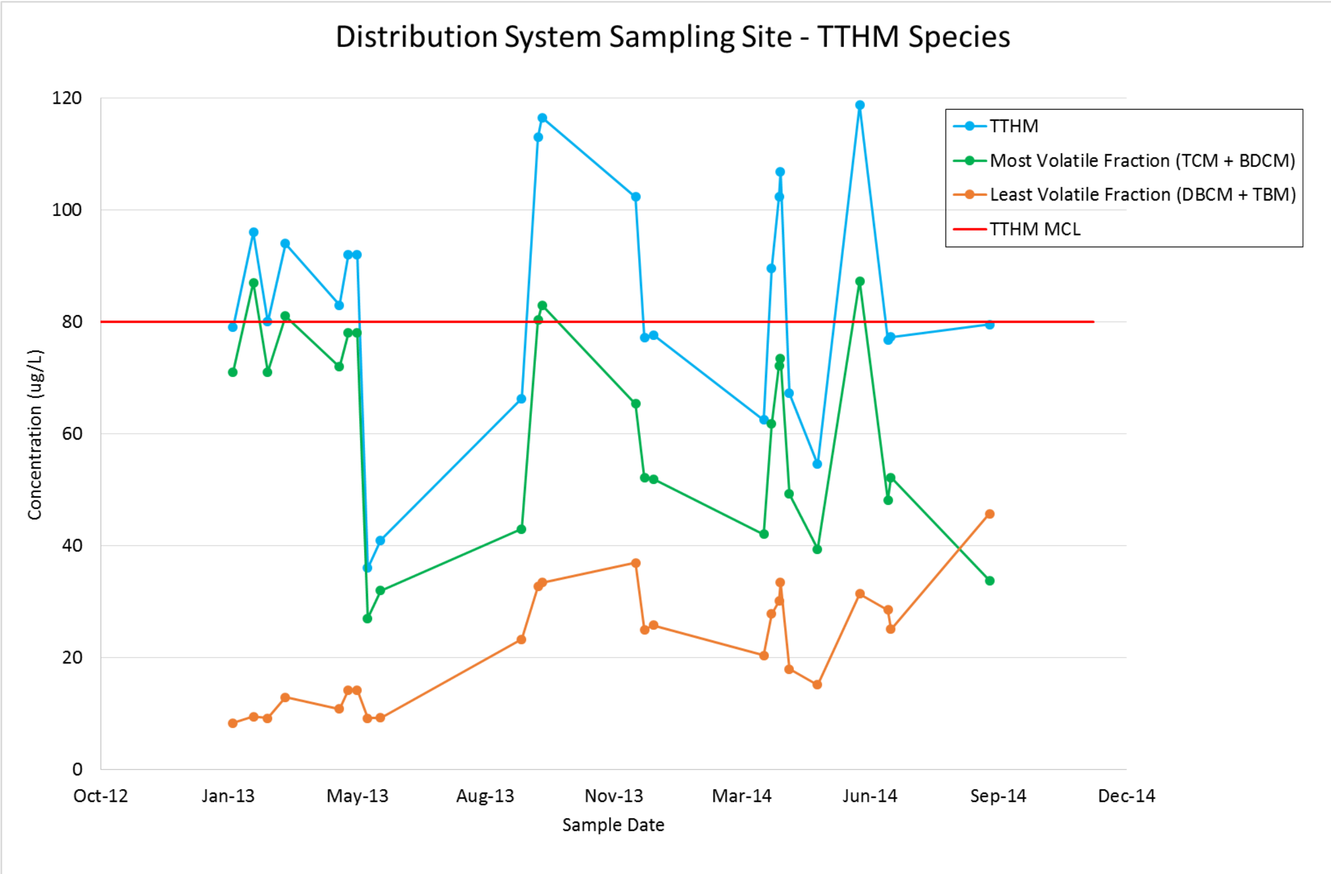



**Figure 3. TTHM Species Concentrations in Distribution System**

In addition to this information, two samples were taken at the storage tank in April and May of 2013. The data from these two water quality tests show that an even higher percentage of the TTHM found in the storage tank is comprised of the more volatile chloroform and bromodichloromethane, as shown in :

**Table 2. Storage Tank Water Sample TTHM Results**

| | Samples Taken From Storage Tank | | | |
|---|---|---|---|---|
| | 4/29/2013 | | 5/6/2013 | |
| **TTHM Species** | **Concentration** | **% of TTHM** | **Concentration** | **% of TTHM** |
| Chloroform | 44 | 53.7% | 43 | 54.4% |
| Bromodichloromethane | 25 | 30.5% | 24 | 30.4% |
| Dibromochloromethane | 12 | 14.6% | 11 | 13.9% |
| Bromoform | 1.2 | 1.5% | 1.1 | 1.4% |
| TTHM | 82 | | 79 | |

Roughly 84% of the TTHM found in the storage tank is chloroform and bromodichloromethane. Given this high percentage of the more volatile species of TTHM, we can expect to get good performance from an air stripping system in TTHM removal. Even if the air stripping process is only 50% efficient, that would still equate to removing

42% of the TTHM in the storage tank. With the highest TTHM concentration recorded to date being 118.7 ug/L, 42% removal would result in an approximate concentration of 69 ug/L. Experience with other systems has shown that recirculating spray systems perform at least at 50% removal efficiency and generally work better than that. Some of the less volatile species are stripped as well. All of this results in a high confidence level that the implementation of a recirculating spray system for volatilization of TTHM will allow for compliance with TTHM limits.

## Air Stripping Design Considerations

Due to the high percentage of chloroform and bromodichloromethane in the storage tank, and the ease with which they are stripped, TTHM removal through air stripping has a very high likelihood of success. There are two primary design factors that have been critical to success in other water systems:

1. The spray system should be able to circulate the entire volume of water in the storage tank during the hydraulic residence time in the storage tank. Utilizing the total maximum day demand of 26.9 gpm from Brown & Caldwell's CSA 7 La Honda Water System Master Plan from 1998, the minimum residence time of the storage tank was calculated to be 13 days. With the storage tank volume being 500,000 gallons, the pumping rate and capacity of the spray system should be, at a minimum, 30-gpm so that the entire tank volume is run through the spray system during the minimum residence time. However, under-sizing the spray system has been a common cause of poor performance, so a minimum 100-gpm system should be designed. This 100-gpm spray system will allow the County to be flexible in regards to the volume of stored water. To save on energy costs, the system can be cycled on and off during lower demand periods or if TTHM removal is better than expected.
2. The headspace of the storage tank should be mechanically ventilated because the TTHMs will volatilize and build up in the headspace. If the TTHMs are not ventilated, it will build up in the headspace and reach equilibrium with the TTHMs in the water, thereby reducing or stopping the air stripping process. Additionally, because the spray system causes a corrosive environment in the headspace, ventilation will reduce the possibility of corrosion damage occurring.

The potential for stripping the chlorine found in the water at the storage tank is a possible concern, as the chlorine residual levels in the distribution system might be negatively affected. However, the Henry's Law coefficient for free chlorine has been found to be 0.0000455. This value is three orders of magnitude smaller than any of the coefficients for the four trihalomethanes discussed in this report, indicating that there should be little to no stripping of free chlorine in the recirculating spray system.

## Air Stripping Capital Costs

Commercially produced air stripping systems for the purpose of TTHM removal are available. Two companies make NSF-61 certified air stripping systems (Medora/GridBee and PAX). Information on these systems is included in Appendix A. Total installed costs for these systems, which include a recirculating spray system and headspace ventilation equipment, are in the range of $100,000. However, many utilities have had success designing and installing their own recirculating spray systems for far less money. This approach is recommended, at least as a starting point, for the CSA 7 water system. These custom-built spray systems typically cost on the order of about $40,000, with about half of the cost going towards designing the system while the other half goes toward the materials of construction (often these systems are constructed by utility operations staff). One such custom-built spray system that has been seen before consisted of a submersible pump that supplies water from the bottom of the tank to a floating sprayer at the water level. Another system consisted of an exterior mounted recirculation pump with fixed spray nozzles. Both systems included headspace exhaust fans. The cost of materials for these systems were each approximately $20-25,000 (labor to install was provided by utility staff).

### Air Stripping O&M Costs

Ongoing O&M costs will include power cost and maintenance cost for the equipment. Power cost will be to run the spray system and ventilation fan. It is unknown whether the system will need to be run 24 hours per day, or whether there will be times when part-time or longer duration shutdowns will be possible. Assuming the worst-case of full-time 24 hours per day/365 days per year operation, the system will draw a total of 7 hp (5 hp for the spray system and 2 hp for the ventilation fan), which is 5.22 kW. 5.22 kW * 24 hours/day = 125 kW-hr/day. At a power cost of $0.15/kW-hr, that would be $18.80/day, or approximately $7000/year.

Using 2% of the $75,000 equipment capital cost for an annual maintenance budget, the annual maintenance cost would be approximately $1500/year. The total O&M Cost could therefore be expected to be up to $8500/year.

## Removing Total Organic Carbon (TOC)

If the strategy of air stripping through a tank recirculating spray system is not successful, the County may want to consider TOC removal. This would be best accomplished through granular activated carbon (GAC) adsorption of TOC following filtration, with typical removal in the range of 50 to 70%. This has two significant cost considerations. First, initial costs for a GAC contractor system which will accommodate WTP flows will be roughly $100,000 to $150,000. Second, the GAC media will have to be periodically replaced, with 2 to 3 year cycles being common. The media replacement would cost about $20,000 every 2 to 3 years. The use of GAC for TOC removal as a control strategy is most effective when implemented in conjunction with air stripping, with the air stripping doing the majority of the removal and the GAC used during problem months in order to extend the life of the GAC media. Given how close the CSA 7 water system is to compliance, it is likely that the addition of GAC for TOC removal will not be necessary to achieve consistent regulatory compliance and that air stripping will be adequate.

## Chloramine as Secondary Disinfectant

Some water utilities use chloramine for their secondary (residual) disinfectant, with primary disinfection still being achieved using free chlorine. Using chloramine as a primary disinfectant requires an enormous contact time (CT) and tends to be impractical, requiring very large chlorine contact volumes. Following primary disinfection, ammonia is added to the water to produce chloramines (the ammonia is added at a 4:1 ratio to the chlorine residual). The use of chloramines for secondary residual can be effective, however, with long water age, issues of nitrification and destruction of chloramine residual can cause issues with compliance with having minimum chlorine residuals in the distribution system. The issue of long water age must be addressed whether using free chlorine or chloramines for disinfection. The use of chloramines at plants that are run intermittently has also been shown to be problematic. Additionally, the County has made it very clear that the La Honda community has strongly voiced their opinion against the use of chloramine as a disinfectant. In light of all of this information, a change in residual disinfectant is not recommended at this time.

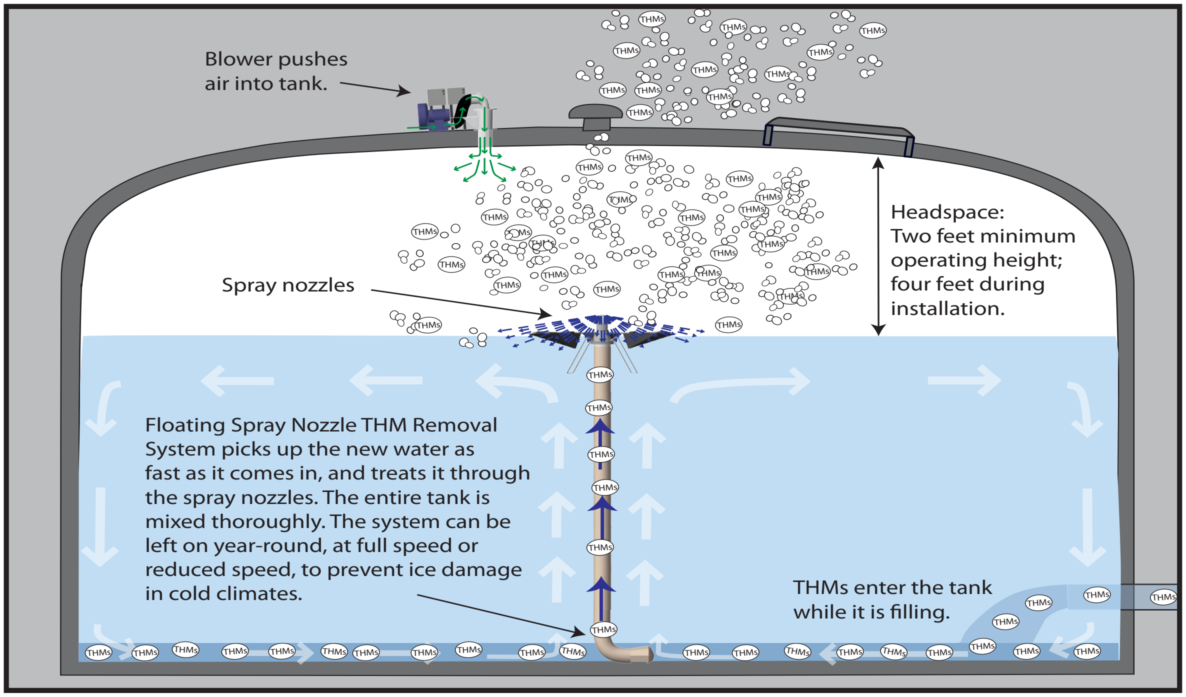
# Recommendation

It is recommended that the County move forward with the installation of a recirculating spray system and headspace ventilation system in the storage tank. With 84% of the TTHM in the storage tank being relatively easily strippable, the anticipated reduction will help comply with TTHM regulations significantly. The spray system should have a capacity of approximately 100 gpm and include headspace ventilation. The County could decide to move forward with a manufactured air stripping system or proceed with the design of a custom-built system for this site. Cost of the air stripping system will be between $40-100,000. O&M costs of operating the system should be expected to be approximately $8500/year.

# Appendix A – Manufactured Air Stripping System Information

# THM Removal Systems

The EPA Stage 2 Disinfectants and Disinfection Byproducts rule with locational maximums for TTHM (80 ug/l) has resulted in compliance pressure for many cities. Mixing alone may not lower the THM concentration enough to comply. For these systems, Medora Corporation has developed an effective and economical floating spray nozzle system for THM removal in tanks and clearwells.



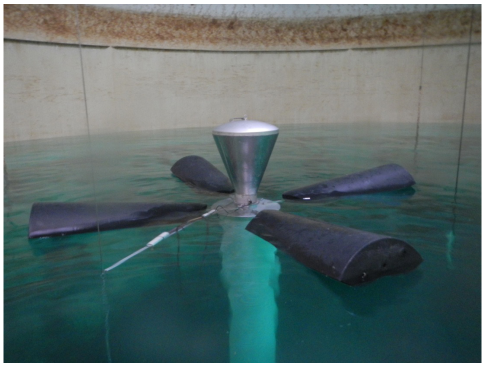
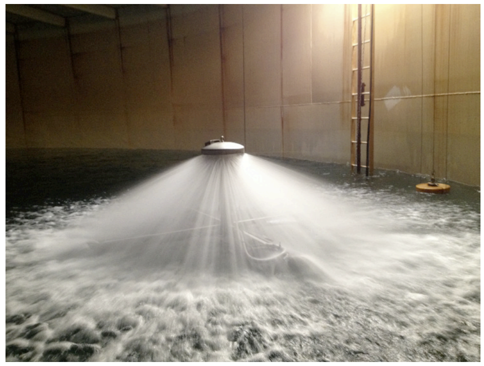

*Floating Spray Nozzle THM Removal System*

## Features and Benefits of the Floating Spray Nozzle THM Removal System

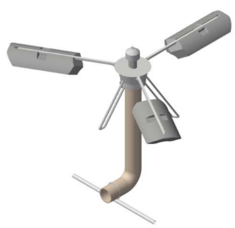
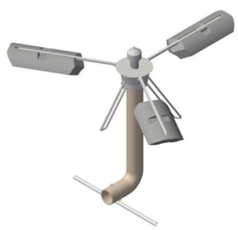
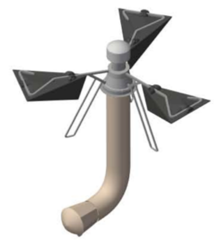
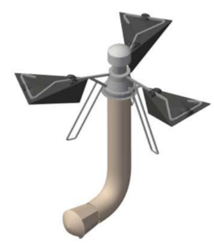
- Four machine sizes, 3 hp, 5 hp, 10 hp, and 15 hp provide for scalable systems for clearwells and tanks from 10,000 to 100,000,000 gallons, and tank flow rates up to 100,000,000 gallons per day
- There are no significant friction or lifting losses, so 98% of the energy consumed by the pump is converted to stripping TTHM at the nozzle assembly, compared to less-efficient fixed-ceiling nozzle designs
- Patented long-life nozzle and intake treat all incoming water, minimize THM formation downstream
- Nozzle angle assures no damage to tank coatings
- Ventilation blowers for headspace included with all systems
- All models fit through a 24" x 24" or larger hatch opening, eliminating the need to install a new larger hatch or special lifting equipment
- No infrastructure piping is required, and no modifications to the tank or clearwell other than small access openings for electrical cable and the headspace air ventilation
- Factory installation is available for entire system except the wiring by the local electrician
- Small-footprint units are easily movable and removable for any future interior tank work
- If the TTHM problem changes, this equipment is portable and can easily be moved to another area of town or sold to another water district
- Low-maintenance, long-life design
- Two year parts and labor warranty; factory maintenance plans available
- Full-scale pilot studies can be provided, with purchase options

*Medora Corporation's potable water products are certified to **NSF/ANSI Standard 61**, and **NSF/ANSI 372** for lead-free content. Learn more at **www.medoraco.com/std61**.*

## Photos


## Specifications

| | Model SN3 | Model SN5 | Model SN10 | Model SN15 |
|---|---|---|---|---|
| |  |  |  |  |
| **Approximate Price Range** | $25,000 to $90,000 per unit depending on configuration. Price range estimates apply to the United States only and do not apply internationally. Please call for exact system proposal. | | | |
| **Unique Features** | Pre-designed • Pre-packaged • Portable • Reliable • Long Life • No need for diver(s) or to drain the tank • Fits through most standard size hatches Full written specifications available upon request. | | | |
| **Flow through nozzles, MGD** | 0.25 MGD | 0.33 MGD | 0.66 MGD | 1.0 MGD |
| **Possible reduction of TTHM, each pass through nozzles** | 35% to 70% | 35% to 70% | 35% to 70% | 35% to 70% |
| **Spray pump horsepower and motor electrical options** | 3HP/230V/1PH/1.15 S.F.<br>3HP/230V/3PH/1.15 S.F.<br>3HP/460V/3PH/1.15 S.F. | 5HP/230V/1PH/1.15 S.F.<br>5HP/230V/3PH/1.15 S.F.<br>5HP/460V/3PH/1.15 S.F. | 10HP/230V/3PH/1.15 S.F.<br>10HP/460V/3PH/1.15 S.F. | 15HP/230V/3PH/1.15 S.F.<br>15HP/460V/3PH/1.15 S.F. |
| **Dimensions** | Working dimension: 8 ft diameter x 5 ft tall, plus draft hose | | Working dimension: 10 ft diameter x 6 ft tall, plus draft hose | |
| **Unit Weight** | Approx. 300 lbs | | Approx. 500 lbs | |
| **Hatch size required** | Minimum 18 inches clear unobstructed diameter | | Minimum 24 inches clear unobstructed diameter | |
| **Head space required** | Minimum 18 inches working height,<br>Minimum 4 feet temporarily during installation | | Minimum 24 inches working height,<br>Minimum 4 feet temporarily during installation | |
| **Water depth required** | Approx. 54 inches | | Approx. 60 inches | |
| **Machine Diameter** | Approx. 8 feet | | Approx. 10 feet | |
| **Ventilation Blower (included)** | 750 CFM | | 750 CFM per blower (Multiple blowers may be required) | |
| **Ventilation Blower horsepower and motor electrical options** | 2HP/230V/1PH/1.15 S.F.<br>2HP/230V/3PH/1.15 S.F.<br>2HP/460V/3PH/1.15 S.F. | | 2HP/230V/1PH/1.15 S.F.<br>2HP/230V/3PH/1.15 S.F.<br>2HP/460V/3PH/1.15 S.F. | |
| **Ventilation blower mounting** | Typically on top of the tank or clearwell | | | |
| **Low Energy Tank mixing system** | GS-series submersible mixer(s) may be included in a THM system proposal for mixing due to tank inflow rate, for low energy mixing when the THM system is off, or for ice considerations | | | |
| **Installation Consdiderations** | Little or no infrastructure changes needed, no need to drain the tank, no need for diver(s), factory installation available,<br>tank owner to provide electrical service and connections | | | |
| **Electrical requirements for the owner to provide** | A power source, conduit and NEMA combination starter / disconnect per electrical code to each pump motor, each blower and each low energy mixer as listed in the THM system proposal | | | |
| **If have power source limitations a VFD may be recommended** | Variable frequency drive (VFD) may be desired to provide a conversion from<br>115V/1ph power source to a 230V/3PH power source<br>or 230V/1ph power source to a 230-460V/3PH power source | | Variable frequency drive (VFD) may be desired to provide a conversion from<br>230V/1ph power source to a 230-460V/3PH power source | |

*SolarBee® and GridBee® are brands of Medora Corporation*

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# TRIS In-Tank Aeration for Stage 2 DBP Compliance

## Trihalomethane Removal System

Lower THM levels in your storage tanks and throughout your distribution system

- Custom-designed
- Energy-efficient
- Reliably-installed
- Performance-optimized
- Small footprint
- Quickly deployed

A Partnership between Utility Service and PAX Water Technologies™

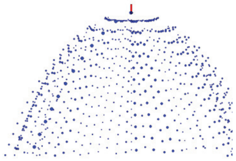
# TRS In-Tank Aeration for Stage 2 DBP Compliance

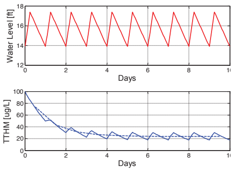
## Trihalomethane Removal System

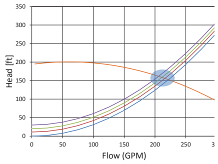
## Intelligent Design – Reliable Performance

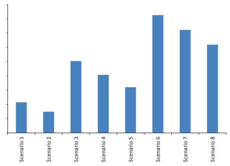
The TRS (Trihalomethane Removal System) is a custom-designed turn-key aeration system to reduce THM levels in drinking water storage tanks and reservoirs. TRS is not a single technology but a portfolio of aeration technologies: sprayers, surface aerators, mixers. Combined with proprietary design and performance modeling software called the NEPTUNE Toolbox™, these tools create in-tank aeration systems that are cost and energy-optimized. Unlike other aeration systems, the TRS is customized for each tank and its operating conditions to maximize effectiveness while minimizing cost.

Aeration Process | Storage Tank Model | Hardware Sizing | Energy Optimization









The NEPTUNE Toolbox™ is a proprietary set of computer models that allow us to accurately predict the performance of aeration systems BEFORE they are built.

## Powerful Partnership

TRS is the product of a partnership between PAX Water Technologies and Utility Service Company. PAX Water is the industry leader in energy-efficient hydrodynamic design. Utility Service is the largest tank maintenance provider in the U.S.. Working together, we provide municipalities with well-designed, reliably-installed aeration systems for potable water storage tanks and reservoirs.

## Valuable and Economical Tool for Stage 2 Compliance

While TRS may not be suitable for all tanks and reservoirs, it provides municipalities and engineers with an additional tool to address disinfection by-products in the distribution system. By combining TRS with other water quality improvements, water systems can reach their Stage 2 DBP goals more quickly and at a lower cost.

To find out more about TRS and how it can help you lower DBPs in your distribution system, watch our video "**Facts About Aeration**" **at www.paxwater.com/factsaboutaeration.**

Utility Service

PAX WATER TECHNOLOGIES™

# Appendix B – La Honda Redwood Tank Structural Evaluation TM

# 1.0 Background

The County of San Mateo owns and operates County Service Area No. 7 (CSA-7), La Honda Water System. A key element to this facility is an existing 70,000 gallon unanchored redwood water storage tank. The redwood tank is used to store raw water adjacent to the water treatment plant. The CSA-7 La Honda Water System Master Plan (Brown and Caldwell, 1998) found that the redwood boards supporting the tank on the concrete foundation were deteriorating and the redwood tank was not anchored to the supporting beams nor the concrete grade beam foundation. The Master Plan recommended replacement of the supporting redwood boards and anchorage of the tank to the foundation. Water Works Engineers, LLC (WWE) completed a site visit and analysis with the intent of updating Master Plan recommendations and designing improvements based on current field conditions.

The redwood tank wall consists of vertical redwood staves wrapped in galvanized steel cables. The walls support a pitched redwood roof system. The roof provides openings at the top of the wall around the entire perimeter for ventilation and is equipped with a roof vent at the center. The tank bottom consists of redwood planks over redwood joist framing which is supported by independent concrete grade beams. The foundation beneath the concrete grade beams is assumed to be compacted granular material. The tank piping is comprised of what appears to be a single Asbestos Cement Pipe (ACP) serving as both inlet and outlet (draw/fill), which is routed through the bottom of the tank, and an overflow pipe routed out the side of tank near the roof interface. The tank is approximately 28 feet in diameter and 16 feet tall. The normal operating level of the tank is a depth of 15.0 feet.

A site visit was performed on November 12, 2014 to observe the existing exterior structural conditions of the redwood tank. Previously, the interior of the tank was observed by a diver and the results of the interior inspection are currently being compiled by the inspection agency.

**Figure 1 70,000 Gallon Redwood Water Storage Tank**

## 2.0 Structural Analysis

A stability analysis of the tank was completed using ASCE 7-10, Minimum Design Loads for Buildings and Other Structures, section 15.7.6 which includes the design requirements for ground-support storage tanks for liquids. The analysis required by section 15.7.6 consists of prescriptive equations that provide components of impulsive (tank and contents) and convective (sloshing) loading to calculate the seismic base shear. Seismic loads are based on Maximum Considered Earthquake (MCE) ground motions, defined as the motions caused by a seismic event with a 2 percent probability of exceedance within a 50 year return period, which is commonly referred to as a 2,475-year earthquake. The known, nearest-site faults are the Pilarcitos Fault, San Andreas Fault, Hermit Fault, San Gergorio Fault, and the Butano Fault. The horizontal and vertical distribution of hydrodynamic and inertia forces were applied using the provisions of ACI 350.3 as allowed by ASCE 7-10 to address potential overturning and sliding. The tank is classified as a flat-bottom ground supported self-anchored tank per ASCE 7-10. The seismic importance factor was determined to be 1.50 consistent with Risk Category IV structures designated as essential facilities.

The seismic input data was determined from the USGS hazard data from 2008 and was used as a basis for the ASCE 7-10 analysis. The period for the convective load component was developed within the ASCE 7-10 analysis. As-built or record drawings were not available at the time of the analysis. Therefore, the structure weight was based on assumptions of member thicknesses and approximated dimensions. Seismic response of the tank was based on a maximum operating water depth of 15.0 feet.

## 3.0 Results of Analysis

The results of the ASCE 7-10 analysis indicated spectral accelerations for convective loading of 0.343g and for impulsive loading of 1.035g. Due to the narrow nature of the tank relative to its height, the overturning ratio was found to be quite high and therefore would require anchorage to prevent overturning during a seismic event. Sliding resistance is provided by friction between the tank joists and supporting wood nailers installed on the concrete grade beams. The coefficient of friction for wet wood is relatively low and does not provide significant resistance to sliding. Based on the calculated seismic base shear, the tank does not have sufficient resistance to resist sliding during a seismic event. The calculated freeboard was determined to be 4.0 feet to accommodate a code level seismic generated sloshing wave. A freeboard height of 1.0 feet was used in the analysis to produce a tank storage capacity of approximately 70,000 gallons. If the 4.0 feet of required freeboard was not accounted for during an earthquake it would likely result in significant damage, or collapse, to the roof system. The stresses in the existing members, e.g. vertical staves and circumferential cables, were not calculated due to a lack of information at the time of the analysis pertaining to member sizes and material properties.

## 4.0 Summary of Site Visit

Observations of the tank were made during the November 12th site visit. The tank was observed with an internal water depth of approximately 14.0 feet. No visual leaks were observed. The tank appeared to be level and did not exhibit any signs of ground settlement. The concrete grade beams and subgrade were observed to be in sufficient condition. The circumferential steel cables exhibited surface corrosion as shown in Figure 2. The vertical wood staves showed mild signs of rot along the bottom and supported moss growth along the vertical exterior surfaces. The roof was observed to be severely deteriorated and potentially unsafe to support live loads. The roof appeared to be lacking a sufficient load path to transfer horizontal shear forces to the wall due to all the openings that were provided for ventilation.

**Figure 2 Circumferential Cable Corrosion**

**Figure 3 Bottom of Vertical Stave**

**Figure 4 Tank Roof**

**Figure 5 Joists and Grade Beam**

## 5.0 Structural Analysis Conclusion

Based on the seismic analysis required by ASCE 7-10 the tank is subject to multiple insufficiencies when subjected to an earthquake. The tank is lacking anchorage, sliding resistance, roof to wall shear transfer, and insufficient freeboard, at a minimum. It was also determined that the existing roof is in poor condition and has likely exceeded its useful life and is in need of replacement.

## 6.0 Tank Retrofit / Replacement Options

Given the conclusions from the structural analysis of the existing 70,000 gallon redwood tank, Water Works identified several options for repair/retrofit or replacement of the existing tank

### Code Compliant Retrofit

The strategy for retrofitting the tank to meet current codes and extend the life of the tank would be extremely invasive. In order to anchor the tank for overturning and sliding resistance a new ring foundation would be required. Installing a ring foundation would require moving the tank or shoring the tank in place while the existing grade beams were modified to allow the placement of a ring foundation. Attaching the anchorage system to the tank walls would require unique detailing to individually anchor each vertical stave to prevent the staves from sliding vertically when the tank was subjected to overturning forces.

The roof would require connections to transfer roof diaphragm forces to the tank wall to prevent the roof from sliding off the wall during a seismic event. The capacity of the vertical staves and circumferential cables was not verified during the seismic analysis due to a lack of information pertaining to member dimensions and material properties. But it would be a fairly safe assumption to assume that the staves and cables are not sized for the hydrodynamic forces that they would be subjected to during an earthquake.

If the tank was to be retrofitted, the capacity of the staves and cables should be verified, and strengthened as required, to support hydrodynamic forces. The condition of the staves and cables would also need to be investigated further to verify that the rot on the staves and corrosion on the cables that was observed did not result in a loss of capacity and that the deterioration could be mitigated to extend the life of the tank. At a minimum, the corrosion and rot should be removed to prevent further degradation.

A planning level construction cost estimate for a code compliant retrofit is provided in Table 1.

**Table 1 Code-Compliant Redwood Tank Retrofit Cost Estimate**

| Item | | Quantity | Unit | Unit Cost | Total Cost |
|---|---|---|---|---|---|
| *Major Structural* | | | | | |
| *1* | Mobilization | 1 | ls | $5,000 | $5,000 |
| *2* | Roof Demo and Replacement | 616 | sf | $40 | $24,630 |
| *3* | Roof Anchorage | 22 | ea | $200 | $4,398 |
| *4* | Tank Wall Cleaning and Sealing | 1407 | sf | $10 | $14,074 |
| *5* | Tank Wall Anchoring | 176 | ea | $150 | $26,389 |
| *6* | Tank Shoring | 1 | ls | $7,500 | $7,500 |
| *7* | Grade Beam Demo | 10 | ea | $500 | $5,000 |
| *8* | Ring Footing | 21 | cy | $750 | $15,446 |
| | | | | | **$102,400** |
| | | | | | |
| **SUBTOTAL** | | | | | **$102,000** |
| Design Contingency | | | | 20% | $20,000 |
| | | | | | |
| **CONSTRUCTION BID COST OPINION** | | | | | **$122,000** |

Note this does not include field studies; design; permitting; and inspection services required for this retrofit alternative (estimated to be $60,000), which are likely to be at least twice as much as a replacement option.

## Code Compliant Replacement

The most cost effective way to provide a code compliant raw water tank is to replace the existing redwood tank with a new tank. Given the required size (70,000 gallons operational) and space limitations of the site, an AWWA D103-09 Factory-Coated Bolted Carbon Steel Tank for Water Storage is the most likely tank type for replacement. American Water Works Association (AWWA) standards are intended to represent a consensus of the water supply industry that the product described will provide satisfactory service. Based on the accumulated knowledge and experience of manufacturers, engineers and end-users of bolted steel tanks, AWWA D103-09 is the standard that governs factory-coated bolted steel tanks for water storage. A planning level construction cost estimate for a code compliant replacement of the existing tank with an AWWA D103 tank is provided in Table 2.

**Table 2 Code Compliant Redwood Tank Replacement with AWWA D103 Tank Cost Estimate**

| Item | | Quantity | Unit | Unit Cost | Total Cost |
|---|---|---|---|---|---|
| *Major Structural* | | | | | |
| *1* | Mobilization | 1 | ls | $5,000 | $5,000 |
| *2* | Existing Tank Salvage / Demo | 1 | ls | $2,100 | $2,100 |
| *3* | AWWA D103-09 Factory-Coated Bolted Steel Tank | 70000 | gal | $0.65 | $45,500 |
| | | | | | $0 |
| | | | | | $0 |
| | | | | | $0 |
| | | | | | $0 |
| *4* | Ring Footing | 21 | cy | $750 | $15,446 |
| | | | | | **$68,000** |
| | | | | | |
| **SUBTOTAL** | | | | | **$68,000** |
| Design Contingency | | | | 20% | $14,000 |
| | | | | | |
| **CONSTRUCTION BID COST OPINION** | | | | | **$82,000** |

Note this does not include field studies; design; permitting; and inspection services required for this replacement alternative (estimated to be $30,000), but these are likely to be less than half as much as a retrofit option.

## Non-Code Compliant Retrofit – Anchorage Only

An additional option is to construct non-code compliant improvements (i.e. some tank anchorage as recommended by the Master Plan) to provide some limited seismic induced failure risk reduction. In order to provide any such anchorage (however minimal), a ring footing would be constructed around the outside diameter of the tank and each vertical stave anchored individually to the new footing. A planning level construction cost estimate for this non-code compliant retrofit is provided in Table 3.

**Table 3 Non-Code-Compliant Redwood Tank Retrofit Cost Estimate**

| Item | | Quantity | Unit | Unit Cost | Total Cost |
|---|---|---|---|---|---|
| *Major Structural* | | | | | |
| *1* | Mobilization | 1 | ls | $2,500 | $2,500 |
| *2* | Roof Demo and Replacement | 0 | sf | $40 | $0 |
| *3* | Roof Anchorage | 0 | ea | $200 | $0 |
| *4* | Tank Wall Cleaning and Sealing | 0 | sf | $10 | $0 |
| *5* | Tank Wall Anchoring | 176 | ea | $150 | $26,389 |
| *6* | Tank Shoring | 1 | ls | $7,500 | $7,500 |
| *7* | Grade Beam Demo | 10 | ea | $500 | $5,000 |
| *8* | Ring Footing | 21 | cy | $750 | $15,446 |
| | | | | | **$56,800** |
| | | | | | |
| **SUBTOTAL** | | | | | **$57,000** |
| Design Contingency | | | | 20% | $11,000 |
| | | | | | |
| **CONSTRUCTION BID COST OPINION** | | | | | **$68,000** |

Note this does not include field studies; design; permitting; and inspection services required for this replacement alternative (estimated to be $25,000).

## 7.0 Recommendation

Water Works recommends complete replacement of the existing tank with a code compliant AWWA D103 Tank. This is the lowest first cost (design and construction) code-compliant option and the comparatively longest design life expectancy (estimated at 50-years).

The code compliant retrofit option has a higher first cost and a comparatively shorter design life expectancy (estimated at 20-years).

The non-code compliant retrofit provides no discernable seismic upgrade to the overall system as any seismic event large enough that the anchorage would be needed would likely cause the tank to fail in another way. Anchoring the tank does not ensure any real reduction in substantial damage following an earthquake and still requires first cost investment of nearly 80% of the code-compliant replacement option. The existing tank is in poor condition and has limited to any salvage value.

Lastly, this tank is also at risk of failure during a wildfire. Wooden tanks are not recommended in fire hazard zones because they are prone to failure when the need for water is in critical demand. Retrofitting the tank to mitigate the seismic insufficiencies would not address the risk that the tank is subjected to during a wildfire.

Due to the many seismic insufficiencies, the poor condition of the roof, and wildfire exposure, Water Works would not recommend moving forward with structural upgrades to the 70,000 gal redwood raw water storage tank (as recommended by Master Plan) and would recommend directing resources toward replacing the tank in-kind with an AWWA D103-09 Factory-Coated Bolted Carbon Steel Tank. The redwood tank has arguably exceeded its useful life and cannot be reasonably or economically upgraded to provide an extended life comparable to a tank replacement.

# Appendix C – Groundwater Development Assessment Report

ANDY ZDON & ASSOCIATES, INC.

# GROUNDWATER DEVELOPMENT ASSESSMENT REPORT LA HONDA CREEK PROJECT, SAN MATEO COUNTY, CALIFORNIA

WATERWORKS ENGINEERS

**PREPARED FOR WATERWORKS ENGINEERS, INC.**

**OCTOBER 9, 2015**

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# GROUNDWATER DEVELOPMENT ASSESSMENT, SAN MATEO COUNTY DEPARTMENT OF PUBLIC WORKS' LA HONDA PROJECT, CALIFORNIA

Prepared For:

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October 9, 2015

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President, Principal Hydrogeologist

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## EXECUTIVE SUMMARY

This Groundwater Assessment Report (Report) was prepared by Andy Zdon & Associates, Inc. (AZI) on behalf of Water Works Engineers for the San Mateo County Department of Public Works' La Honda project. Due to availability of water from alternate sources described later in this report, San Mateo County is evaluating additional water being derived from the La Honda Creek drainage. This would potentially include the use of groundwater. The primary goal of this project is to identify a potential test well site to develop a groundwater source in the La Honda area. Although the geology of the region is well-documented, we are unaware of any previous detailed hydrogeologic investigations in the La Honda Area.

This assessment was based on the results of a fracture trace analysis. In most rock environments, groundwater is found within zones of secondary permeability (i.e. fractures). Fracture trace analysis uses existing geologic data regarding geologic structures in combination with locating natural linear features on aerial/satellite imagery and topographic maps. These linear features, or "fracture traces," are surface expressions of joints and zones of joint concentration, or faults (Fetter, 2001).

Based on the results of this analysis, several potential test well sites were identified. The sites in order of preference are:

- The vacant lot immediately east of the San Mateo County yard (the yard address is 59 Entrada, La Honda;
- The Memory Lane location;
- The Glenwood Boys Camp site; and,
- The San Mateo County Yard site on Entrada.

Information regarding well siting requirements (state and local), permitting and well development area described and will need to follow local and state regulations.

# 1.0 INTRODUCTION

This Groundwater Assessment Report (Report) was prepared by Andy Zdon & Associates, Inc. (AZI) on behalf of Water Works Engineers for the San Mateo County Department of Public Works' La Honda project. La Honda is a community of approximately 1,000 residents located in the northern Santa Cruz Mountains (Figure 1). Potable water is supplied to the community by County Service Area No. 7 (CSA-7), the operator of the La Honda Public Water System. The source of water for the CSA-7 water treatment plant for the system is Alpine Creek. Due to water rights issues described later in this report, San Mateo County is evaluating additional water being derived from the La Honda Creek drainage. This would potentially include the use of groundwater.

The primary goal of this project is to identify a potential test well site to potentially develop a groundwater source in the La Honda area. Although the geology of the region is well-documented, we are unaware of any previous detailed hydrogeologic investigations in the La Honda Area.

## 1.1 Scope of Work

In order to complete the goals of this project, AZI conducted the following tasks:

- An initial site reconnaissance;
- Review of hydrogeologic literature and data for the area;
- Fracture-trace analysis to evaluate potentially optimal well locations;
- Second site visit to revisit locations identified in the fracture-trace analysis; and,
- Preparation of this Report.

### 1.1.1 Fracture Trace Analysis

This assessment was based on the results of a fracture trace analysis and field inspection of geologic and other site conditons. In most rock environments, groundwater is found within zones of secondary permeability (i.e. fractures). Fracture trace analysis uses existing geologic data regarding geologic structures in combination with locating natural linear features on aerial/satellite imagery and topographic maps. These linear features, or "fracture traces," are surface expressions of joints and zones of joint concentration, or faults (Fetter, 2001). In addition to locating potential well sites, fracture trace analysis has been used for varying purposes in hydrogeologic investigations (e.g., Hanson (1972), Stewart and Pettyjohn (1989), and Podwysocki (1974). It has been recommended that conducting the analysis over multiple sessions is preferred (Fetter, 2001) which was conducted in this analysis.

## 1.2 Location and Physiographic Setting

The Project Area (La Honda and Alpine Creek drainages) covers an area of roughly 13,000 acres (approximately 18 square miles) in northern California (Figure 1). The Project Area is within the Coast

Ranges, and is not within a California Department of Water Resources designated groundwater basin (DWR, 2003). However, La Honda and Alpine Creeks join to form San Gregorio Creek which flows into the San Gregorio Valley Groundwater Basin (DWR Basin #2-24).

The La Honda area is in a canyon surrounded by variously gentle to steeply sloping hills on the west slope of the northern Santa Cruz Mountains. Ground surface elevations in the La Honda / Alpine Creek watershed ranges from 2,572 feet above mean sea level (ft msl) at Borel Hill on Russian Ridge, (approximately three miles east of La Honda) to approximately 240 ft msl at Redwood Terrace along San Gregorio Creek (approximately one mile west of La Honda).

### 1.3 Climate

Climate data for the area is generally from discontinuous sources. The California Department of Water Resources (DWR, 2003) reports that precipitation in the San Gregorio Valley Groundwater Basin ranges from 24 to 28 inches. There are no currently operating stations in the La Honda / San Gregorio Creek watershed that comprises the project area. However, there have been three stations in the vicinity that have discontinuous records that provides an adequate understanding of precipitation characteristics. Generally, rainfall appears to increase eastward from the coast toward the crest of the Santa Cruz Mountains.

A station was formerly present in La Honda and operated from January 1954 to September 1977. The average annual precipitation at that station was 30.34 inches, with the wettest months being December and January when more than a third of the precipitation was typically recorded. A second station was present to the west at an elevation of 270 ft (San Gregorio 2SE). This station operated from June 1954 to November 2007, with average annual precipitation during this time being 29.42 inches. The average annual high temperature was 64.6 degree Fahrenheit, with the average annual low temperature being 44.5 degrees Fahrenheit. Finally, a third station along the crest of the Santa Cruz Mountains (Black Mountain 2WSW) operated from February 1954 to June 1995, and was at an elevation of 2,120 ft msl. The average annual precipitation at that station was 36.65 inches. There was insufficient temperature data for the La Honda and Black Mountain Stations for adequate temperature averages.

For the purposes of this investigation, it is important to note that the current field conditions are indicative of below normal precipitation for two of the last three years, and for 6 out of the last 8 years (inclusive of 2014).

### 1.4 Land Use

The principal land uses (not including open space / wild lands) in the Project Area are agricultural, residential and wildlife uses. Agricultural use is primarily crops such as grapes.

### 1.5 Water Rights

AZI reviewed the water rights summaries provided for the Project Area in the California State Water Resources Control Board's Electronic Water Rights Information Management System (eWRIMS). Although a detailed review of water rights is beyond the scope of this report, the surface water rights in the La Honda Creek / Alpine Creek area are adjudicated under the San Gregorio Creek Adjudication (California State Water Resources Control Board, 1989).

According to Superior Court of the State of California, County of San Mateo Decree No. 355792:

> *"In order to continue to serve those of its customers who hold decreed riparian rights to water from La Honda Creek, San Mateo County Service Area No. 7 (CSA No. 7) shall establish a new point of diversion on La Honda Creek or provide them with water from another source under other rights."*

Due to water system demands and available resources, providing water to the La Honda community can be problematic, particularly during summer (Brown & Caldwell, 1998).

### 1.6 Groundwater Management.

San Mateo County Department of Public Works operates Community Service Area (CSA) #7 serving the La Honda area. The water system provides service to approximately 70 customers along with the Camp Glenwood Boys' Ranch and Sam McDonald Park. The Public Works Department is also responsible for activities related to watershed protection. San Mateo County Environmental Health issues permits for water wells and other subsurface drilling; inspects wells and developed springs to assure proper construction, monitor water quality and certify that water is meeting local standards; and provides oversight and permitting for design, construction and operation of septic systems.

Since 2006, Stetson Engineers, Inc., has served as the Watermaster for the San Gregorio Creek adjudication. Their responsibilities include hydrologic monitoring, evaluating transfers, meter-related activities, maintaining a water usage database, and water right dispute resolution.

Groundwater quality issues are regulated by the California State Water Resources Control Board (California Regional Water Quality Control Board – Central Valley Region (Sacramento).

### 1.7 Sources of Information

Hydrologic data and other information gathered by AZI and used in this Report were from communications with, and reports by, San Mateo County, U.S. Geological Survey, California State Water Resources Control Board, California Department of Water Resources, Google Earth imagery, CalClim, and other consultants' reports collected by AZI and within AZI's water resources library.

# 2.0 GROUNDWATER SYSTEM

To put the well placement and potential groundwater development into context, a brief description of the groundwater system is presented below.

The Project Area is located in the northern Santa Cruz Mountains in San Mateo County, California. The geology of the Project Area is presented on geologic map (Figure 2). The area is within the Coast Ranges geomorphic provence. The Coast Ranges are a northwest-trending series of mountains and valleys generally parallel to the San Andreas Fault, and bounded on the west and east by the Pacific Ocean and Great Valley, respectively.

## 2.1 Hydrogeologic Units and Structures

Within the Project Area, the principal hydrogeologic units are the Quaternary-aged unconsolidated colluvium and fluvial deposits along the creeks and the Tertiary bedrock units. Each of these units have very different water-bearing characteristics and are described separately below, and are presented in the geologic map provided (Figure 2). AZI was unable to obtain any well logs for the purposes of this investigation to evaluate the hydrologic characteristics of these units. There were no wells noted in the project area on either DWR or U.S. Geological Survey databases.

### 2.1.1 Unconsolidated Deposits

Within the project area, the unconsolidated, Quaternary-aged colluvium and fluvial deposits are present within the stream channel and adjacent stream terraces that are surrounded by the bedrock terrain. Based on the geometry of the canyons containing La Honda and Alpine Creeks, it is believed that the unconsolidated materials are generally shallow in depth. Given the limited extent of these deposits in the project area, and the immediate location of the creeks, it is not anticipated that these deposits will be the principal aquifer material from which any future groundwater extraction will be focused.

### 2.1.2 Bedrock Units

Where the unconsolidated deposits are not present, bedrock units comprised of Tertiary-aged sedimentary and volcanic rocks are present in the immediate La Honda area. The principal bedrock units present in the La Honda and Alpine Creek drainages consist of:

- Tertiary-aged Purisima Formation (Tehana member);
- Tertiary-aged Monterey Formation;
- Tertiary-aged San Lorenzo Formation (Lambert Shale)
- Tertiary-aged Mindego Basalt;

In the La Honda area, the Purisima Formation (Tahana Member) consists primarily of medium to very-fine-grained lithic sandstone and siltstone with some silty mudstone (Brabb, Graymer and Jones, 1998). 2004). The Monterey Formation consists of shale and mudstone with some diatomite, claystone, and sandstone. The San Lorenzo Formation and Lambert Shale consists of mudstone, siltstone and shale, with beds of fine-to course grained sandstone. Pearce, et. al. (2004), lumped these units into one undivided Tertiary-aged sedimentary package for use in their review. This is also a convenient lumping from a hydrogeologic perspective as all of these units would generally have similar hydraulic characteristics although the Purisima Formation would likely exhibit greater water-bearing characteristics due to its coarser-grained material. Generally, these units would be of low permeability (hydraulic conductivities of less than 1 foot per day typical (Bureau of Reclamation, 1985)) and would not serve as typical "aquifer" materials except where fractures are present. As mentioned previously the Purisima Formation would likely exhibit improved water-bearing characteristics in areas where fractures were present. The Purisima Formation is also the unit most prevalent in the immediate La Honda area.

The Mindego Basalt generally consists of basalt and basaltic breccia with minor tuff, sandstone and mudstone (Brabb, Graymer and Jones, 1998). It is generally the most competent rock unit present in the area, and likely has the most open fracture sets of any of the Tertiary-aged units. However, it is generally present above the town of La Honda, beyond the area where well development associated with this project would be feasible.

### 2.1.3 Geologic Structure

The structural geology in the Santa Cruz Mountains is complex. This complexity is due to geologic history of the La Honda area having been one in which the basin in which the sediments were deposited was always near the tectonically active plate boundary (Stanley, 1990). In the Project Area, the principal fault is the La Honda Fault (Figure 2), approximately one mile west of La Honda. The La Honda Fault is a right-lateral strike slip fault (probable) that extends approximately 16 miles along a northwest trend. The effects of faulting on groundwater flow are generally two-fold:

- Increased groundwater flow in rocks fractured by faulting; and,
- Decreased flow (or barriers to flow) along fault planes where clayey fault gouge is present or where higher permeability water-bearing units are faulted adjacent to lower permeability units.

The degree of openness associated with La Honda Fault related fracturing is unclear. The La Honda Fault has been described as a Pre-Quaternary fault or a fault without recognized Quaternary displacement. This can be the result of a lack of detailed mapping (the La Honda area has not been mapped for Alquist-Priolo zones) and does not categorically mean the fault is not active (Jennings, 1994). Recent movement would tend to result in more open fractures. Given the absence of specific hydrogeologic data in the La Honda area such as those derived from aquifer testing, how these faults affect groundwater movement is uncertain.

## 2.2 Surface Water

The principal surface water body in the area is the San Gregorio Creek system of which La Honda and Alpine Creeks are tributaries. It is likely that there is communication between groundwater and surface water in the project area. It has been suspected that groundwater withdrawals may affect streamflow during low flow or otherwise dry periods (Stillwater Sciences, 2010). However, there are no specific data to support this assumption.

# 3.0 ANALYSIS AND RECOMMENDATIONS

In order to evaluate potential well locations, AZI conducted a fracture trace analysis of the area. This method is typically used in fractured rock terrains and is well described in the literature (e.g., Fetter, 2001) as described earlier in this report. Given the presence of the La Honda Fault in the project area, and the numerous lineaments identified in the fracture trace analysis, structural control on groundwater production in the La Honda area is likely.

In a fracture or fault-trace analysis, geologic structures are located by the study of existing geologic and/or fault maps, aerial photography, satellite imagery, and topographic map analysis. Fracture or fault traces may be identified as obvious features on the ground surface, or by lineaments only observable on topographic maps or various types of aerial imagery. Although a field inspection was conducted in association with the analysis, ground cover, development, and limited views of larger scale geologic features made the field visit of limited utility.

Maps and images used by AZI include:

- Google Earth imagery;
- Published geologic maps; and,
- Topographic quadrangle maps.

A map showing some key fracture and fault traces is provided on Figure 3. Reported faults are shown by thicker lines, whereas pertinent lineaments are presented by the more numerous thinner lines. The yellow rectangles are areas in which intersecting lineaments are most numerous. It is these areas that would likely provide the most successful well sites. The most prominent area of intersecting lineaments is in the area immediately east and west of La Honda Creek in the La Honda area (and north of Alpine Creek). Of note is that this area is within the mapped Purisima Formation, which is likely to be have better yields than other Tertiary sedimentary units such as the Monterey Formation or the San Lorenzo/Lambert Shale units. The prevalence of lineaments along La Honda Creek is to be expected given that fracture zones are less resistant to erosion than less fractured rock so streams tend to run along them (Fetter, 2001).

Given the geometry of the canyon and the nearby presence of La Honda Creek, it is possible that groundwater pumping could affect streamflow in the creek. The effect may be minimal, particularly if the well yield is not significant when compared to the combined stream flow (both surface flow and underflow) that occurs along the La Honda Creek or Alpine Creek channels. Although the locations have rankings associated with them on the figure, this should only be seen as guidance as any one of the areas could serve equally well.

With respect to the well sites topographically higher and away from the creeks, the additional costs of deeper drilling, well construction, and long-term power costs could be significant when compared to a well placed in the area west of La Honda Creek.

For this study, it was not within the scope of work to evaluate the overall effects of additional pumping such as an impact analysis in the area. Such a review could be accomplished as a separate task.

### 3.1 Recommendations

The areas marked in yellow immediately west and east of La Honda Creek (Figure 3) likely will provide the best opportunity for the development of production well to meet the needs of CSA No. 7. Of these, the four locations appeared to be the most promising locations for a production well. Photographs of the potential well sites noted on Figure 3 are provided on Figures 4 through 7. The sites in order of preference are:

- The vacant lot immediately east of the San Mateo County yard (the yard address is 59 Entrada, La Honda, CA (Figure 4);
- The Memory Lane location (Figure 5);
- The Glenwood Boys Camp site (Figure 6); and,
- The San Mateo County Yard site on Entrada (Figure 7).

#### 3.1.1 Vacant Lot East of San Mateo County Yard

This is the preferred site for a potential production well based on the geological analysis and site conditions. The vacant lot site has ample space for drilling equipment and support vehicles, power at the site, and available facilities if needed at the adjacent County yard. Given the elevation of the site relative to La Honda Creek, it is likely that groundwater would be relatively shallow reducing drilling costs. The proximity of the creek may also lead to stricter permitting requirements (e.g., a waste discharge permit).

#### 3.1.2 Memory Lane Location

The Memory Lane location is on private land adjacent to several residences. Although the site is forested, it is an open parking area, and a drilling rig would likely be able to raise its mast at the site without overhead obstruction. It would be recommended that a driller visit the site prior to bringing out heavy equipment. Further, Memory Lane has some low-hanging branches from trees on properties and a few branches may need to be trimmed to avoid tree damage depending on the drilling rig's clearance. As with the vacant lot site described above, given the elevation of the site relative to La Honda Creek and subsidiary creek that feeds it, total depth of drilling and associated costs may be less at this site, than for instance the Glenwood Boys Camp site. The proximity of the creek and residences may also lead to stricter permitting requirements.

### 3.1.3 Glenwood Boys Camp Site

While this site is geologically favorable with several intersecting lineaments identified, it is at significantly higher elevation and could lead to significantly higher drilling and well development costs. The presence of the seepage ponds up gradient may pose a potential water quality issue for local groundwater that would be tapped by the well.

### 3.1.4 San Mateo County Yard, 59 Entrada

The only issue that keeps this site from being the most preferred site is the presence of the fuel island. This site is listed on the California State Water Resources Control Board Geotracker site as having had a past gasoline fuel release in 1990. According to the Geotracker report, only soil was impacted. Apparently, the site was deemed to not need remedial action and the case was closed. In any event, the proximity of petroleum hydrocarbon facilities results in an added future risk to production well even if soils and groundwater are currently not impacted. If this site were to be utilized, it is recommended that frequent groundwater quality monitoring be conducted to assure that groundwater entering the well is not impacted by gasoline or other petroleum hydrocarbons.

## 3.2 Other Considerations

The yield of such a well would nonetheless likely be of low yield. Given the absence of any information regarding surrounding wells if they exist, we are not able to estimate what that would be although a yield in excess of 10 gallons per minute would seem plausible. It is possible the yield could be significantly more than that. With respect to well placement, there is limited flexibility. For example, a well that is placed somewhat outside of the potential locations identified on Figure 3, would be acceptable as long as the location remained within close proximity to multiple intersecting lineaments.

Given AZI's scope of work, we have presented potential well locations based on preferred areas of groundwater yield which are in turn based on hydrogeologic conditions. However, additional considerations should be recognized when marking the actual drilling location on-site. In all cases, the new wells should not be placed immediately next to existing wells (if present) so that well interference between the wells does not become a problem. When marking the well location in the field, other aspects will need to be taken into consideration including the presence of overhead utilities or trees which could obstruct drilling equipment and/or present a safety hazard during drilling operations. Additionally, California Well Standards recommend placing any well a minimum of 50 feet horizontally from any sewer line (sanitary, lateral, etc.); 100 feet from any watertight septic tank or sewage leach field. The well should also be placed upgradient, or off gradient from any of these features if possible. San Mateo County may also have a setback requirement from any surface water body such as La Honda or Alpine Creeks and the County of San Mateo should be consulted for such a requirement. A well permit from the County of San Mateo will also need to be obtained.

Further, it is important to note that, the California Well Standards state that "*If possible, a well should be located outside areas of flooding. The top of the well casing shall terminate above grade and above known levels of flooding caused by drainage or runoff from the surrounding land. For community water supply wells, this level is defined as the: "…floodplain of a 100-year flood..." (Section 66417, Siting Requirements, Title 22 of the California Code of Regulations."*

Should a test well in that location be explored, it is recommended that a controlled aquifer test be run on the that test well with monitoring on La Honda Creek to evaluate pumping characteristics and to be able to gather information that would allow evaluation of pumping scenarios that would have the least effect, if any, on the creek(s).

### 3.3 Steps for Developing a Well

Should groundwater exploration be desired at one or more of the sites described in this report, a test well will need to be completed at each location. Prior to drilling, the well location(s) will need to be marked for underground utility clearance. Additionally, a well permit will need to be obtained from San Mateo County, and a discharge permit may also be required by the California Regional Water Quality Control Board (Board) if there are discharges due to drilling activities or well testing. Containment of drilling fluids/cuttings, etc., may result in a permit not being required. Regardless, the Board should be consulted about a potential permit requirement. A California-licensed driller (C-57 license) will be required to be contracted to install the test well. It is also recommended that a California Professional Geologist be contracted for drilling oversight, logging and performance of well tests.

If the results of test drilling are favorable, the well can be completed as a production well. In this case, it is likely that the well will have a relatively low yield, therefore the test well will probably be completed as a final production well. The well will need to be installed to meet state and local regulations. Upon completion of the well, it will need to be developed and a test pump installed. In order to evaluate well yield, a step-drawdown test should be sufficient (pumping is conducted at varying rates and the associated drawdown in the well is measured). It is also recommended that a longer duration constant discharge and recovery test be conducted to evaluate the effects of pumping and given the geologic structures present, to evaluate the potential for any boundary conditions. If that is completed, gaging of La Honda Creek may be needed, particularly if the potential for induced recharge from La Honda Creek and associated reduced stream flow is deemed an issue that needs to be evaluated. The potential well yield may be insignificant in comparison to stream flow in which case a change in stream flow would likely also be insignificant. Based on the results of the aquifer test, an environmental analysis of the effects of pumping could then be conducted if needed.

## 4.0 CONDITIONS AND LIMITATIONS

This report has been prepared according to generally accepted standards of hydrogeologic practice in California at the time this Report was prepared. Findings, conclusions, and recommendations contained in this Report represent our professional opinion and are based, in part, on information developed by other individuals, corporations, and government agencies. The opinions presented herein are based on currently available information and developed according to the accepted standards of hydrogeologic practice in California. AZI does not guarantee that a well that is developed as a result of the recommendations of this report will produce a specific quantity of water. Other than this, no warranty is implied or intended.

## 5.0 REFERENCES

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**FIGURES**


Figure 1. Location of La Honda Project Area, San Mateo County

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Adapted from Brabb and Pampeyan (1972)

**Geologic Units**

Qt – Quaternary Terrace Deposits
Tpt – Tertiary Purisima Formation, Tehana member
Tmb – Tertiary Mindego Basalt
Tls – San Lorenzo Formation / Lambert Shale

N

Figure 2. Geology of La Honda Project Area, San Mateo County

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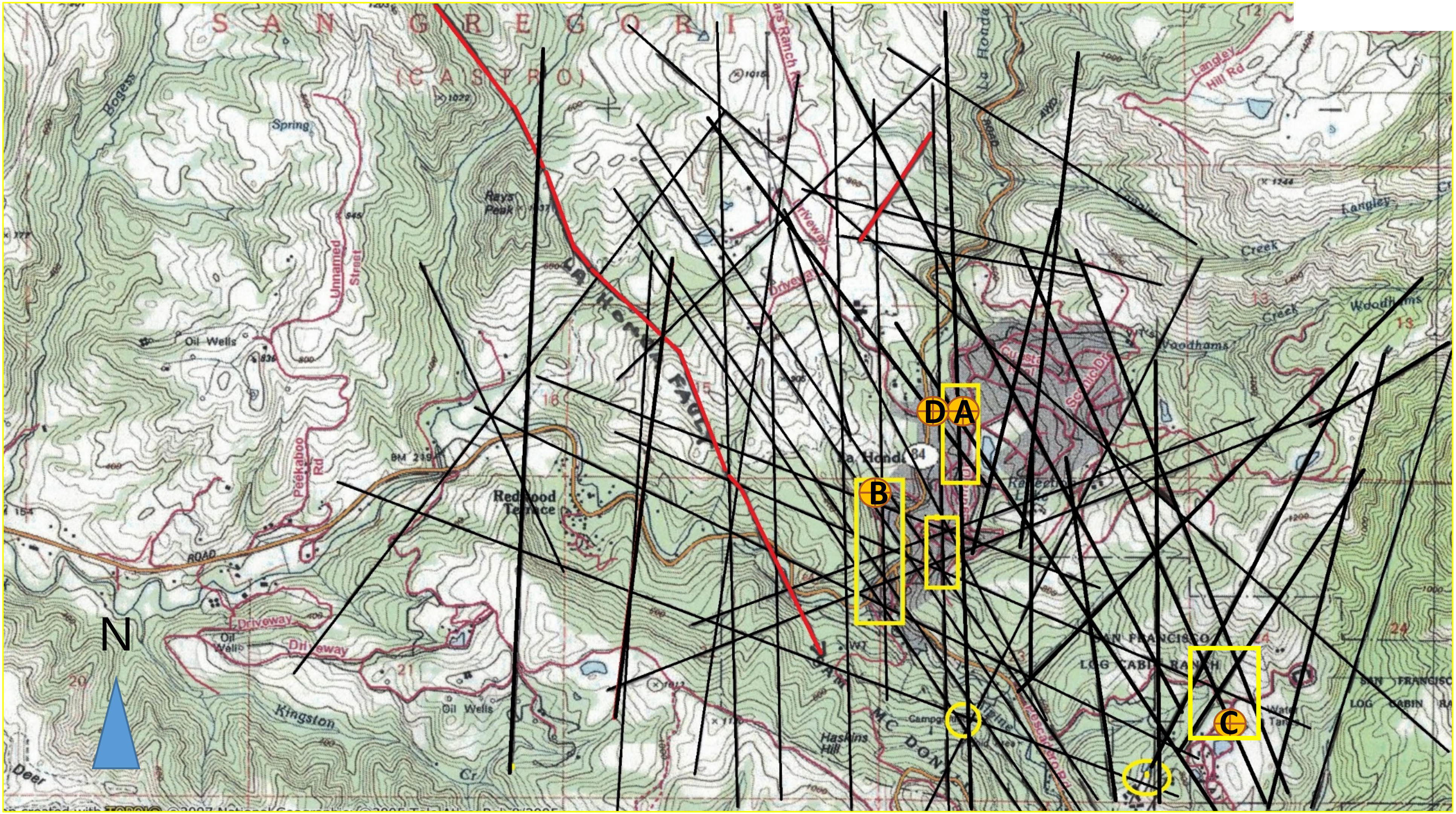


## Well Sites

A - East of County Yard
B - Memory Lane Site
C - Glenwood Boys Camp Site
D - San Mateo County Yard Site

Figure 3
Fracture Trace Analysis & Recommended Well Site Areas

Date: January 16, 2015
Project: La Honda
Image Source: TOPO!

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Figure 4. Site East of San Mateo County Yard, Entrada Way

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Figure 5. Memory Lane Site

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Figure 6. Glenwood Boys Camp Site

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Figure 7. San Mateo County Yard Site

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# Appendix D – TTHM/DBP Compliance Letter from DDW

**State Water Resources Control Board**
Division of Drinking Water

May 20, 2015

Ms. Ann Stillman
Deputy Director
County of San Mateo – Department of Public Works
555 County Center, 5th Floor
Redwood City, CA 94063

Dear Ms. Stillman:

**DISINFECTION BYPRODUCT FORMATION ASSESSMENT**
**County Service Area 7, Water System No. 4100509**

This letter is in regards to the Disinfection Byproduct Formation Assessment Technical Memorandum (memo) prepared by Waterworks Engineers for the County Service Area 7 (CSA 7) water system. The CSA 7 water system is operated by the County of San Mateo – Department of Public Works (DPW) and provides domestic water to approximately 70 residential customers in the La Honda community. The water system consists of a surface water source (Alpine Creek), raw water intake pump, a 70,000 gallon raw water storage tank, a surface water treatment plant (WTP), a 500,000 gallon treated water storage tank and a distribution system. Treated water from the WTP can feed the distribution system directly or fill the 500,000 tank for gravity distribution. Citation No. 02-17-13C-033 was issued to CSA 7 on December 31, 2012 for failure to comply with the total trihalomethane (TTHM) maximum contaminant level (MCL) of 80 ug/L based on a locational running annual average (LRAA). To determine the appropriate level and location of treatment, CSA 7 collected a series of TTHM data after the WTP, treated water storage tank and within the distribution system. The data suggested that the primary formation of TTHM occurs in the treated water storage tank. As such, CSA 7 proposed within the memo to install a recirculating spray system and headspace ventilation system in the treated water storage tank.

In discussions with DPW staff, it was noted that CSA 7 will design and install a custom-built aeration system. As part of the design and permitting documents, please submit an Engineering Report, plans and specifications, and an operations plan for the aeration system. The Engineering Report shall discuss the expected performance of the specific aeration system chosen and the calculations and other supporting documents demonstrating that the proposed design and operation will consistently and reliably reduce the TTHM levels to below standards. The plans and specifications shall include the specification sheet for each treatment component. Please note that pursuant to Section 64590 of the California Waterworks Standard, all components that come into contact with the drinking water supply shall be tested and certified as meeting the specification of NSF/ANSI 61-2005. The operations plan shall discuss the operations and maintenance of the aeration system and water quality monitoring.

Please respond within 30 days of receipt of this letter with a proposed schedule for submitting the above stated documents and construction. If you have any questions regarding this letter, please contact Ms. Van Tsang at (510) 620-3602.

Sincerely,

Eric Lacy, P.E.
District Engineer
Santa Clara District
Drinking Water Field Operations Branch
Division of Drinking Water

cc: San Mateo County Environmental Health