Silicon Valley Clean Water

San Carlos Odor Control Facility
Project Planning Report

Task Order 2016-05

REGISTERED PROFESSIONAL ENGINEER
WILLIAM JAMES SCHILLING
C 75959
Exp. 6/30/2018
CIVIL
STATE OF CALIFORNIA

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CDM Smith

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Executive Summary

ES.1 Document Purpose

This planning report presents the current thinking regarding the San Carlos Odor Control (SCOC) Facility Project (Project), which is one of several projects included in an overall Capital Improvements Program (CIP) being executed by Silicon Valley Clean Water (SVCW). Information provided here is conceptual in nature and is provided for information only mostly as background. SVCW staff and consultants have developed many ideas regarding the CIP projects and these ideas are described in the various planning reports. The intent is to describe the projects developed for and as generally presented in the Environmental Impact Report (EIR). It is not meant to be a preliminary or final design and it is not intended to be prescriptive to a progressive design build entity. A progressive design build entity will review this information as background and then work collaboratively with SVCW to develop additional alternative concepts, preliminary design, a final design, and then construct the Project. Alternative concepts may be developed that vary from the concepts contained in the planning reports. These new concepts will be considered and evaluated as alternatives. If the final project varies significantly from the concepts shown in these planning reports, additional California Environmental Quality Act (CEQA) review may be required. The level and timing of this possible CEQA review will be considered as the concepts are evaluated.

ES.2 Project Background

SVCW is implementing a CIP to improve the reliability of their conveyance system and waste water treatment plant (WWTP). The CIP includes rehabilitation and repurposing of several collection system pump stations and installation of the following new facilities:

- Gravity Pipeline to replace the existing 54-inch force main that conveys wastewater to the treatment plant.
- Receiving Lift Station (RLS) located on the treatment plant site at the end of the new Gravity Pipeline.
- Headworks Facility to remove screenings and grit from influent wastewater.
- Influent Connector Pipes to convey flow from the Headworks Facility to the primary clarifiers.
- Odor control facilities to treat foul air venting from the RLS and Headworks Facility, referred to as the Front of Plant (FoP) Odor Control Facilities.
- Odor control facilities to treat foul air venting from a Gravity Pipeline drop shaft structure, referred to as the SCOC Facility.
- Flow Diversion Structure (FDS) to be used to equalize flows to the plant during dry weather conditions (This would be a future project if desired).

- Civil Improvements for the FoP area to accommodate the new RLS, Headworks Facility, and FDS.
- Nutrient Removal Facilities, including new aeration basins and secondary clarifiers, to remove nitrogen and phosphorus from outgoing wastewater in preparation for new regulations (This would be a future project when required).
- Stormwater Treatment Planters and a Stormwater Pump Station to handle stormwater in the FoP area.
- Belmont Force Main Rehabilitation to line the existing force main that conveys wastewater flow from the City of Belmont to the SVCW WWTP.
- San Carlos Pump Station (SCPS) Site Improvements.
- Redwood City Pump Station Replacement and Menlo Park Pump Station Rehabilitation to improve the existing conveyance system.

ES.3 Project Objectives

As part of the conveyance system modifications being performed as part of the CIP, a drop shaft will be installed at the site of the existing SCPS. The drop shaft will receive sewage from the Cities of San Carlos and Belmont, and convey it into the Gravity Pipeline. When wastewater flows are stored in the Gravity Pipeline, to equalize dry weather flows or reduce peak wet weather flows conveyed to the WWTP, the Gravity Pipeline may fill at the RLS so that air could be forced out of the pipeline through the Drop Shaft at the SCPS site. Therefore, odor control facilities will be placed at the SCPS site to contain and treat any odors venting from the Drop Shaft.

ES.4 Project Location

The SCPS is located on an approximately 1-acre site at the northwest end of Monte Vista Drive, adjacent to the San Carlos Airport. The SCPS currently receives sewage via gravity sewers, and 48-inch forcemains, and pumps it into a 54-inch force main that conveys the sewage to the SVCW WWTP.

After execution of the San Carlos service area conveyance system modifications, which are proposed as CIP, sewage currently pumped by the SCPS will flow by gravity into the Gravity Pipeline and the SCPS will no longer be needed for pumping sewage. Therefore, it is proposed that the existing SCPS building be used to house the odor control facilities proposed as part of this Project

ES.5 Project Description

A conceptual mechanical layout of the SCOC Facility is shown in Figure ES-1. Design criteria for the facility is provided in Table ES-1.

As shown, the facility consists of chemical scrubbers and chemical storage/metering equipment installed inside the existing SCPS building. The equipment would be installed on the ground level floor of the pump station. The equipment would be located on concrete pads and would be surrounded by concrete curbs to provide secondary containment. The containment areas would be coated with a chemical resistant coating.

Prior to installing the new odor control equipment, the existing equipment would need to be removed, including large wastewater pumps, small chemical metering pumps, chemical storage tanks, air handling fans, electrical motor control centers (MCCs), and other miscellaneous equipment, piping and conduit. In addition, interior walls would need to be removed, new walls erected, floor openings sealed, the roof modified to accommodate odor scrubber vent stacks, and new doors installed to provide access to the equipment. Renovations to the building may also include updates to meet the latest codes and cosmetic updates to the building's exterior, which would be addressed during detailed design.

The chemical scrubbers would require an approximately 42-inch duct, ran underground from the Drop Shaft to the odor control equipment to convey the odorous air. The 42-inch duct could run in the same alignment as an existing 48-inch steel pipe. The existing 48-inch pipe would be removed to make room for the duct. In addition, each scrubber would require a water supply line sized for 3 gpm and a 6-inch sanitary sewer line to drain spent scrubbing water from the odor control units back into the Gravity Pipeline. The sewer line could run parallel to the 42-inch air duct. The depth of the excavation required for these two pipes is approximately 8 feet.

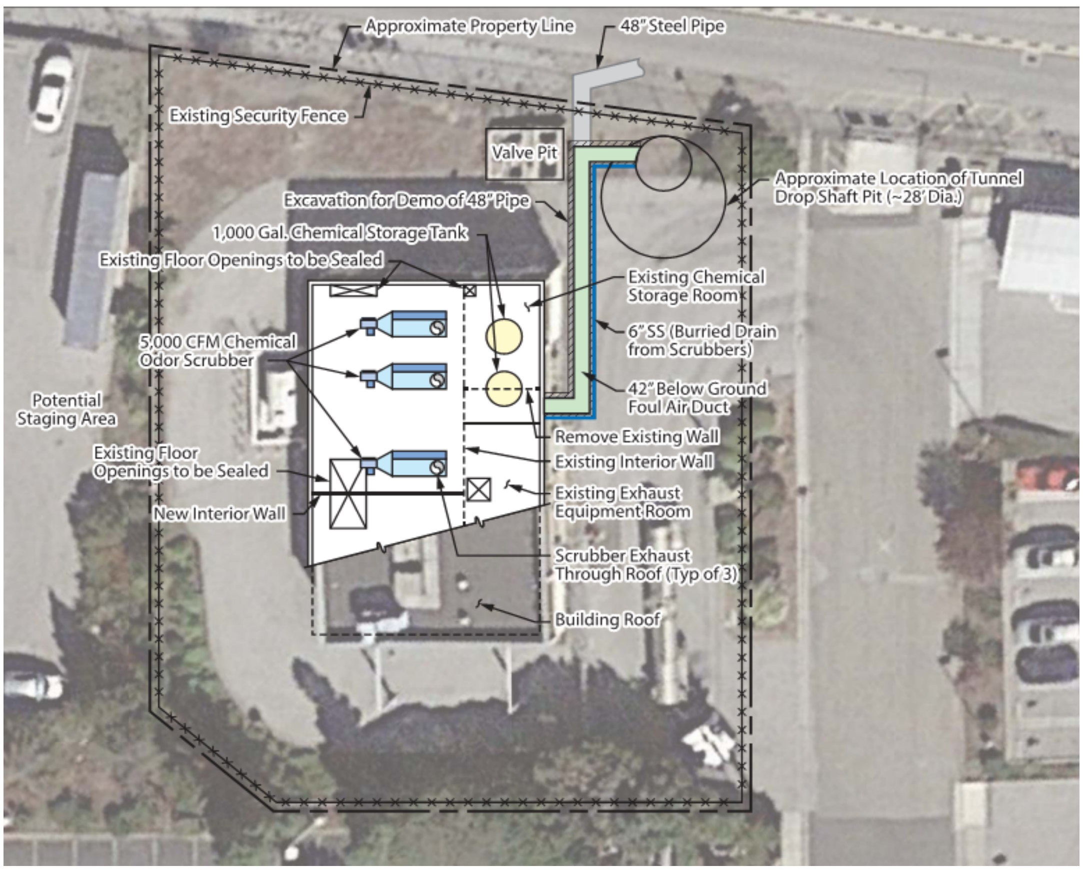

Figure ES-1
San Carlos Odor Control Facility Conceptual Layout

Table ES-1 San Carlos Odor Control Facility Preliminary Design Criteria

Item	Value
Scrubber Units	
Number	3
Capacity, ea.	5,500 cfm
Ventilation Fan	
Number	1 per scrubber
Motor Size, ea.	15 hp
Recirculation Pumps	
Number	2 per scrubber
Motor Size, ea.	10 hp
Chemical Demand	
25% Sodium Hydroxide (NaOH)	660 gpd
12.5% Sodium Hypochlorite (NaOCl)	160 gpd
Sodium Hydroxide Storage	
Storage Tank Volume	8,000 gal
Days of Storage	12 days
Sodium Hypochlorite Storage	
Storage Tank Volume	3,000 gal
Days of Storage	19 days

ES.6 Construction

Construction of the SCOC Facility will take approximately 6 months. The proposed SCOC Facility is located on the same site as the proposed San Carlos Drop Shaft. Modifications to the San Carlos conveyance system piping will also be made at this site. Regardless of the project delivery method that SVCW chooses for executing the CIP Projects, the SCOC Facility will likely not be constructed under a contract that does not include construction of the Drop Shaft or San Carlos conveyance system pipe modifications. Therefore, the sequencing of construction of these projects will need to be closely coordinated.

The SCOC facility cannot be constructed until the Gravity Pipeline and San Carlos Drop Shaft are installed; the San Carlos conveyance system modifications are completed; and the San Carlos Pump Station is decommissioned. This means the Gravity Pipeline and associated Drop Shaft will be operational before the SCOC facility is constructed. Therefore, temporary odor control will be needed to treat foul air venting form the Drop Shaft while the SCOC Facility is being constructed. Trailer mounted carbon canisters could be used for this purpose.

ES.7 Life Cycle Cost

A 50-Year Life Cycle Cost (LCC) was calculated for the San Carlos Odor Control (SCOC) Facility. The LCC is for a 50-year period from 2016 to 2066. The LCC for the SCOC Facility includes the following components:

- Capital Costs

- Annual O&M Costs, including
  - Labor
  - Power
  - Chemicals
- Periodic Equipment Rehabilitation and Replacement Costs

The cost for each of the components listed above were developed for each year over a 50-year period between 2016 and 2066. The Net Present Value (NPV) of the cash flow over that 50-year period was then calculated for all the cost components. The LCC is summarized in Table ES-2 below.

Table ES-2 Total Life Cycle Costs

	Cost
Capital Cost (2022 Dollars)[1]	
Base Market Fluctuation	$6.8 million
Low Market Fluctuation	$7.0 million
High Market Fluctuation	$7.6 million
NPV of Annual O&M and Rehabilitation & Replacement Costs (2022 Dollars)	
Labor	$1.9 million
Power	$2.6 million
Chemicals	$1.4 million
Rehabilitation & Replacement	$4.5 million
50-Year Life Cycle Cost (LCC) (2022 Dollars)	$17.1 - $17.9 million

[1] Capital Cost reflects the Raw Construction Cost ($3,280,000 in 2016 Dollars) with Project Contingency, Soft Costs, Market Fluctuations, and Escalation applied to the raw cost.

ES.8 Outstanding Issues to Carry into Design

Outstanding issues to be carried over into the design phase of the Project include the following:

- A more detailed analysis of carbon adsorbers versus chemical scrubbers should be conducted during detailed design to determine which approach has a lower life cycle cost and better meets the objectives of the project.
- Further sampling and evaluation should be conducted to confirm design airflows and odor characteristics for the SCOC facility.
- A more detailed condition assessment of the existing San Carlos Pump Station (SCPS) should be performed, as some areas were not accessible during assessments.
- Preliminary structural calculations show that the existing 8-inch concrete slab may not be sufficient to support the new scrubbers due to excessive flexure. This should be verified with a detailed analysis using more accurate existing concrete and reinforcing steel strength and design loads.

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Section 1

Introduction and Background

1.1 Introduction

This report presents the status of the San Carlos Odor Control (SCOC) Facility Project (Project), which is one of several projects included in an overall Capital Improvements Program (CIP) being executed by Silicon Valley Clean Water (SVCW). An overview of the existing facilities, the CIP, the Project, and any relevant background information are presented in this section. Further detail regarding existing conditions and the design, construction, operation, maintenance, and environmental impacts of the SCOC Facility are discussed in subsequent sections of this report. Additional background information for the project planning reports being created as part of the CIP may be found in Appendix H appended to the end of this report.

1.2 Overview of Existing Facilities

The SVCW wastewater treatment plant (WWTP) is a regional facility that treats sewage from the West Bay Sanitary District, the City of Redwood, the City of San Carlos, the City of Belmont, and portions of unincorporated San Mateo County. The treatment plant is located at 1400 Radio Road in Redwood City, CA. The facility receives sewage via four main pump stations and a network of force main conveyance pipelines. A location and vicinity map of the SVCW WWTP and collection system is provided in Figure 1-1. These facilities are described in greater detail in the following sections.

Figure 1-1
Location and Vicinity Map

1.2.1 Existing Collection System

Figure 1-2 below shows a schematic of the collection system that conveys wastewater to the SVCW WWTP. As shown, there is a 54-inch force main which receives flow from the four main collection system pump stations and delivers it to the plant. The Belmont Pump station and the San Carlos Pump Station discharge flow into the 54-inch force main via a 24-inch and 48-inch pipes, respectively. The combined flow from the Redwood City and the Menlo Park Pump Stations are discharged into the 54-inch force main via a 48-inch pipe. The pump stations receive flow from their respective service areas via gravity conveyance piping. The locations of the four main collection system pump stations and the collection system force mains are shown in Figure 1-1.

Not shown in Figures 1-1 and 1-2 is the Redwood Shores Pump Station and its force main. This pump station receives flow from the Redwood Shores community and pumps it to the SVCW WWTP via an 18-inch pipe. The 18-inch pipe connects to the 54-inch force main directly upstream of the existing headworks facility, as described in Section 1.2.2 below.

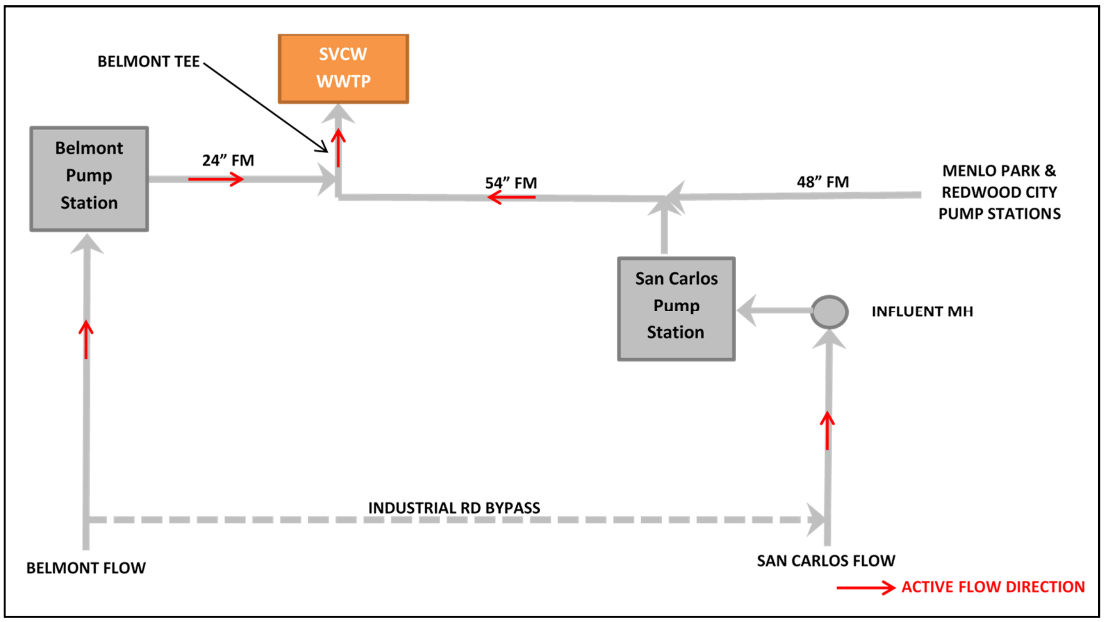

Figure 1-2
Existing Conveyance System and WWTP

1.2.2 Existing Wastewater Treatment Plant

The SVCW WWTP was originally designed in 1977. The existing liquid treatment stream at the treatment plan includes preliminary treatment consisting of a screening facility; primary treatment consisting of primary clarifiers; secondary treatment consisting of fixed film reactors, aeration basins, and secondary clarifiers; and tertiary treatment consisting of dual media filters and disinfection facilities. Solids treatment processes at the SVCW WWTP consist of gravity thickening, a gravity belt thickener, anaerobic digestion and sludge dewatering (through either a centrifuge, low speed fan press or sludge drying beds). Most of the treated effluent is discharged through a deep-water outfall into the lower San Francisco Bay. A portion of the final effluent is reused by the City of Redwood's recycled water program. Dewatered and/or dried biosolids are disposed of at a local landfill. A site layout of the existing SVCW WWTP showing the location of the process units described above is provided in Figure 1-3. The preliminary treatment facilities, which are the immediate focus of the CIP are described in greater detail in Section 1.3.1.

Figure 1-3
Existing Facility Site Plan

1.2.3 Existing San Carlos Pump Station Facility

The San Carlos Pump Station (SCPS) is located on an approximately 1-acre site at the northwest end of Monte Vista Drive adjacent to the San Carlos Airport as shown in Figure 1-4 below.
The SCPS currently receives sewage from the City of San Carlos and unincorporated areas of San Mateo County via gravity sewers, and pumps it into a 54-inch force main that conveys the sewage to the SVCW WWTP, as described in Section 1.2.1 above. The SCPS also includes booster pumping capability to reduce operating pressure in the conveyance system to prevent pressure-related pipe failures, which is used primarily for wet weather flows.

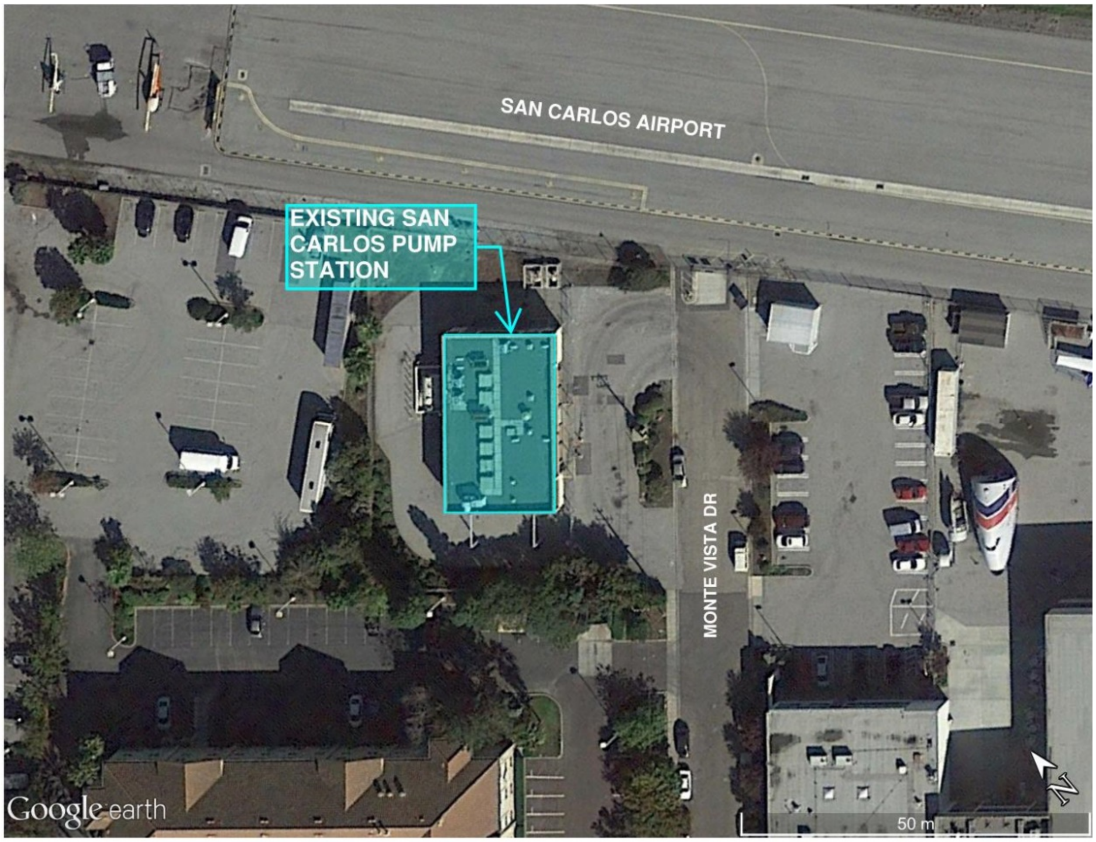

Figure 1-4
Existing San Carlos Pump Station

1.3 Capital Improvement Project (CIP) Overview

1.3.1 Improvements Proposed in the CIP

SVCW is implementing a CIP to improve the reliability of their conveyance system and WWTP. The CIP includes rehabilitation and repurposing of several collection system pump stations and installation of the following new facilities:

- Gravity Pipeline to replace the existing 54-inch force main that conveys wastewater to the treatment plant
- Receiving Lift Station (RLS) located on the treatment plant site at the end of the new Gravity Pipeline
- Headworks Facility to remove screenings and grit from influent wastewater
- Influent Connector Pipes to convey flow from the Headworks Facility to the primary clarifiers
- Odor control facilities to treat foul air venting from the RLS and Headworks Facility, referred to as the Front of Plant (FoP) Odor Control Facilities

- Odor control facilities to treat foul air venting from a Gravity Pipeline drop shaft structure, referred to as the SCOC Facility
- Flow Diversion Structure (FDS) to be used to equalize flows to the plant during dry weather conditions (This would be a future project if desired)
- Civil Improvements for the FoP area to accommodate the new RLS, Headworks Facility, and FDS
- Nutrient Removal Facilities, including new aeration basins and secondary clarifiers, to remove nitrogen and phosphorus from outgoing wastewater in preparation for new regulations (This would be a future project when required)
- Stormwater Treatment Planters and a Stormwater Pump Station to handle stormwater in the FoP area
- Belmont Force Main Rehabilitation to line the existing force main that conveys wastewater flow from the City of Belmont to the SVCW WWTP
- San Carlos Pump Station (SCPS) Site Improvements
- Redwood City Pump Station Replacement and Menlo Park Pump Station Rehabilitation to improve the existing conveyance system

A schematic of the proposed conveyance system modifications is shown in Figure 1-5. A site plan showing the location of the proposed new facilities at the treatment plant site is provided in Figure 1-6.

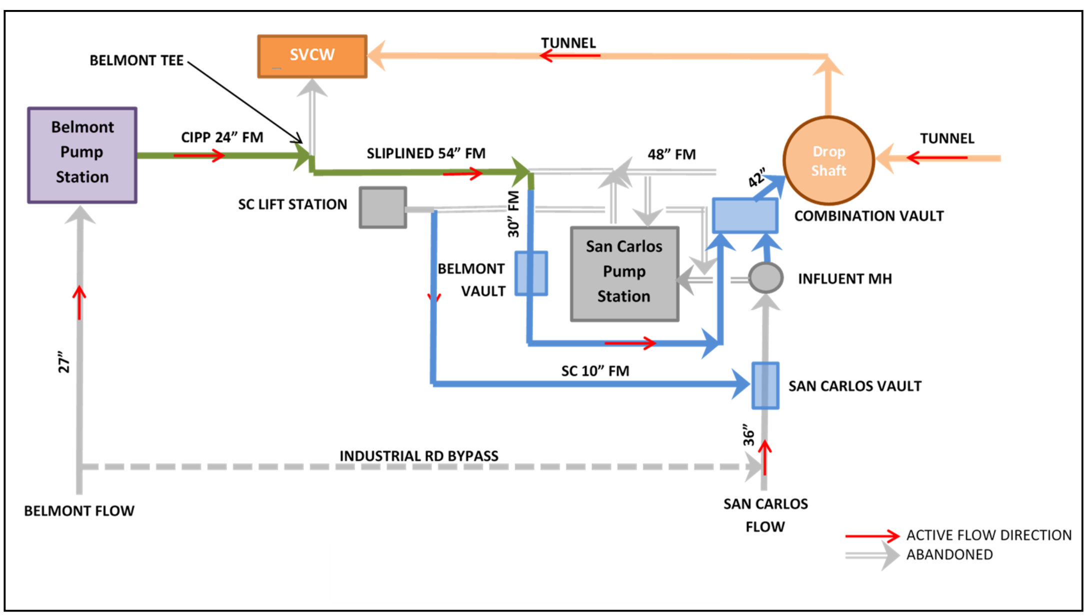

Figure 1-5
Proposed Conveyance System Modification Projects in CIP

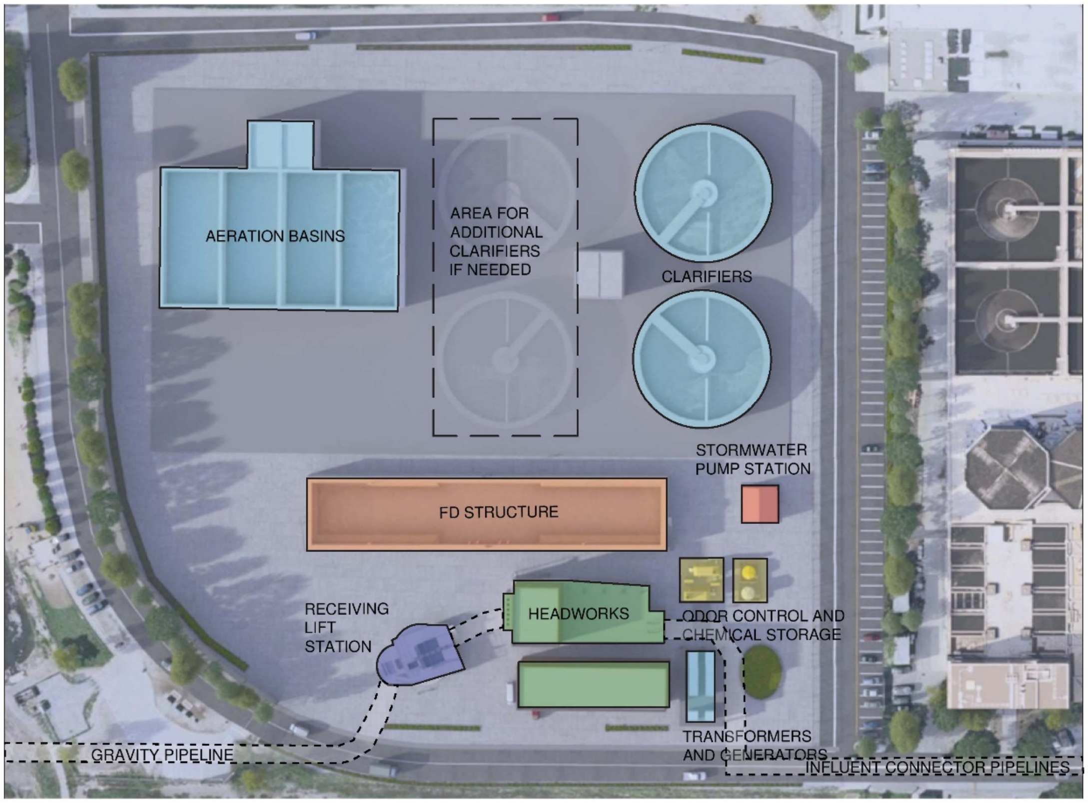

Figure 1-6
Proposed WWTP Facility Projects in CIP

1.3.2 Currently Proposed Improvements

Since the CIP was drafted, SVCW has decided to move forward with only 15 of the 17 proposed projects. At this time, SVCW has chosen not to immediately move forward with the FDS and Nutrient Removal Facilities Projects to equalize flows to the plant during dry weather conditions and to add wastewater treatment processes to the existing WWTP in anticipation of new nitrogen and phosphorus regulations, respectively. The following are the CIP Projects SVCW has chosen to move forward with:

- Gravity Pipeline
- RLS
- Headworks Facility
- ICP
- FoP Odor Control Facilities
- SCOC Facility
- FoP Civil Improvements
- Stormwater Treatment Planters and a Stormwater Pump Station

- Belmont Force Main Rehabilitation
- SCPS Site Improvements
- Redwood City Pump Station replacement and Menlo Park Pump Station Rehabilitation

1.3.3 Delivery Method for CIP Projects

In the initial planning stages of the CIP, SVCW had intended to use a design-bid-build project delivery approach for all the proposed improvements. Under this approach, the CIP improvements could be grouped together in the following projects, each with their own design team and Contractor:

- Gravity Pipeline Project
- Pump Station Modifications Project, which includes the SCPS Site Improvements, Redwood City Pump Station Replacement, and Menlo Park Pump Station Rehabilitation
- RLS Project
- Headworks Facility Project, which includes the Headworks Facility, the FoP Odor Control Facility, and the SCOC Facility
- The ICP
- The Civil Site Improvements Project, which includes the FoP Civil Improvements and installation of the Storm Water Pump Station

However, SVCW is now considering using a design-build project delivery method for some of the proposed improvements. Under this approach, the proposed improvements would be grouped together and executed as follows:

- The Gravity Pipeline Project, which includes the Gravity Pipeline and piping improvements at San Carlos pump station, would be executed using a progressive design-build delivery method.
- The Front of Plant (FoP) Improvements Project, which includes the RLS, Headworks Facility, the FoP Odor Control Facility, and the ICP, would be executed using a progressive design-build delivery method.
- The Civil Site Improvements Project will be executed in two phases. The first phase, which includes initial soil stabilization work, will be executed using a traditional design-bid-build delivery method. The remainder of the work will be executed under the FoP Improvements Project design-build contract.
- The SCOC Facility could be executed under either a Design-Bid-Build or Design-Build project delivery method.

1.4 San Carlos Odor Control Facility Objectives and Approach

When the Gravity Pipeline is flowing partially full, the air in the headspace of the pipeline is expected to travel down to the RLS wet well, where it will be extracted with exhaust fans, and conveyed to the odor control facilities located at the WWTP. Under these conditions, air is expected to be pulled into the Gravity Pipeline through structures along the pipeline that are open to the atmosphere, including the SCPS shaft.

The Gravity Pipeline may be used to store sewage to equalize dry weather flows, and/or to reduce the peak wet weather flows conveyed to the WWTP. During these storage events, the Gravity Pipeline would be partially filled with water. As it fills, the water level could rise above the crest of the pipe at the downstream end and air in the headspace of the pipe would be blocked from exiting at that end. Under these conditions, the exhaust fans located at the WWTP would not be able to extract the air in the headspace of the pipeline. Consequently, the Gravity Pipeline would become pressurized with air which would be forced out at the Drop Shaft at the SCPS site. Therefore, odor control facilities would be needed at the SCPS site to contain and treat odors venting from the Drop Shaft.

1.5 Related and Supporting Studies

The layout of the SCOC Facility was developed to a conceptual level as part of the Headworks Facility Project, which was executed under Task Order 2015-05. The following technical memoranda, prepared as part of that project, include design and cost information for various elements of the SCOC Facility:

- San Carlos Odor Control Facility Strategy TM (January 6, 2017)
- San Carlos Odor Control Facility Opinion of Probable Construction Cost TM (May 6, 2016)
- San Carlos Odor Control Facility Life Cycle Cost TM (August 29, 2016)

SVCW has also developed a draft Environmental Impact Report (EIR) for the CIP. The EIR, prepared by SVCW, was publicly reviewed for a 45-day public review period beginning on November 29, 2016, and ending on January 13, 2017. The document is anticipated to be finalized once all the responses to the comments from the public review period including the public meeting held on December 14, 2016, at SVCW's Administrative Offices have been addressed and any necessary edits have been incorporated.

Section 2

Existing Conditions

2.1 Project Location Overview

The San Carlos Pump Station (SCPS) property is owned by the City of San Carlos and is located at the northwest end of Monte Vista Drive adjacent to the San Carlos Airport, as shown in Figure 2-1. The 0.92-acre site includes the existing 0.48-acre SCPS building, and a 0.44-acre paved parking lot adjacent to a restaurant (Izzy's at 525 Skyway Road).

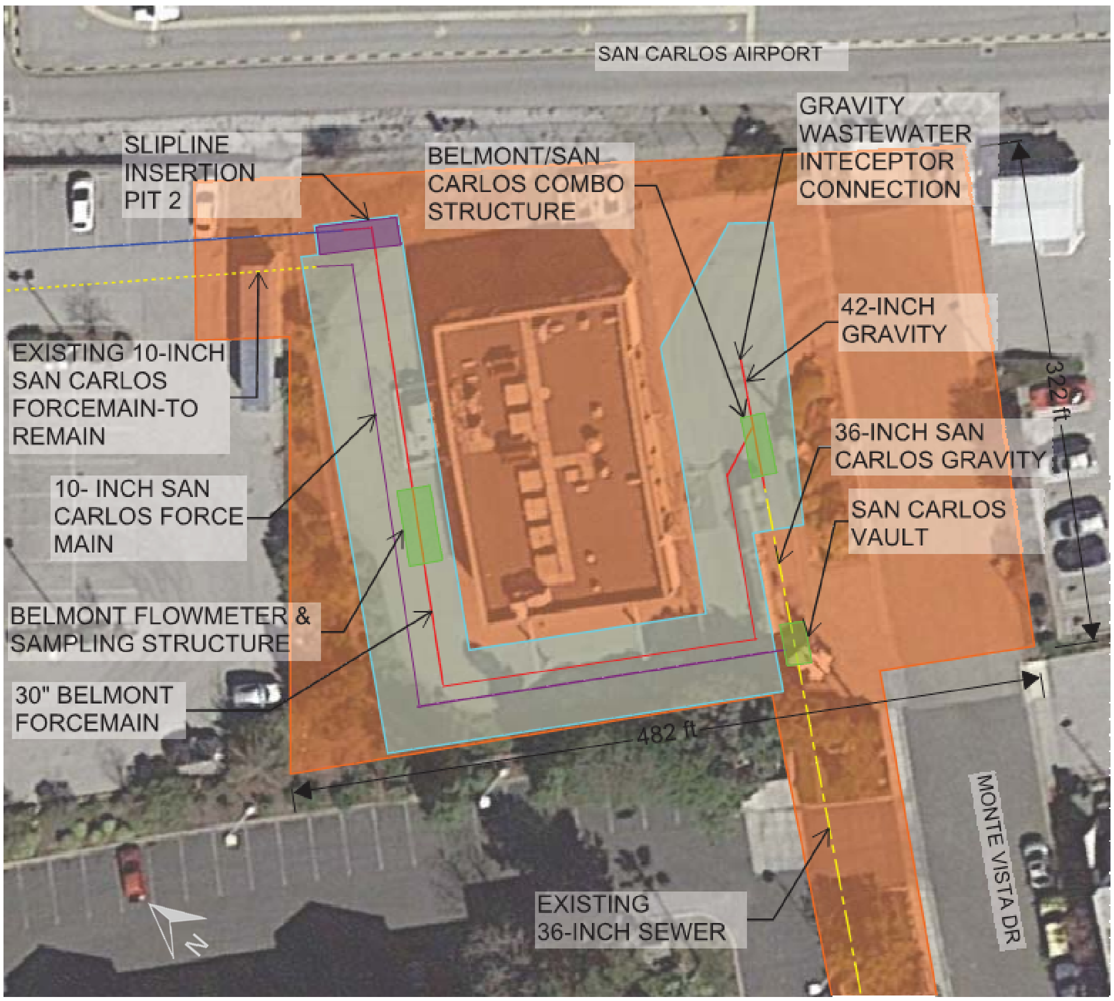

Figure 2-1
San Carlos Re-Purposing Improvements

2.2 Physical Features of Project Location

This section details the topographic, geologic, and hydrologic features of the existing project area.

2.2.1 Topographic Features

The existing topography surrounding the SCPS and San Carlos Odor Control (SCOC) Facility Project area is shown in Figure 2-2 below. Site earthwork is anticipated to be required for this Project to create large pipe trenches for an air duct between the Drop Shaft and the existing pump station building.

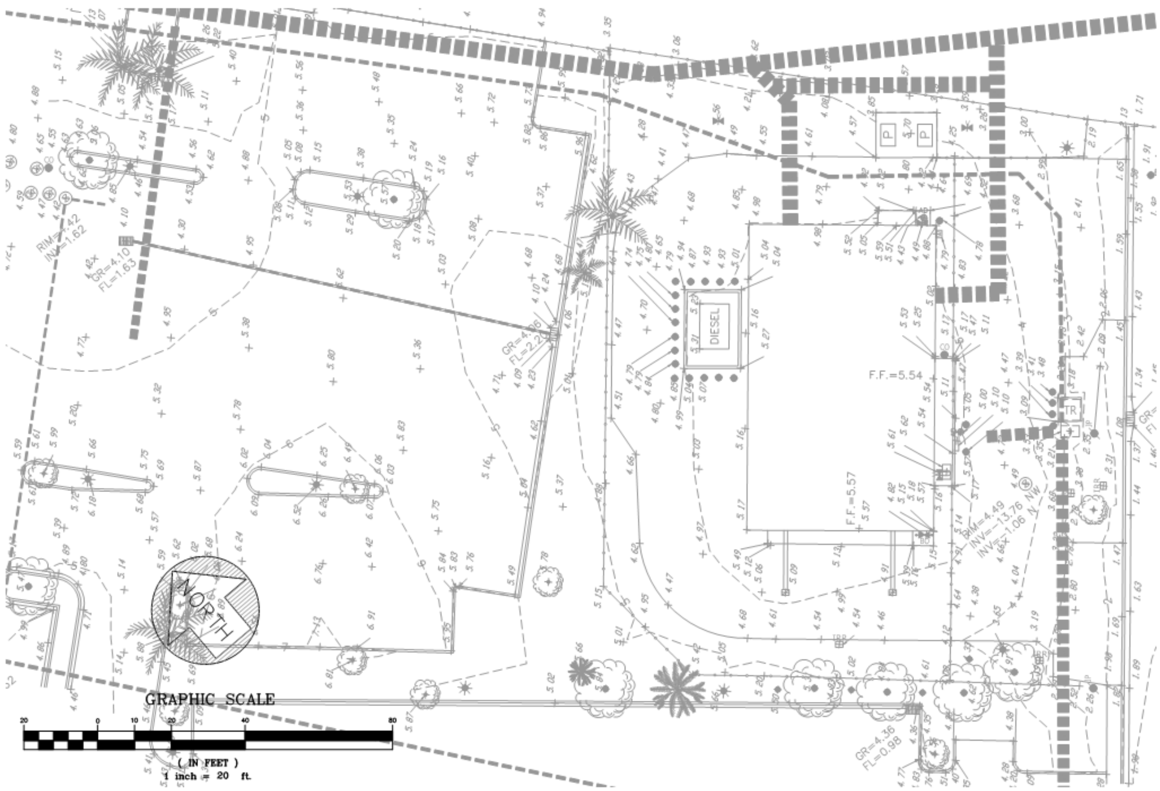

Figure 2-2
Topographic Map of Existing Project Area

2.2.2 Geology

A geotechnical investigation was conducted around the proposed San Carlos Drop Shaft located on the same site as the proposed SCOC facility. The results of that investigation are documented in the *Geotechnical Data Report, Silicon Valley Clean Water Gravity Pipeline*, prepared by Geotechnical Consultants, dated April 3, 2017. Additional geotechnical investigations will need to be conducted around the San Carlos Pump Station facility during design of the Project.

2.2.3 Ground and Surface Water Resources

No ground and surface water resources are anticipated to be applicable for this project.

2.3 Current and Future Land Uses

The Project site is currently used for operation of the San Carlos Pump Station. The site is immediately adjacent to the San Carlos Airport. Nearby commercial buildings include a hotel (Fairfield Inn and Suites) and the Hiller Aviation Museum.

After execution of the San Carlos service area conveyance system modifications, which are proposed as part of the Capital Improvements (CIP), sewage from the San Carlos service area will flow by gravity into the Gravity Pipeline and the SCPS will no longer be needed for pumping sewage. Therefore, it is proposed that the existing SCPS building be used to house the odor control facilities proposed as part of this Project.

The San Carlos Pump Station and the San Carlos Airport property are zoned *Airport*. The *Airport* zoning designation permits public, and quasi-public uses and facilities, including fire protection, policing, and the furnishing of utility services, as a use within this district. Therefore, the use of the site as a pump station or an odor control facility is consistent with current uses. Per the Draft EIR, Form 7460-1 needs to be submitted to the Federal Aviation Administration (FAA) for any construction equipment which penetrates into San Carlos Airport airspace. Details about permit requirements are provided in Section 8 of this report. The surrounding offices and commercial buildings are zoned *General Commercial/Industrial.*

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Section 3

Proposed Project

3.1 Design Airflows and Odor Characteristics

3.1.1 Design Airflows

As discussed in Section 1.4, air is expected to periodically vent from the Drop Shaft at the San Carlos Pump Station (SCPS) site when the Gravity Pipeline is used for storage. The amount of air that would vent during storage events and the frequency of the storage events is documented in the *SVCW Gravity Pipeline Planning Level Technical Memorandum No. 6 – Odor Generation Evaluation*, prepared by Air Quality Engineering, dated April 3, 2017, which is included in the Gravity Pipeline Project Planning Report. The key findings of that TM, which need to be further evaluated during detailed design, are as follows:

- No air would vent from the San Carlos Drop Shaft during non-storage events when the Gravity Pipeline is flowing partially full.
- Approximately 5,000 cubic feet per minute would vent from the Drop Shaft for a period of 2 to 3 hours during dry weather diurnal storage events, which would occur daily.
- Approximately 10,000 cfm would vent from the Drop Shaft for a period of 24 hours during wet weather storage events, which would occur 2 to 3 times per year.
- Approximately 16,000 cfm would vent from the Drop Shaft for up to 48 hours during wet weather storage events when the RLS is not operating. This would only occur in the event of a catastrophic equipment failure. This is a very rare event and may occur less than once every 10 years.

Air venting from the Drop Shaft would need to be ventilated through a fiberglass (FRP) duct to the San Carlos Odor Control (SCOC) Facility. Therefore, the facility needs to accommodate the range of airflows described above and summarized in Table 3-1. The airflows presented in Table 3-1 should be further evaluated during the design phase of the project.

Table 3-1 Odor Control Ventilation Rates

Condition	Required Ventilation Rate	Frequency of Condition	Duration of Condition	Percent of Time Operating at Condition
No Storage in Tunnel	0 cfm	Daily	21 – 22 hrs/day	74.8%
Dry Weather Diurnal Storage in Tunnel	5,000 cfm	Daily	2 – 3 hrs/day	22.8%
Wet Weather Storage in Tunnel	10,000 cfm	2 – 3 times/year	24 hours	2.3%
Peak Wet Weather & RLS Out of Service	16,000 cfm	1 time/10 years	48 hours	0.1%

3.1.2 Design Odor Characteristics

To quantify and characterize current odors in the wastewater entering the SVCW WWTP, a sampling event was conducted on February 24, 2016, through March 6, 2016. The sampling event was conducted in accordance with the Sampling and Analysis Plan included in Appendix A.

An automated sampler was installed in the Influent Mix Box at a location upstream of the existing bar screens and downstream of where the influent force main discharges into the plant. The automated sampler monitored H_2S concentrations in the vapor space of the influent mix box for the period from February 24, 2016, through March 6, 2016.

On March 2, 2016, liquid and vapor grab samples were collected from the Influent Mix Box by CDM Smith. Two vapor samples were collected and sent to an off-site laboratory where they were analyzed for the following:

- Volatile Organic Compounds (VOCs)
- Total Reduced Sulfur (TRS) Compounds

Four liquid grab samples were collected and analyzed on-site for the following:

- Dissolved Sulfide (dS)
- Dissolved Oxygen (DO)
- Oxidation Reduction Potential (ORP)
- pH
- Temperature

The results of the sampling are provided in Appendix B, and summarized in Table 3-2.

Table 3-2 Summary of Odor Sampling Results

Sample	Sample Date	H_2S (avg/max) (ppm)	TRS (ppb)	VOCs (ppb)	dS (mg/l)	ORP (mV)	pH	DO (mg/l)	Temp (deg C)
Auto-sampler	Feb 24, 2016 – Mar 2, 2016	9/113	-	-	-	-	-	-	-
Auto-sampler	Mar 2, 2016 – Mar 6, 2016	11/132	-	-	-	-	-	-	-
Vapor Grab #1	Mar 2, 2016	-	130	35.33	-	-	-	-	-
Vapor Grab #2	Mar 2, 2016	-	1400	14.49	-	-	-	-	-
Liquid Grab #1	Mar 2, 2016	-	-	-	0.4	-261	7.00	-	20.0

Table 3-2 Summary of Odor Sampling Results (continued)

Sample	Sample Date	H_2S (avg/max) (ppm)	TRS (ppb)	VOCs (ppb)	dS (mg/l)	ORP (mV)	pH	DO (mg/l)	Temp (deg C)
Liquid Grab #2	Mar 2, 2016	-	-	-	-	-272	7.24	2.1	20.1
Liquid Grab #3	Mar 2, 2016	-	-	-	1.3	-270	7.16	1.1	20.1
Liquid Grab #4	Mar 2, 2016	-	-	-	1.6	-291	7.16	1.9	20.1

Based on these observations, it is recommended that the San Carlos Odor Control Facility be designed based on the criteria summarized in Table 3-3.

Table 3-3 Chemical Scrubber Design Criteria

Constituent	Vapor Phase Concentration (ppm)
H_2S, avg	10
H_2S, peak	130
TRS, avg	2

The criteria in Table 3-3 were developed based on sampling data collected from the Influent Mix Box, as described above. The characteristics of the water and air at the Influent Mix Box, will likely be different than the characteristics of the water and air in the Gravity Pipeline near the Drop Shaft. Therefore, further sampling and evaluation should be performed during the design phase of the project to confirm the design criteria presented in Table 3-3.

3.2 Odor Control Equipment Technology Evaluation

Two treatment options were considered for the SCOC Facility:

- Chemical Scrubbers
- Carbon Adsorption

An evaluation of these odor control technologies and a recommendation on the preferred technology is provided below.

3.2.1 Chemical Scrubbers

A chemical scrubber consists of a tower, partially filled with plastic media. Odorous air is forced into the bottom of the tower with an exhaust fan. Liquid chemicals, typically sodium hydroxide and sodium hypochlorite, are sprayed into the top of the stack. The chemicals trickle down through the plastic media to the bottom of the stack, running countercurrent to the direction of the odorous air. As the liquid trickles through the plastic media, it comes in contact with the odorous air and odor-causing contaminants are transferred to the liquid.

There are three main types of chemical scrubbers:

- Single Stage Packed Tower

- Two-stage Packed Tower
- Low Profile Multi-Stage Chemical Scrubber

A process flow diagram of a single stage packed tower chemical scrubber is shown in Figure 3.1. As shown, in this type of scrubber, the odorous air makes a single pass through a tower of media. NaOH and NaOCl are recirculated through the vessel to maintain the pH at 9.5–10.0 and the oxidation reduction potential (ORP) at 600 mV. Single stage scrubbers can remove organic sulfur compounds and up to 99 percent of H_2S provided the incoming odorous air has an H_2S concentration less than 25 ppm.

A process flow diagram of a two-stage packed tower chemical scrubber is shown in Figure 3-2. In this type of scrubber, the odorous air passes through two towers of media, or stages, in series. The stages of media are contained in separate towers, with ductwork connecting the two towers. Sodium hydroxide (NaOH) is recirculated through the first stage. NaOH and sodium hypochlorite (NaOCl) are recirculated through the second stage. The first stage typically removes 90 percent of H_2S in the odorous air. The second stage polishes any residual H_2S, but its primary purpose is to remove residual organic sulfur compounds.

A low profile multi-stage chemical scrubber is shown in Figure 3-3. This type of scrubber functions like a dual stage packed tower chemical scrubber. However, in this type of scrubber, the stages of media are contained within a single housing, with baffles separating the stages. This setup has a smaller footprint than the dual stage packed tower arrangement shown in Figure 3-2.

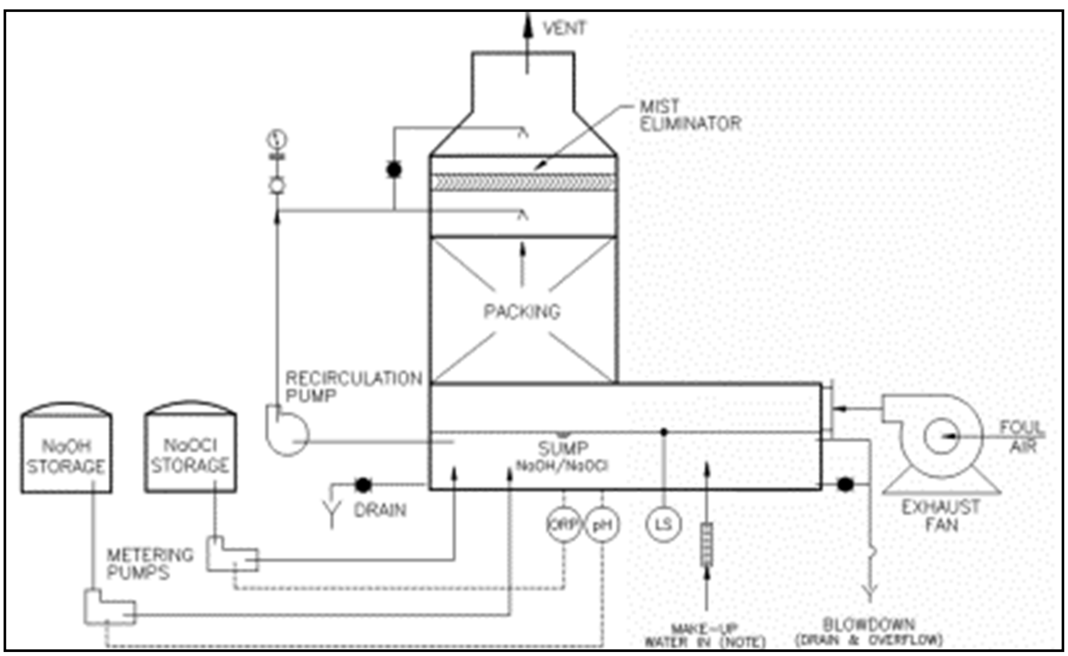


Figure 3-1
Process Flow Diagram for a Single Stage Packed Tower Chemical Scrubber

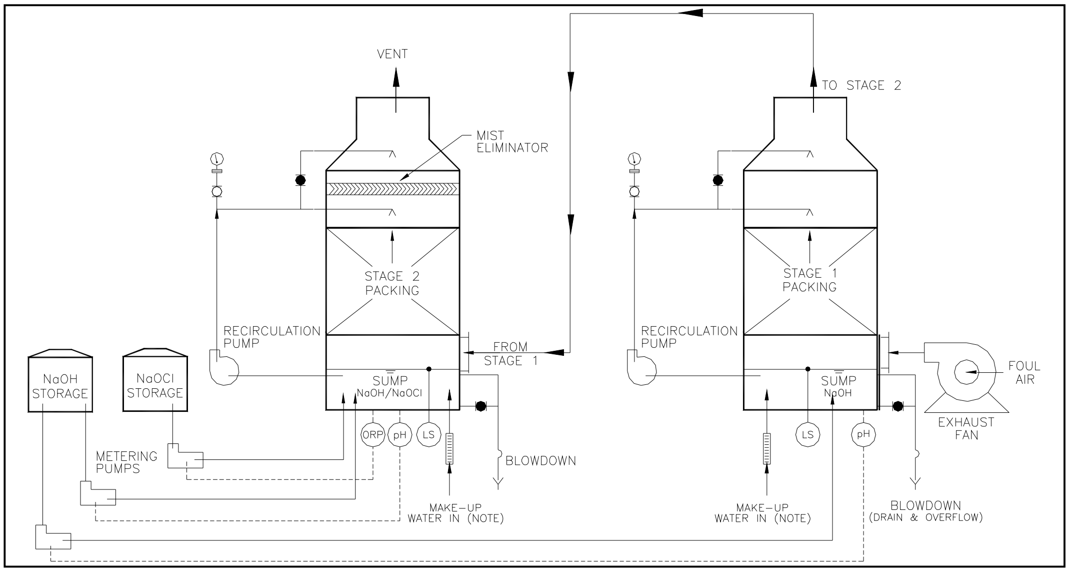


Figure 3-2
Process Flow Diagram for a Two-Stage Packed Tower Chemical Scrubber

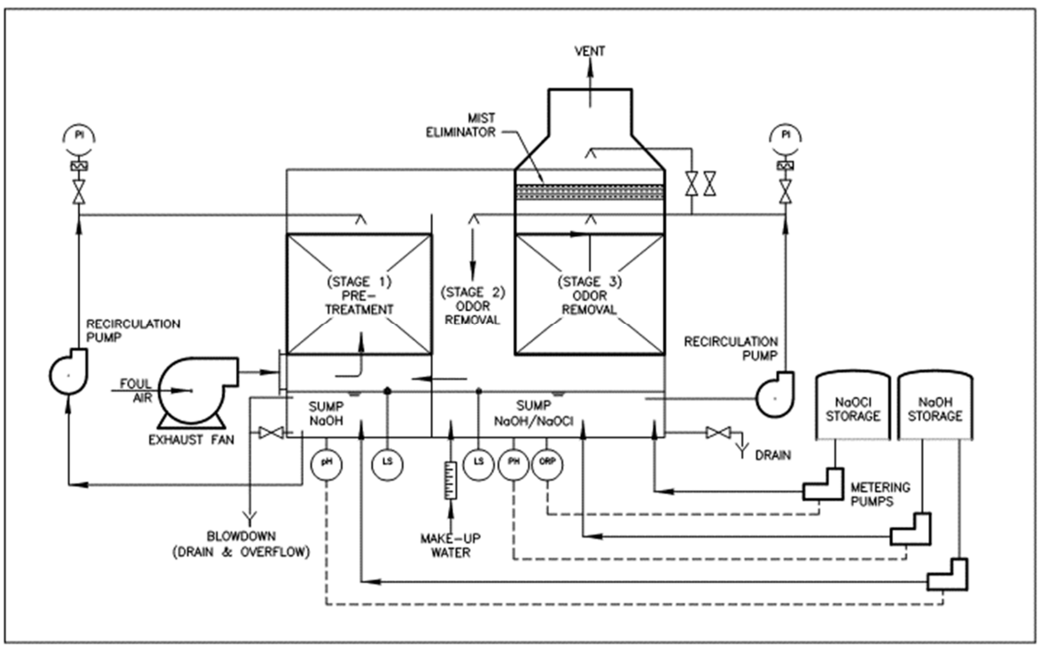


Figure 3-3
Process Flow Diagram for a Low-Profile Multi-Stage Chemical Scrubber

3.2.2 Carbon Adsorbers

Carbon adsorption is the most basic odor control process available. In this process, odorous air is passed through a bed of highly adsorbent material that can be blended to include activated carbon, permanganate impregnated alumina, and catalytic carbon. The selection of the blend is based on the type of odor. Hydrogen sulfide is readily removed with catalytic carbon whereas more recalcitrant organic sulfur compounds require an oxidizer. Volatile organic compounds (VOCs) are removed with virgin activated carbon.

There are three arrangements for carbon adsorbers:

- Vertical Flow
- Horizontal Flow
- Radial Flow

A schematic for a vertical flow carbon adsorber is shown in Figure 3-4. As shown, vertical flow carbon adsorbers have the media layered in beds 3 ft. deep within a cylindrical vessel. Air is introduced in the bottom of the vessel and forced through the media to the top.

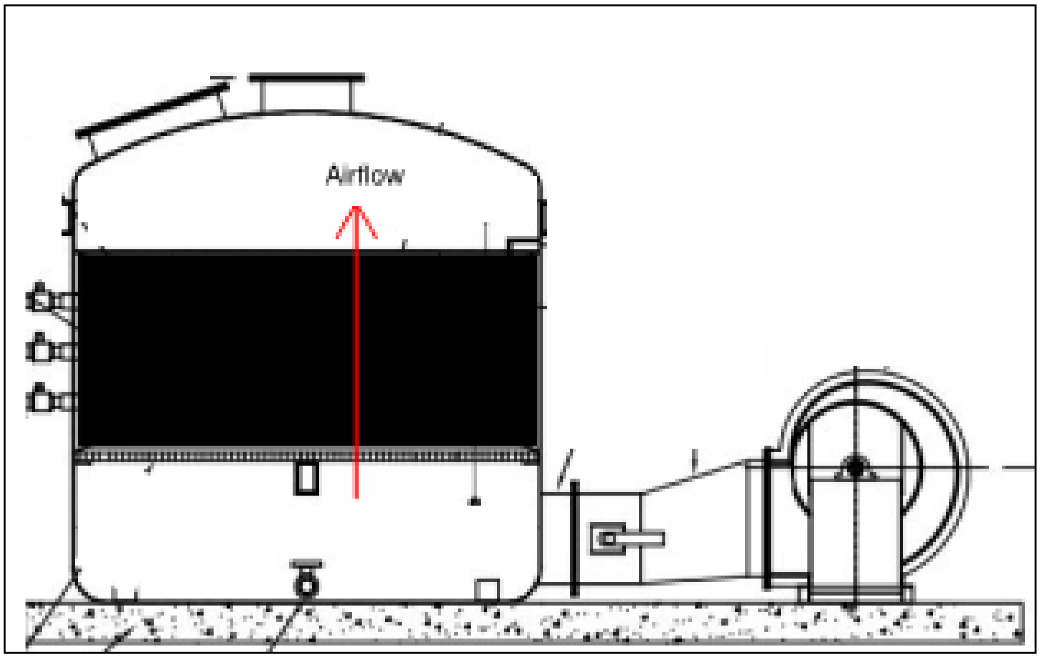


Figure 3-4
Vertical Flow Carbon Adsorber Schematic (Side View)

A schematic of a horizontal bed scrubber is shown in Figure 3.5. As shown, in a horizontal bed scrubber the air is forced to flow horizontally through media beds that are oriented vertically. Horizontal flow scrubbers are designed to handle large airflows.

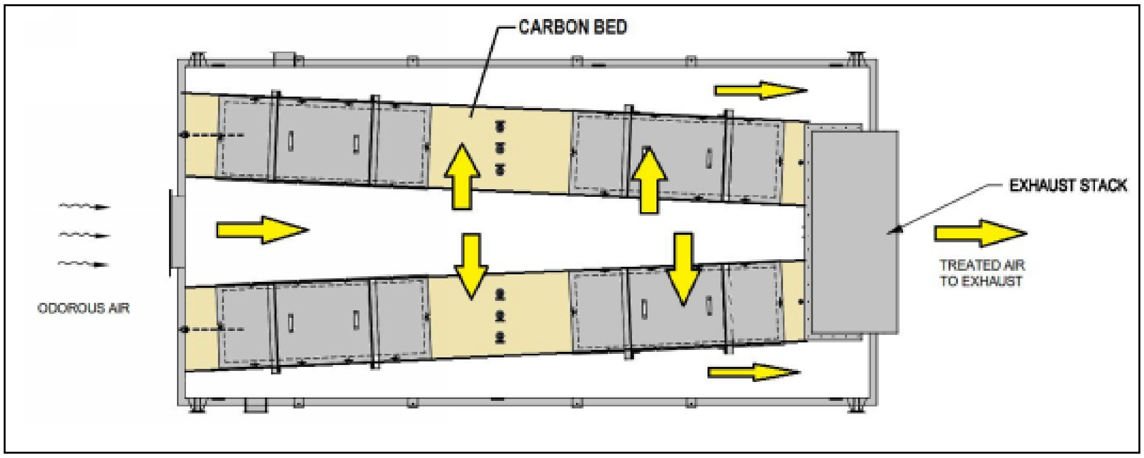


Figure 3-5
Horizontal Flow Carbon Adsorber Schematic (Top View)

A schematic of a radial scrubber adsorber is shown in Figure 3-6. As shown, in a radial scrubber, the airflow travels into the vessel tangentially and enters the media radially and out the top of the vessel. The radial design is used for high airflow rates where carbon is the preferred treatment and there are space constraints. They have a smaller footprint than other types of carbon adsorbers but are taller.

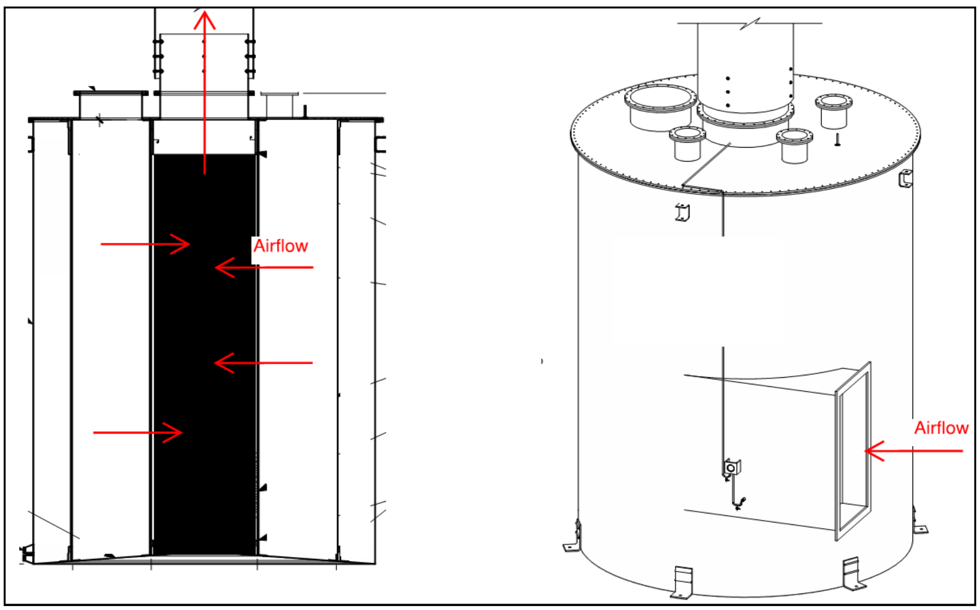


Figure 3-6
Radial Flow Carbon Adsorber Schematic

3.2.3 Recommended Technology

Low profile multi-stage chemical scrubbers and carbon adsorbers are both viable options for the SCOC Facility. It is recommended that a thorough evaluation of these two technologies be made during the preliminary design of the SCOC Facility. It is recommended that low profile multi-stage chemical scrubbers be used as the basis for development of the conceptual layout of the

SCOC Facility, because it will be the most conservative approach in terms of cost and most conservative from an environmental impact perspective because of the required chemicals.

Single stage packed tower scrubbers and two-stage packed tower scrubbers are not recommended for use at the SCOC Facility for the following reasons:

- Single stage packed tower scrubbers are an effective technology to implement in applications where the H_2S levels in the odorous air are < 25 ppm. However, the H_2S levels for this Project could be as high as 130 ppm. Therefore, single stage packed tower scrubbers are not recommended.
- The footprint of the two-stage packed tower scrubber would exceed the space available, due to the interconnecting ductwork between stages.

The height of the two-stage packed tower chemical scrubber would exceed 14 feet. This would eliminate the possibility of locating the scrubbers inside the existing SCPS building.

3.3 Process Design Criteria

The sizing of the chemical scrubber equipment was determined based on the ventilation rates and odor characteristics presented in Section 3.1. The required equipment sizing is summarized in Table 3-4 and shows the SCOC Facility would need to consist of three parallel low profile multi-stage scrubbers, rated at 5,500 cfm each. Three scrubbers are needed because the operational strategy is to operate one scrubber during dry weather storage events in the Gravity Pipeline, two scrubbers during wet weather storage events in the Gravity Pipeline, and all three scrubbers during peak wet weather events when the RLS is out of service, as described in Section 3.1.1. Each scrubber would need to be equipped with one 15 hp ventilation fan and two 10 hp recirculation pumps. A brochure for a typical low profile multi-stage chemical scrubber of this size is included in Appendix C.

The scrubbers would require approximately 660 gallons per day (gpd) of 25 percent Sodium Hydroxide and 160 gpd of 12.5 percent Sodium Hypochlorite. Chemical storage tanks fitted with level sensors, fill ports, and drains would be required to store the chemicals required by the scrubbers. The calculations used to determine the chemical demands are included in Appendix D.

The sizing of the odor control and chemical storage facilities presented in Table 3-4 should be further evaluated during detailed design.

Table 3-4 Chemical Scrubber Equipment Sizing

Item	Value
Scrubber Units	
Number	3
Capacity, ea.	5,500 cfm
Ventilation Fan	
Number	1 per scrubber
Motor Size, ea.	15 hp
Recirculation Pumps	
Number	2 per scrubber
Motor Size, ea.	10 hp
Chemical Demand	
25% Sodium Hydroxide (NaOH)	660 gpd
12.5% Sodium Hypochlorite (NaOCl)	160 gpd
Sodium Hydroxide Storage	
Storage Tank Volume	8,000 gal
Days of Storage	12 days
Sodium Hypochlorite Storage	
Storage Tank Volume	3,000 gal
Days of Storage	19 days

3.4 Conceptual Layout

A conceptual mechanical layout of the SCOC Facility is shown in Figure 3-7. A more detailed mechanical layout is included in Appendix E.

As shown in Figure 3-7, since the SCPS building would no longer be needed for pumping, it is proposed that the building be re-purposed to house the chemical scrubbers and chemical storage equipment. Enclosing the equipment in the new building would protect it from vandalism and weather and would shield the scrubbers from public view.

The equipment would be installed on the ground level floor of the pump station. The equipment would be located on concrete pads and would be surrounded by concrete curbs to provide secondary containment. The containment areas would be coated with a chemical resistant coating.

Prior to installing the new odor control equipment, the existing equipment would need to be removed, including large wastewater pumps, small chemical metering pumps, chemical storage tanks, air handling fans, electrical motor control centers (MCCs), and other miscellaneous equipment, piping and conduit. In addition, interior walls would need to be removed, new walls erected, floor openings sealed, the roof modified to accommodate odor scrubber vent stacks, and new doors installed to provide access to the equipment. Renovations to the building may also include updates to meet the latest codes and cosmetic updates to the building exterior, which would be addressed during detailed design.

The chemical scrubbers would require an approximately 42-inch duct, ran underground from the Drop Shaft to the odor control equipment to convey the odorous air. Ducts have been preliminarily sized based on a gas flow of 1,600 cubic feet per minute (CFM), which is based on American Society of Heating, Refrigeration, and Air-Conditioning Engineers (ASHRAE) standards. These flows should be further evaluated during the detailed design phase. The 42-inch duct could run in the same alignment as an existing 48-inch steel pipe. The existing 48-inch pipe would be removed to make room for the duct. In addition, each scrubber would require a water supply line sized for 3 gpm and a 6-inch sanitary sewer line to drain spent scrubbing water from the odor control units back into the Gravity Pipeline. The sewer line could run parallel to the 42-inch air duct. The depth of the excavation required for these two pipes is approximately 8 feet.

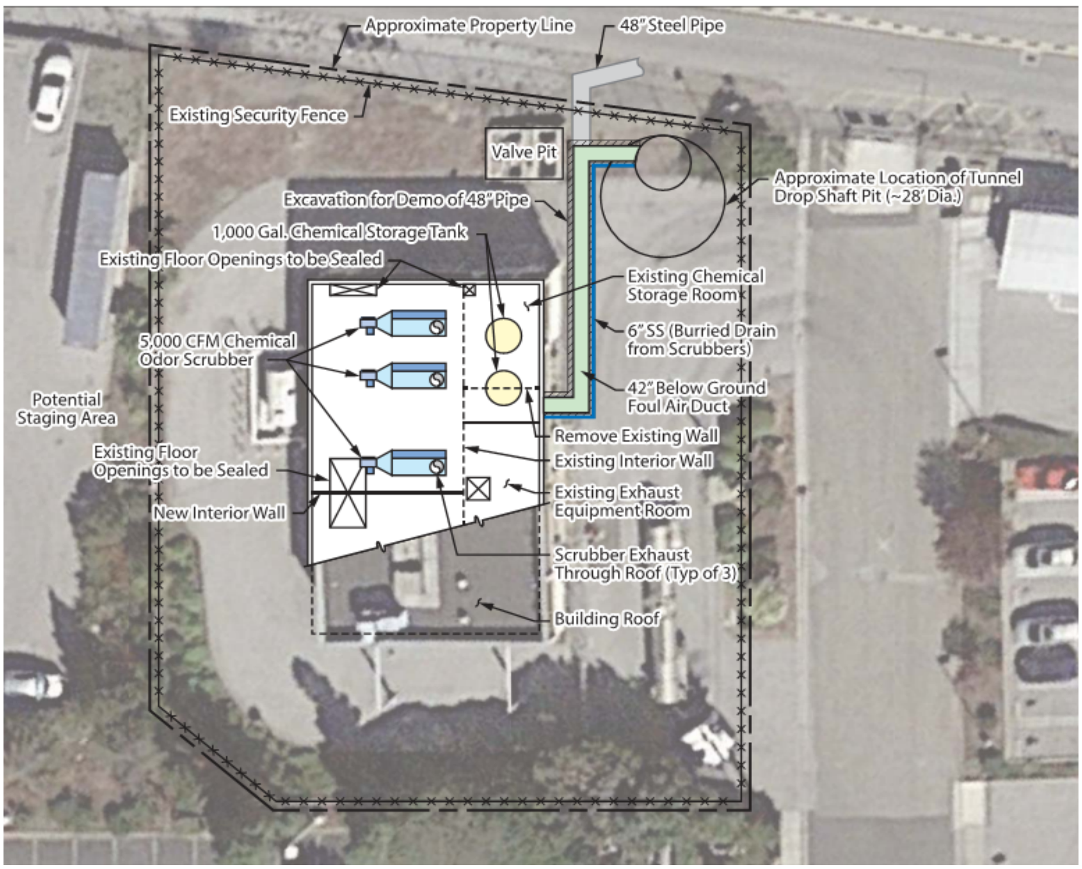


Figure 3-7
San Carlos Odor Control Facility – Conceptual Layout

Section 4

Detailed Design Considerations

4.1 Civil

The San Carlos Odor Control (SCOC) Facility will be constructed in an existing building and pad. Aside from paving, very little civil work will be required. Yard and process piping shall be designed per the following principles:

- Pipes and ducting will be sized based to convey design flows while providing appropriate flow velocities and minimizing headloss and settling.
- Pipe and ducting wall thicknesses are determined based on burial depth, trench dimensions, backfill material, traffic loading and groundwater conditions.
- Trenches will be designed with appropriate bedding and backfill materials per local soil conditions.

Utility design will take into consideration pertinent local, state and federal codes and industry standards. The design of the civil components of project will adhere to the following standards:

- *American Association of State Highway Transportation Officials (AASHTO) -A Policy on Geometric Design of Highways and Streets, 6th Edition, 2011 (Green Book.)*

4.2 Architectural

The architectural design of the structure should be developed to minimize visual impacts to surrounding residents as well as the nearby San Carlos Municipal Airport. Architectural design of the facility should incorporate all relevant federal, state and local requirements.

4.3 Structural

The San Carlos Odor Control Facility will be constructed in the existing San Carlos Pump Station located at 150 Monte Vista Drive. To accommodate the three new low-profile multi-stage chemical scrubbers, and two new 1,000-gallon chemical storage tanks, two interior nonstructural walls will be relocated and existing floor openings and pipe penetrations will be sealed. New equipment pads will be cast at the grade-level slab to support the new chemical scrubbers and chemical storage tanks, and new penetrations will be constructed to vent scrubber exhaust.

4.3.1 Applicable Codes and Regulations

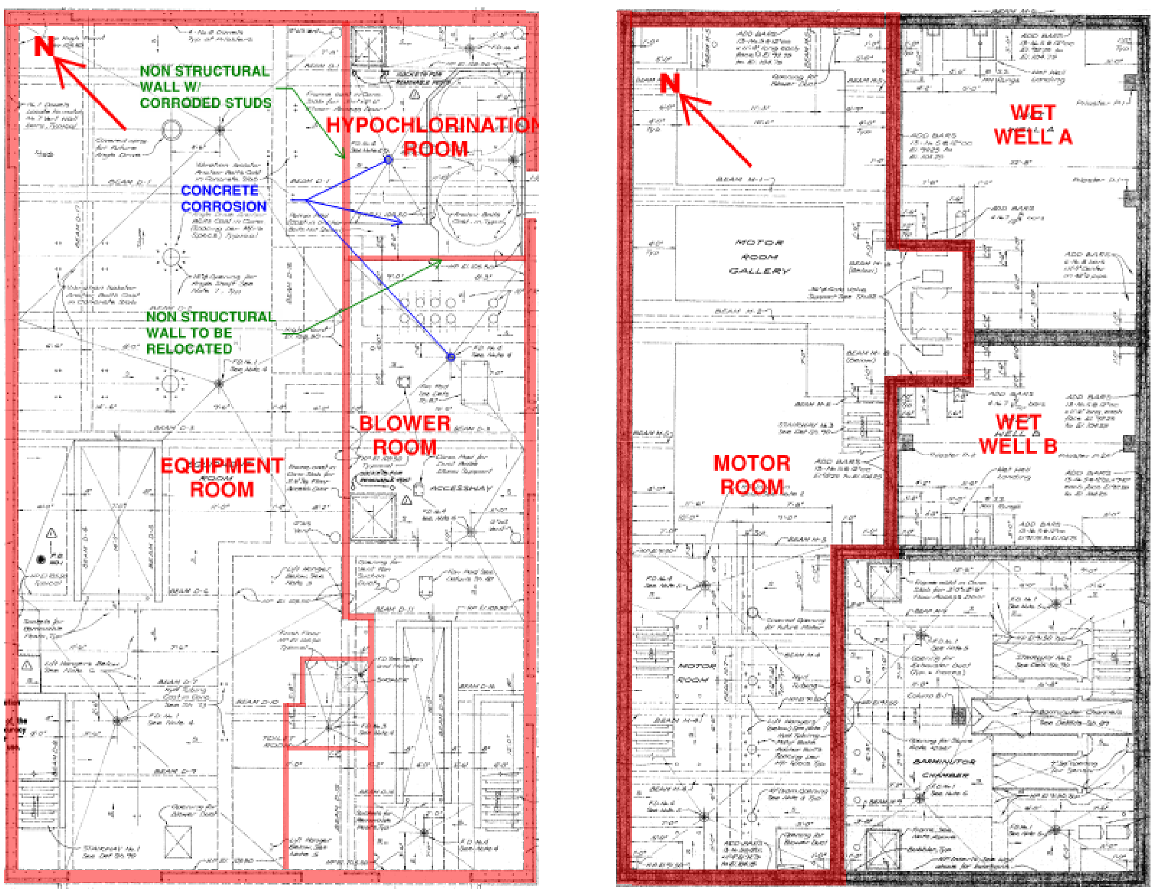
The strength, serviceability, and quality for materials and design procedures will be in accordance with the codes and standards listed below:

- California Building Code (CBC), 2016
- American Society of Civil Engineers (ASCE), ANSI/ASCE 7-10 – Minimum Design Loads for Buildings and Other Structures

- American Concrete Institute (ACI) Standards:
  - ACI 318-14, Building Code Requirements and Commentary for Reinforced Concrete
  - ACI 530-13 Building Code for Masonry Structures
- American Welding Society Structural Steel Welding Code (AWS) D1.1-10 and D1.4-11

4.3.2 Structural Feasibility Evaluation

A structural assessment consisting of a site visit and review of available drawings was performed to determine the feasibility of these modifications. The site visit was conducted on January 24, 2017. Access during the site visit was limited to the three rooms on the ground floor (Equipment Room, Blower Room and Hypochlorination Room per 1982 record drawings) and the room immediately below the Equipment Room (Motor Room per 1982 record drawings). See Figure 4-1 for plan views of the pump station.



GROUND FLOOR PLAN LOWER FLOOR PLAN

Figure 4-1
San Carlos Pump Station Plan View.

Observations made during the site visit and during review of record drawings are as follows:

- There was concrete corrosion and some rust stains around the Blower Room's northeast floor drain near the exhaust blower (see Figure 4-2). Concrete was delaminating at the surface and sounded hollow in some locations when stomped on, indicating further delamination than is visible from the surface. Rust stains indicate possible rebar corrosion.

Figure 4-2
Concrete at the Blower Room Floor Drain Above Wet Well B

- Similar concrete corrosion was observed at the northwest floor drain of the Hypochlorination Room (See Figure 4-3) and on the side of the hypochlorite metering pump pads (See Figure 4-4).

Figure 4-3
Concrete at the Hypochlorination Room Northwest Floor Drain Above Wet Well A

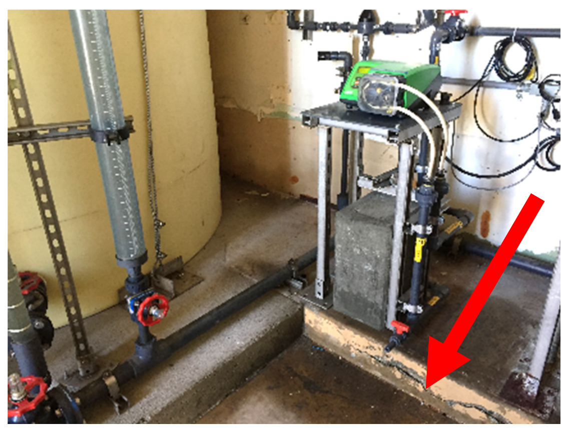


Figure 4-4
Concrete at Side of Equipment Pad in Hypochlorination Room

- There appeared to be adequate vertical and horizontal clearance between the floor and roof beams and at the door opening for transporting and installing the new chemical scrubbers inside the existing Equipment Room. Each chemical scrubber is anticipated to be 6- by 8-foot in plan and 11 feet tall. Section C'-C' on Sheet 96 of 141 of the 1982 Record Drawings shows 12 feet-8 inches clear height to the bottom of the precast concrete roof beams, and the floor plan on Sheet 96 of 141 shows an 8 feet-0 inches wide door opening into the Equipment Room.

- A steel monorail cantilevers out from the Equipment Room double doors and extends approximately 40 feet inside (see Figure 4-5). This could impede the installation of the scrubbers and could require at least temporary removal to facilitate construction.

Figure 4-5
Steel Monorail at Entrances to Equipment Room (left) and to the Blower Room (right)

- There were aluminum guardrails located around a 14- by 7-foot floor opening in the Equipment Room, with a removable section on the southwest side of the opening (See Figure 4-6). The opening and/or the guardrails could also impede the installation of the scrubbers.

Figure 4-6
Aluminum Guardrails Around Opening on Equipment Room Floor

- The concrete slabs, concrete roof and CMU walls were generally in good condition.
- Inspection of the underside of the precast concrete beams above the Hypochlorination Room showed those beams and beam-to-wall connection to be in good condition.
- There were two openings in the metal stud wall between the Equipment Room and the Hypochlorination Room. The metal studs at these openings showed evidence of corrosion (See Figures 4-7 and 4-8).

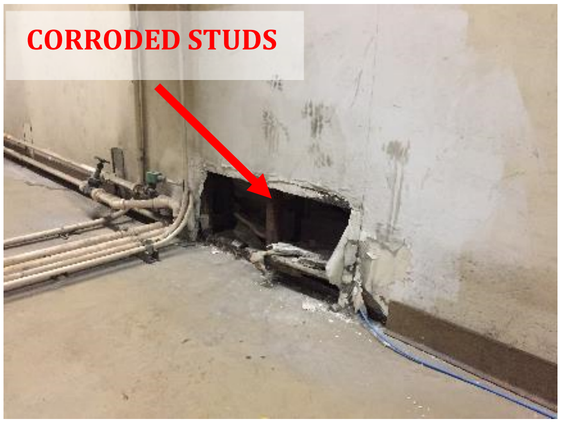


Figure 4-7
Opening in Base of Wall Between Equipment and Hyperchlorination Rooms

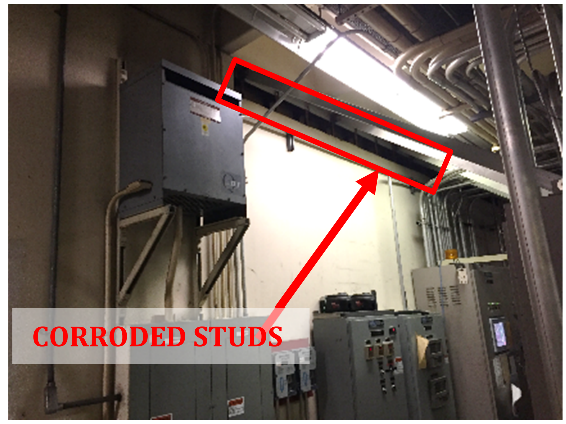


Figure 4-8
Opening Near Top of Wall between Equipment and Hypochlorination Rooms

4.3.3 Considerations for Detailed Design

Based on the observations described in Section 4.3.3, the following should be considered during detailed design:

- The condition of the underside of the 8-inch thick slab over wet wells A and B could not be determined because the wet wells were in service. Hence, full evaluation of the slab structural capacity (particularly at the floor drains in the Hypochlorination and Blower Rooms) should be conducted during detailed design to determine the extent of the damage to the concrete and reinforcement. The concrete delamination observed on the top of the floor slabs could be due to hydrogen sulfide gases leaking from the floor below through cracks around the floor drain. In this case the damage on the underside of the slab could be worse than what was observed on top. Measures to prevent hydrogen sulfide leakage in the new odor control facility should be implemented.

- The drawings provided for this feasibility study do not show the concrete or reinforcing steel strength used in the original design. Preliminary calculations using ASCE 41-13 lower bound values for 1977 (3000 psi concrete and 40000 psi reinforcing steel) show that the existing 8-inch concrete slab may not be sufficient to support the new scrubbers due to excessive flexure. This will be verified with a detailed analysis using more accurate existing concrete and reinforcing steel strength and design loads.

- There appears to be adequate vertical clearance for an equipment pad below the chemical scrubbers. However, if direct equipment anchorage is used, detailed anchorage analysis should be performed as the existing 8-inch thick slab provides minimal embedment depth for concrete anchors. A detail of the existing 8-inch thick slab is shown in Figure 4-9.

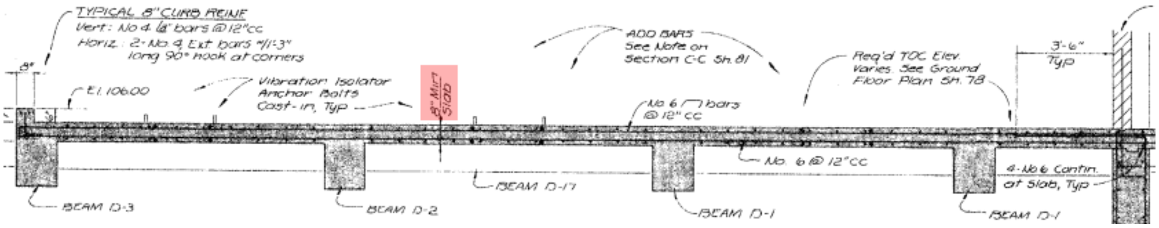


Figure 4-9
Existing Slab Thickness and Reinforcing from the 1982 Record Drawings

- Evaluation of the roof membrane should be performed in a future site visit.
- The metal stud wall between the Hypochlorination Room and Equipment Room may need replacement, even though it is not a load-bearing wall, depending on extent of corrosion, fire protection required, and whether any equipment will be supported on the wall. The extent of metal stud corrosion at openings in the metal stud wall noted previously should be determined and its impact on the metal stud wall integrity confirmed.
- The monorail could be available to facilitate installation of the chemical scrubbers; however, it will only be able to transport equipment to just above the 14 by 7 foot floor opening. Thus, unless equipment will be moved from or to the lower floors, it is recommended that a portable gantry crane be used instead and the monorail be decommissioned. There also appears to be enough floor space to transport the scrubbers around the 14 by 7 foot floor opening using a portable gantry crane, depending on the location of any other new equipment to be installed in the room. Removing the guardrails around the opening and/or filling in the opening may also facilitate installation.

4.3.4 Summary

There is concern about the condition of the existing slab, and its ability to support the new chemical scrubbers and tanks, due to the observed concrete corrosion and unknown material strengths. Concrete slab repair, or partial replacement, may be necessary. This will be determined through additional investigation and detailed analyses. Coordination and further analysis are also required for determining the suitability for continued use of the existing nonstructural walls. Otherwise, conversion of the existing pump station into an odor control facility appears structurally feasible.

4.4 Mechanical

Process and mechanical design should take the following into consideration:

- Scrubbers and chemical feed systems should be placed to allow for ease of operation and maintenance. For example, sufficient space should be available to operate valves and instruments in good ergonomic positions and for maintenance access.
- Existing process and storm water drains shall be modified to ensure that they are suitable for chemicals and organic waste.

Process and mechanical design of the facility shall conform to the following standards:

- American Water Works Association (AWWA) applicable standards
- American National Standards Institute (ANSI) applicable standards
- American Society of Mechanical Engineers (ASME) applicable standards
- National Fire Protection Association (NFPA) applicable standards

4.5 Electrical

The electrical design of the facility shall conform to the following standards:

- American National Standards Institute (ANSI) standards
- Insulated Cable Engineers Association (ICEA) standards
- Institute of Electrical and Electronics Engineers (IEEE) standards
- International Society of Automation (ISA) standards
- California Electrical Code (CEC), 2016 edition based on National Electrical Code 2014
- California Energy Code 2016
- National Fire Protection Agency (NFPA 70E) Standard for Electrical Safety in the Workplace
- National Fire Protection Agency (NFPA 820) Standard for Fire Protection in Wastewater Treatment and Collection Facilities
- National Electrical Manufacturers Association (NEMA) standards
- Occupational Safety and Health Administration (OSHA) standards
- International Building Code (IBC) 2012, amended by state of California (CBC 2013)
- Acceptance Testing Specifications of Electrical Power Distribution Equipment and Systems, International Electrical Testing Association (NETA)
- National Fire Protection Association (NFPA) 70 (National Electrical Code), 2011 edition
- Underwriters Laboratories, Inc. (UL)
- Pacific Gas and Electric (PG&E)
- American Society for Testing and Materials (ASTM)
- Electrical Testing Laboratories (ETL)
- Illuminating Engineering Society of North America (IESNA)

- National Electrical Installation Standards (NEIS)
- National Electrical Contractor Association (NECA)
- Life Safety Code.
- National Electrical Safety Code.

4.6 Instrumentation and Control

The instrumentation and control systems shall conform to the following standards:

- National Electrical Code (NEC) – Latest Revision of NEC as Amended by the State of California.
- International Society of Automation (ISA) standards
- National Electrical Manufacturers Association (NEMA) standards
- Underwriters Laboratories, Inc. (UL)
- American National Standards Institute (ANSI) standards
- Institute of Electrical and Electronic Engineers (IEEE) standards
- SVCW automation, Instrumentation and Controls Standards

4.7 Corrosion Issues

Corroded concrete has been observed onsite during CDM Smith's site visit on January 24 2017. The design of the SCOC should include concrete coatings to prevent damage from vapors and chemical spills.

Corrosivity of the soils should be considered in designing buried facilities at the site.

4.8 Security

Access to the site will be controlled by locks and fences. Only authorized personnel will be allowed to enter the building

4.9 Safety

All facilities will be designed to meet Federal and State of California Occupational Health and Safety (USOSHA) and (CalOSHA) standards. Safety features will include:

- Engineering controls
- Guarding of rotating machinery.
- National Fire Protection Association (NFPA), as well as all federal, state and local fire codes.

- The SCOC will be storing sodium hydroxide (caustic) and sodium hypochlorite onsite. Storage of these chemicals shall comply with the San Mateo County Hazardous Materials Business Program.
- Chemical storage tank design shall incorporate the proper containment, fire walls, venting, etc.

4.10 Outstanding Issues

- A more detailed analysis of carbon adsorbers versus chemical scrubbers should be conducted during detailed design to determine which approach has a lower life cycle cost and better meets the objectives of the project.
- Further sampling and evaluation should be conducted to confirm design airflows and odor characteristics for the SCOC facility.
- A condition assessment of the existing SCPS wet wells should be performed, as those areas where not accessible during previous site visits.
- Preliminary structural calculations show that the existing 8-inch concrete slab may not be sufficient to support the new scrubbers due to excessive flexure. This should be verified with a detailed analysis using more accurate existing concrete, and reinforcing steel strength and design loads.

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Section 5

Construction

5.1 Construction Staging

The construction staging area for the San Carlos Odor Control (SCOC) Facility Project is shown in Figure 5-1. As shown, the hotel parking lot adjacent to the existing San Carlos Pump Station (SCPS) site will be considered for Contractor laydown area.

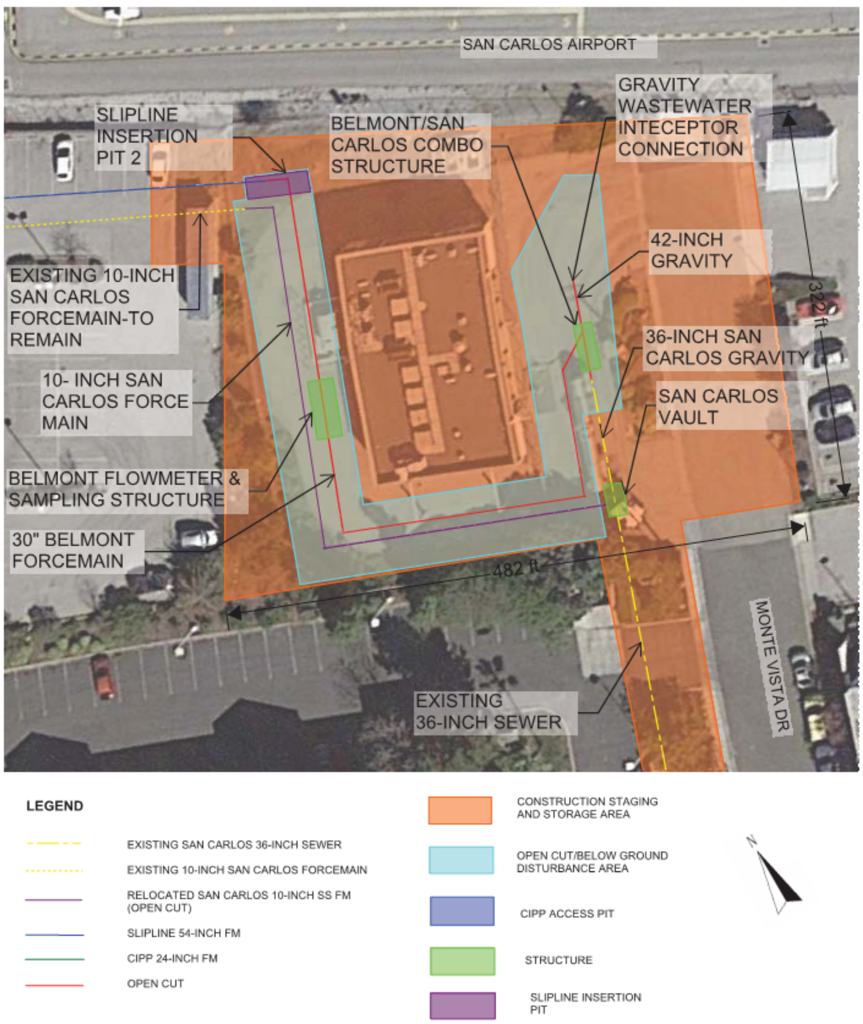

Figure 5-1
San Carlos Odor Control Facility Staging Area

5.2 Construction Sequencing

The proposed SCOC Facility is located on the same site as the proposed San Carlos Drop Shaft. Modifications to the San Carlos collection system piping will also be made at this site. Therefore, the sequencing of construction of these projects will need to be closely coordinated.

Regardless of the project delivery method that SVCW chooses for executing the CIP Projects, the SCOC Facility will likely be constructed under a contract that does not include construction of the San Carlos Drop Shaft or San Carlos conveyance system pipe modifications. Therefore, the sequence of construction for the SCOC Facility, under either project delivery methods, will be as follows:

- The Gravity Pipeline, including the proposed Drop Shaft at the SCPS site, will be constructed first.
- The modifications to the San Carlos conveyance system will be performed.
- The SCPS will be taken offline and sewage will begin to flow into the Gravity Pipeline via gravity flow. The process equipment, HVAC equipment and ductwork, electrical gear, piping, conduit, and cables on the inside and outside of the SCPS building will be demolished.
- Required structural modifications will be made to the building.
- Equipment and piping will be installed along with electrical, instrumentation, and control cables.
- Programming, calibration, and testing will be performed.
- Startup will occur.

As discussed above, the Gravity Pipeline and associated San Carlos Drop Shaft will be operational before the SCOC facility is constructed. Therefore, temporary odor control will be needed to treat foul air venting form the Drop Shaft while the SCOC Facility is being constructed. Trailer mounted carbon canisters could be used for this purpose.

5.3 Schedule

Construction of the SCOC Facility will take approximately 8 months. The construction period is shown in the proposed construction schedule in Table 5-1.

Table 5-1 San Carlos Odor Control Facility Schedule

Task	Start Date[1]	End Date[1]
SCOC Facility Bid and Award	Aug 24, 2022	Dec 27, 2022
SCOC Facility Construction	Dec 28, 2022	Sept 1, 2023

[1]Based on CIP Program Schedule Version #26, dated December 2016

5.4 Construction Energy

Energy is consumed in construction in the form of heavy equipment, generators and lighting. Construction equipment including excavators, and pile drivers, as well as trucks hauling materials to the site burn diesel fuel. Transportation to the jobsite generally requires automobiles powered by gasoline, as do onsite generators. As discussed in the EIR, construction of the SCOC Facility is estimated to require 176 total truck trips, or approximately less than one per day. Greenhouse

Gas (GHG) emissions associated with the construction of the SCOC facilities are summarized in Table 5-2 below.

Table 5-2 San Carlos Odor Control Greenhouse Gas (GHG) Emissions

Project Component	GHG (Metric Tons)
Site Improvements	137
SCOC Facility	27
Total	**164**

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Section 6

Operation & Maintenance

6.1 Control Descriptions

The chemical scrubbers will operate in a lead, lag, lag operating sequence. Chemical scrubbers will be brought on and offline automatically based on airflow escaping the Drop Shaft. Chemical tanks will be re-filled manually on an as-needed basis.

6.2 Annual O&M Costs

The annual requirements for Operation and Maintenance (O&M) staff labor, power, chemical usage, and debris hauling associated with the San Carlos Odor Control (SCOC) Facility are described in detail below.

6.2.1 Labor

The annual O&M activities associated with the SCOC Facility are itemized in Table 6-1, below. The labor associated with each activity and the frequency of each activity are also included in Table 6-1. The total number of labor hours was divided by 2,080 hours to determine the number of Full-Time Equivalents (FTE) of labor required. The cost associated with the labor was then calculated based on a cost of $150,000/FTE, per the Life Cycle Cost Guidance TM (Appendix F).

Table 6-1 O&M Labor Costs for the SVCW San Carlos Odor Control Facility

Activity	Staff	Frequency		Total Annual
	Hours	No.	Basis	Staff Hours
Odor Control				
Oversight	0.25	1	per day	91.25
Maintenance	1	1	per week	52
Calibration	1	1	per month	12
Acid Wash	4	2	per year	8
Other Mechanical Systems				
Inspection/Maintenance	1	1	per week	52
Electrical Equipment				
Inspection/Maintenance	1	1	per week	52
Instrumentation and Controls				
Calibrations Checks/Programming	1	1	per week	52
Maintenance Management				
Procurement, Tracking, etc.	1	1	per week	52
			Total Staff Hours	371.25
			FTEs	0.2
			Total Labor Cost	$26,773

6.2.2 Power

The power costs associated with the SCOC Facility are itemized in Table 6-2 below. Power costs for the project are determined by multiplying the estimated annual power usage of each type of equipment by the electrical cost. For the SCOC Facility, the electric cost is $0.196 per kilowatt-hour used, per the Life Cycle Cost Guidance TM (Appendix F).

Table 6-2 Power Costs for the SVCW San Carlos Odor Control Facility

Equipment	Power Demand (Hp)	Total No. of Units	Average Operating Time (% of Year)	Total Power Use (kWh/yr.)	Annual Power Cost
Three Chemical Scrubbers Operating					
Fan	35	3	0.11	986	$193
Pump	10	6	0.11	564	$111
Two Chemical Scrubbers Operating					
Fan	35	2	2.28	27,256	$5,342
Pump	10	4	2.28	3,894	$763
One Chemical Scrubber Operating					
Fan	35	1	22.8	136,282	$26,711
Pump	10	2	22.8	19,469	$3,816
				Total	$36,936

6.2.3 Chemicals

Chemical costs associated with the SCOCl Facility are itemized in Table 6-3 below. As shown, the SCOC Facility will require 25 percent Sodium Hydroxide (NaOH) and 12.5 percent Sodium Hypochlorite (NaOCl).

Table 6-3 Chemical Costs for the SVCW San Carlos Odor Control Facility

Chemical Name	Total Annual Demand (gal)	Cost per Gallon	Total Cost
25% NaOH	15,226	$0.85	$12,942
12.5% NaOCl	6,350	$1.20	$7,620
		Total	$ 21,000

6.3 Periodic Equipment Rehabilitation and Replacements

The rehabilitation and replacement activities associated with the SCOC Facility are itemized in Table 6-4, below. The frequency and cost associated with each activity are also shown. Rehabilitation and replacement activities and costs were determined on an equipment-by-equipment basis, based on typical equipment lifespan and costs.

Table 6-4 Rehabilitation and Replacement Costs for the SVCW San Carlos Odor Control Facility

Equipment	No. of Units	Type of Rehabilitation	No.	Basis	Cost of Rehab
Chemical Scrubber	3	Replacement	1	every 20 years	$ 667,000
Chemical Scrubber	3	Replace Media	1	every 5 years	$ 36,000
Chemical Scrubber	3	Replace Sensor	1	every 3 years	$ 2,400

Table 6-4 Rehabilitation and Replacement Costs for the SVCW San Carlos Odor Control Facility

Equipment	No. of Units	Type of Rehabilitation	No.	Basis	Cost of Rehab
Chemical Scrubber	3	Acid Wash	2	per year	$ 6,750
Chemical Scrubber	3	Replace Fan Belt	1	every 5 years	$ 4,500
Chemical Scrubber	6	Rehab Recirc Pump	1	every 5 years	$ 90,000
Chemical Metering Pump	3	Replacement	1	every 5 years	$ 3,500

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Section 7

Life Cycle Costs

7.1 Overview

This section presents the 50-Year Life Cycle Cost (LCC) associated with the San Carlos Odor Control (SCOC) Facility that will be installed as part of the SVCW Capital Improvements Program (CIP). The LCCs are for a 50-year period from 2016 to 2066. The LCCs were prepared in accordance with the Life Cycle Cost Analysis Guidelines Technical Memoranda (Appendix F), dated July 13, 2016. The life cycle costs for the SCOC Facility include the following cost components:

- Capital Costs
- Annual O&M Costs, including
  - Labor
  - Power
  - Chemicals
- Periodic Equipment Rehabilitation and Replacement Costs

The cost for each of the components listed above were developed for each year over a 50-year period between 2016 and 2066 in present day dollars, as described in Section 7.2 through 7.6 below. The Net Present Value (NPV) of the cash flow over that 50-year period was then calculated for all the cost components as described in Section 7.3.

7.2 Capital Cost

7.2.1 Construction Costs

An Opinion of Probable Construction Cost (OPCC) of the Headworks Facility Project is summarized in Table 7-1. A detailed breakdown of costs is included in Appendix G. The OPCC was prepared using the computerized estimating system Sage Timberline Estimating System (TES). The system operates using a customized database that includes costs for over 130,000 items, which are continuously updated. Current prevailing wage rates were used in the estimate to calculate labor based on the intended project construction bid period. Construction equipment pricing was based on Primedia Blue Book Equipment Rates adjusted for the bid period. Material pricing was based on the TES database in addition to bid and budget pricing obtained by CDM Smith and adjusted to market conditions. Major equipment prices were based on vendor quotes escalated to midpoint of construction. The OPCC included the following markups on the direct costs:

- Sales Tax (Material): 9 percent
- Field Direct Cots: 10 percent of direct costs + sales tax
- Field Overhead & Profit: 5 percent of direct costs + sales tax + field direct costs
- Home Office Overhead & Profit: 10 percent of direct costs + sales tax + field direct costs
- General Contractor Bond: 2 percent of direct costs + above markups
- Builder's Risk Insurance: 1 percent of direct costs + above markups
- General Liability Insurance: 1.5 percent of direct costs + above markups

The level of accuracy of the OPCC is consistent with the Association for the Advancement of Cost Engineering (AACE) best practice for a Class IV estimate which defines project definition between 1-15 percent. The expected level of accuracy of a Class IV OPCC ranges from -30 percent for the lower range of cost and +50 percent for the high range.

Table 7-1 Opinion of Probable Cost of Construction Summary

Area	Opinion of Probable Cost of Construction ($M)
Demolition	$430,000
Site Work	$110,000
Odor Control Equipment and Chemical Storage Tanks	$1,740,000
Electrical and I&C Improvements	$650,000
Building Mechanical Improvements (HVAC, fire sprinklers, etc.)	$350,000
Total	**$3,280,000**

Notes:

1. Costs include the following markups:
   Sales Tax: 9 percent
   Field Indirect Costs: 10 percent
   Field Overhead and Profit: 5 percent
   Home Office Overhead & Profit: 10 percent
   General Contractor Bonds: 2 percent
   Builder's Risk Insurance: 1 percent
   General Liability Insurance: 1.5 percent
2. SVCW will apply 20 percent to this OPCC for a construction contingency, but the 20 percent markup is not included in the costs shown in this table
3. SVCW will apply 2-5 percent to this OPCC for change order during construction, but the 2-5 percent markups are not included in the costs shown in this table.
4. SVCW will escalate costs to the midpoint of construction, but the escalation is not shown in this table

7.2.2 Total Project Capital Costs

The capital cost, in 2016 dollars, is calculated based on the project's raw construction cost, project contingency, soft costs, and market fluctuations, per Equation 1, below. The result from Equation 1 is then escalated to the mid-point of construction.

Equation 1 – Capital Costs

$$Capital\ Cost = Construction\ Cost * (1 + Project\ Contingency + \sum Soft\ Cost + Market\ Fluctuations)$$

The calculation of the capital cost is summarized in Table 7-2 below. As shown, the capital cost was determined to be between $6.8M and $7.6M, depending on market fluctuations.

Table 7-2 SVCW San Carlos Odor Control Facility Capital Cost

	Rate
Raw Construction Cost (2016 Dollars)[1]	$3,280,000
Project Contingency[2]	25%
Soft Costs[2]	
CM, ESDC, Testing, Inspection	18%
Contract Change Orders (CCO)	5%
Planning	5%
Design	10%
Project Management	5%
Market Fluctuations	
Low	-5%
Base	0%
High	15%
Escalation[2]	4%
Mid-Point of Construction[3]	2022
Capital Cost (2022 Dollars)	
Low Market Fluctuation	$6,770,000
Base Market Fluctuation	$6,970,000
High Market Fluctuation	$7,600,000

[1] Based on the construction cost included in the Opinion of Probable Cost of Construction TM, dated April 2016

[2] Based on guidance in the Life Cycle Cost Analysis Guidelines TM, dated July 2016.

[3] Based on CIP Program Schedule Version #21, dated July 2016

7.3 Annual Operation and Maintenance Costs

The annual requirements for O&M staff labor, power, chemicals, and debris hauling are detailed in Section 6.2. A summary of the annual costs for each of these items is included in Table 7-3

Table 7-3 SVCW Headworks Facility Capital Cost

Item	Annual Cost
O&M Staff Labor	$26,773
Power	$36,936
Chemicals	$20,562
Total	$84,271

7.4 Periodic Equipment Rehabilitation and Replacement Costs

The costs for periodic equipment rehabilitation and replacement are presented in Section 6.3.

7.5 Net Present Value Calculation

The NPV of the cost components discussed in Sections 7.2, 7.3, and 7.4 was calculated in three steps. First, the O&M costs for each year, from 2016 to 2066, were tabulated based on the information presented in Section 7.3 and 7.4, in terms of 2016 dollars. The tabulated O&M costs are shown in Table 7-4 below.

Next, the O&M costs for each year were escalated to the year in which the cost would be incurred using Equation 2. The escalated costs for each year are shown in Table 7-5 below.

Equation 2 – Costs Before Year of Beneficial Use

$$FV = PV * (1 + i)^{(Y_n - Y_{2016})}$$

Where:

FV= Future Value
PV = Present Value
i = Escalation (4 percent)
Y_n = Year of Cost Occurrence
Y_{2016} = Present Year (2016)

The NPV of the escalated costs were then determined by discounting the costs to the Year of Beneficial Use, using Equation 3. The NPV of the O&M costs for each year are shown in Table 7-6 below. For this LCC analysis, the Year of Beneficial Use was assumed to be 2022. Discounting was performed, per Equation 3, on all future costs occurring after the Year of Beneficial Use. All costs incurred before the Year of Beneficial Use are considered "sunk costs" are calculated using Equation 2, and then added to the sum of costs calculated with Equation 3, to determine the 50-year LCC at the Year of Beneficial Use.

Equation 3 – Discounting Function

$$Z_i = FV_i * (1 + r)^{-(Y_n - Y_b)}$$

Where:

Z_i= Future Cost at Year of Beneficial Use
FV_i = Future Value, as calculated by Equation 1
r = Discount Rate (7 percent for rehab and replacement, 3 percent for all else)
Y_n = Year of Cost Occurrence
Y_b = Year of Beneficial Use

Table 7-4 O&M Costs for San Carlos Odor Control Facility for Years 2016 – 2066 (2016 dollars)

Year	Labor	Power	Chemicals	Rehab and Replace
2016	$0	$0	$0	$0
2017	$0	$0	$0	$0
2018	$0	$0	$0	$0
2019	$0	$0	$0	$0
2020	$0	$0	$0	$0
2021	$0	$0	$0	$0
2022	$0	$0	$0	$0
2023	$26,773	$36,936	$20,562	$6,750
2024	$26,773	$36,936	$20,562	$6,750
2025	$26,773	$36,936	$20,562	$9,150
2026	$26,773	$36,936	$20,562	$6,750
2027	$26,773	$36,936	$20,562	$140,750
2028	$26,773	$36,936	$20,562	$6,750
2029	$26,773	$36,936	$20,562	$6,750
2030	$26,773	$36,936	$20,562	$9,150
2031	$26,773	$36,936	$20,562	$6,750
2032	$26,773	$36,936	$20,562	$140,750
2033	$26,773	$36,936	$20,562	$6,750
2034	$26,773	$36,936	$20,562	$6,750
2035	$26,773	$36,936	$20,562	$9,150
2036	$26,773	$36,936	$20,562	$6,750
2037	$26,773	$36,936	$20,562	$140,750
2038	$26,773	$36,936	$20,562	$6,750
2039	$26,773	$36,936	$20,562	$6,750
2040	$26,773	$36,936	$20,562	$9,150
2041	$26,773	$36,936	$20,562	$6,750
2042	$26,773	$36,936	$20,562	$806,750
2043	$26,773	$36,936	$20,562	$6,750
2044	$26,773	$36,936	$20,562	$6,750
2045	$26,773	$36,936	$20,562	$9,150
2046	$26,773	$36,936	$20,562	$6,750
2047	$26,773	$36,936	$20,562	$140,750
2048	$26,773	$36,936	$20,562	$6,750
2049	$26,773	$36,936	$20,562	$6,750
2050	$26,773	$36,936	$20,562	$9,150
2051	$26,773	$36,936	$20,562	$6,750
2052	$26,773	$36,936	$20,562	$140,750
2053	$26,773	$36,936	$20,562	$6,750
2054	$26,773	$36,936	$20,562	$6,750
2055	$26,773	$36,936	$20,562	$9,150
2056	$26,773	$36,936	$20,562	$6,750
2057	$26,773	$36,936	$20,562	$140,750
2058	$26,773	$36,936	$20,562	$6,750
2059	$26,773	$36,936	$20,562	$6,750
2060	$26,773	$36,936	$20,562	$9,150
2061	$26,773	$36,936	$20,562	$6,750
2062	$26,773	$36,936	$20,562	$806,750
2063	$26,773	$36,936	$20,562	$6,750
2064	$26,773	$36,936	$20,562	$6,750
2065	$26,773	$36,936	$20,562	$9,150
2066	$26,773	$36,936	$20,562	$6,750
Total	$1,178,005	$1,625,205	$904,719	$2,722,600

Table 7-5 O&M Costs for San Carlos Odor Control Facility for Years 2016 – 2066 (Future Values)

Year	Labor	Power	Chemicals	Rehab and Replace
2016	$0	$0	$0	$0
2017	$0	$0	$0	$0
2018	$0	$0	$0	$0
2019	$0	$0	$0	$0
2020	$0	$0	$0	$0
2021	$0	$0	$0	$0
2022	$0	$0	$0	$0
2023	$35,231	$48,606	$27,058	$8,883
2024	$36,640	$50,550	$28,140	$9,238
2025	$38,106	$52,572	$29,266	$13,023
2026	$39,630	$54,675	$30,436	$9,992
2027	$41,216	$56,862	$31,654	$216,678
2028	$42,864	$59,136	$32,920	$10,807
2029	$44,579	$61,502	$34,237	$11,239
2030	$46,362	$63,962	$35,606	$15,845
2031	$48,216	$66,520	$37,031	$12,156
2032	$50,145	$69,181	$38,512	$263,622
2033	$52,151	$71,949	$40,052	$13,148
2034	$54,237	$74,827	$41,654	$13,674
2035	$56,406	$77,820	$43,321	$19,278
2036	$58,663	$80,932	$45,053	$14,790
2037	$61,009	$84,170	$46,856	$320,737
2038	$63,449	$87,536	$48,730	$15,997
2039	$65,987	$91,038	$50,679	$16,637
2040	$68,627	$94,679	$52,706	$23,454
2041	$71,372	$98,467	$54,814	$17,994
2042	$74,227	$102,405	$57,007	$2,236,690
2043	$77,196	$106,501	$59,287	$19,463
2044	$80,284	$110,762	$61,659	$20,241
2045	$83,495	$115,192	$64,125	$28,536
2046	$86,835	$119,800	$66,690	$21,893
2047	$90,308	$124,592	$69,358	$474,769
2048	$93,921	$129,575	$72,132	$23,679
2049	$97,678	$134,758	$75,017	$24,627
2050	$101,585	$140,149	$78,018	$34,718
2051	$105,648	$145,755	$81,139	$26,636
2052	$109,874	$151,585	$84,384	$577,629
2053	$114,269	$157,648	$87,760	$28,810
2054	$118,840	$163,954	$91,270	$29,962
2055	$123,593	$170,512	$94,921	$42,240
2056	$128,537	$177,333	$98,718	$32,407
2057	$133,678	$184,426	$102,666	$702,773
2058	$139,026	$191,803	$106,773	$35,051
2059	$144,587	$199,475	$111,044	$36,453
2060	$150,370	$207,454	$115,486	$51,391
2061	$156,385	$215,752	$120,105	$39,428
2062	$162,640	$224,383	$124,909	$4,900,863
2063	$169,146	$233,358	$129,906	$42,645
2064	$175,912	$242,692	$135,102	$44,351
2065	$182,948	$252,400	$140,506	$62,525
2066	$190,266	$262,496	$146,126	$47,970
Total	$4,066,137	$5,609,744	$3,122,833	$10,612,942

Table 7-6 O&M Costs for San Carlos Odor Control Facility for Years 2016 – 2066 (NPV)

Year	Labor	Power	Chemicals	Rehab and Replace
2016	$0	$0	$0	$0
2017	$0	$0	$0	$0
2018	$0	$0	$0	$0
2019	$0	$0	$0	$0
2020	$0	$0	$0	$0
2021	$0	$0	$0	$0
2022	$0	$0	$0	$0
2023	$34,205	$47,190	$26,270	$8,624
2024	$34,537	$47,648	$26,525	$8,708
2025	$34,872	$48,111	$26,782	$11,918
2026	$35,211	$48,578	$27,042	$8,877
2027	$35,553	$49,050	$27,305	$186,908
2028	$35,898	$49,526	$27,570	$9,051
2029	$36,247	$50,007	$27,838	$9,139
2030	$36,599	$50,492	$28,108	$12,508
2031	$36,954	$50,982	$28,381	$9,317
2032	$37,313	$51,477	$28,656	$196,160
2033	$37,675	$51,977	$28,935	$9,499
2034	$38,041	$52,482	$29,216	$9,591
2035	$38,410	$52,991	$29,499	$13,127
2036	$38,783	$53,506	$29,786	$9,778
2037	$39,159	$54,025	$30,075	$205,869
2038	$39,540	$54,550	$30,367	$9,969
2039	$39,923	$55,079	$30,662	$10,066
2040	$40,311	$55,614	$30,959	$13,777
2041	$40,702	$56,154	$31,260	$10,262
2042	$41,098	$56,699	$31,563	$1,238,401
2043	$41,497	$57,250	$31,870	$10,462
2044	$41,900	$57,806	$32,179	$10,564
2045	$42,306	$58,367	$32,492	$14,459
2046	$42,717	$58,933	$32,807	$10,770
2047	$43,132	$59,506	$33,126	$226,752
2048	$43,551	$60,083	$33,447	$10,980
2049	$43,973	$60,667	$33,772	$11,087
2050	$44,400	$61,256	$34,100	$15,174
2051	$44,831	$61,850	$34,431	$11,303
2052	$45,267	$62,451	$34,765	$237,975
2053	$45,706	$63,057	$35,103	$11,523
2054	$46,150	$63,669	$35,444	$11,635
2055	$46,598	$64,288	$35,788	$15,925
2056	$47,050	$64,912	$36,135	$11,862
2057	$47,507	$65,542	$36,486	$249,754
2058	$47,968	$66,178	$36,840	$12,094
2059	$48,434	$66,821	$37,198	$12,211
2060	$48,904	$67,470	$37,559	$16,714
2061	$49,379	$68,125	$37,924	$12,450
2062	$49,858	$68,786	$38,292	$1,502,393
2063	$50,343	$69,454	$38,664	$12,692
2064	$50,831	$70,128	$39,039	$12,816
2065	$51,325	$70,809	$39,418	$17,541
2066	$51,823	$71,496	$39,801	$13,066
Total	$1,866,481	$2,575,043	$1,433,475	$4,463,750

7.6 Life Cycle Cost Summary

The 50-year life cycle cost (LCC) associated with the San Carlos Odor Control Facility, calculated as described above, is summarized in Table 7-7. A pie chart showing the breakdown of life cycle costs is included in Figure 7-1. As shown, the total 50-year LCC is determined to be between $17.1 million and $17.9 million dollars, depending on market fluctuations.

Table 7-7 50-Year Life Cycle Cost for San Carlos Odor Control Facility

Item	NPV
Capital Cost (2022 Dollars) [1]	**$6.8 – 7.6 million**
NPV of O&M Costs, Total (2022 Dollars)	**$10.3 million**
Labor	$1.9 million
Power	$2.6 million
Chemicals	$1.4 million
Rehabilitation & Replacement	$4.5 million
50-year LCC (2022 dollars) [1]	**$17.1 – $17.9 million**

[1] Range based on market fluctuations from -5 to 15 percent.

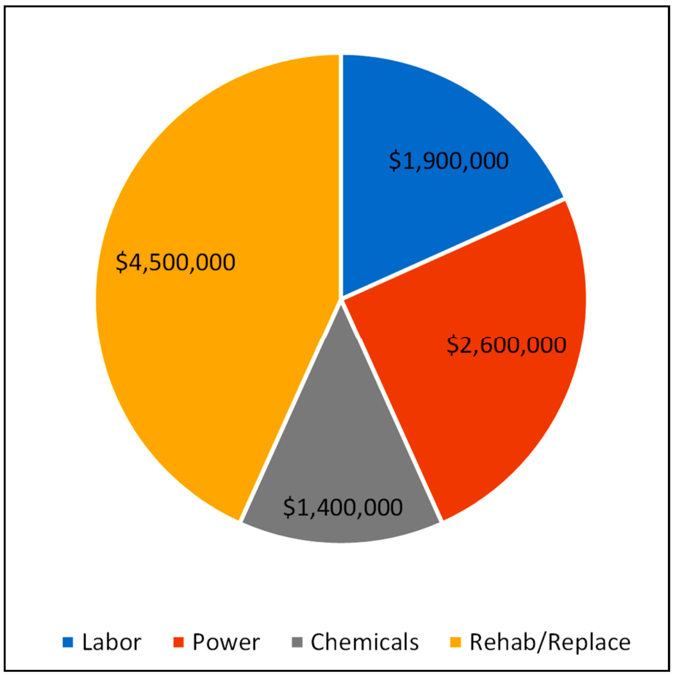

Figure 7-1
50-Year Life Cycle Cost for San Carlos Odor Control Facility

Section 8

Permitting and Environmental Impacts

8.1 Required Permits

Since the Project site lies within the San Carlos Airport Influence, as shown by the red rectangular box directly adjacent to the San Carlos Airport in Figure 8-1, SVCW will be required to obtain necessary approvals from San Carlos Airport and/or the Federal Aviation Administration (FAA) for any anticipated encroachments into the airspace.

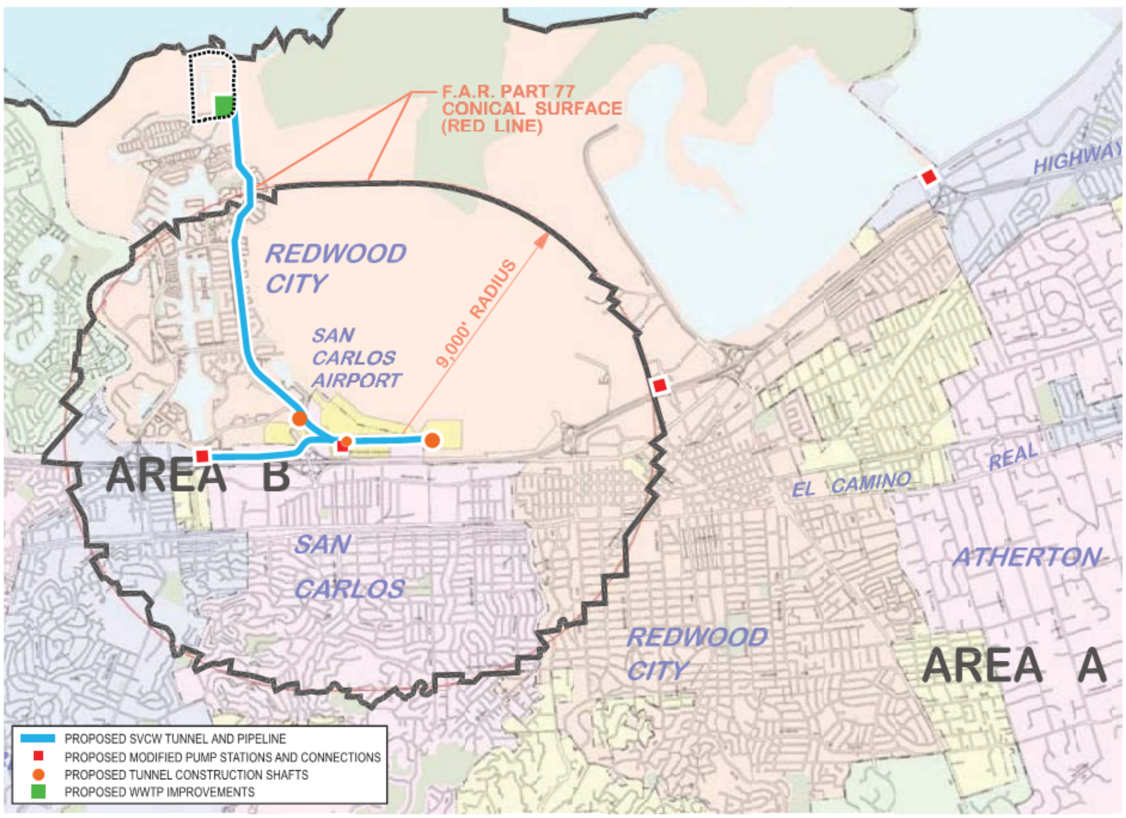

Figure 8-1
San Carlos Airport Influent Zones

8.2 Property Acquisition

The Project site, located at the existing SCPS, is owned by the City of San Carlos, part of the JWA with SVCW. Because the Project consists of repurposing the existing SCPS, within the property boundary, there is no anticipated property acquisition for completion of this project.

8.3 Stakeholders

In addition to any SVCW employees or visitors who will frequent the constructed San Carlos Odor Control (SCOC) Facility located at the existing SCPS site, the users and tenants of the surrounding commercial buildings and San Carlos Airport are stakeholders to consider during construction and operation of this Facility.

8.4 Environmental Impacts

8.4.1 Visual Environmental Impacts

Construction Impacts

Cranes will be used for shaft construction. Because of the height of the cranes, they may have a temporary impact on the visual environment during construction. However, because the construction will occur in a commercial area, surrounded by commercial buildings and the San Carlos Airport, visual environmental impacts will be minor during construction.

Operational Impacts

The Project does not propose to remove any residential units or introduce any new incompatible land uses to the sites. Furthermore, the Project does not propose to construct new infrastructure that would physically divide the community as it repurposes the existing SCPS structure. However, once constructed, the Project will introduce new exhaust stacks for wet scrubbers used for odor control to the Project site. These exhaust stacks will be taller than the existing height of the building and, therefore, may have a minor impact on the visual environment during operation of the proposed Project.

8.4.2 Noise Impacts

During the Pump Station Demolition and Civil Site Work, the nearby hotel and Hiller Aviation Museum would be exposed to noise in excess above temporary noise thresholds. However, overall construction noise from the SCOC facility would be less than a significant impact.

8.4.3 Air Quality Impacts

Construction Impacts

Construction, and associated activities, will result in temporary increases in air pollution emissions from construction equipment exhaust, truck traffic, and construction-related vehicle trips to and from the site. Per the current program implementation schedule, the Project will be constructed in the year 2022. A summary of the annual emissions from construction-related activities for the project is presented in Table 8-1 below.

Table 8-1 Annual (tons) Emissions from Construction of the SCOC Facility

Year	ROG	NOx	CO	SO_2	PM_{10}	$PM_{2.5}$
2022	0.02	0.18	0.20	0.00	0.04	0.01

Furthermore, there will be short term emissions of construction related greenhouse gas (GHG) emissions during the period of construction mentioned above (2022). A summary of the annual GHG emissions from construction-related activities for the project is presented in Table 8-2 below. The Bay Area Air Quality Management District currently has no recommended significance threshold of GHG emissions resulting from construction projects. However, SVCW plans on implementing some of the practices listed below to reduce construction GHG emissions to less than significant levels:

- Using alternative-fueled (e.g., biodiesel, electric) construction vehicles/equipment of at least 15 percent of the fleet, as feasible;
- Using local building materials (within 100 miles) of at least 10 percent; and
- Recycling at least 50 percent of construction waste or demolition materials.

Table 8-2 Annual (tons) Greenhouse Gas Emissions from Construction of the SCOC Facility

Year	GHG
2022	27

Operational Impacts

The Project will have minor air quality impacts due to construction activities. Once operational, the SCOC Facility is not anticipated to generate any additional vehicle trips, and related air quality impacts will therefore be negligible. In addition, during operation of this Facility, no additional greenhouse gas or other emissions over those emitted when the project site was used as a pump station are expected.

8.4.4 Impacts to Biological Resources

Both the Project footprint and the Study Area surrounding the Project area are entirely developed lands, including commercial real estate and the San Carlos Airport. For this reason, no sensitive habitat communities are present near the SCOC Facility.

Construction Impacts

The SCPS study area may provide suitable nesting habitat for non-special-status nesting birds, as construction activities may destroy active nests, or cause disturbances that result in nest abandonment. To reduce the potential impacts to the nesting bird population, the following mitigation measures will be required:

- Initiation of construction activities during the avian nesting season (February 1 through August 31) will be avoided to the extent feasible.
- If construction initiation during the nesting season cannot be avoided, pre-construction nesting bird surveys will be conducted within 14 days of initial ground disturbance.
- An exclusion zone, where no construction would be allowed, will be established around any active nests of any avian species found in the Study Area until a qualified biologist has determined that all young have fledged and are independent of the nest.

Operational Impacts

During operation of the SCOC Facility, there are no anticipated impacts to biological resources within the Project area.

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Appendix A

Odor Sampling and Analysis Plan

DRAFT TECHNICAL MEMORANDUM

Sampling and Analysis Guidance

1.1 Introduction

The Silicon Valley Clean Water (SVCW) WWTP Headworks and Screening Project - CIP #9160 will include facilities to mitigate odors. In preparation for future design efforts, existing hydrogen sulfide (H_2S) concentration data from the plant is being compiled for these facilities, but additional data is needed. This technical memorandum outlines supplemental sampling needs to support future odor control design efforts.

The data from the proposed sampling may also provide information that could assist in determining the cause of the extensive grease mat observed at the facilities coarse screens.

1.2 Sampling

A two-phase approach is recommended:

- Phase 1: H_2S survey. This survey would be performed to further the understanding of the sewer odor dynamics and any potential industrial effects on odors. OdaLog data loggers are recommended for this effort.

Phase 2: Targeted Sampling. Sampling of: (1) wastewater for dissolved sulfide, pH, and oxidation reduction potential (ORP) and (2) atmospheric sampling for volatile organic compounds (VOCs) and Total Reduced Sulfur (TRS) compounds. Wastewater sampling and analysis can be performed on site, however air samples would need to be sent to an air laboratory for analysis. Recommended analyses are gas chromatography–mass spectrometry (GC-MS) to identify potential VOCs (via EPA Method TO-15), and ASTM-D5044 for TRS compounds.

For the sake of economy Tedlar sample bags are proposed for air sample collection rather than Summa Canisters. Before sampling, local air labs should be consulted to determine which labs would do GC/MS for TO-15 parameters and TRS from Tedlar bags, and what size bag they would need; the lab should supply “pre-cleaned” bags with known background. Two bags (duplicates) are recommended for each analysis (VOC and TRS).

1.2.1 Equipment

- Odalogs with a range that will exceed the highest H2S levels expected, in this case 0-1000 ppm. Detection Instruments offers the LL-H2S-1000 with a 30 day deployment capability.
- Liquid sampler to collect a wastewater sample
- LaMotte dissolved sulfide kit
- Portable pH/ORP/temp probe (Hach HQ11d or equal) or transport to the plant lab for pH.

- Portable ORP probe (may be combined with the pH probe)
- Four Tedlar sampling bags as recommended by the lab
- Flux Chamber and tubing
- N_2 sweep gas
- SKC Sample pump or vacuum chamber

1.2.2 Procedures

1. Hang the OdaLog unit at the influent channel (to pre-screen H_2S levels) for 7-10 days to evaluate the data in order to determine what points in time are of interest. For example a point where the levels are peaking will provide the most concentrated data for VOCs and TRS.
2. After downloading initial data replace the Odalog for an additional 7 - 10 days.
3. At the time selected to measure VOCs/TRS (based on pre-screening above), draw air from the flux chamber into the Tedlar bags with either a vacuum chamber and SKC sampling pump (see attached). Record sample time and other information required on Chain of Custody forms (to be provided by labs). Also review Odalog data (once the unit is removed from its second deployment) to identify and note H_2S concentrations at the time of Tedlar bag sampling.
4. Concurrent with drawing air samples collect liquid samples for dissolved sulfide, temperature, pH, ORP measurements. A minimum of 2 samples should be collected.
5. Ship the air samples to the lab for VOC and TRS analysis.
6. Concurrent with sampling done above in items 3-5 the contribution from the Redwood residential area should be logged with dissolved sulfide grab samples.

1.3 Conclusion

Sampling should be scheduled during a period of time when flow is at an average and not affected by a storm event. The data collected will be integrated with historical data from the plant to support future odor control design efforts.

Appendix B

Odor Sampling Data

Odor Sampling Log for Silicon Valley Clean Water

Date: March 2, 2016 Completed by: Melissa Woo and Dane Whitmer

Weather Conditions: Sunny, partly cloudy, breezy to windy; temperatures in the 60's (deg F)

Preliminary Emission Sampling Locations and Methods

		Vapor Phase				Liquid Phase					
No.	Location	H2S (Odalog)	TRS	VOCs	Velocity[2]	dS (mg/L)	ORP (mV)	pH	Temp (deg C)	Time	Notes:
S-L-1	Influent Mix Box					0.3 - 0.4	-261	7.00	20.0	11:20 AM	
S-L-2	Influent Mix Box					-	-272	7.24	20.1	11:30 AM	DO (not calibrated) was at 2.1 mg/L
S-L-3	Influent Mix Box					1.3	-270	7.16	20.1	4:00 PM	DO (not calibrated) was at 1.1 mg/L
S-L-4	Influent Mix Box					1.6	-291	7.16	20.1	4:20 PM	DO (not calibrated) was at 1.9 mg/L
S-TRS-1	Influent Mix Box		Collected		Flux (5 lpm)					4:05 PM	Eurofins Air Toxics - ASTM D-5504
S-TRS-2	Influent Mix Box		Collected		Flux (5 lpm)					4:15 PM	
S-VOC-1	Influent Mix Box			Collected	Flux (5 lpm)					4:10 PM	Eurofins Air Toxics - EPA Method TO-15
S-VOC-2	Influent Mix Box			Collected	Flux (5 lpm)					4:20 PM	
S-H2S-1	Influent Mix Box	1 ppm (instantaneous)								11:20 AM	L2 - 0-1000, recording continuously
S-H2S-2	Influent Mix Box	3 ppm (instantaneous)								3:00 PM	L2 - 0-1000, recording continuously
S-H2S-2	Influent Mix Box	6 ppm (instantaneous)								3:20 PM	L2 - 0-1000, recording continuously

Notes:
1. For TRS and VOCs column, indicate: collected or not collected.
2. For Velocity column, indicate: enclosed, flux chamber, or recorded wind velocity

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3/9/2016
Ms. Melissa Woo
CDM Smith Inc.
12357-A Riata Trace Parkway, Suite 210

Austin TX 78727

Project Name: Silicon Valey Clean Water
Project #: 111171
Workorder #: 1603044A

Dear Ms. Melissa Woo

The following report includes the data for the above referenced project for sample(s) received on 3/3/2016 at Air Toxics Ltd.

The data and associated QC analyzed by TO-15 are compliant with the project requirements or laboratory criteria with the exception of the deviations noted in the attached case narrative.

Thank you for choosing Eurofins Air Toxics Inc. for your air analysis needs. Eurofins Air Toxics Inc. is committed to providing accurate data of the highest quality. Please feel free to the Project Manager: Brian Whittaker at 916-985-1000 if you have any questions regarding the data in this report.

Regards,

Brian Whittaker

Brian Whittaker
Project Manager

WORK ORDER #: 1603044A

Work Order Summary

CLIENT:	Ms. Melissa Woo CDM Smith Inc. 12357-A Riata Trace Parkway, Suite 210 Austin, TX 78727	**BILL TO:**	Mr. Bruce Singleton CDM Smith Inc. 15 British American Blvd. Latham, NY 12000
PHONE:	512-346-1100	**P.O. #**	
FAX:	512-345-1483	**PROJECT #**	111171 Silicon Valey Clean Water
DATE RECEIVED:	03/03/2016	**CONTACT:**	Brian Whittaker
DATE COMPLETED:	03/09/2016		

FRACTION #	**NAME**	**TEST**	**RECEIPT VAC./PRES.**	**FINAL PRESSURE**
03A	S-VOC-1	TO-15	Tedlar Bag	Tedlar Bag
04A	S-VOC-2	TO-15	Tedlar Bag	Tedlar Bag
05A	Lab Blank	TO-15	NA	NA
06A	CCV	TO-15	NA	NA
07A	LCS	TO-15	NA	NA
07AA	LCSD	TO-15	NA	NA

CERTIFIED BY: ______________________ DATE: 03/09/16

Technical Director

Certification numbers: AZ Licensure AZ0775, NJ NELAP - CA016, NY NELAP - 11291,
TX NELAP - T104704343-14-7, UT NELAP CA009332014-5, VA NELAP - 460197, WA NELAP - C935
Name of Accreditation Body: NELAP/ORELAP (Oregon Environmental Laboratory Accreditation Program)
Accreditation number: CA300005, Effective date: 10/18/2014, Expiration date: 10/17/2015.
Eurofins Air Toxics Inc.. certifies that the test results contained in this report meet all requirements of the NELAC standards

LABORATORY NARRATIVE
EPA Method TO-15
CDM Smith Inc.
Workorder# 1603044A

Two 1 Liter Tedlar Bag samples were received on March 03, 2016. The laboratory performed analysis via EPA Method TO-15 using GC/MS in the full scan mode.

This workorder was independently validated prior to submittal using 'USEPA National Functional Guidelines' as generally applied to the analysis of volatile organic compounds in air. A rules-based, logic driven, independent validation engine was employed to assess completeness, evaluate pass/fail of relevant project quality control requirements and verification of all quantified amounts.

Receiving Notes

There were no receiving discrepancies.

Analytical Notes

All Quality Control Limit exceedances and affected sample results are noted by flags. Each flag is defined at the bottom of this Case Narrative and on each Sample Result Summary page.

Method TO-15 is validated for samples collected in specially treated canisters. As such, the use of Tedlar bags for sample collection is outside the scope of the method and not recommended for ambient or indoor air samples. It is the responsibility of the data user to determine the usability of TO-15 results generated from Tedlar bags.

Definition of Data Qualifying Flags

Eight qualifiers may have been used on the data analysis sheets and indicates as follows:

B - Compound present in laboratory blank greater than reporting limit (background subtraction not performed).

J - Estimated value.

E - Exceeds instrument calibration range.

S - Saturated peak.

Q - Exceeds quality control limits.

U - Compound analyzed for but not detected above the reporting limit, LOD, or MDL value. See data page for project specific U-flag definition.

UJ- Non-detected compound associated with low bias in the CCV

N - The identification is based on presumptive evidence.

File extensions may have been used on the data analysis sheets and indicates as follows:

a-File was requantified

b-File was quantified by a second column and detector

r1-File was requantified for the purpose of reissue

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Summary of Detected Compounds
EPA METHOD TO-15 GC/MS FULL SCAN

Client Sample ID: S-VOC-1

Lab ID#: 1603044A-03A

Compound	Rpt. Limit (ppbv)	Amount (ppbv)	Rpt. Limit (ug/m3)	Amount (ug/m3)
Freon 12	0.50	0.52	2.5	2.6
Ethanol	2.0	12	3.8	22
Acetone	5.0	6.9	12	16
Tetrahydrofuran	0.50	0.74	1.5	2.2
Chloroform	0.50	4.2	2.4	21
Trichloroethene	0.50	0.63	2.7	3.4
Toluene	0.50	6.0	1.9	23
Ethyl Benzene	0.50	0.52	2.2	2.2
m,p-Xylene	0.50	1.8	2.2	7.7
o-Xylene	0.50	0.63	2.2	2.7
4-Ethyltoluene	0.50	0.73	2.4	3.6
1,2,4-Trimethylbenzene	0.50	0.66	2.4	3.2

Client Sample ID: S-VOC-2

Lab ID#: 1603044A-04A

Compound	Rpt. Limit (ppbv)	Amount (ppbv)	Rpt. Limit (ug/m3)	Amount (ug/m3)
Ethanol	2.0	7.9	3.8	15
Toluene	0.50	3.2	1.9	12
m,p-Xylene	0.50	1.5	2.2	6.5
o-Xylene	0.50	0.59	2.2	2.6
4-Ethyltoluene	0.50	0.70	2.4	3.5
1,2,4-Trimethylbenzene	0.50	0.60	2.4	3.0

Client Sample ID: S-VOC-1

Lab ID#: 1603044A-03A

EPA METHOD TO-15 GC/MS FULL SCAN

File Name:	**17030407**	**Date of Collection: 3/2/16 4:10:00 PM**
Dil. Factor:	**1.00**	**Date of Analysis: 3/4/16 02:13 PM**

Compound	Rpt. Limit (ppbv)	Amount (ppbv)	Rpt. Limit (ug/m3)	Amount (ug/m3)
Freon 12	0.50	0.52	2.5	2.6
Freon 114	0.50	Not Detected	3.5	Not Detected
Chloromethane	5.0	Not Detected UJ	10	Not Detected UJ
Vinyl Chloride	0.50	Not Detected	1.3	Not Detected
1,3-Butadiene	0.50	Not Detected	1.1	Not Detected
Bromomethane	5.0	Not Detected	19	Not Detected
Chloroethane	2.0	Not Detected	5.3	Not Detected
Freon 11	0.50	Not Detected	2.8	Not Detected
Ethanol	2.0	12	3.8	22
Freon 113	0.50	Not Detected	3.8	Not Detected
1,1-Dichloroethene	0.50	Not Detected	2.0	Not Detected
Acetone	5.0	6.9	12	16
2-Propanol	2.0	Not Detected	4.9	Not Detected
Carbon Disulfide	2.0	Not Detected	6.2	Not Detected
3-Chloropropene	2.0	Not Detected	6.3	Not Detected
Methylene Chloride	5.0	Not Detected	17	Not Detected
Methyl tert-butyl ether	0.50	Not Detected	1.8	Not Detected
trans-1,2-Dichloroethene	0.50	Not Detected	2.0	Not Detected
Hexane	0.50	Not Detected	1.8	Not Detected
1,1-Dichloroethane	0.50	Not Detected	2.0	Not Detected
2-Butanone (Methyl Ethyl Ketone)	2.0	Not Detected	5.9	Not Detected
cis-1,2-Dichloroethene	0.50	Not Detected	2.0	Not Detected
Tetrahydrofuran	0.50	0.74	1.5	2.2
Chloroform	0.50	4.2	2.4	21
1,1,1-Trichloroethane	0.50	Not Detected	2.7	Not Detected
Cyclohexane	0.50	Not Detected	1.7	Not Detected
Carbon Tetrachloride	0.50	Not Detected	3.1	Not Detected
2,2,4-Trimethylpentane	0.50	Not Detected	2.3	Not Detected
Benzene	0.50	Not Detected	1.6	Not Detected
1,2-Dichloroethane	0.50	Not Detected	2.0	Not Detected
Heptane	0.50	Not Detected	2.0	Not Detected
Trichloroethene	0.50	0.63	2.7	3.4
1,2-Dichloropropane	0.50	Not Detected	2.3	Not Detected
1,4-Dioxane	2.0	Not Detected	7.2	Not Detected
Bromodichloromethane	0.50	Not Detected	3.4	Not Detected
cis-1,3-Dichloropropene	0.50	Not Detected	2.3	Not Detected
4-Methyl-2-pentanone	0.50	Not Detected	2.0	Not Detected
Toluene	0.50	6.0	1.9	23
trans-1,3-Dichloropropene	0.50	Not Detected	2.3	Not Detected
1,1,2-Trichloroethane	0.50	Not Detected	2.7	Not Detected
Tetrachloroethene	0.50	Not Detected	3.4	Not Detected
2-Hexanone	2.0	Not Detected	8.2	Not Detected

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Client Sample ID: S-VOC-1

Lab ID#: 1603044A-03A

EPA METHOD TO-15 GC/MS FULL SCAN

File Name:	**17030407**	**Date of Collection: 3/2/16 4:10:00 PM**
Dil. Factor:	**1.00**	**Date of Analysis: 3/4/16 02:13 PM**

Compound	Rpt. Limit (ppbv)	Amount (ppbv)	Rpt. Limit (ug/m3)	Amount (ug/m3)
Dibromochloromethane	0.50	Not Detected	4.2	Not Detected
1,2-Dibromoethane (EDB)	0.50	Not Detected	3.8	Not Detected
Chlorobenzene	0.50	Not Detected	2.3	Not Detected
Ethyl Benzene	0.50	0.52	2.2	2.2
m,p-Xylene	0.50	1.8	2.2	7.7
o-Xylene	0.50	0.63	2.2	2.7
Styrene	0.50	Not Detected	2.1	Not Detected
Bromoform	0.50	Not Detected	5.2	Not Detected
Cumene	0.50	Not Detected	2.4	Not Detected
1,1,2,2-Tetrachloroethane	0.50	Not Detected	3.4	Not Detected
Propylbenzene	0.50	Not Detected	2.4	Not Detected
4-Ethyltoluene	0.50	0.73	2.4	3.6
1,3,5-Trimethylbenzene	0.50	Not Detected	2.4	Not Detected
1,2,4-Trimethylbenzene	0.50	0.66	2.4	3.2
1,3-Dichlorobenzene	0.50	Not Detected	3.0	Not Detected
1,4-Dichlorobenzene	0.50	Not Detected	3.0	Not Detected
alpha-Chlorotoluene	0.50	Not Detected	2.6	Not Detected
1,2-Dichlorobenzene	0.50	Not Detected	3.0	Not Detected
1,2,4-Trichlorobenzene	2.0	Not Detected	15	Not Detected
Hexachlorobutadiene	2.0	Not Detected	21	Not Detected

UJ = Analyte associated with low bias in the CCV and/or LCS.

Container Type: 1 Liter Tedlar Bag

Surrogates	%Recovery	Method Limits
Toluene-d8	99	70-130
1,2-Dichloroethane-d4	91	70-130
4-Bromofluorobenzene	112	70-130

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Client Sample ID: S-VOC-2

Lab ID#: 1603044A-04A

EPA METHOD TO-15 GC/MS FULL SCAN

File Name:	**17030408**	**Date of Collection:**	**3/2/16 4:20:00 PM**
Dil. Factor:	**1.00**	**Date of Analysis:**	**3/4/16 02:40 PM**

Compound	Rpt. Limit (ppbv)	Amount (ppbv)	Rpt. Limit (ug/m3)	Amount (ug/m3)
Freon 12	0.50	Not Detected	2.5	Not Detected
Freon 114	0.50	Not Detected	3.5	Not Detected
Chloromethane	5.0	Not Detected UJ	10	Not Detected UJ
Vinyl Chloride	0.50	Not Detected	1.3	Not Detected
1,3-Butadiene	0.50	Not Detected	1.1	Not Detected
Bromomethane	5.0	Not Detected	19	Not Detected
Chloroethane	2.0	Not Detected	5.3	Not Detected
Freon 11	0.50	Not Detected	2.8	Not Detected
Ethanol	2.0	7.9	3.8	15
Freon 113	0.50	Not Detected	3.8	Not Detected
1,1-Dichloroethene	0.50	Not Detected	2.0	Not Detected
Acetone	5.0	Not Detected	12	Not Detected
2-Propanol	2.0	Not Detected	4.9	Not Detected
Carbon Disulfide	2.0	Not Detected	6.2	Not Detected
3-Chloropropene	2.0	Not Detected	6.3	Not Detected
Methylene Chloride	5.0	Not Detected	17	Not Detected
Methyl tert-butyl ether	0.50	Not Detected	1.8	Not Detected
trans-1,2-Dichloroethene	0.50	Not Detected	2.0	Not Detected
Hexane	0.50	Not Detected	1.8	Not Detected
1,1-Dichloroethane	0.50	Not Detected	2.0	Not Detected
2-Butanone (Methyl Ethyl Ketone)	2.0	Not Detected	5.9	Not Detected
cis-1,2-Dichloroethene	0.50	Not Detected	2.0	Not Detected
Tetrahydrofuran	0.50	Not Detected	1.5	Not Detected
Chloroform	0.50	Not Detected	2.4	Not Detected
1,1,1-Trichloroethane	0.50	Not Detected	2.7	Not Detected
Cyclohexane	0.50	Not Detected	1.7	Not Detected
Carbon Tetrachloride	0.50	Not Detected	3.1	Not Detected
2,2,4-Trimethylpentane	0.50	Not Detected	2.3	Not Detected
Benzene	0.50	Not Detected	1.6	Not Detected
1,2-Dichloroethane	0.50	Not Detected	2.0	Not Detected
Heptane	0.50	Not Detected	2.0	Not Detected
Trichloroethene	0.50	Not Detected	2.7	Not Detected
1,2-Dichloropropane	0.50	Not Detected	2.3	Not Detected
1,4-Dioxane	2.0	Not Detected	7.2	Not Detected
Bromodichloromethane	0.50	Not Detected	3.4	Not Detected
cis-1,3-Dichloropropene	0.50	Not Detected	2.3	Not Detected
4-Methyl-2-pentanone	0.50	Not Detected	2.0	Not Detected
Toluene	0.50	3.2	1.9	12
trans-1,3-Dichloropropene	0.50	Not Detected	2.3	Not Detected
1,1,2-Trichloroethane	0.50	Not Detected	2.7	Not Detected
Tetrachloroethene	0.50	Not Detected	3.4	Not Detected
2-Hexanone	2.0	Not Detected	8.2	Not Detected

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Client Sample ID: S-VOC-2

Lab ID#: 1603044A-04A

EPA METHOD TO-15 GC/MS FULL SCAN

File Name:	**17030408**	**Date of Collection: 3/2/16 4:20:00 PM**
Dil. Factor:	**1.00**	**Date of Analysis: 3/4/16 02:40 PM**

Compound	Rpt. Limit (ppbv)	Amount (ppbv)	Rpt. Limit (ug/m3)	Amount (ug/m3)
Dibromochloromethane	0.50	Not Detected	4.2	Not Detected
1,2-Dibromoethane (EDB)	0.50	Not Detected	3.8	Not Detected
Chlorobenzene	0.50	Not Detected	2.3	Not Detected
Ethyl Benzene	0.50	Not Detected	2.2	Not Detected
m,p-Xylene	0.50	1.5	2.2	6.5
o-Xylene	0.50	0.59	2.2	2.6
Styrene	0.50	Not Detected	2.1	Not Detected
Bromoform	0.50	Not Detected	5.2	Not Detected
Cumene	0.50	Not Detected	2.4	Not Detected
1,1,2,2-Tetrachloroethane	0.50	Not Detected	3.4	Not Detected
Propylbenzene	0.50	Not Detected	2.4	Not Detected
4-Ethyltoluene	0.50	0.70	2.4	3.5
1,3,5-Trimethylbenzene	0.50	Not Detected	2.4	Not Detected
1,2,4-Trimethylbenzene	0.50	0.60	2.4	3.0
1,3-Dichlorobenzene	0.50	Not Detected	3.0	Not Detected
1,4-Dichlorobenzene	0.50	Not Detected	3.0	Not Detected
alpha-Chlorotoluene	0.50	Not Detected	2.6	Not Detected
1,2-Dichlorobenzene	0.50	Not Detected	3.0	Not Detected
1,2,4-Trichlorobenzene	2.0	Not Detected	15	Not Detected
Hexachlorobutadiene	2.0	Not Detected	21	Not Detected

UJ = Analyte associated with low bias in the CCV and/or LCS.

Container Type: 1 Liter Tedlar Bag

Surrogates	%Recovery	Method Limits
Toluene-d8	100	70-130
1,2-Dichloroethane-d4	92	70-130
4-Bromofluorobenzene	113	70-130

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Client Sample ID: Lab Blank

Lab ID#: 1603044A-05A

EPA METHOD TO-15 GC/MS FULL SCAN

File Name:	17030406	Date of Collection: NA
Dil. Factor:	1.00	Date of Analysis: 3/4/16 12:25 PM

Compound	Rpt. Limit (ppbv)	Amount (ppbv)	Rpt. Limit (ug/m3)	Amount (ug/m3)
Freon 12	0.50	Not Detected	2.5	Not Detected
Freon 114	0.50	Not Detected	3.5	Not Detected
Chloromethane	5.0	Not Detected UJ	10	Not Detected UJ
Vinyl Chloride	0.50	Not Detected	1.3	Not Detected
1,3-Butadiene	0.50	Not Detected	1.1	Not Detected
Bromomethane	5.0	Not Detected	19	Not Detected
Chloroethane	2.0	Not Detected	5.3	Not Detected
Freon 11	0.50	Not Detected	2.8	Not Detected
Ethanol	2.0	Not Detected	3.8	Not Detected
Freon 113	0.50	Not Detected	3.8	Not Detected
1,1-Dichloroethene	0.50	Not Detected	2.0	Not Detected
Acetone	5.0	Not Detected	12	Not Detected
2-Propanol	2.0	Not Detected	4.9	Not Detected
Carbon Disulfide	2.0	Not Detected	6.2	Not Detected
3-Chloropropene	2.0	Not Detected	6.3	Not Detected
Methylene Chloride	5.0	Not Detected	17	Not Detected
Methyl tert-butyl ether	0.50	Not Detected	1.8	Not Detected
trans-1,2-Dichloroethene	0.50	Not Detected	2.0	Not Detected
Hexane	0.50	Not Detected	1.8	Not Detected
1,1-Dichloroethane	0.50	Not Detected	2.0	Not Detected
2-Butanone (Methyl Ethyl Ketone)	2.0	Not Detected	5.9	Not Detected
cis-1,2-Dichloroethene	0.50	Not Detected	2.0	Not Detected
Tetrahydrofuran	0.50	Not Detected	1.5	Not Detected
Chloroform	0.50	Not Detected	2.4	Not Detected
1,1,1-Trichloroethane	0.50	Not Detected	2.7	Not Detected
Cyclohexane	0.50	Not Detected	1.7	Not Detected
Carbon Tetrachloride	0.50	Not Detected	3.1	Not Detected
2,2,4-Trimethylpentane	0.50	Not Detected	2.3	Not Detected
Benzene	0.50	Not Detected	1.6	Not Detected
1,2-Dichloroethane	0.50	Not Detected	2.0	Not Detected
Heptane	0.50	Not Detected	2.0	Not Detected
Trichloroethene	0.50	Not Detected	2.7	Not Detected
1,2-Dichloropropane	0.50	Not Detected	2.3	Not Detected
1,4-Dioxane	2.0	Not Detected	7.2	Not Detected
Bromodichloromethane	0.50	Not Detected	3.4	Not Detected
cis-1,3-Dichloropropene	0.50	Not Detected	2.3	Not Detected
4-Methyl-2-pentanone	0.50	Not Detected	2.0	Not Detected
Toluene	0.50	Not Detected	1.9	Not Detected
trans-1,3-Dichloropropene	0.50	Not Detected	2.3	Not Detected
1,1,2-Trichloroethane	0.50	Not Detected	2.7	Not Detected
Tetrachloroethene	0.50	Not Detected	3.4	Not Detected
2-Hexanone	2.0	Not Detected	8.2	Not Detected

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Client Sample ID: Lab Blank

Lab ID#: 1603044A-05A

EPA METHOD TO-15 GC/MS FULL SCAN

File Name:	**17030406**	**Date of Collection: NA**	
Dil. Factor:	**1.00**	**Date of Analysis: 3/4/16 12:25 PM**	

Compound	Rpt. Limit (ppbv)	Amount (ppbv)	Rpt. Limit (ug/m3)	Amount (ug/m3)
Dibromochloromethane	0.50	Not Detected	4.2	Not Detected
1,2-Dibromoethane (EDB)	0.50	Not Detected	3.8	Not Detected
Chlorobenzene	0.50	Not Detected	2.3	Not Detected
Ethyl Benzene	0.50	Not Detected	2.2	Not Detected
m,p-Xylene	0.50	Not Detected	2.2	Not Detected
o-Xylene	0.50	Not Detected	2.2	Not Detected
Styrene	0.50	Not Detected	2.1	Not Detected
Bromoform	0.50	Not Detected	5.2	Not Detected
Cumene	0.50	Not Detected	2.4	Not Detected
1,1,2,2-Tetrachloroethane	0.50	Not Detected	3.4	Not Detected
Propylbenzene	0.50	Not Detected	2.4	Not Detected
4-Ethyltoluene	0.50	Not Detected	2.4	Not Detected
1,3,5-Trimethylbenzene	0.50	Not Detected	2.4	Not Detected
1,2,4-Trimethylbenzene	0.50	Not Detected	2.4	Not Detected
1,3-Dichlorobenzene	0.50	Not Detected	3.0	Not Detected
1,4-Dichlorobenzene	0.50	Not Detected	3.0	Not Detected
alpha-Chlorotoluene	0.50	Not Detected	2.6	Not Detected
1,2-Dichlorobenzene	0.50	Not Detected	3.0	Not Detected
1,2,4-Trichlorobenzene	2.0	Not Detected	15	Not Detected
Hexachlorobutadiene	2.0	Not Detected	21	Not Detected

UJ = Analyte associated with low bias in the CCV and/or LCS.

Container Type: NA - Not Applicable

Surrogates	%Recovery	Method Limits
Toluene-d8	99	70-130
1,2-Dichloroethane-d4	91	70-130
4-Bromofluorobenzene	108	70-130

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Client Sample ID: CCV

Lab ID#: 1603044A-06A

EPA METHOD TO-15 GC/MS FULL SCAN

File Name:	**17030402**	**Date of Collection: NA**
Dil. Factor:	**1.00**	**Date of Analysis: 3/4/16 09:52 AM**

Compound	%Recovery
Freon 12	91
Freon 114	104
Chloromethane	63 Q
Vinyl Chloride	83
1,3-Butadiene	74
Bromomethane	103
Chloroethane	85
Freon 11	98
Ethanol	78
Freon 113	102
1,1-Dichloroethene	87
Acetone	85
2-Propanol	78
Carbon Disulfide	86
3-Chloropropene	86
Methylene Chloride	83
Methyl tert-butyl ether	87
trans-1,2-Dichloroethene	89
Hexane	78
1,1-Dichloroethane	84
2-Butanone (Methyl Ethyl Ketone)	86
cis-1,2-Dichloroethene	88
Tetrahydrofuran	79
Chloroform	88
1,1,1-Trichloroethane	91
Cyclohexane	85
Carbon Tetrachloride	98
2,2,4-Trimethylpentane	79
Benzene	88
1,2-Dichloroethane	93
Heptane	85
Trichloroethene	91
1,2-Dichloropropane	84
1,4-Dioxane	88
Bromodichloromethane	92
cis-1,3-Dichloropropene	92
4-Methyl-2-pentanone	82
Toluene	94
trans-1,3-Dichloropropene	92
1,1,2-Trichloroethane	91
Tetrachloroethene	106
2-Hexanone	79

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Client Sample ID: CCV

Lab ID#: 1603044A-06A

EPA METHOD TO-15 GC/MS FULL SCAN

File Name:	**17030402**	**Date of Collection: NA**
Dil. Factor:	**1.00**	**Date of Analysis: 3/4/16 09:52 AM**

Compound	%Recovery
Dibromochloromethane	97
1,2-Dibromoethane (EDB)	95
Chlorobenzene	98
Ethyl Benzene	97
m,p-Xylene	98
o-Xylene	96
Styrene	94
Bromoform	111
Cumene	97
1,1,2,2-Tetrachloroethane	88
Propylbenzene	96
4-Ethyltoluene	102
1,3,5-Trimethylbenzene	102
1,2,4-Trimethylbenzene	98
1,3-Dichlorobenzene	104
1,4-Dichlorobenzene	101
alpha-Chlorotoluene	93
1,2-Dichlorobenzene	102
1,2,4-Trichlorobenzene	93
Hexachlorobutadiene	108

Q = Exceeds Quality Control limits.

Container Type: NA - Not Applicable

Surrogates	%Recovery	Method Limits
Toluene-d8	101	70-130
1,2-Dichloroethane-d4	86	70-130
4-Bromofluorobenzene	113	70-130

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Client Sample ID: LCS

Lab ID#: 1603044A-07A

EPA METHOD TO-15 GC/MS FULL SCAN

File Name:	**17030403**	**Date of Collection: NA**
Dil. Factor:	**1.00**	**Date of Analysis: 3/4/16 10:17 AM**

Compound	%Recovery	Method Limits
Freon 12	96	70-130
Freon 114	112	70-130
Chloromethane	78	70-130
Vinyl Chloride	87	70-130
1,3-Butadiene	73	70-130
Bromomethane	112	70-130
Chloroethane	87	70-130
Freon 11	102	70-130
Ethanol	84	70-130
Freon 113	102	70-130
1,1-Dichloroethene	88	70-130
Acetone	80	70-130
2-Propanol	84	70-130
Carbon Disulfide	77	70-130
3-Chloropropene	83	70-130
Methylene Chloride	80	70-130
Methyl tert-butyl ether	87	70-130
trans-1,2-Dichloroethene	92	70-130
Hexane	80	70-130
1,1-Dichloroethane	82	70-130
2-Butanone (Methyl Ethyl Ketone)	87	70-130
cis-1,2-Dichloroethene	87	70-130
Tetrahydrofuran	80	70-130
Chloroform	88	70-130
1,1,1-Trichloroethane	92	70-130
Cyclohexane	87	70-130
Carbon Tetrachloride	99	70-130
2,2,4-Trimethylpentane	83	70-130
Benzene	91	70-130
1,2-Dichloroethane	94	70-130
Heptane	89	70-130
Trichloroethene	94	70-130
1,2-Dichloropropane	87	70-130
1,4-Dioxane	93	70-130
Bromodichloromethane	96	70-130
cis-1,3-Dichloropropene	89	70-130
4-Methyl-2-pentanone	86	70-130
Toluene	97	70-130
trans-1,3-Dichloropropene	94	70-130
1,1,2-Trichloroethane	94	70-130
Tetrachloroethene	110	70-130
2-Hexanone	86	70-130

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Client Sample ID: LCS

Lab ID#: 1603044A-07A

EPA METHOD TO-15 GC/MS FULL SCAN

File Name:	**17030403**	**Date of Collection: NA**
Dil. Factor:	**1.00**	**Date of Analysis: 3/4/16 10:17 AM**

Compound	%Recovery	Method Limits
Dibromochloromethane	102	70-130
1,2-Dibromoethane (EDB)	99	70-130
Chlorobenzene	101	70-130
Ethyl Benzene	100	70-130
m,p-Xylene	100	70-130
o-Xylene	101	70-130
Styrene	101	70-130
Bromoform	119	70-130
Cumene	102	70-130
1,1,2,2-Tetrachloroethane	93	70-130
Propylbenzene	103	70-130
4-Ethyltoluene	109	70-130
1,3,5-Trimethylbenzene	109	70-130
1,2,4-Trimethylbenzene	109	70-130
1,3-Dichlorobenzene	109	70-130
1,4-Dichlorobenzene	108	70-130
alpha-Chlorotoluene	103	70-130
1,2-Dichlorobenzene	108	70-130
1,2,4-Trichlorobenzene	109	70-130
Hexachlorobutadiene	118	70-130

Container Type: NA - Not Applicable

Surrogates	%Recovery	Method Limits
Toluene-d8	102	70-130
1,2-Dichloroethane-d4	92	70-130
4-Bromofluorobenzene	113	70-130

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Client Sample ID: LCSD

Lab ID#: 1603044A-07AA

EPA METHOD TO-15 GC/MS FULL SCAN

File Name:	**17030404**	**Date of Collection: NA**	
Dil. Factor:	**1.00**	**Date of Analysis: 3/4/16 10:42 AM**	

Compound	%Recovery	Method Limits
Freon 12	97	70-130
Freon 114	112	70-130
Chloromethane	81	70-130
Vinyl Chloride	88	70-130
1,3-Butadiene	74	70-130
Bromomethane	114	70-130
Chloroethane	89	70-130
Freon 11	104	70-130
Ethanol	85	70-130
Freon 113	104	70-130
1,1-Dichloroethene	89	70-130
Acetone	83	70-130
2-Propanol	84	70-130
Carbon Disulfide	77	70-130
3-Chloropropene	82	70-130
Methylene Chloride	81	70-130
Methyl tert-butyl ether	89	70-130
trans-1,2-Dichloroethene	91	70-130
Hexane	82	70-130
1,1-Dichloroethane	83	70-130
2-Butanone (Methyl Ethyl Ketone)	87	70-130
cis-1,2-Dichloroethene	88	70-130
Tetrahydrofuran	80	70-130
Chloroform	89	70-130
1,1,1-Trichloroethane	93	70-130
Cyclohexane	88	70-130
Carbon Tetrachloride	101	70-130
2,2,4-Trimethylpentane	84	70-130
Benzene	90	70-130
1,2-Dichloroethane	94	70-130
Heptane	89	70-130
Trichloroethene	93	70-130
1,2-Dichloropropane	87	70-130
1,4-Dioxane	93	70-130
Bromodichloromethane	96	70-130
cis-1,3-Dichloropropene	88	70-130
4-Methyl-2-pentanone	88	70-130
Toluene	97	70-130
trans-1,3-Dichloropropene	93	70-130
1,1,2-Trichloroethane	93	70-130
Tetrachloroethene	110	70-130
2-Hexanone	87	70-130

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Client Sample ID: LCSD

Lab ID#: 1603044A-07AA

EPA METHOD TO-15 GC/MS FULL SCAN

File Name:	**17030404**	**Date of Collection: NA**
Dil. Factor:	**1.00**	**Date of Analysis: 3/4/16 10:42 AM**

Compound	%Recovery	Method Limits
Dibromochloromethane	102	70-130
1,2-Dibromoethane (EDB)	99	70-130
Chlorobenzene	102	70-130
Ethyl Benzene	100	70-130
m,p-Xylene	101	70-130
o-Xylene	103	70-130
Styrene	101	70-130
Bromoform	119	70-130
Cumene	102	70-130
1,1,2,2-Tetrachloroethane	93	70-130
Propylbenzene	103	70-130
4-Ethyltoluene	111	70-130
1,3,5-Trimethylbenzene	108	70-130
1,2,4-Trimethylbenzene	110	70-130
1,3-Dichlorobenzene	111	70-130
1,4-Dichlorobenzene	109	70-130
alpha-Chlorotoluene	104	70-130
1,2-Dichlorobenzene	110	70-130
1,2,4-Trichlorobenzene	120	70-130
Hexachlorobutadiene	129	70-130

Container Type: NA - Not Applicable

Surrogates	%Recovery	Method Limits
Toluene-d8	102	70-130
1,2-Dichloroethane-d4	92	70-130
4-Bromofluorobenzene	113	70-130

LABSAMPID	LABCODE	MATRIX	METHOD	CLIENTSAMPID	SAMPDATET	ANALDATE	ANALTIME	LABCTLID	DILUTION	REPLMT	UNITS	RESULTS	DATAFLAGS	COMPOUND NAME	CASNUM	COMMENTS
1603044B-01A	ATL	AIR	ASTM D-5504	S-TRS-1	03/02/2016	03/03/2016	1123	gck03Mar2016	1.00	4.0	PPBV	110		Hydrogen Sulfide	7783-06-4	
1603044B-01A	ATL	AIR	ASTM D-5504	S-TRS-1	03/02/2016	03/03/2016	1123	gck03Mar2016	1.00	4.0	PPBV		ND	Carbonyl Sulfide	463-58-1	
1603044B-01A	ATL	AIR	ASTM D-5504	S-TRS-1	03/02/2016	03/03/2016	1123	gck03Mar2016	1.00	4.0	PPBV	11		Methyl Mercaptan	74-93-1	
1603044B-01A	ATL	AIR	ASTM D-5504	S-TRS-1	03/02/2016	03/03/2016	1123	gck03Mar2016	1.00	4.0	PPBV		ND	Ethyl Mercaptan	75-08-1	
1603044B-01A	ATL	AIR	ASTM D-5504	S-TRS-1	03/02/2016	03/03/2016	1123	gck03Mar2016	1.00	4.0	PPBV		ND	Dimethyl Sulfide	75-18-3	
1603044B-01A	ATL	AIR	ASTM D-5504	S-TRS-1	03/02/2016	03/03/2016	1123	gck03Mar2016	1.00	20	PPBV		ND	Carbon Disulfide	75-15-0	
1603044B-01A	ATL	AIR	ASTM D-5504	S-TRS-1	03/02/2016	03/03/2016	1123	gck03Mar2016	1.00	4.0	PPBV		ND	Isopropyl Mercaptan	75-33-2	
1603044B-01A	ATL	AIR	ASTM D-5504	S-TRS-1	03/02/2016	03/03/2016	1123	gck03Mar2016	1.00	4.0	PPBV		ND	tert-Butyl Mercaptan	75-66-1	
1603044B-01A	ATL	AIR	ASTM D-5504	S-TRS-1	03/02/2016	03/03/2016	1123	gck03Mar2016	1.00	4.0	PPBV		ND	n-Propyl Mercaptan	107-03-9	
1603044B-01A	ATL	AIR	ASTM D-5504	S-TRS-1	03/02/2016	03/03/2016	1123	gck03Mar2016	1.00	4.0	PPBV		ND	Ethyl Methyl Sulfide	624-89-5	
1603044B-01A	ATL	AIR	ASTM D-5504	S-TRS-1	03/02/2016	03/03/2016	1123	gck03Mar2016	1.00	4.0	PPBV		ND	Thiophene	110-02-1	
1603044B-01A	ATL	AIR	ASTM D-5504	S-TRS-1	03/02/2016	03/03/2016	1123	gck03Mar2016	1.00	4.0	PPBV		ND	Isobutyl Mercaptan	513-44-0	
1603044B-01A	ATL	AIR	ASTM D-5504	S-TRS-1	03/02/2016	03/03/2016	1123	gck03Mar2016	1.00	4.0	PPBV		ND	Diethyl Sulfide	352-93-2	
1603044B-01A	ATL	AIR	ASTM D-5504	S-TRS-1	03/02/2016	03/03/2016	1123	gck03Mar2016	1.00	4.0	PPBV		ND	n-Butyl Mercaptan	109-79-5	
1603044B-01A	ATL	AIR	ASTM D-5504	S-TRS-1	03/02/2016	03/03/2016	1123	gck03Mar2016	1.00	4.0	PPBV		ND	Dimethyl Disulfide	624-92-0	
1603044B-01A	ATL	AIR	ASTM D-5504	S-TRS-1	03/02/2016	03/03/2016	1123	gck03Mar2016	1.00	4.0	PPBV		ND	3-Methylthiophene	616-44-4	
1603044B-01A	ATL	AIR	ASTM D-5504	S-TRS-1	03/02/2016	03/03/2016	1123	gck03Mar2016	1.00	4.0	PPBV		ND	Tetrahydrothiophene	110-01-0	
1603044B-01A	ATL	AIR	ASTM D-5504	S-TRS-1	03/02/2016	03/03/2016	1123	gck03Mar2016	1.00	4.0	PPBV		ND	2-Ethylthiophene	872-55-9	
1603044B-01A	ATL	AIR	ASTM D-5504	S-TRS-1	03/02/2016	03/03/2016	1123	gck03Mar2016	1.00	4.0	PPBV		ND	2,5-Dimethylthiophene	638-02-8	
1603044B-01A	ATL	AIR	ASTM D-5504	S-TRS-1	03/02/2016	03/03/2016	1123	gck03Mar2016	1.00	4.0	PPBV		ND	Diethyl Disulfide	110-81-6	
1603044B-01A	ATL	AIR	ASTM D-5504	S-TRS-1	03/02/2016	03/03/2016	1123	gck03Mar2016	1.00	20	PPBV	130		Total Reduced Sulfur ref. to H2S (MW=34)	NA	
1603044B-02A	ATL	AIR	ASTM D-5504	S-TRS-2	03/02/2016	03/03/2016	1300	gck03Mar2016	6.00	24	PPBV	1400		Hydrogen Sulfide	7783-06-4	
1603044B-02A	ATL	AIR	ASTM D-5504	S-TRS-2	03/02/2016	03/03/2016	1300	gck03Mar2016	6.00	24	PPBV		ND	Carbonyl Sulfide	463-58-1	
1603044B-02A	ATL	AIR	ASTM D-5504	S-TRS-2	03/02/2016	03/03/2016	1300	gck03Mar2016	6.00	24	PPBV	72		Methyl Mercaptan	74-93-1	
1603044B-02A	ATL	AIR	ASTM D-5504	S-TRS-2	03/02/2016	03/03/2016	1300	gck03Mar2016	6.00	24	PPBV		ND	Ethyl Mercaptan	75-08-1	
1603044B-02A	ATL	AIR	ASTM D-5504	S-TRS-2	03/02/2016	03/03/2016	1300	gck03Mar2016	6.00	24	PPBV		ND	Dimethyl Sulfide	75-18-3	
1603044B-02A	ATL	AIR	ASTM D-5504	S-TRS-2	03/02/2016	03/03/2016	1300	gck03Mar2016	6.00	120	PPBV		ND	Carbon Disulfide	75-15-0	
1603044B-02A	ATL	AIR	ASTM D-5504	S-TRS-2	03/02/2016	03/03/2016	1300	gck03Mar2016	6.00	24	PPBV		ND	Isopropyl Mercaptan	75-33-2	
1603044B-02A	ATL	AIR	ASTM D-5504	S-TRS-2	03/02/2016	03/03/2016	1300	gck03Mar2016	6.00	24	PPBV		ND	tert-Butyl Mercaptan	75-66-1	
1603044B-02A	ATL	AIR	ASTM D-5504	S-TRS-2	03/02/2016	03/03/2016	1300	gck03Mar2016	6.00	24	PPBV		ND	n-Propyl Mercaptan	107-03-9	
1603044B-02A	ATL	AIR	ASTM D-5504	S-TRS-2	03/02/2016	03/03/2016	1300	gck03Mar2016	6.00	24	PPBV		ND	Ethyl Methyl Sulfide	624-89-5	
1603044B-02A	ATL	AIR	ASTM D-5504	S-TRS-2	03/02/2016	03/03/2016	1300	gck03Mar2016	6.00	24	PPBV		ND	Thiophene	110-02-1	
1603044B-02A	ATL	AIR	ASTM D-5504	S-TRS-2	03/02/2016	03/03/2016	1300	gck03Mar2016	6.00	24	PPBV		ND	Isobutyl Mercaptan	513-44-0	
1603044B-02A	ATL	AIR	ASTM D-5504	S-TRS-2	03/02/2016	03/03/2016	1300	gck03Mar2016	6.00	24	PPBV		ND	Diethyl Sulfide	352-93-2	
1603044B-02A	ATL	AIR	ASTM D-5504	S-TRS-2	03/02/2016	03/03/2016	1300	gck03Mar2016	6.00	24	PPBV		ND	n-Butyl Mercaptan	109-79-5	
1603044B-02A	ATL	AIR	ASTM D-5504	S-TRS-2	03/02/2016	03/03/2016	1300	gck03Mar2016	6.00	24	PPBV		ND	Dimethyl Disulfide	624-92-0	
1603044B-02A	ATL	AIR	ASTM D-5504	S-TRS-2	03/02/2016	03/03/2016	1300	gck03Mar2016	6.00	24	PPBV		ND	3-Methylthiophene	616-44-4	
1603044B-02A	ATL	AIR	ASTM D-5504	S-TRS-2	03/02/2016	03/03/2016	1300	gck03Mar2016	6.00	24	PPBV		ND	Tetrahydrothiophene	110-01-0	
1603044B-02A	ATL	AIR	ASTM D-5504	S-TRS-2	03/02/2016	03/03/2016	1300	gck03Mar2016	6.00	24	PPBV		ND	2-Ethylthiophene	872-55-9	
1603044B-02A	ATL	AIR	ASTM D-5504	S-TRS-2	03/02/2016	03/03/2016	1300	gck03Mar2016	6.00	24	PPBV		ND	2,5-Dimethylthiophene	638-02-8	
1603044B-02A	ATL	AIR	ASTM D-5504	S-TRS-2	03/02/2016	03/03/2016	1300	gck03Mar2016	6.00	24	PPBV		ND	Diethyl Disulfide	110-81-6	
1603044B-02A	ATL	AIR	ASTM D-5504	S-TRS-2	03/02/2016	03/03/2016	1300	gck03Mar2016	6.00	120	PPBV	1400		Total Reduced Sulfur ref. to H2S (MW=34)	NA	
1603044B-03A	ATL	AIR	ASTM D-5504	Lab Blank	00:00	03/02/2016	2226	gck03Mar2016	1.00	4.0	PPBV		ND	Hydrogen Sulfide	7783-06-4	
1603044B-03A	ATL	AIR	ASTM D-5504	Lab Blank	00:00	03/02/2016	2226	gck03Mar2016	1.00	4.0	PPBV		ND	Carbonyl Sulfide	463-58-1	
1603044B-03A	ATL	AIR	ASTM D-5504	Lab Blank	00:00	03/02/2016	2226	gck03Mar2016	1.00	4.0	PPBV		ND	Methyl Mercaptan	74-93-1	
1603044B-03A	ATL	AIR	ASTM D-5504	Lab Blank	00:00	03/02/2016	2226	gck03Mar2016	1.00	4.0	PPBV		ND	Ethyl Mercaptan	75-08-1	
1603044B-03A	ATL	AIR	ASTM D-5504	Lab Blank	00:00	03/02/2016	2226	gck03Mar2016	1.00	4.0	PPBV		ND	Dimethyl Sulfide	75-18-3	
1603044B-03A	ATL	AIR	ASTM D-5504	Lab Blank	00:00	03/02/2016	2226	gck03Mar2016	1.00	20	PPBV		ND	Carbon Disulfide	75-15-0	
1603044B-03A	ATL	AIR	ASTM D-5504	Lab Blank	00:00	03/02/2016	2226	gck03Mar2016	1.00	4.0	PPBV		ND	Isopropyl Mercaptan	75-33-2	
1603044B-03A	ATL	AIR	ASTM D-5504	Lab Blank	00:00	03/02/2016	2226	gck03Mar2016	1.00	4.0	PPBV		ND	tert-Butyl Mercaptan	75-66-1	
1603044B-03A	ATL	AIR	ASTM D-5504	Lab Blank	00:00	03/02/2016	2226	gck03Mar2016	1.00	4.0	PPBV		ND	n-Propyl Mercaptan	107-03-9	
1603044B-03A	ATL	AIR	ASTM D-5504	Lab Blank	00:00	03/02/2016	2226	gck03Mar2016	1.00	4.0	PPBV		ND	Ethyl Methyl Sulfide	624-89-5	
1603044B-03A	ATL	AIR	ASTM D-5504	Lab Blank	00:00	03/02/2016	2226	gck03Mar2016	1.00	4.0	PPBV		ND	Thiophene	110-02-1	
1603044B-03A	ATL	AIR	ASTM D-5504	Lab Blank	00:00	03/02/2016	2226	gck03Mar2016	1.00	4.0	PPBV		ND	Isobutyl Mercaptan	513-44-0	
1603044B-03A	ATL	AIR	ASTM D-5504	Lab Blank	00:00	03/02/2016	2226	gck03Mar2016	1.00	4.0	PPBV		ND	Diethyl Sulfide	352-93-2	
1603044B-03A	ATL	AIR	ASTM D-5504	Lab Blank	00:00	03/02/2016	2226	gck03Mar2016	1.00	4.0	PPBV		ND	n-Butyl Mercaptan	109-79-5	
1603044B-03A	ATL	AIR	ASTM D-5504	Lab Blank	00:00	03/02/2016	2226	gck03Mar2016	1.00	4.0	PPBV		ND	Dimethyl Disulfide	624-92-0	
1603044B-03A	ATL	AIR	ASTM D-5504	Lab Blank	00:00	03/02/2016	2226	gck03Mar2016	1.00	4.0	PPBV		ND	3-Methylthiophene	616-44-4	
1603044B-03A	ATL	AIR	ASTM D-5504	Lab Blank	00:00	03/02/2016	2226	gck03Mar2016	1.00	4.0	PPBV		ND	Tetrahydrothiophene	110-01-0	
1603044B-03A	ATL	AIR	ASTM D-5504	Lab Blank	00:00	03/02/2016	2226	gck03Mar2016	1.00	4.0	PPBV		ND	2-Ethylthiophene	872-55-9	

1603044B-03A	ATL	AIR	ASTM D-5504	Lab Blank	00:00	03/02/2016 2226	gck03Mar2016	1.00	4.0	PPBV		ND	2,5-Dimethylthiophene	638-02-8
1603044B-03A	ATL	AIR	ASTM D-5504	Lab Blank	00:00	03/02/2016 2226	gck03Mar2016	1.00	4.0	PPBV		ND	Diethyl Disulfide	110-81-6
1603044B-03A	ATL	AIR	ASTM D-5504	Lab Blank	00:00	03/02/2016 2226	gck03Mar2016	1.00	20	PPBV		ND	Total Reduced Sulfur ref. to H2S (MW=34)	NA
1603044B-04A	ATL	AIR	ASTM D-5504	LCS	00:00	03/02/2016 2135	gck03Mar2016	1.00		%R	118		Hydrogen Sulfide	7783-06-4
1603044B-04A	ATL	AIR	ASTM D-5504	LCS	00:00	03/02/2016 2135	gck03Mar2016	1.00		%R	81		Carbonyl Sulfide	463-58-1
1603044B-04A	ATL	AIR	ASTM D-5504	LCS	00:00	03/02/2016 2135	gck03Mar2016	1.00		%R	100		Methyl Mercaptan	74-93-1
1603044B-04A	ATL	AIR	ASTM D-5504	LCS	00:00	03/02/2016 2135	gck03Mar2016	1.00		%R	92		Ethyl Mercaptan	75-08-1
1603044B-04A	ATL	AIR	ASTM D-5504	LCS	00:00	03/02/2016 2135	gck03Mar2016	1.00		%R	96		Dimethyl Sulfide	75-18-3
1603044B-04A	ATL	AIR	ASTM D-5504	LCS	00:00	03/02/2016 2135	gck03Mar2016	1.00		%R	99		Carbon Disulfide	75-15-0
1603044B-04A	ATL	AIR	ASTM D-5504	LCS	00:00	03/02/2016 2135	gck03Mar2016	1.00		%R	95		Isopropyl Mercaptan	75-33-2
1603044B-04A	ATL	AIR	ASTM D-5504	LCS	00:00	03/02/2016 2135	gck03Mar2016	1.00		%R	96		tert-Butyl Mercaptan	75-66-1
1603044B-04A	ATL	AIR	ASTM D-5504	LCS	00:00	03/02/2016 2135	gck03Mar2016	1.00		%R	99		n-Propyl Mercaptan	107-03-9
1603044B-04A	ATL	AIR	ASTM D-5504	LCS	00:00	03/02/2016 2135	gck03Mar2016	1.00		%R	101		Ethyl Methyl Sulfide	624-89-5
1603044B-04A	ATL	AIR	ASTM D-5504	LCS	00:00	03/02/2016 2135	gck03Mar2016	1.00		%R	96		Thiophene	110-02-1
1603044B-04A	ATL	AIR	ASTM D-5504	LCS	00:00	03/02/2016 2135	gck03Mar2016	1.00		%R	96		Isobutyl Mercaptan	513-44-0
1603044B-04A	ATL	AIR	ASTM D-5504	LCS	00:00	03/02/2016 2135	gck03Mar2016	1.00		%R	98		Diethyl Sulfide	352-93-2
1603044B-04A	ATL	AIR	ASTM D-5504	LCS	00:00	03/02/2016 2135	gck03Mar2016	1.00		%R	97		n-Butyl Mercaptan	109-79-5
1603044B-04A	ATL	AIR	ASTM D-5504	LCS	00:00	03/02/2016 2135	gck03Mar2016	1.00		%R	103		Dimethyl Disulfide	624-92-0
1603044B-04A	ATL	AIR	ASTM D-5504	LCS	00:00	03/02/2016 2135	gck03Mar2016	1.00		%R	103		3-Methylthiophene	616-44-4
1603044B-04A	ATL	AIR	ASTM D-5504	LCS	00:00	03/02/2016 2135	gck03Mar2016	1.00		%R	108		Tetrahydrothiophene	110-01-0
1603044B-04A	ATL	AIR	ASTM D-5504	LCS	00:00	03/02/2016 2135	gck03Mar2016	1.00		%R	119		2-Ethylthiophene	872-55-9
1603044B-04A	ATL	AIR	ASTM D-5504	LCS	00:00	03/02/2016 2135	gck03Mar2016	1.00		%R	120		2,5-Dimethylthiophene	638-02-8
1603044B-04A	ATL	AIR	ASTM D-5504	LCS	00:00	03/02/2016 2135	gck03Mar2016	1.00		%R	122		Diethyl Disulfide	110-81-6
1603044B-04AA	ATL	AIR	ASTM D-5504	LCSD	00:00	03/02/2016 2159	gck03Mar2016	1.00		%R	110		Hydrogen Sulfide	7783-06-4
1603044B-04AA	ATL	AIR	ASTM D-5504	LCSD	00:00	03/02/2016 2159	gck03Mar2016	1.00		%R	81		Carbonyl Sulfide	463-58-1
1603044B-04AA	ATL	AIR	ASTM D-5504	LCSD	00:00	03/02/2016 2159	gck03Mar2016	1.00		%R	97		Methyl Mercaptan	74-93-1
1603044B-04AA	ATL	AIR	ASTM D-5504	LCSD	00:00	03/02/2016 2159	gck03Mar2016	1.00		%R	97		Ethyl Mercaptan	75-08-1
1603044B-04AA	ATL	AIR	ASTM D-5504	LCSD	00:00	03/02/2016 2159	gck03Mar2016	1.00		%R	97		Dimethyl Sulfide	75-18-3
1603044B-04AA	ATL	AIR	ASTM D-5504	LCSD	00:00	03/02/2016 2159	gck03Mar2016	1.00		%R	98		Carbon Disulfide	75-15-0
1603044B-04AA	ATL	AIR	ASTM D-5504	LCSD	00:00	03/02/2016 2159	gck03Mar2016	1.00		%R	94		Isopropyl Mercaptan	75-33-2
1603044B-04AA	ATL	AIR	ASTM D-5504	LCSD	00:00	03/02/2016 2159	gck03Mar2016	1.00		%R	95		tert-Butyl Mercaptan	75-66-1
1603044B-04AA	ATL	AIR	ASTM D-5504	LCSD	00:00	03/02/2016 2159	gck03Mar2016	1.00		%R	99		n-Propyl Mercaptan	107-03-9
1603044B-04AA	ATL	AIR	ASTM D-5504	LCSD	00:00	03/02/2016 2159	gck03Mar2016	1.00		%R	103		Ethyl Methyl Sulfide	624-89-5
1603044B-04AA	ATL	AIR	ASTM D-5504	LCSD	00:00	03/02/2016 2159	gck03Mar2016	1.00		%R	96		Thiophene	110-02-1
1603044B-04AA	ATL	AIR	ASTM D-5504	LCSD	00:00	03/02/2016 2159	gck03Mar2016	1.00		%R	96		Isobutyl Mercaptan	513-44-0
1603044B-04AA	ATL	AIR	ASTM D-5504	LCSD	00:00	03/02/2016 2159	gck03Mar2016	1.00		%R	100		Diethyl Sulfide	352-93-2
1603044B-04AA	ATL	AIR	ASTM D-5504	LCSD	00:00	03/02/2016 2159	gck03Mar2016	1.00		%R	101		n-Butyl Mercaptan	109-79-5
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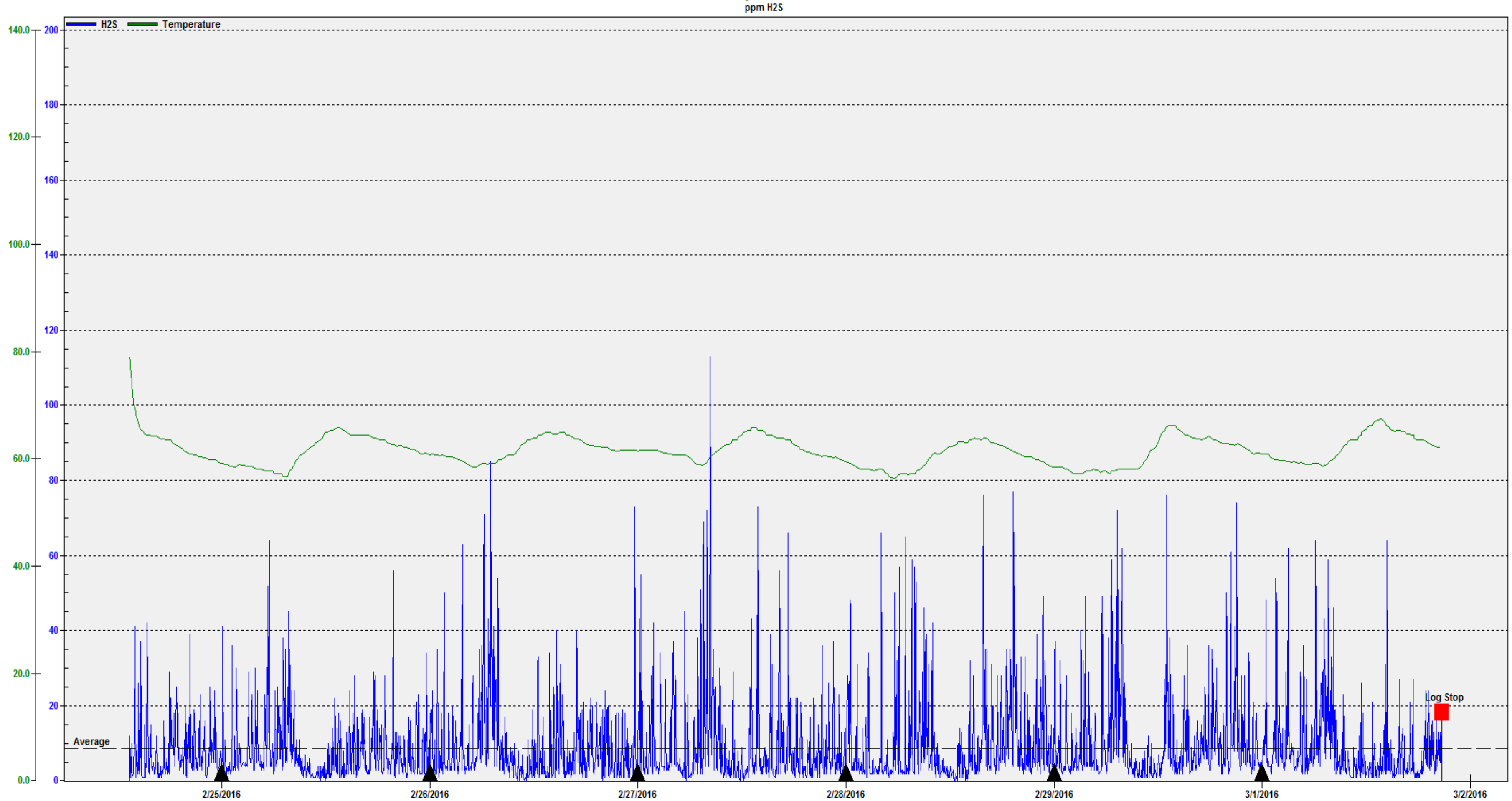
1603044B-04AA	ATL	AIR	ASTM D-5504	LCSD	00:00	03/02/2016 2159	gck03Mar2016	1.00		%R	107		3-Methylthiophene	616-44-4
1603044B-04AA	ATL	AIR	ASTM D-5504	LCSD	00:00	03/02/2016 2159	gck03Mar2016	1.00		%R	110		Tetrahydrothiophene	110-01-0
1603044B-04AA	ATL	AIR	ASTM D-5504	LCSD	00:00	03/02/2016 2159	gck03Mar2016	1.00		%R	120		2-Ethylthiophene	872-55-9
1603044B-04AA	ATL	AIR	ASTM D-5504	LCSD	00:00	03/02/2016 2159	gck03Mar2016	1.00		%R	120		2,5-Dimethylthiophene	638-02-8
1603044B-04AA	ATL	AIR	ASTM D-5504	LCSD	00:00	03/02/2016 2159	gck03Mar2016	1.00		%R	123		Diethyl Disulfide	110-81-6

Silicon Valley Influent Channel



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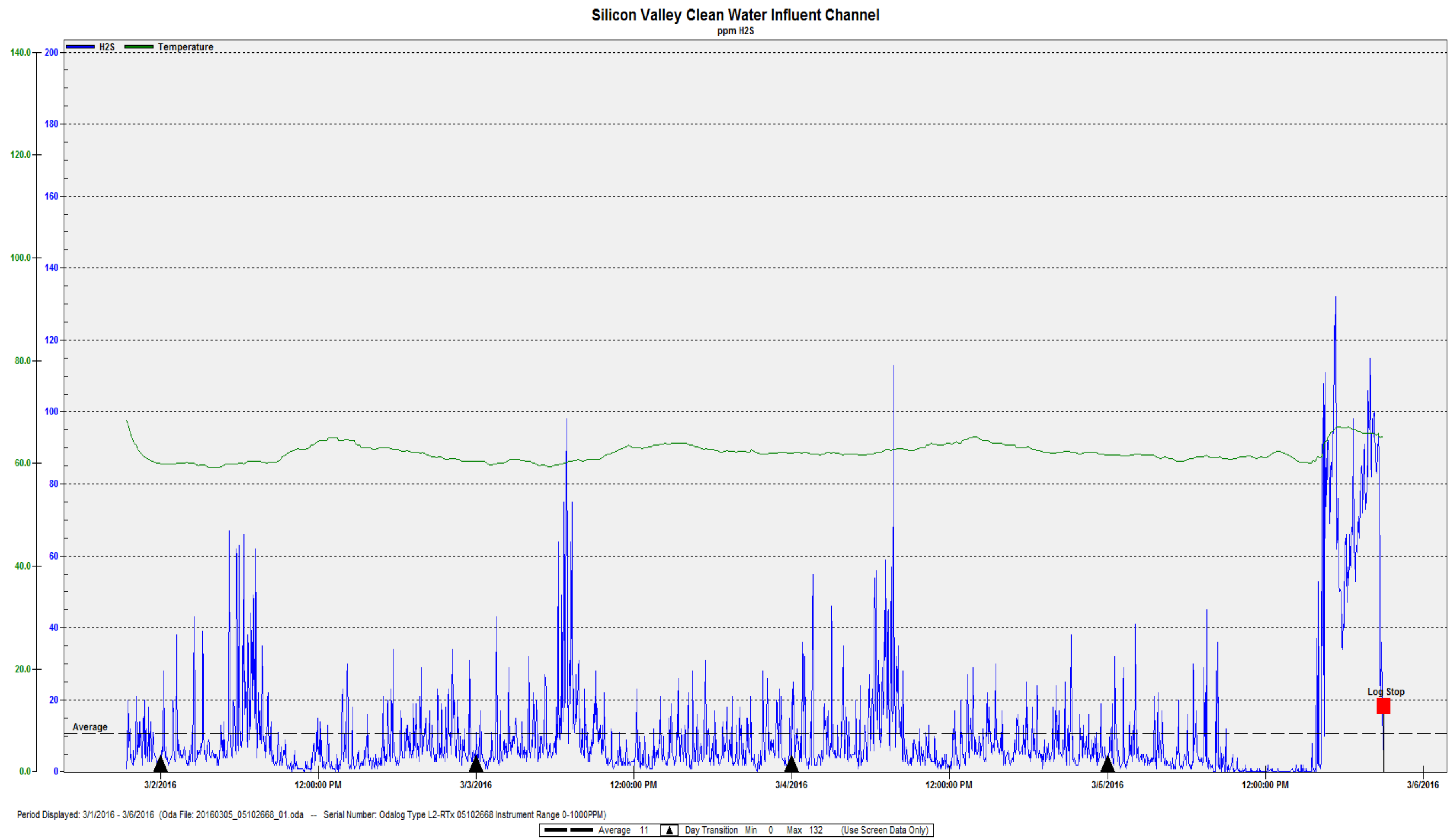
Average 9 | Month Transition Min 0 Max 113 (Use Screen Data Only)


Silicon Valley Clean Water Influent Channel
ppm H2S
H2S
Temperature
140.0
120.0
100.0
80.0
60.0
40.0
20.0
0.0
200
180
160
140
120
100
80
60
40
20
0
Average
Log Stop
3/2/2016
12:00:00 PM
3/3/2016
12:00:00 PM
3/4/2016
12:00:00 PM
3/5/2016
12:00:00 PM
3/6/2016
Period Displayed: 3/1/2016 - 3/6/2016 (Oda File: 20160305_05102668_01.oda -- Serial Number: Odalog Type L2-RTx 05102668 Instrument Range 0-1000PPM)
Average 11
Day Transition Min 0 Max 132 (Use Screen Data Only)

Appendix C

LO/PRO Packaged Odor Control System Brochure

LO/PRO® Packaged Odor Control System

Evoqua Water Technologies offers a full range of chemical scrubber odor control systems for municipal and industrial odor control.

LO/PRO Multi-Stage Scrubber

The patented LO/PRO® multi-stage scrubber system is the most efficient and versatile chemical odor control system available. By promoting different chemical reactions in each stage, the LO/PRO system can target a range of compounds in a single scrubber system.

The LO/PRO can treat up to 30,000 cfm (50,000 m^3/h) of odorous air in a single scrubber with very compact footprint. Because of the low profile it may easily be installed indoors or outdoors.

Standard Configuration

In the standard configuration, the first stage uses NaOH to remove 70% of the H_2S. The second and third stages use NaOH and NaOCl to remove the remaining H_2S and organic odors. This multi-chemistry system reduces chemical costs to less than half that required by conventional packed tower scrubbers.

Special Configurations

The LO/PRO system may also be configured to remove ammonia and amines in the first stage using H_2SO_4, and then remove H_2S and organic odors in the second and third stages using NaOH and NaOCl. This configuration is well suited to dewatering and solids handling operations , where lime stabilization causes ammonia and amine odors.

When operating at high ORP levels the LO/PRO is very efficient at oxidizing mercaptans and organic sulfides. In such systems a final NaOH stage may be used to prevent any residual chlorine odors.

Standard Features

- Patented Multi-stage Odor Control Process
- Removes H2S, Mercaptans, Organic Sulfides, Ammonia and Amines in One System
- Low Profile enables indoor installations
- Factory Assembled for near "Plug & Play" Installation
- FRP Construction
- Service and Support

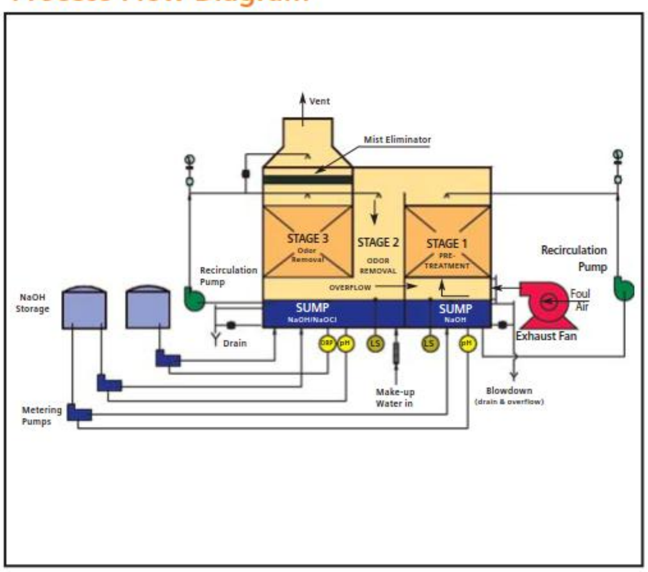
EVOQUA
WATER TECHNOLOGIES

The LO/PRO Design Information

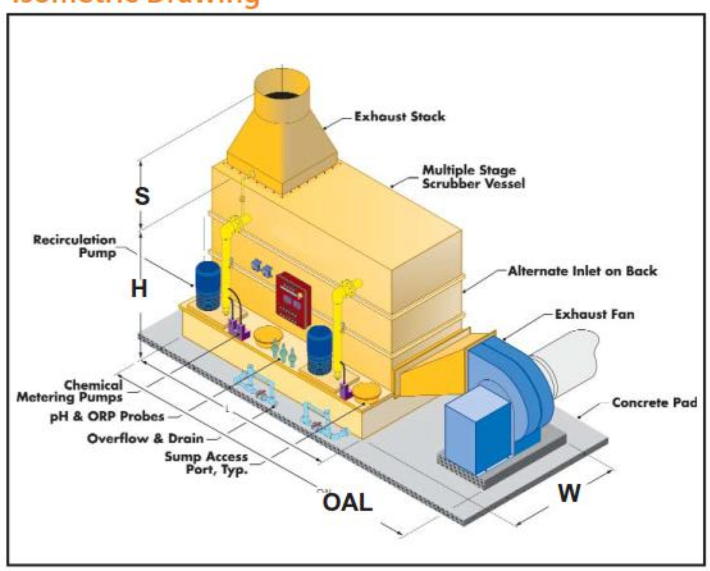
Model	Airflow Rate*	Dimensions LxWxH	Overall Length (OAL)	Shipping Wt	Operating Wt	Fan Motor	Recirc Pump Motors
Unit	cfm	ft	ft	lbs	lbs	HP	HP
LP-1500	1,000	4.50 x 4.00 x 8.50	9.0	1,000	3,500	5.0	3.5
LP-1750	1,300	5.25 x 4.25 x 9.25	10.0	1,600	4,500	5.0	5.0
LP-2000	1,700	6.00 x 4.50 x 9.25	11.0	2,200	6,000	7.5	7.0
LP-2250	2,200	6.75 x 4.75 x 9.25	12.5	2,500	7,000	7.5	8.0
LP-2500	2,700	7.50 x 5.00 x 9.50	13.0	1,100	8,000	7.5	8.0
LP-2750	3,300	8.25 x 5.25 x 9.50	15.0	3,700	9,500	7.5	10.0
LP-3000	4,000	9.00 x 5.50 x 10.50	15.5	4,400	11,000	10	10.0
LP-3500	5,500	8.75 x 6.00 x 11.00	16.0	5,000	12,000	15	10.0
LP-4000	7,100	10.00 x 6.50 x 11.00	17.5	5,600	14,500	15	12.5
LP-4500	9,100	11.25 x 7.00 x 11.25	19.5	6,200	17,000	20	12.5
LP-5000	11,200	12.50 x 7.50 x 11.50	20.5	6,800	19,500	25	15.0
LP-5500	13,600	13.75 x 8.00 x 11.75	22.0	7,500	22,000	30	17.5
LP-6000	16,200	15.00 x 8.50 x 12.00	24.0	8,300	22,500	40	17.5
LP-6500	20,000	16.25 x 9.00 x 12.25	26.0	9,100	28,500	50	25.0
LP-7000	24,500	17.50 x 9.50 x 12.50	27.0	10,000	32,000	60	35.0
LP-7000Q	30,000	28.00 x 9.50 x 12.50	38.0	16,000	51,000	100	35.0

** Standard Exhaust Stack "S" is six feet*

Process Flow Diagram



Isometric Drawing



Evoqua
Water Technologies
12316 World Trade Drive, Suite 100
San Diego, California 92128
Phone: 858-487-2200

OC-RJLOUSAdr-DS-0108
Subject to change without prior notice.

The United States and Trademark Office has recognized the novelty of the design of the LO/PRO with the award of two patents (U.S. Patent Nos. 5,876,662 & 6,174,498) An additional patent is now pending.

Appendix D

Odor Control Chemical Calculations

Odor Control San Carlos Shaft Chemical Calculations

CLIENT: **SVCW**

PROJECT **Silicon Valley**

JOB NO.:

FILE NAMI **San Carlos Shaft Chemcial Calcs**

FILE LOC/ **PW**

COMPUTE	**BJS**	DATE:	**12/1/3016**
CHECKED BY:		DATE:	
REVIEWED BY:		DATE:	

Location: **San Carlos Shaft Odor Control**

CALCULATIONS:

DESCRIPTION:

Chemical calculations for NaOH and NaOCl for the chemical scrubbers at the San Carlos Shaft

Three operating points

Dewatering San Carlos Odor Control Facility

Q =	Air Flow/Scrubber*	4,100	cfm				
y1 =	H2S in	10	ppm	0.217813	lb/hr	5.23	lb/day
y2 =	H2S out	0.1	ppm	0.002178	lb/hr	0.05	lb/day
	TRS in	5	ppm	0.230286	lb/hr	5.53	lb/day
	TRS out	1	ppm	0.000112	lb/hr	0.00	lb/day
	NH3 in	0	ppm	0	lb/hr	0.00	lb/day
	NH3 Out	0	ppm	0	lb/hr	0.00	lb/day
n =	H2S Removal	99.00%		0.215634	lb/hr	5.18	lb/day
Blowdown rate =		2.00%					
Liquid loading (recycle) =		82.00	gpm				

	Hrs/year	% year
A. PWWF Pump Failure at 16,000 cfm	10	0.11%
B. PWWF Storage	200	2.28%
C. Diurnal Storage	2000	22.83%

hrs/year
8760

H_2S - Caustic Use

H_2S + 2 NaOH ---> Na_2S + 2 H_2O
1 mole H_2S reacts with 2 moles NaOH
34 lb H_2S reacts with 80 lb NaOH
or 2.35 lb NaOH per lb H_2S

H2S removal % 99

NaOH = 12.16 lb/day

Assume 25% caustic is used — density = 2.7 lb_{NaOH}/gal_{NaOH25}

$NaOH_{25}$ = 5 gal/day

0.19 gph

CO_2 - Caustic Use

Per Waltrip, 1984
Assume 10% CO_2 removed at pH 11.5
Assume atmospheric CO_2 = 400 ppm
Equates to approx 0.4 lb $NaOH_{25}$ per lb CO_2 applied

2NaOH + CO_2 = Na_2CO_3 + H_2O

CO_2 removed	1	lb/hr
NaOH @ 0.4lb/lb	0.45	lb/hr
$NaOH_{25}$ =	1.804	lb/hr
$NaOH_{25}$ =	0.67	gph

Assume 2500 mg/L in the sump and a blowdown rate given above as % and recycle rate

NaOH =	49.24	lb/day
NaOH =	2.05	lb/hr
$NaOH_{25}$ =	8.21	lb/hr
$NaOH_{25}$ =	3.04	gph

Total Caustic Use	**3.90**	**gph**	as 25% NaOH

Caustic Use - Second Stage

Assume only 90% removed in first stage (Conservative)
Assume CO_2 does not consume any NaOH because pH is less than 9

NaOH =	1.22	lb/day
$NaOH_{25}$ =	4.89	lb/day
$NaOH_{25}$ =	**0.08**	**gph**

Assume 2500 mg/L in the sump and a blowdown rate given above as % and recycle rate

NaOH =	49.24	lb/day
NaOH =	2.05	lb/hr
$NaOH_{25}$ =	8.21	lb/hr
$NaOH_{25}$ =	3.04	gph

Waste rate	**3.11**	**gph**

Hypochlorite Use

$H_2S + 4NaOCl + 2\ NaOH \rightarrow Na_2SO_4 + 4NaCl + 2\ H_2O$
1 mole H_2S reacts with 4 moles NaOCl
34 lb H_2S reacts with 298 lb NaOCl
or 8.76 lb NaOCl per lb H_2S

Assume 90% H_2S removal and 10% TRS Compound removal in first stage (conservative for sizing)

H_2S in =	0.02	lb/hr	
TRS in=	0.23	lb/hr	
NaOCl =	2.21	lb/hr	second stage

Assume 12.5% hypo is used — density = 10.56 lb/gal

$NaOCl_{12.5}$ =	18	lb/hr	second stage
$NaOCl_{12.5}$ =	**1.7**	**gph**	**second stage**

Assume 2500 mg/L in the sump and a blowdown rate given above as % and recycle rate

NaOCl =	49.24	lb/day
NaOCl =	2.05	lb/hr
$NaOCl_{15}$ =	16.41	lb/hr
$NaOCl_{15}$ =	1.55	gph

Note, if the blowdown from the first stage scrubber is returned to the plant ahead of the aeration basins, some hydrogen sulfide may be released to the atmosphere in order to prevent this, the blowdown stream should be fully or partially oxidized. Under the worst case condition, all of the hydrogen sulfide removed by the system would be oxidized by hypochlorite. Hypochlorite feed would then have to be:

2.5 **first stage max.**

This flow rate will not be sufficient to oxidize blowdown under maximum conditions I consider such a condition too conservative and the pump will not be able to turn down to dose under average conditions or anything less than average.

Specify first stage pumps at this rate, which will be equivalent to second stage stage pumps at design peak.

Caustic Storage

Design for 14 days consumption under average conditions, but no less than 1000 gal as this is a stand-alone facility

Average consumption - all uses @ 25% strength

	7.01	gph	
	168.2	gpd	
	2355.4	gal	for 14 day's storage
Use	**2,000**	**gal**	
Providing	**11.9**	**days of storage under average conditions**	

Hypochlorite Storage

Design for 14 days consumption at average conditions assuming that hypochlorite is added tc the first stage. This will account for oxidizing the blow-down, if it is needed to prevent re-release

	1.7	gph	
	40.1	gpd	
	561.9	gal	for 14 day's storage
Use	**1,000**	**gal**	
Providing	**24.9**	**days of storage under average conditions**	

Dewatering San Carlos Odor Control Facility

Q =	Air Flow/Sc	9,700	cfm				
y1 =	H2S in	10	ppm	0.515313 lb/hr		12.37	lb/day
y2 =	H2S out	0.1	ppm	0.005153 lb/hr		0.12	lb/day
	TRS in	5	ppm	0.544824 lb/hr		13.08	lb/day
	TRS out	1	ppm	0.000112 lb/hr		0.00	lb/day
	NH3 in	0	ppm	0 lb/hr		0.00	lb/day
	NH3 Out	0	ppm	0 lb/hr		0.00	lb/day
n =	H2S Remov	99.00%		0.510159 lb/hr		12.24	lb/day
Blowdown rate =		2.00%					
iquid loading (recycle)		194.00	gpm				

	Hrs/year	% year
A. PWWF Pump Failure at 16,000 cfm	10	0.11%
B. PWWF Storage	200	2.28%
C. Diurnal Storage	2000	22.83%

hrs/year
8760

H_2S - Caustic Use

$H_2S + 2\ NaOH \rightarrow Na_2S + 2\ H_2O$
1 mole H_2S reacts with 2 moles NaOH
34 lb H_2S reacts with 80 lb NaOH
or 2.35 lb NaOH per lb H_2S

H2S remov 99

NaOH = 28.77 lb/day

Assume 25% caustic is used density = 2.7 lb/gal

$NaOH_{25}$ = 11 gal/day

0.44 gph

CO_2 - Caustic Use

Per Waltrip, 1984
Assume 10% CO_2 removed at pH 11.5
Assume atmospheric CO_2 = 300 ppm
Equates to approx 0.4 lb $NaOH_{25}$ per lb CO_2 applied

$2NaOH + CO_2 = Na_2CO_3 + H_2O$

CO_2 removed	2	lb/hr
NaOH @ 0.4lb/lb	0.80	lb/hr
$NaOH_{25}$ =	3.201	lb/hr
$NaOH_{25}$ =	1.19	gph

Assume 2500 mg/L in the sump and a blowdown rate given above as % and recycle rate.

NaOH =	116.49	lb/day
NaOH =	4.85	lb/hr
$NaOH_{25}$ =	19.42	lb/hr
$NaOH_{25}$ =	7.19	gph

Total Caustic Use **8.82 gph** as 25% NaOH

Caustic Use - Second Stage

Assume only 90% removed in first stage (Conservative)
Assume CO_2 does not consume any NaOH because pH is less than 9

NaOH =	2.89	lb/day
$NaOH_{25}$ =	11.57	lb/day
$NaOH_{25}$ =	**0.18**	**gph**

Assume 2500 mg/L in the sump and a blowdown rate given above as % and recycle rate.

NaOH =	116.49	lb/day
NaOH =	4.85	lb/hr
$NaOH_{25}$ =	19.42	lb/hr
$NaOH_{25}$ =	7.19	gph

Waste rate **7.37 gph**

Hypochlorite Use

$H_2S + 4NaOCl + 2\ NaOH \rightarrow Na_2SO_4 + 4NaCl + 2\ H_2O$
1 mole H_2S reacts with 4 moles NaOCl
34 lb H_2S reacts with 298 lb NaOCl
or 8.76 lb NaOCl per lb H_2S

Assume 90% H_2S removal and 10% TRS Compound removal in first stage (conservative for sizing)

H_2S in =	0.05	lb/hr		
TRS in=	0.54	lb/hr		
NaOCl =	5.22	lb/hr	second stage	

Assume 12.5% hypo is used density = 10.56 lb/gal

$NaOCl_{12.5}$ =	42	lb/hr	second stage
$NaOCl_{12.5}$:	**4.0**	**gph**	**second stage**

Assume 2500 mg/L in the sump and a blowdown rate given above as % and recycle rate.

NaOCl =	116.49	lb/day
NaOCl =	4.85	lb/hr
$NaOCl_{15}$ =	38.83	lb/hr
$NaOCl_{15}$ =	3.68	gph

Note, if the blowdown from the first stage scrubber is returned to the plant ahead of the aeration basins, some hydrogen sulfide may be released to the atmosphere in order to prevent this, the blowdown stream should be fully or partially oxidized. Under the worst case condition, all of the hydrogen sulfide removed by the system would be oxidized by hypochlorite. Hypochlorite feed would then have to be:

5.9 **first stage max.**

This flow rate will not be sufficient to oxidize blowdown under maximum conditions I consider such a condition too conservative and the pump will not be able to turn down to dose under average conditions or anything less than average.

Specify first stage pumps at this rate, which will be equivalent to second stage stage pumps at design peak.

Caustic Storage

Design for 14 days consumption under average conditions, but no less than 1000 gal as this is a stand-alone facility

Average consumption - all uses @ 25% strength

	16.19	gph	
	388.6	gpd	
	5439.8	gal	for 14 day's storage
Use	**4,500**	**gal**	
Providing	**11.6**	**days of storage under average conditions**	

Hypochlorite Storage

Design for 14 days consumption at average conditions assuming that hypochlorite is added to the first stage. This will account for oxidizing the blow-down, if it is needed to prevent re-release.

	4.0	gph	
	95.0	gpd	
	1329.7	gal	for 14 day's storage
Use	**2,000**	**gal**	
Providing	**21.1**	**days of storage under average conditions**	

Dewatering San Carlos Odor Control Facility

Q =	Air Flow/Sc	16,000	cfm				
y1 =	H2S in	10	ppm	0.85	lb/hr	20.40	lb/day
y2 =	H2S out	0.1	ppm	0.0085	lb/hr	0.20	lb/day
	TRS in	5	ppm	0.898678	lb/hr	21.57	lb/day
	TRS out	1	ppm	0.000112	lb/hr	0.00	lb/day
	NH3 in	0	ppm	0	lb/hr	0.00	lb/day
	NH3 Out	0	ppm	0	lb/hr	0.00	lb/day
n =	H2S Remov	99.00%		0.8415	lb/hr	20.20	lb/day
Blowdown rate =		2.00%					
iquid loading (recycle)		320.00	gpm				

	Hrs/year	% year
A. PWWF Pump Failure at 16,000 cfm	10	0.11%
B. PWWF Storage	200	2.28%
C. Diurnal Storage	2000	22.83%

hrs/year
8760

H_2S - Caustic Use

$H_2S + 2\ NaOH \rightarrow Na_2S + 2\ H_2O$
1 mole H_2S reacts with 2 moles NaOH
34 lb H_2S reacts with 80 lb NaOH
or 2.35 lb NaOH per lb H_2S

H2S remov 99

NaOH = 47.46 lb/day

Assume 25% caustic is used   density = 2.7 lb/gal

$NaOH_{25}$ = 18 gal/day

0.73 gph

CO_2 - Caustic Use

Per Waltrip, 1984
Assume 10% CO_2 removed at pH 11.5
Assume atmospheric CO_2 = 400 ppm
Equates to approx 0.4 lb $NaOH_{25}$ per lb CO_2 applied

$2NaOH + CO_2 = Na_2CO_3 + H_2O$

CO_2 removed	4	lb/hr
NaOH @ 0.4lb/lb	1.76	lb/hr
$NaOH_{25}$ =	7.04	lb/hr
$NaOH_{25}$ =	2.61	gph

Assume 2500 mg/L in the sump and a blowdown rate given above as % and recycle rate.

NaOH =	192.15	lb/day
NaOH =	8.01	lb/hr
$NaOH_{25}$ =	32.03	lb/hr
$NaOH_{25}$ =	11.86	gph

Total Caustic Use **15.20 gph** as 25% NaOH

Caustic Use - Second Stage

Assume only 90% removed in first stage (Conservative)
Assume CO_2 does not consume any NaOH because pH is less than 9

NaOH =	4.77	lb/day
$NaOH_{25}$ =	19.08	lb/day
$NaOH_{25}$ =	**0.29**	**gph**

Assume 2500 mg/L in the sump and a blowdown rate given above as % and recycle rate.

NaOH =	192.15	lb/day
NaOH =	8.01	lb/hr
$NaOH_{25}$ =	32.03	lb/hr
$NaOH_{25}$ =	11.86	gph

Waste rate **12.16 gph**

Hypochlorite Use

$H_2S + 4NaOCl + 2\ NaOH \rightarrow Na_2SO_4 + 4NaCl + 2\ H_2O$
1 mole H_2S reacts with 4 moles NaOCl
34 lb H_2S reacts with 298 lb NaOCl
or 8.76 lb NaOCl per lb H_2S

Assume 90% H_2S removal and 10% TRS Compound removal in first stage (conservative for sizing)

H_2S in = 0.09 lb/hr
TRS in= 0.90 lb/hr
NaOCl = 8.62 lb/hr second stage

Assume 12.5% hypo is used density = 10.56 lb/gal

$NaOCl_{12.5}$ = 69 lb/hr second stage

$NaOCl_{12.5}$: 6.5 gph second stage

Assume 2500 mg/L in the sump and a blowdown rate given above as % and recycle rate.

NaOCl = 192.15 lb/day
NaOCl = 8.01 lb/hr
$NaOCl_{15}$ = 64.05 lb/hr
$NaOCl_{15}$ = 6.07 gph

Note, if the blowdown from the first stage scrubber is returned to the plant ahead of the aeration basins, some hydrogen sulfide may be released to the atmosphere in order to prevent this, the blowdown stream should be fully or partially oxidized. Under the worst case condition, all of the hydrogen sulfide removed by the system would be oxidized by hypochlorite. Hypochlorite feed would then have to be:

9.8 first stage max.

This flow rate will not be sufficient to oxidize blowdown under maximum conditions I consider such a condition too conservative and the pump will not be able to turn down to dose under average conditions or anything less than average.

Specify first stage pumps at this rate, which will be equivalent to second stage stage pumps at design peak.

Caustic Storage

Design for 14 days consumption under average conditions, but no less than 1000 gal as this is a stand-alone facility

Average consumption - all uses @ 25% strength

27.36 gph
656.6 gpd
9191.9 gal for 14 day's storage

Use **8,000 gal**
Providing **12.2 days of storage under average conditions**

Hypochlorite Storage

Design for 14 days consumption at average conditions assuming that hypochlorite is added to the first stage. This will account for oxidizing the blow-down, if it is needed to prevent re-release.

6.5 gph
156.7 gpd
2193.5 gal for 14 day's storage

Use **3,000 gal**
Providing **19.1 days of storage under average conditions**

Dewatering San Carlos Odor Control Facility

Operating Assumptions

Operating Mode	Hrs/year	% year
A. PWWF Pump Failure at 16,000 cfm	10	0.11%
B. PWWF Storage at 9,700 cfm	200	2.28%
C. Diurnal Storage at 4,100 cfm	2000	22.83%

hrs/year

8760

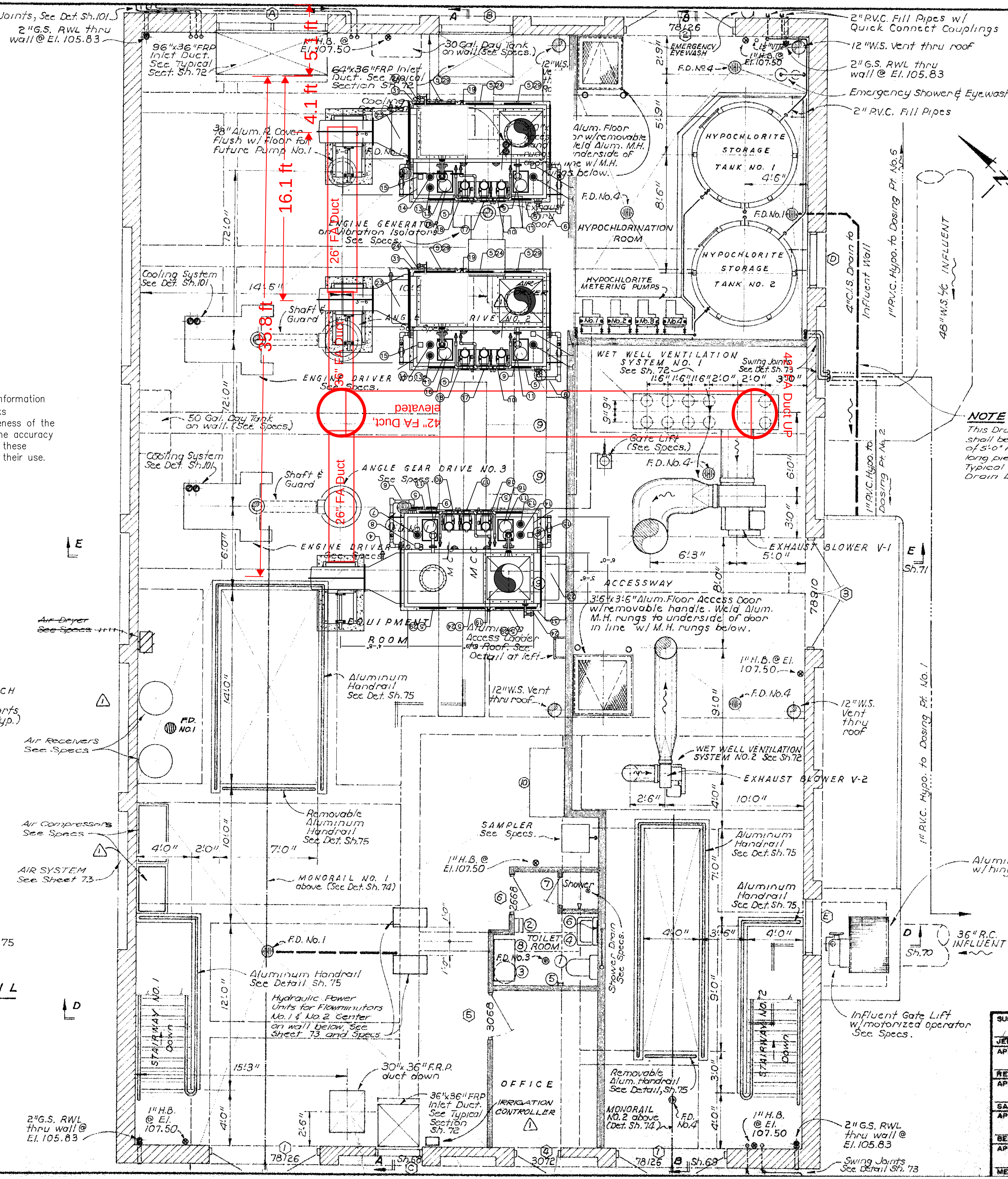
	gpd		gpy		Corrected gpy	
	NaOH	**NaOCl**	**NaOH**	**NaOCl**	**NaOH**	**NaOCl**
16,000 cfm	657	157	239647	57188	274	65
10,000 cfm	389	95	141824	34667	3238	791
5,000 cfm	168	40	61409	14649	14020	3345
				Total	17532	4201
20 day				**Storage**	961	230

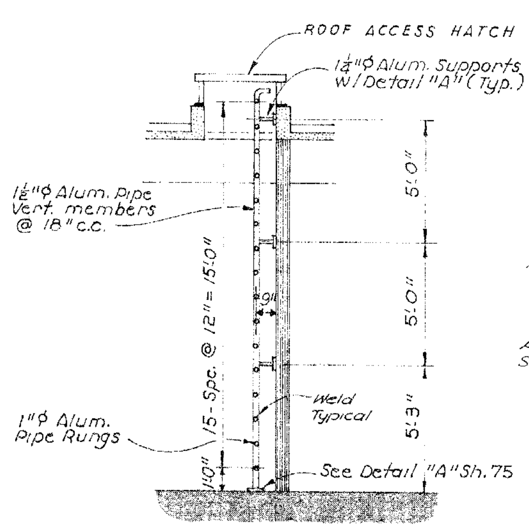
Appendix E

San Carlos Pump Station Mechanical Plan

Record Drawing

These Record Drawings have been prepared based on information provided by the contractor and others. Kennedy/Jenks Consultants has not verified the accuracy or completeness of the information provided to them and does not warrant the accuracy or completeness of these Record Drawings. Users of these Record Drawings assume all risk of loss resulting from their use.





ACCESS LADDER DETAIL

NOTES

1. Furred walls shall consist of metal studs @ 16" cc with Req'd. plates, etc. & ½" sheetrock covering, taped & painted, see Sh. 96.
2. See Sh. 98 for Door & Louver Schedule.
3. FINISH SCHEDULE
   - EQUIPMENT ROOM:
     - Concrete Block & Plaster Walls & Concrete Ceiling: Two coats Latex Masonry Paint, Flat.
     - Concrete Floor: Color Hardener
   - ACCESSWAY & HYPOCHLORINATION ROOM: Finishes same as Equip. Rm.
   - OFFICE:
     - Concrete Block & Plaster Walls & Plaster Ceiling: Two coats Latex Masonry Paint, Flat.
     - Concrete Floor: 1/8"x12"x12" Vinyl Asbestos Tile Flooring.
   - TOILET ROOM:
     - Plaster Walls & Plaster Ceiling: Two coats Latex Enamel, Satin.
     - Concrete Floor: 1/8"x12"x12" Vinyl Asbestos Tile Flooring.
     - Shower: Walls: ½"x3"x6" Ceramic Tile; Floor & Base: ½"x6"x6" Quarry Tile over waterproof Shower Pan
4. FIXTURE AND EQUIPMENT LIST — See Specifications for description
   1. Water Closet
   2. Towel Dispenser
   3. Water Heater
   4. Lavatory
   5. Paper Holder
   6. Mirror (24"x18")
   7. Shower Door
   8. Storage Cabinet (2-Ea.)
   9. Shelving (4-Ea.)
   10. Workbench
5. FLOOR DRAINS
   - F.D. No. 1 = 4" C.I. Bottom Outlet body w/ adjustable collar and 10" Min. φ deep set D.I. Tractor Grate
   - F.D. No. 2 = 6" C.I. Bottom Outlet body w/ adjustable collar and 10" Min. φ deep set D.I. Tractor Grate
   - F.D. No. 3 = 2" C.I. Bottom Outlet body w/ adjustable collar and 8"φ Min. anti-tilt D.I. Grate
   - F.D. No. 4 = 3" C.I. Bottom Outlet body w/ adjustable collar and 8"φ Min. anti-tilt D.I. Grate

NOTE: This Drain Line shall be made up of 5'0" maximum long pieces of pipe. Typical for 4" C/S Drain Lines

NOTE: SEE DIMENSIONAL PLAN SH. 78 FOR STRUCTURE DIMENSIONS

(REVISED SET JUNE 2006)

65 OF 141

⚠ RECORD DRAWING, JUNE 1982

SUBMITTED	
JENKS & HARRISON	DATE
APPROVED	
REDWOOD CITY	DATE
APPROVED	
SAN CARLOS	DATE
APPROVED	
BELMONT	DATE
APPROVED	
MENLO PARK S.D.	DATE

SOUTH BAYSIDE SYSTEM AUTHORITY
SAN MATEO COUNTY, CALIFORNIA

SUBREGIONAL WASTEWATER WORKS

SAN CARLOS PUMP STATION
PIPEWORK AND EQUIPMENT
GROUND FLOOR PLAN

JENKS & HARRISON
CONSULTING SANITARY & CIVIL ENGINEERS

Drawn by: LLK LFI	Scale: 1/4"=1'-0"
Des./Chkd by: DAB	Date: 8-77/9-79

Appendix F

Life Cycle Cost Analysis Guidelines Technical Memorandum

Brown AND Caldwell

201 North Civic Drive, Suite 115
Walnut Creek, California 94596
Tel: 925-937-9010
Fax: 925-937-9026

Technical Memorandum

Prepared for: Silicon Valley Clean Water

Project Title: PS Predesign Project – CIP#7010

Project No.: 142399

Technical Memorandum No. 11.3 - FINAL

Subject: Task 11 – Life Cycle Cost Analysis Guidelines

Date: July 13, 2016

To: Kim Hackett, Engineering Director, South Bayside System Authority

From: Charles Joyce, Project Manager, Brown and Caldwell

Copy to: Roanne Ross, Whitley Burchett and Associates

Prepared by: __________________________
Bernadette Visitacion-Sumida, P.E., Project Engineer
California License No. C82377

Reviewed by: __________________________
Charles Joyce, P.E., Quality Control
California License No. C33166

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Table of Contents

List of Tables

List of Abbreviations

BC	Brown and Caldwell
BPS	Belmont Pump Station
CEQA	California Environmental Quality Act
CSMP	Conveyance System Master Plan
EQ	Equation
FEF	Flow Equalization Facilities
FoP	Front of Plant
FRP	Fiberglass Reinforced Plastic
FTE	Full-Time Equivalent
LCC	Life Cycle Cost
LF	Linear Feet
MCC	Motor Control Center
MPPS	Menlo Park Pump Station
NPDES	National Pollutant Discharge Elimination System
NPV	Net Present Value
O&M	Operation and Maintenance
PWWF	Peak Wet Weather Flow
RCPS	Redwood City Pump Station
RLS	Receiving Lift Station
SCPS	San Carlos Pump Station
SRF	California State Revolving Fund
SVCW	Silicon Valley Clean Water
TM	Technical Memorandum
WWTP	Wastewater Treatment Plant
$	Dollars

Executive Summary

In May 2015, the Silicon Valley Clean Water (SVCW) Commissioners approved Alternative 4BE as the recommended conveyance system alternative to proceed with California Environmental Quality Act (CEQA) documentation and predesign. Alternative 4BE includes a deep gravity tunnel from the San Carlos Pump Station (SCPS) to the Wastewater Treatment Plant (WWTP), varying combinations of pump station rehabilitation, Receiving Lift Station (RLS) and new Headworks facility with Influent Connector Pipe. Since the Commissioners' approval, the project components were refined and updated costs were developed.

The purpose of this technical memorandum (TM) is to summarize the methods and guidelines for performing a life cycle cost (LCC) analyses of the various conveyance system components for Alternative 4BE. Brown and Caldwell (BC) performed the original LCC model used as part of the process to evaluate the conveyance system alternatives that resulted in the Alternative 4BE selection. SVCW requested that each of the SVCW conveyance system consultants perform an LCC on their individual project components using the updated construction costs developed by each team. SVCW will compile the costs to develop the updated 50-year LCC. The major considerations in developing each project component's LCC include capital cost, annual operation and maintenance (O&M) running costs, replacement/rehabilitation costs and overall project schedule.

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Section 1: Introduction

The purpose of this technical memorandum (TM) is to summarize the assumptions, sources of information and methodology of the LCC analyses originally performed by Brown and Caldwell (BC) for the various conveyance system components to use as a guideline for the project-specific LCC analyses. The project components consist of varying combinations of pump stations, gravity tunnels, Flow Diversion Structure and force mains to convey wastewater from SVCW's Member Agencies to their WWTP.

Each of the SVCW's conveyance system consultants (consultants) will perform LCCs for their individual project components. The LCC models developed by each consultant should include an economic analysis that accounts for the current and future costs of facilities over the course of its lifetime; including initial capital, O&M, and rehabilitation/replacement costs.

1.1 Background

SVCW decided to consider several alternatives to the conveyance system upgrades that were identified in the 2011 Conveyance System Master Plan (CSMP). The CSMP included replacement of the existing 54-inch force main that transports wastewater from the San Carlos Pump Station (SCPS) to the WWTP with a new 63-inch force main located through Redwood Shores. After meeting with the public in Redwood Shores, SVCW looked at other pipeline alignments and construction methods to reduce the construction impact to the Redwood Shores area businesses and residents. This evaluation resulted in the development of several alternatives to eliminate the force main that would be installed by open-cut methods through Redwood Shores.

BC performed the original LCC analysis for the recommendation of Alternative 4BE that was approved by the Commissioners in May 2015 to proceed to the environmental entitlements phase. The original Alternative 4BE included the following components:

- Tunnel and Gravity Pipeline
- Belmont Force Main Improvements
- Belmont Pump Station Rehabilitation
- Menlo Park Pump Station Rehabilitation
- Redwood City Pump Station Replacement
- Elimination of the Existing San Carlos Pump Station
- Receiving Lift Station
- Flow Equalization Facility
- Headworks Facility

Since May 2015, each of these components have been refined during conceptual design and the construction costs updated. Additional projects have also been added to the overall conveyance system improvements program. The following is a list of current projects included within the program with a short description of changes that occurred over the past year:

- **Tunnel and Gravity Pipeline.** The Gravity Pipeline was originally designed to be 6 ft in diameter. The current inner diameter is 11 ft within a maximum 15 ft exterior diameter tunnel. The reason for the change is to allow wet weather flow storage within the tunnel and reduce the Receiving Lift Station pumping capacity.
- **Belmont Force Main Improvements.** The Belmont Force Main will be reused and convey flows back to the San Carlos Pump Station site and combine with the incoming flows from the City of San Carlos before discharge into the Gravity Pipeline.

- **Belmont Pump Station Rehabilitation.** No major updates – remains as a rehabilitation project.
- **Menlo Park Pump Station Rehabilitation.** The Menlo Park Pump Station will be designed to convey dry weather flows to the Bair Island Drop Shaft for discharge into the Gravity Pipeline. During wet weather, the pumps are designed to convey flows to the Redwood City Pump Station where it will be combined within the screenings building and pumped to the Bair Island Drop Shaft.
- **Redwood City Pump Station Replacement.** The wet weather capacity of the Redwood City Pump Station increases to 60 MGD (combination of Menlo Park and Redwood City flows) from the original 38 MGD that accounted only for Redwood City flows.
- **Elimination of the Existing San Carlos Pump Station.** The San Carlos Pump Station will be repurposed to include flow metering for Belmont and San Carlos flows, trash rack and odor control for the Gravity Pipeline.
- **Receiving Lift Station.** The Receiving Lift Station will be designed to convey 80 MGD Peak Wet Weather Flow (PWWF) instead of the 102.9 MGD PWWF originally proposed.
- **Flow Equalization Facility.** The Flow Equalization Facility has been eliminated from the program, replaced by storage in the tunnel.
- **Headworks Facility.** The Headworks Facility will be designed for a capacity of 80 MGD and will house electrical equipment and odor control equipment associated with the Receiving Lift Station and Gravity Tunnel.

Additional projects added to the program include the following:

- **Influent Connector Pipe.** The Influent Connector Pipe will connect the Headworks to the primary sedimentation basins and serve as a bypass during wet weather events when flows exceed the Headworks Facility capacity.
- **Front of Plant Civil Improvements.** The Front of Plant Civil Improvements will include ground improvements to accommodate the Receiving Lift Station and Headworks Facility, including a pipeline from the Headworks to Sludge Drying Bed A for emergency wastewater storage. It will also include a storm drain pump station for storm water conveyance offsite.

Detailed descriptions and consultant teams assigned to each project are included in Section 2. LCC model runs will be required for each project by the respective consultant teams for use in the upcoming California State Revolving Fund (SRF) application process.

1.2 LCC Model Requirements

Each consultant will develop/complete a LCC calculation/model to perform an economic analysis for each consultant's respective project components that includes the following:

- Net Present Value (NPV) analysis including appropriate discount and escalation rates, established by SVCW as presented in this TM.
- Capital costs
- Annual operation and maintenance (O&M) costs, established by each project team.
- Replacement and rehabilitation costs, established by each project team.
- Construction schedules, established by each project team.

The following sections describe the assumptions, sources, development, and guidelines for developing the LCC model.

Section 2: Conveyance System Components

SVCW selected four consultants to work on various components of the Conveyance System upgrades. The four consultants are Brown and Caldwell (BC), CDM Smith (CDM), Freyer and Laureta (F+L) and Kennedy Jenks (K/J). The consultant assigned to each project is designated in the project headers below. The major project components are briefly summarized below. These project components are the most current project elements that were included in the May 2016 construction cost estimates submitted by each consultant team.

2.1 Tunnel and Gravity Pipeline (K/J)

The Tunnel and Gravity Pipeline (referred to as Gravity Pipeline herein) component consists of a new 17,600-linear foot pipeline constructed by a tunnel boring machine between the SVCW WWTP and the north end of Inner Bair Island. The Gravity Pipeline will store wastewater during wet weather when flows exceed the WWTP capacity. The new 11-foot inside diameter pipeline will be installed within a 13-foot inside diameter concrete tunnel (up to 15-foot outside diameter) in two separate sections of tunnel. Costs include the pipeline, tunneling, tunnel launch and receiving shafts. This project includes the new drop structure connection at the San Carlos Pump Station location. The connection for the leachate discharge will be directly into the drop structure as part of this project.

2.2 Receiving Lift Station (RLS; BC)

The RLS will be located at the terminus of the Gravity Pipeline at the WWTP. The RLS will be used to pump raw sewage from the Gravity Pipeline to the Headworks. The RLS will consist of an inlet area, isolation gates and channels followed by two trench-style wet wells that will each house three submersible pumps for a total of six pumps. Cost components included in the RLS May 2016 construction cost estimate are summarized in Table 1. Additional items to be designed/constructed by others are also included in this table.

Table 1. RLS Cost Components

Consultant	Components
BC	• Shaft interior improvements including plastic lining. • Slide gates. • Tunnel to inlet channel transition. • Flushing lines at each pump and slide gate. • Pumps and associated mechanical and piping. • RLS interior walls and structures (e.g., components to form inlet channel separation, trench wet wells, ogee ramp, etc.) • Exhaust ducting within the RLS routed to just outside of the Headworks building. • Two supply air blowers and associated ducting. • Pump control cabinets. • Variable frequency drives. • Instrumentation systems. • Motor Control Centers (MCCs). • Electrical and instrumentation cable/conduit and duct banks from the pumps to just outside of the Headworks building. • Pipe gallery and pile supports.
CDM as part of the Headworks	• Odor Control Ducting within the Headworks Building. • Odor Control System. • Exhaust fans.

Table 1. RLS Cost Components

Consultant	Components
	• Electrical and Instrumentation cable/conduit within the Headworks Building. • Flow Distribution Structure located at the RLS pump discharges.
F+L as part of the Civil Improvements	• Ground improvements surrounding the RLS to accommodate heavy equipment during construction and long-term maintenance. • RLS access and paving. • General site civil in the RLS area. Drainage is assumed to be away from the RLS and pipe galleries.
K/J as part of the Gravity Pipeline	• Tunnel shaft. • Gravity Pipeline connection.

Electrical and operational costs associated with the RLS, including supply air to the RLS for odor control, will be developed by BC.

2.3 Headworks Facility (CDM)

The Headworks will be constructed upstream of the existing primary treatment process areas and downstream of the RLS. It will consist of grit and screening processing equipment, odor control facilities, electrical room, and standby generator. The electrical room and odor control facilities will service the RLS, Tunnel exhaust, and Headworks. See Section 2.2 for RLS components that will be included as part of the Headworks Facility.

2.4 Influent Connector Pipe (CDM)

The Influent Connector Pipe currently includes two parallel pipes, 44-inch diameter and 72-inch diameter that connect the Headworks at Flow Distribution Box No. 2 to the existing influent system. Each of the pipes are ~900 ft long and are sized to accommodate a range of flows while maintaining adequate flushing velocity. The Headworks Facility is considered a separate project component from the Influent Connector Pipe.

2.5 Front of Plant (FoP) Civil Improvements (F+L)

Civil improvements are needed for the front of the plant area to accommodate the new RLS, Headworks, and support construction activities. These improvements include: soil stabilization, flow diversion pipe from Headworks Facility to Sludge Drying Bed A, general setting of the site elevations to allow access to new facilities and for proper drainage away from the RLS and Headworks facilities; storm drainage improvements to prevent site flooding; driveway and roadway improvements to create safe vehicle routing; walls and fencing for site securing and screening; and tree planting for further site screening and visual improvements. In addition, a storm water pump station collects and conveys rainwater and storm water that falls on the FoP portion of the WWTP site for treatment as required by the plant's National Pollution Discharge Elimination System (NPDES) permit. This work will occur across three construction phases and each of these three phases needs to be developed separately in the LCC.

2.6 Belmont Force Main Improvements (BC)

The Belmont Force Main component will consist of rehabilitating the existing force main that conveys the wastewater flow from the City of Belmont to the SVCW system, back to the existing San Carlos Pump Station (SCPS) location. The project will include rehabilitation of an existing ~1,150 foot 24-inch segment of the force main; and slipline of ~3,550 feet of the 54-inch force main to transport the Belmont flow to the new gravity wastewater pipeline in the vicinity of the SCPS.

2.7 Belmont Pump Station (BPS) Rehabilitation (BC)

The Belmont Pump Station Rehabilitation includes rehabilitation of the pump station and replacement of the three existing pumps with new pumps that accommodate future flow rates and pressures. The existing electrical equipment, diminutor, controls, and standby generator have reached the end of their useful and will be replaced with new equipment.

2.8 SCPS Repurposing (BC)

The SCPS Improvements will include the installation of the piping and improvements on the site to take the existing pump station off line, provide individual metering and sampling of the San Carlos and Belmont flows, and connect the two pipelines to the Gravity Pipeline at a drop structure connection (drop structure is part of the Gravity Pipeline project). Piping improvements include extending the San Carlos sanitary sewer to the proposed Gravity Pipeline; extending the Belmont force main to connect to the proposed Gravity Pipeline; relocating the 10-inch San Carlos force main to connect to the San Carlos inlet sewer; installing flow metering and sampling structures; and installing a Belmont/San Carlos Combination Structure and 42-inch diameter pipe at the drop structure stub-out to connect to the Gravity Pipeline. On the San Carlos inlet to the Belmont/San Carlos Combination Structure, a trash rack will be placed to remove large debris and to connect the relocated 10-inch San Carlos force main upstream of the San Carlos flow meter.

2.9 San Carlos Odor Control Facility (CDM)

An odor control facility at the San Carlos Connection will be installed to contain and treat foul air venting from the Gravity Pipeline drop shaft. Equipment includes chemical scrubbers, storage tanks for chemicals used in the scrubbers, metering pumps, secondary containment piping, electrical equipment, and other ancillary equipment that will be located in the existing San Carlos Pump Station building. The installation of the new odor control equipment includes removal of existing equipment (only needed for odor control equipment space) and interior walls, and other building or site upgrades/renovations to maintain the long-term operation of the odor control facility.

2.10 Redwood City Pump Station (RCPS) Replacement (BC)

At the location of the existing Redwood City Pump Station, a new pump station will be built to pump the wastewater flow from Redwood City into the SVCW Conveyance System. The current pump station building will be repurposed to house odor control, standby generator and electrical/control facilities. A new pump station facility will be constructed adjacent and to the west of the existing RCPS building and will include two new trench-style wet wells that will contain two dry weather and two wet weather pumps for a total of eight pumps. In addition, a new screenings building will be built to the north of the new pump station wet well that includes coarse screens to remove large solids, rags and debris from the Redwood City flows.

2.11 Menlo Park Pump Station (MPPS) Rehabilitation (BC)

Improvements to the pump station include both above ground and below ground modifications. The above-grade improvements include exterior façade upgrades to the existing pump station building, a new 18-inch exterior perimeter wall and access ramps for flood protection/access, onsite storm water management, new security fencing and lighting, landscaping, new vacuum relief valves, a new odor control system, seismic upgrades to the existing building, and an upgraded HVAC system. In addition, five new 5.5 MGD, 75-HP pumps, new pump discharge manifold and valves, flow meter, grinders, and related equipment will be installed below grade. The existing pump station building will be reused and will house electrical/control equipment, standby power, odor control, and other ancillary equipment needed to operate and maintain the rehabilitated pump station. The proposed improvements, with the exception of the flow meter, will be located within the existing MPPS building. Vehicle access to the site will be from the existing gate on Marsh Road.

Section 3: Cost Components

The following sections discuss the assumptions and sources of information for the cost components to be incorporated into the LCC model. The LCC model primarily considers three types of costs: construction, annual O&M, and rehabilitation/replacement costs. Assumptions and sources of these cost components are discussed in the following sections. Salvage costs for equipment and benefits will not be considered in this analysis since it was not included in the original LCC analysis completed for the Conveyance System.

3.1 Construction Costs

Construction costs were developed by SVCW's consultants following a set of guidelines prepared by Joe Covello and The Covello Group. The construction costs must be converted into capital costs by applying soft costs, project contingencies, and market fluctuations to each individual cost component using Equation (EQ) 3-1.

$$\textit{Capital Cost} = \textit{Construction Cost} \times [1 + \textit{Project Contingency} + \Sigma(\textit{Soft Costs}) + \textit{Market Fluctuations}] \quad \text{[EQ 3-1]}$$

The construction contingencies, soft costs, and market fluctuations are summarized in Table 2. Market fluctuations are applied to capture the range of costs that could potentially occur over the construction period for the entire conveyance system program upgrade.

Table 2. Capital Cost Factors	
Cost Factor	Markup
Construction Contingency[1]	
Tunnel	20%
All Other Projects	25%
Soft Costs[2]	
Construction Management, Engineering Services During Construction, Testing, Inspection	15% (Tunnel and Pipeline Projects) 18% (All Other Projects)
Contract Change Orders (CCO)	5%
Planning	5%
Design	10%
Project Management	5%
Soft Cost Subtotal	
Tunnel and Pipeline	40%
All Other Projects	43%
Market Fluctuations[3]	
Low	-5%
High	15%

Notes:

[1,2]Construction contingency developed by SVCW as presented in the comparison of construction cost estimates during the June 2, 2016 Department Head Meeting.

[3]Market fluctuations developed by SVCW. Source: SVCW Conveyance System Construction Cost Analysis, Front of Plan, Revision Date: April 22, 2015, Revision 28b.

3.1.1 Operation and Maintenance Costs

O&M costs for each alternative are grouped by the type of facility. The types of O&M costs are described below. O&M for the existing conveyance facilities will not be included in this LCC analysis. Rehabilitation and replacement costs are accounted for separately from O&M costs in Section 3.1.2 below. The following list includes the assumptions that were made during the LCC analysis that was done as part of the Alternative Analysis process. **The project teams should verify either that these assumptions are still correct or propose new assumptions for the development of O&M costs for their projects.**

- **Tunnel and Gravity Pipeline.** During the initial LLC analysis, the annual O&M costs for the tunnel were assumed to negligible as most O&M for the gravity pipeline will be included conveyance system pump station O&M costs; therefore, annual O&M costs do not need to be included in the Gravity Pipeline LCC model. Tunnel cleaning and inspection and associated cycles will be included per the Gravity Pipeline consultant team's recommendation.
- **Receiving Lift Station.** The RLS costs are based on the operation of submersible pumps within trench-style wet wells. During the initial LLC analysis, the RLS annual O&M cost were equal to one Full-Time Equivalent (FTE) employee at a cost of $150,000/year/employee. Additional costs for pump inspection and electrical use should be included as separate O&M cost items. Electrical power and equipment for the RLS (pumps, valve operators, supply air blowers, etc. at the RLS site or part of the RLS in the Headworks building) should be incorporated into the RLS life cycle cost.

- **Headworks Facility.** During the initial LLC analysis, the annual O&M costs for the Headworks facility were equal to one FTE at a cost of $150,000/year/employee that included screening, grit removal and standby generator (generator maintenance is no longer required for this updated LCC) maintenance. In addition to the annual O&M costs, odor control costs, electrical costs, and equipment inspection costs should be included. Odor control costs include costs for electrical power, chemical and water to operate the system on an annual basis. RLS O&M costs and electrical costs will be included by BC as part of the RLS LCC analysis.
- **Influent Connector Pipe.** CDM shall coordinate with SVCW regarding the annual O&M costs for the influent connector pipe. The influent connector pipe was not included as part of the original LCC analysis. Cleaning, inspection and associated activity cycles will be included per the influent connector pipe consultant team's recommendation.
- **FoP Civil Improvements.** Annual maintenance costs and storm water pumping power requirements will need to be determined by F+L.
- **Belmont Force Main.** During the initial LLC analysis, the annual O&M costs for the force main were assumed to part of the annual conveyance system pump station O&M costs. The Belmont design team should determine whether they need to be accounted for in the Belmont Force Main LCC model for this phase of estimating. Additional force main O&M costs include internal pipe inspection with inspection intervals to be determined by the force main consultant team.
- **BPS Rehabilitation.** During the original LCC analysis, the BPS O&M annual costs were included as part of the MPPS and RCPS general maintenance costs. Odor control costs, electrical costs and pump inspection costs should be included in this LCC analysis. Odor control costs include costs for chemical and water to operate the system on an annual basis. Pump inspection and electrical costs to operate each pump station should also be included as separate O&M cost items.
- **RCPS Replacement.** During the initial LCC analysis, the annual O&M cost for RCPS was equal to one FTE employee at a cost of $150,000/year/employee. The annual O&M cost for RCPS assumes costs for screens, cranes, standby generator, and surge control maintenance. Additional costs for water, odor control chemicals, pump inspection and electrical use should be included as separate cost items. The pumps for this LCC analysis are assumed to submersible pumps within trench-style wet wells.
- **MPPS Rehabilitation.** The annual O&M cost for MPPS was equal to one FTE employee at a cost of $150,000/year/employee in the initial LCC analysis. This annual O&M cost for MPPS assumes costs for cranes, standby generator, and surge control maintenance. Additional costs for water, odor control chemicals, pump inspection and electrical use should be included as separate cost items. The pumps for this LCC analysis are assumed to dry-pit submersible.
- **SCPS Repurposing.** Annual O&M costs will be accounted for in the San Carlos Odor Control Facility Project.
- **San Carlos Odor Control Facility.** San Carlos Odor Control Facility annual O&M costs shall be coordinated with SVCW. Two separate O&M cost items should be included to account for power requirements to run the odor control facility and for providing chemical and water to support the odor control facility.

Electrical costs should be calculated using the location of the facility and the electrical rates displayed in Table 3. These electrical costs are based on current SVCW electrical bills with the exception of the FoP rate. The FoP rate was based on the WWTP winter time rate.

Table 3. Electrical Rates	
City	Electrical Rate
Belmont	$0.163/KWh
FoP	$0.129/KWh
Menlo Park	$0.150/KWh
Redwood City	$0.161/KWh
San Carlos	$0.196/KWh

A summary of the O&M cost items applicable to each project are displayed below in Table 4. O&M items not identified above or in Table 4 should not preclude the consultant team from including it in their LCC analysis, unless specifically stated not to include.

Table 4. O&M Cost Component Summary[1]

Conveyance System Component	General O&M Allowance[2]	Pipe Cleaning	Pipe Inspection	Mechanical Equipment Inspection	Power Requirements[3]	Odor Control (Chemical and Water)
Tunnel and Gravity Pipeline		✓	✓			
Receiving Lift Station	✓			✓	✓	
Headworks Facility	✓			✓	✓	✓
Influent Connector Pipe		✓	✓			
FoP Civil Improvements	✓			✓	✓	
Belmont Force Main Improvements			✓			
BPS Rehabilitation				✓	✓	✓
SCPS Repurposing					✓	
San Carlos Odor Control Facility	✓				✓	✓
RCPS Replacement	✓			✓	✓	✓
MPPS Rehabilitation	✓			✓	✓	✓

Notes:

[1]Check marks denote O&M cost item to be included as part of conveyance system component LCC analysis.

[2]General O&M Allowance is one FTE for the pump stations and Headworks, and one-half FTE for the FoP Site Civil and Flow Diversion Basin Projects. The cost for a FTE is $150,000/year.

[3]Power requirements should be calculated using the electrical rates displayed in Table 3.

3.1.2 Rehabilitation and Replacement Costs

Rehabilitation and replacements costs for each facility were developed based on the following general assumptions:

- **Facility Design Life.** The following design life should be assumed for each facility based on discussions with SVCW:
  - Force Main – 75 years for new pipelines.
  - Tunnel/Gravity Pipeline – 100 years.
  - Conveyance System Pump Stations, RLS, Headworks, and Odor Control Facilities – various based on component, see below.
- **Component Rehabilitation/Replacement Costs.** Rehabilitation and/or replacement costs should be accounted for the various system components below. The rehabilitation/replacement intervals and costs should be assigned at the discretion of the facilities' design teams.
  - **Pump Refurbishing.** Includes pump refurbishing for the conveyance system pump stations, RLS, FoP storm water pump station.
  - **Mechanical Equipment Replacement.** Pump replacement costs should be accounted for the conveyance system pump stations, RLS, FoP storm water pump station and Flow Diversion return pumps. Replacement costs for odor control, screens, grit removal systems, etc. should also be accounted for in the LCC analyses.
  - **Structural Rehabilitation.** Structural rehabilitation includes piping, valves, HVAC, odor control and building rehabilitation or replacement.
  - **Electrical and Instrumentation Rehabilitation/Replacement.** Electrical equipment replacement is assumed at 25 year intervals, and instrumentation and control equipment replacement at 15 year intervals for all applicable facilities.

Section 4: Net Present Value Analysis

The LCC is based on a net-present-value (NPV) analysis. NPV analysis summarizes the present value of cash flow over a set period. All anticipated cost items for each project component should be estimated in 2016 dollars. The following sections discuss the escalation rates, discount rates and equations for applying these rates in the LCC analysis. Additionally, years of analysis and year of expenditure occurrence are discussed.

4.1 Escalation Rate, Discount Rates and Equations

Escalation and discount rates are displayed in Table 5. Each capital cost, O&M cost, and rehabilitation/replacement cost item should be escalated at a rate of four percent to determine the future value. To determine the present value of these items in the Year of Analysis, their values were adjusted at a discount rate of seven percent for capital projects and rehabilitation/replacement items and three percent for operation and maintenance items. The discount rates were developed by SVCW based on current and projected investment return rates.

Table 5. Escalation and Discount Rates	
Factor	**Rate**
Escalation	4%
Capital Project and Rehabilitation/Replacement Discount	7%
O&M Discount	3%

Escalation should be applied to each cost item using EQ 4-1 below to determine the future cost of each cost item.

$$FV = PV \cdot (1+i)^{(Y_n - Y_{2016})}$$ *[EQ 4-1]*, where

- FV = Future Value
- PV = Present Value
- i = Escalation (4%)
- Y_n = Year of Capital Outlay/Occurrence
- Y_{2016} = Present Year = 2016

After escalating all cost items to future values, using Year 2016 as the present year, the 50-Year LCC should be determined at the Year of Beneficial Use. The Year of Beneficial Use was determined to be the year that the major facilities (i.e., Tunnel, RLS and Headworks) start up. Based on the current program-wide schedule (Version 13 dated June 23, 2016) developed by SVCW, the Year of Beneficial Use is the Year 2022.

To determine the costs at the Year of Beneficial Use, discounting is applied to place the different costs that occur on different timelines on a comparable basis. Discounting also facilitates the determination of how much funds SVCW will need to invest today to pay for future assets and expenses. Each consultant should use the sum of cost items calculated by EQ 4-1 and EQ 4-2 over a 50-year period to determine the 50-Year LCC at the Year of Beneficial Use.

Costs items occurring before 2022 are considered sunk costs; therefore, the costs can simply be calculated using EQ 4-1 without any discount factors applied. For costs that occur after 2022, EQ 4-2 should be used to account for assets and expenses incurred at the time of Beneficial Use.

$$Z_i = FV_i \cdot (1+r)^{-(Y_n - Y_{2022})}$$ *[EQ 4-2]*, where

- Z_i = Future Cost at Year of Beneficial Use
- FV_i = Future Value as calculated by EQ 4-1
- r = Discount Rate (Per Table 4)
- Y_n = Year of Capital Outlay/Occurrence
- Y_{2022} = Year of Beneficial Use = 2022

All cost components should be summed over a 50-Year Period ending in the Year 2066, which will provide the overall LCC for each project. SVCW will compile the LCCs from each project team to determine the program-wide LCC value. A simplified, example calculation for determining the LCC of a particular project is included in Attachment A.

4.2 Construction Schedules

Construction schedules were established based on the timing and scheduling of permitting, design and construction on a program-wide level. Each consultant team should use the current program-wide schedule (Version 13 dated June 23, 2016) developed by SVCW. A midpoint year and an end year of construction were established for each capital cost component. Capital costs should be entered into the LCC model at the midpoint year of construction. For example, if the tunnel and Gravity Pipeline's midpoint of construction occurs in the Year 2020, the capital outlay or sunk cost for that facility is placed in the Year 2020. The end year of construction should be used to establish abandonment years for existing facilities and to establish O&M, replacement, and rehabilitation for new facilities. Recurring O&M or rehabilitation/replacement costs should occur at the scheduled maintenance and/or rehabilitation/replacement intervals determined by each consultant team.

Section 5: LCC Analysis Deliverable

In addition to SVCW, the audience for the LCC reports is the State's SRF staff. They will be conducting a detailed due-diligence review of the LCC assumptions, calculations and estimated costs. To support the SRF application each consultant team needs to prepare a separate LCC analysis for each project identified within this TM. Each project package will need to include a cover letter describing the LCC analysis assumptions. The cover letter should include the following assumptions:

- Construction cost components including assumed structures, facilities, equipment and construction activities to be included in the project.
- Markups (project contingency, soft costs and market fluctuations) assumed to convert construction costs into capital costs.
- Midpoint year of construction.
- Year of construction completion.
- O&M costs.
- Rehabilitation and replacement costs.
- Escalation and discount rates.

Calculations should be included as an attachment. The calculations should clearly show all equations, costs and markups used in the analysis.

Attachment A: LCC Example Calculation

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SVCW Life Cycle Cost (LCC) Example Calculation

A. Purpose: This sheet provides a simplied, example LCC calculation for a 50-year analysis period. The equations used below are further explained in TM 11-3: Life Cycle Cost Analysis Guidelines. This example is based on the Belmont Force Main Project.

All user inputs are highlighted below in green.

B. Step 1: Conversion from Construction Cost to Capital Cost: Equation 3-1 from TM 11-3 is used to convert the construction cost developed by each team into a capital cost. Contingency, soft cost and market fluctuation cost factors are displayed below.

Capital Cost = Construction Cost x [1 + Project Contingency + Σ(Soft Costs) + Market Fluctuations] [EQ 3-1]

1. Project Contingency (all projects except Gravity Pipeline), Cont: $Cont := 25\%$

2. Soft Costs, SC:

- Construction Management and Engineering Service for Pipeline Projects: $SC_{CM} := 15\%$
- Conract Change Orders: $SC_{CCO} := 5\%$
- Planning: $SC_{Plan} := 5\%$
- Design: $SC_{Design} := 10\%$
- Project Management $SC_{PM} := 5\%$

3. Market Fluctuation, MF:

$MF_{low} := -5\%$

$MF_{base} := 0\%$

$MF_{high} := 15\%$

4. Capital Cost, CC: For the Belmont Force Main Project, the construction cost is $3,200,000 and occurs in the midyear of construction.

Display Unit of Dollars: $dollars := 1$

$Cost_{Construction} := 3.2 \cdot 10^{6} dollars$ *Note: From Consultant's Construction Cost Estimate, May 2016*

$$Cost_{Capital\_low} := Cost_{Construction} \cdot \left(1 + Cont + SC_{CM} + SC_{CCO} + SC_{Plan} + SC_{Design} + SC_{PM} + MF_{low}\right) = 5.12 \times 10^{6} \cdot dollars$$

$$Cost_{Capital\_base} := Cost_{Construction} \cdot \left(1 + Cont + SC_{CM} + SC_{CCO} + SC_{Plan} + SC_{Design} + SC_{PM} + MF_{base}\right) = 5.28 \times 10^{6} \cdot dollars$$

$$Cost_{Capital\_high} := Cost_{Construction} \cdot \left(1 + Cont + SC_{CM} + SC_{CCO} + SC_{Plan} + SC_{Design} + SC_{PM} + MF_{high}\right) = 5.76 \times 10^{6} \cdot dollars$$

$Y_{capital}$ = Midpoint Year of Construction $Y_{capital} := 2022$

C. Step 2: Calculate Operation and Maintenance (O&M) Costs: The following O&M assumptions are made for the Belmont Force Main:

1. Future Annual O&M Costs are assumed to be included in the conveyance system pump stations; therefore, do not need to be accounted for in this analysis.
2. The force main does not require regular cleaning; therefore, there are no cleaning costs associated with the Belmont Force Main.
3. Inspections are completed by acoustic doppler technology every 10 years after rehabilitation at the cost shown below.

Consultant should determine the project specific O&M elements for Step 2.

1. Pipe Inspections

- Construction Finish Year, $Y_{EndConst}$: $Y_{EndConst} := 2023$
- Inspection Cost, $Cost_{Unit\_Inspect}$: $Cost_{Unit\_Inspect} := \frac{10dollars}{ft}$
- Length of Belmont Force Main, L_{FM}: $L_{FM} := 4700ft$

Annual cost for pipe inspections is calculated as follows:

$$Cost_{Annual\_Inspect} := L_{FM} \cdot Cost_{Unit\_Inspect} = 47000 \cdot dollars$$

Inspection occurs every 10 years under a 50-year cycle; therefore, inspections occur in the following years:

$$Y_{OM\_1} := Y_{EndConst} + 10 = 2033$$

$$Y_{OM\_2} := Y_{EndConst} + 20 = 2043$$

$$Y_{OM\_3} := Y_{EndConst} + 30 = 2053$$

$$Y_{OM\_4} := Y_{EndConst} + 40 = 2063$$

D. Step 3: Calculate Rehabilitation and Replacement Costs: The anticipated design life for new force mains is 75 years; thus, no rehabilitation or replacement costs need to be calculated for the force main since the design life occurs outside of the analysis window of 50 years.

Consultant should determine the project specific Rehabilitation and Replacement Costs for Step 3.

E. Step 4: Calculate the Future Value of All Costs:

- Current Year, $Y_{current}$: $Y_{current} := 2016$
- Escalation, i: $i := 4\%$
- Calculate future values, FV using TM 11-3, EQ 4-1:
  FV = PV x $(1+i)^{Yn-Ycurrent}$,
  where Y_n is the year the cost occurs and PV = present value.

$$FV_{capital\_low} := Cost_{Capital\_low} \cdot (1+i)^{Y_{capital} - Y_{current}} = 6.48 \times 10^{6} \cdot dollars$$

$$FV_{capital\_base} := Cost_{Capital\_base} \cdot (1+i)^{Y_{capital} - Y_{current}} = 6.68 \times 10^{6} \cdot dollars$$

$$FV_{capital\_high} := Cost_{Capital\_high} \cdot (1+i)^{Y_{capital} - Y_{current}} = 7.29 \times 10^{6} \cdot dollars$$

$$FV_{OM\_1} := round\left[Cost_{Annual\_Inspect} \cdot (1+i)^{Y_{OM\_1} - Y_{current}}, -4\right] = 90000 \cdot dollars$$

$$FV_{OM\_2} := round\left[Cost_{Annual\_Inspect} \cdot (1+i)^{Y_{OM\_2} - Y_{current}}, -4\right] = 140000 \cdot dollars$$

$$FV_{OM\_3} := round\left[Cost_{Annual\_Inspect} \cdot (1+i)^{Y_{OM\_3} - Y_{current}}, -4\right] = 200000 \cdot dollars$$

$$FV_{OM\_4} := round\left[Cost_{Annual\_Inspect} \cdot (1+i)^{Y_{OM\_4} - Y_{current}}, -4\right] = 300000 \cdot dollars$$

F. Step 5: Calculate Present Value at Year of Beneficial Use:

- Year of Beneficial Use, Y_{BFU}: $Y_{BFU} := 2022$
- Discount Rate for O&M, r_{OM}: $r_{OM} := 3\%$
- Discount Rate for Capital and Rehab/Replace, $r_{capital}$: $r_{capital} := 7\%$
- Calculate Present Values for all Years above Year of Beneficial Use using TM 11-3, EQ 4-2:

  Z = FV x (1+r)^(Y_{BFU}-$Y_{current}$),
  where Z is the cost at the Year of Beneficial Use and FV is the future value calcuated in Step 4.

- For all costs occuring before Year of Beneficial Use, assume these costs are sunk costs in the year it occurs. Therefore, the future value as calculated in Step 4 will be used.

$$Z_{capital\_low} := \text{if}\left[Y_{capital} \le Y_{BFU}, FV_{capital\_low}, FV_{capital\_low}\cdot(1 + r_{capital})^{-(Y_{capital}-Y_{BFU})}\right] = 6.48 \times 10^{6}\cdot\text{dollars}$$

$$Z_{capital\_base} := \text{if}\left[Y_{capital} \le Y_{BFU}, FV_{capital\_base}, FV_{capital\_base}\cdot(1 + r_{capital})^{-(Y_{capital}-Y_{BFU})}\right] = 6.68 \times 10^{6}\cdot\text{dollars}$$

$$Z_{capital\_high} := \text{if}\left[Y_{capital} \le Y_{BFU}, FV_{capital\_high}, FV_{capital\_high}\cdot(1 + r_{capital})^{-(Y_{capital}-Y_{BFU})}\right] = 7.29 \times 10^{6}\cdot\text{dollars}$$

$$Z_{OM\_1} := \text{round}\left[\text{if}\left[Y_{OM\_1} \le Y_{BFU}, FV_{OM\_1}, FV_{OM\_1}\cdot(1 + r_{OM})^{-(Y_{OM\_1}-Y_{BFU})}\right], -4\right] = 70000\cdot\text{dollars}$$

$$Z_{OM\_2} := \text{round}\left[\text{if}\left[Y_{OM\_2} \le Y_{BFU}, FV_{OM\_2}, FV_{OM\_2}\cdot(1 + r_{OM})^{-(Y_{OM\_2}-Y_{BFU})}\right], -4\right] = 80000\cdot\text{dollars}$$

$$Z_{OM\_3} := \text{round}\left[\text{if}\left[Y_{OM\_3} \le Y_{BFU}, FV_{OM\_3}, FV_{OM\_3}\cdot(1 + r_{OM})^{-(Y_{OM\_3}-Y_{BFU})}\right], -4\right] = 80000\cdot\text{dollars}$$

$$Z_{OM\_4} := \text{round}\left[\text{if}\left[Y_{OM\_4} \le Y_{BFU}, FV_{OM\_4}, FV_{OM\_4}\cdot(1 + r_{OM})^{-(Y_{OM\_4}-Y_{BFU})}\right], -4\right] = 90000\cdot\text{dollars}$$

G. Step 6: Calculate the Total Cost for the Year of Beneficial Use by Summing the Adjusted Values in Step 5:

$$Z_{total\_low} := Z_{capital\_low} + Z_{OM\_1} + Z_{OM\_2} + Z_{OM\_3} + Z_{OM\_4} = 6.8 \times 10^{6} \cdot dollars$$

$$Z_{total\_base} := Z_{capital\_base} + Z_{OM\_1} + Z_{OM\_2} + Z_{OM\_3} + Z_{OM\_4} = 7 \times 10^{6} \cdot dollars$$

$$Z_{total\_high} := Z_{capital\_high} + Z_{OM\_1} + Z_{OM\_2} + Z_{OM\_3} + Z_{OM\_4} = 7.61 \times 10^{6} \cdot dollars$$

The total 50-Year LCC for the Year of Beneficial Use is $7.00 million for the Belmont Force Main with a range of $6.80 million to $7.61 million accounting for market fluctuations.

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Appendix G

San Carlos Odor Control Facility Opinion of Probable Cost of Construction

Technical Memorandum

To: *Bill Bryan, SVCW*

From: *Bill Schilling, CDM Smith*

Date: *May 6, 2016*

Subject: *San Carlos Odor Control Facility Project – Opinion of Probable Cost of Construction*

1.0 Introduction to OPCC

CDM Constructors Inc. has prepared the Opinion of Probable Cost of Construction (OPCC) included with this memorandum. CDM Constructors Inc. uses the computerized estimating system Sage Timberline Estimating System (TES). The system operates using our proprietary customized database that includes over 130,000 items with assemblies that group items into definable cost systems and a spreadsheet to display results grouped according to user defined work breakdown structures (WBS). Current prevailing wage rates were used in the estimate to calculate labor based on the intended project construction bid period. Similarly construction equipment pricing is based on Primedia Blue Book Equipment Rates adjusted for the bid period. Material pricing in the OPCC include pricing based on our TES Database in addition to bid and budget pricing we have obtained and adjusted to market conditions. Major equipment prices are based on vendor quotes FOB Redwood City 2016. The level of accuracy of the OPCC is consistent with the Association for the Advancement of Cost Engineering (AACE) best practice for a Class IV estimate which defines project definition between 1-15%. The expected level of accuracy of a class IV OPCC ranges from -30% for the lower range of cost and +50% for the high range. The detailed estimate is attached.

2.0 Summary of Markups

The OPCC's cost are inclusive of the following markups, which were specified by the Covello Group:

- Sales Tax (Material): 9%
- Field Direct Cots: 10% of direct costs + sales tax
- Field Overhead & Profit: 5% of direct costs + sales tax + field direct costs
- Home Office Overhead & Profit: 10% of direct costs + sales tax + field direct costs
- General Contractor Bond: 2% of direct costs + above markups
- Builder's Risk Insurance: 1% of direct costs + above markups
- General Liability Insurance: 1.5% of direct costs + above markups

It should be noted that the OPCC does not include markups for construction contingency (SVCW applies 20% to this OPCC), an allowance for change orders during construction (SVCW applies 2-5% to this OPCC), escalation to the midpoint of construction (SVCW will add escalation separately) engineering design fees, or engineering services during construction.

3.0 OPCC Summary

The project includes five major elements as outlined in Table 1 below. The approximate cost of each major element, including markups, is listed in Table 1. A detailed breakdown of the costs for each of the major elements is included in the attached document.

Table 1. Opinion of Probable Cost of Construction Summary

Area	Opinion of Probable Cost of Construction ($M)
Demolition	$430,000
Site Work	$110,000
Odor Control Equipment & Chemical Storage Tanks	$1,740,000
Electrical and I&C Improvements	$650,000
Building Mechanical Improvements (HVAC, fire sprinklers, etc.)	$350,000
Total	**$3,280,000**

Notes:

1. Costs include the following markups:
   Sales Tax: 9%
   Field Indirect Costs: 10%
   Field Overhead & Profit: 5%
   Home Office Overhead & Profit: 10%
   General Contractor Bonds: 2%
   Builder's Risk Insurance: 1%
   General Liability Insurance: 1.5%
2. SVCW will apply 20% to this OPCC for a construction contingency, but the 20% markup is not included in the costs shown in this table
3. SVCW will apply 2-5% to this OPCC for change order during construction, but the 2-5% markups is not included in the costs shown in this table.
4. SVCW will escalate costs to the midpoint of construction, but the escalation is not shown in this table

Opinion of Probable Cost - March - 2016- Preliminary Design

Project name	SCPS Odor Control Est
Estimator	SH,SM
Labor rate table	CA16 San Francisco
Equipment rate table	00 15 Equip Rate BOF
Notes	This is an Opinion of Probable Construction Cost only, as defined by the documents provided at the level of design indicated above. CDM has no control over the cost of labor, materials, equipment, or services furnished, over schedules, over contractor's methods of determining prices, competitive bidding (at least 3 each - both prime bidders and major subcontractors), market conditions or negotiating terms. CDM does not guarantee that this opinion will not vary from actual cost, or contractor's bids. There are not any costs provided for: Change Orders, Design Engineering, Construction Oversight, Client Costs, Finance or Funding Costs, Legal Fees, Land Acquisition or temporary/permanent Easements, Operations, or any other costs associated with this project that are not specifically part of the bidding contractor's proposed scope. Assumptions: No rock excavation is required. No Dewatering is included No consideration for contaminated soils or hazardous materials (e.g. asbestos, lead) Based on a 40 hour work week with no overtime.
Report format	Sorted by 'Bid Item/95CSI Sctn/Element' 'Detail' summary Allocate addons

Spreadsheet Level	Takeoff Quantity	Labor Amount	Material Amount	Equip Amount	Sub Amount	Other Amount	Total Cost/Unit	Total Amount
01 Demolition								
02220 Demolition								
02220.4502 Demo Silencers	1.00 ls	1,033		869	895		2,797.19 /ls	2,797
02220.4504 Demo Cooling System Radiators	1.00 ls	1,380		1,149	1,181		3,709.88 /ls	3,710
02220.4506 Demo Gravity Exhausters	1.00 ls	434		360	369		1,163.05 /ls	1,163
02220.4508 Demo Supply Blower	1.00 ls	1,100		916	942		2,957.88 /ls	2,958
02220.4510 Demo Sewage Pump Motors	1.00 ls	522		433	444		1,399.28 /ls	1,399
02220.4512 Demo Booster Pump Shaft Support Platforms	1.00 ls	478		393	402		1,271.84 /ls	1,272
02220.4514 Demo 24"x24" Gate	1.00 ls	58		40	38		135.66 /ls	136
02220.4516 Demo Air Compressors	1.00 ls	171		141	145		456.55 /ls	457
02220.4518 Demo Air Recievers	1.00 ls	341		282	290		913.15 /ls	913
02220.4520 Demo 30 Gal Day Tank	1.00 ls	113		89	90		292.72 /ls	293
02220.4522 Demo Engine Generator and Equipment Pad	1.00 ls	862		714	732		2,307.87 /ls	2,308
02220.4524 Demo Air Equipment Pad	1.00 ls	155		127	130		411.07 /ls	411
02220.4526 Demo Cooling System/Engine Drivers	1.00 ls	2,476		2,056	2,111		6,642.30 /ls	6,642
02220.4528 Demo MCC and Equipment Pad	1.00 ls	2,533		2,107	2,165		6,803.92 /ls	6,804
02220.4530 Demo Hydraulic Power Units (for Flow Meters)	1.00 ls	87		72	74		234.00 /ls	234
02220.4532 Demo Hypochlorite Tanks	1.00 ls	4,136		3,413	3,498		11,047.79 /ls	11,048
02220.4534 Demo Sampler	1.00 ls	48		41	42		130.64 /ls	131
02220.4536 Demo Bathroom Finishes	1.00 ls	539		448	460		1,447.06 /ls	1,447
02220.4538 Demo 42"x42" Floor Hatches	1.00 ls	112		93	96		300.53 /ls	301
02220.4540 Demo Exhaust Blowers and Equipment Pads	1.00 ls	1,078		896	920		2,894.19 /ls	2,894
02220.4542 Demo Hypo Metering Pumps/Piping/Equipment Pad	1.00 ls	342		283	290		915.41 /ls	915
02220.4544 Demo 36"x36" Gate	1.00 ls	59		49	51		159.06 /ls	159
02220.4545 Demo Existing CMU Wall - 15.5'	1.00 ls	1,369		1,157	566		3,091.41 /ls	3,091
02220.4546 Demo Flowminutors	1.00 ls	409		340	349		1,097.20 /ls	1,097
02220.4548 Demo Barscreen	1.00 ls	207		171	176		554.29 /ls	554
02220.4550 Demo 3'-3"x4'-3" FRP Slide Gates	1.00 ls	827		687	705		2,218.28 /ls	2,218
02220.4552 Demo Booster Pumps	1.00 ls	7,116		5,910	6,070		19,095.69 /ls	19,096
02220.4554 Demo Sewage Pumps	1.00 ls	1,674		1,391	1,428		4,493.38 /ls	4,493
02220.4556 Demo Wet Well Emptying Pumps & Piping	1.00 ls	394		327	336		1,056.33 /ls	1,056
02220.4558 Demo Sump Pumps	1.00 ls	448		372	382		1,201.74 /ls	1,202
02220.4560 Demo 36"x36" Gate	1.00 ls	59		49	51		159.06 /ls	159
02220.4562 Pipe and Duct Haul and Demo	1.00 ls	22,505		4,531	6,481		33,517.42 /ls	33,517
02220.4563 Small Pipe Demo	1.00 ls	5,984		1,533			7,516.98 /ls	7,517
02220.4563. Demo 4" Cooling Radiator Pipe - 117lf	1.00 ls	1,024		801			1,825.16 /ls	1,825
02220.4564 Demo 6" Wet Well Discharge - 76lf	1.00 ls	716		576			1,292.18 /ls	1,292
02220.4565 Demo 8" Silencer Pipe - 62lf	1.00 ls	644		534			1,177.73 /ls	1,178
02220.4565. Demo 4" Drain Pipe - 98lf	1.00 ls	863		677			1,539.90 /ls	1,540
02220.4566 Demo 18" Pipe/Valves/Fittings - 15.5lf	1.00 ls	490		163			653.06 /ls	653
02220.4567 Demo 18" Pipe/Valves/Fittings - 24lf	1.00 ls	759		253			1,011.95 /ls	1,012
02220.4567. Demo 6" Drain Pipe - 38lf	1.00 ls	359		289			647.86 /ls	648
02220.4568 Demo 24" Pipe/Valves/Fittings - 82lf	1.00 ls	3,169		1,413			4,581.70 /ls	4,582
02220.4568. Demo 10" & 12" Wet Well Ventilation Piping - 76lf	1.00 ls	1,692		480			2,172.08 /ls	2,172
02220.4570 Demo 36" Influent Pipe - 7lf	1.00 ls	693		252			945.36 /ls	945
02220.4571 Demo 30" Pipe - 20lf	1.00 ls	1,888		621			2,509.05 /ls	2,509
02220.4572 Demo 48" Pipe/Valves/Fittings - 38lf	1.00 ls	4,249		1,896			6,144.84 /ls	6,145
02220.4572. Demo 48" Pipe/Valves/Fittings - 45lf	1.00 ls	5,034		2,248			7,281.84 /ls	7,282
02220.4573 Sewage Pump Shafts	1.00 ls	198		159			356.36 /ls	356
02220.4573. Booster Pump Shafts	1.00 ls	296		237			532.95 /ls	533
02220.4574 Allowance for Removal of Additional Scope	1.00 ls	13,321	282	3,032			16,634.67 /ls	16,635
02220.4575 Wall Pipe Demo	1.00 ls	4,995		1,137			6,132.19 /ls	6,132
02220.4802 Demo Conduit & Wire	1.00 ls	8,798		638	702		10,137.80 /ls	10,138
02220.4850 Demo Existing Panels & Lighting	1.00 ls	7,094		90	303		7,487.16 /ls	7,487
02220.4854 Demo Existing Panels & Lighting	1.00 ls	2,066		51	83		2,199.37 /ls	2,199
02220.48602 Trench Surface Demo	1.00 ls	5,390	274	3,228	2,808		11,700.37 /ls	11,700

Spreadsheet Level	Takeoff Quantity	Labor Amount	Material Amount	Equip Amount	Sub Amount	Other Amount	Total Cost/Unit	Total Amount
02220.4862 Demo Existing Panels & Lighting	1.00 ls	2,273		53	92		2,417.42 /ls	2,417
02220.4876 Demo Conduit & Wire	1.00 ls	2,061		148	164		2,373.41 /ls	2,373
02221.4502 Demo Selective Handrail	1.00 ls	2,070		1,404			3,474.16 /ls	3,474
02221.4504 Demo Monorails	1.00 ls	2,614		1,006			3,620.03 /ls	3,620
02225.4502 Demo Ductwork	1.00 ls	9,692		4,966			14,658.30 /ls	14,658
02220 Demolition		141,497	556	57,787	36,060			235,900
02300 Earthwork								
02315.4502 Exc/Shoring/Dewatering for Wall Pipe Demo - Inv. El. 92.75' - 132cy	1.00 ls	20,287	1,128	2,066			23,480.47 /ls	23,480
02315.4504 Exc/Shoring/Dewatering for Wall Pipe Demo - Inv. El. 86.4' - 156cy	1.00 ls	22,669	1,349	2,422			26,439.91 /ls	26,440
02315.4506 Exc/Shoring/Dewatering for Wall Pipe Demo - Inv. El. 79.5' - 170cy	1.00 ls	25,390	1,623	2,631			29,644.08 /ls	29,644
02300 Earthwork		68,345	4,101	7,119				79,564
01 Demolition		**209,842**	**4,656**	**64,906**	**36,060**			**315,464**
02 Site Civil								
02505 Utilities								
02505.4802 42" Foul Air Duct Below Grade	95.00 lf	8,192	33,524	3,746			478.55 /lf	45,462
02505.4804 6" Stainless Steel Drain Line	95.00 lf	6,471	4,477	2,876			145.51 /lf	13,824
02505 Utilities		14,663	38,001	6,622				59,286
02740 Asphalt Paving								
02740.48602 Trench Restoration	1,500.00 sf	2,972	13,834	1,996	2,359		14.11 /sf	21,161
02740 Asphalt Paving		2,972	13,834	1,996	2,359			21,161
02 Site Civil		**17,635**	**51,835**	**8,617**	**2,359**			**80,447**
03 Chemical Scrubbers & Chemical Tanks								
03300 Cast-in-Place Concrete								
03002.4534 6" Thick Equipment Scrubber Pads - 3ea - 17.52cy	17.52 cy	8,525	7,289	1,265			974.84 /cy	17,079
03002.4535 10" Thick Equipment Chem Tank Pads - 2 ea - 7cy	7.00 cy	3,406	2,912	505			974.84 /cy	6,824
03300.4502 Concrete Repair 10" to 36" Penetrations - 13ea	13.00 ea	12,915	819	1,408			1,164.82 /ea	15,143
03300.4504 Elevated Slab w/ Beams Infill - 3.25cy	3.25 cy	13,118	3,660	335	26	9	5,276.30 /cy	17,148
03300.4506 Elevated Slab Infill at Access Hatches - .85cy	0.85 cy	2,646	1,051	92	6	2	4,468.14 /cy	3,798
03300.4508 Elevated Slab Infill at Duct Penetration - .36cy	0.36 cy	1,121	445	39	3	1	4,468.19 /cy	1,609
03300.4510 Concrete Wall Repair 24" to 48" Penetrations - 3ea	3.00 ea	2,311	763	10	15	2	1,033.37 /ea	3,100
03300.4512 Concrete Wall Repair 48" Penetrations - 1ea	1.00 ea	1,024	337	4	7	1	1,372.89 /ea	1,373
03300 Cast-in-Place Concrete		45,066	17,278	3,658	56	15		66,073
04220 Concrete Masonry Units								
04220.4502 12" CMU Walls(180.5 sf W/ Rollup Doors)	180.50 sf	11,636	1,225				71.25 /sf	12,861
04220 Concrete Masonry Units		11,636	1,225					12,861
07530 Elastomeric Membrane Roofing								
07530.4520 Roof Repair 4" to 36" Penetrations - 17ea	17.00 ea	6,218	5,410				684.00 /ea	11,628
07530 Elastomeric Membrane Roofing		6,218	5,410					11,628
09981 Special & High Performance Coatings								
09981.4552 Concrete Coatings for Odor Control Chemical Area	485.00 sf	2,046	7,093				18.84 /sf	9,139
09981 Special & High Performance Coatings		2,046	7,093					9,139
11218 Chemical Sample/Transfer/Metering Pumps								
11218.2202 Chemical Pumps - Install (Supply with Odor Control)	1.00 ls	5,592	3,782	1,898		777	12,048.54 /ls	12,049
11218 Chemical Sample/Transfer/Metering Pumps		5,592	3,782	1,898		777		12,049
11375 Aeration Equipment								
11375.2202 Install Odor Control Blower (Supply with Odor Control)	1.00 ls	7,558	3,782	1,623		569	13,531.85 /ls	13,532
11375 Aeration Equipment		7,558	3,782	1,623		569		13,532
13200 Tanks								
13200.2200 Sodium Hydroxide Tank (NaOH) 1,000 gal	1.00 ea		7,564				7,564.24 /ea	7,564
13200.2201 Sodium Hypo Tank (NaOCl) 1,000 gal	1.00 ea		7,564				7,564.25 /ea	7,564
13200.2202 Install Sodium Hydroxide Tank (NaOH)	1.00 ea	5,542		610		121	6,273.27 /ea	6,273
13200.2204 Install Sodium Hypo Tank (NaOCl)	1.00 ea	5,542		610		121	6,273.27 /ea	6,273
13200 Tanks		11,085	15,128	1,220		242		27,675
15060 Hangers & Supports								
15060.2202 Odor Control Duct Pipe Supports	52.00 ea	38,773	33,322				1,386.44 /ea	72,095
15060 Hangers & Supports		38,773	33,322					72,095
15220 Mech Pipe								

Spreadsheet Level	Takeoff Quantity	Labor Amount	Material Amount	Equip Amount	Sub Amount	Other Amount	Total Cost/Unit	Total Amount
15220.4502 Blind Flanges at Bottom Level Slab Penetrations 6", 18", & 36"	8.00 ea	5,404	14,649				2,506.64 /ea	20,053
15220.48302 2" PVC Chemical Piping (Dual Contained)	300.00 lf	9,231	32,450	2			138.95 /lf	41,683
15220 Mech Pipe		14,635	47,099	2				61,737
15248 FRP Pipe								
15248.2202 Odor Control Duct Main Header and Screening	300.00 lf	45,334	99,087	2			481.41 /lf	144,424
15248 FRP Pipe		45,334	99,087	2				144,424
15900 Odor Control								
15900.2202 Multi Stage Scrubber - LP-3000 - Supply (5,000 cfm)	3.00 ea		666,000				222,000.00 /ea	666,000
15900.2204 Multi Stage Scrubber - LP-3000 - Install	3.00 ea	122,073		44,542	4,320	2,016	57,650.36 /ea	172,951
15900 Odor Control		122,073	666,000	44,542	4,320	2,016		838,951
03 Chemical Scrubbers & Chemical Tanks		**310,018**	**899,206**	**52,945**	**4,376**	**3,618**		**1,270,164**
04 Electrical Gear & I&C								
16000 Electrical Allowance/Miscellaneous								
16000.0032 I & C Instruments	8.00 ea				14,024		1,753.00 /ea	14,024
16000.0091 Measurement & Control Commissioning	2.00 dy				6,400		3,200.00 /dy	6,400
16000.0120 I&C Software & Programming	1.00 ls				80,000		80,000.00 /ls	80,000
16000.0122 Fire Alarm System	1.00 ls				35,000		35,000.00 /ls	35,000
16000.0124 MV Transformer 12KV / 480 V-350KW	350.00 kw				14,350		41.00 /kw	14,350
16000.0126 New MCC	1.00 ea				45,000		45,000.00 /ea	45,000
16000.0128 Automatic Transfer Switch (ATS 600A)	1.00 ea				11,000		11,000.00 /ea	11,000
16000.0130 Grounding and Lightning Protection System	1.00 ls				9,900		9,900.00 /ls	9,900
16000.0132 Building lighting Fixtures	1.00 ls				33,600		33,600.00 /ls	33,600
16000.0134 Motor starts / (13) disconnecting switches /LV Transformer)	15.00 ea				22,500		1,500.00 /ea	22,500
16000.0136 Backup Generator 350KW	1.00 ea				125,000		125,000.00 /ea	125,000
16000.0138 Power Feeders & Receptacles Wire / Conduit	1,500.00 lf				18,000		12.00 /lf	18,000
16000.0140 Connection To Existing 12KV MV	1.00 ea				3,000		3,000.00 /ea	3,000
16000.0142 Connections : 1 Transformers/ 1 Generator / 15 Equipment	17.00 ea				20,400		1,200.00 /ea	20,400
16000.0144 Security system	1.00 ls				20,000		20,000.00 /ls	20,000
16000.0146 Electrical Commissioning and Testing	4.00 dy				12,800		3,200.00 /dy	12,800
16000 Electrical Allowance/Miscellaneous					470,974			470,974
04 Electrical Gear & I&C					**470,974**			**470,974**
05 HVAC & Building Mechanical								
15500 HVAC								
15500.4804 HVAC Square Foot Allowance	9,180.00 sf	110,027	99,653	43,685			27.60 /sf	253,366
15500 HVAC		110,027	99,653	43,685				253,366
05 HVAC & Building Mechanical		**110,027**	**99,653**	**43,685**				**253,366**

Estimate Totals

Description	Amount	Totals	Hours	Rate	
Labor	647,522		6,183 hrs		
Material	1,055,351				
Subcontract	513,769				
Equipment	170,154		1,782 hrs		
Other	3,618				
Subtotal Direct Cost	2,390,414	2,390,414			
Sales Tax	88,844			9.00 %	
Subtotal Direct Cost	88,844	2,479,258			
Field Indirect Cost	247,926			10.00 %	
Subtotal Field Indirect	247,926	2,727,184			7.56
Field OH	136,359			5.00 %	4.16%
Home Office OH&P	272,718			10.00 %	
Subtotal with OH&P	409,077	3,136,261			12.47
GC Bonds	62,725			2.00 %	
Subtotal with GC Bonds	62,725	3,198,986			1.91
Bldr's Risk Ins	31,990			1.00 %	
Subtotal with Bldr's Risk Ins	31,990	3,230,976			0.98
Gen Liab Ins	49,203			1.50 %	
Subtotal with Gen Liab Ins	49,203	3,280,179			1.50
Contingency not Incl					
Total Cost at:		3,280,179			
Escalation Not Included					
		3,280,179			
Total		***3,280,179***			

"This Opinion of Probable Construction Cost is produced in accordance with CDM Smith's Firmwide Quality policies and best practices as described in CDM Smith's Estimating Manual Dated 01/03/12 Section 10 titled Quality Control. I hereby attest that the Cost Estimating policies and procedures were followed in preparation of the Opinion of Probable Cost"

Lead Estimator initials: SH,SM *Date:*

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Appendix H

Program Supplied General Background Section and Reason for the Project

Program Supplied

General Background Section and Reason for the Project

February 15, 2017

Note to design teams: SVCW is providing the following text to the design teams for use in their project planning reports. The progressive design build procurement, the WIFIA funding application, and public outreach efforts may also find this information useful. The intended audience is assumed to be unfamiliar with SVCW facilities and its history, such as staff at the SWRCB and progressive design build contractors. Firms may edit the text to fit the flow, voice, structure, and style of their reports.

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1. BACKGROUND

1.1. SVCW is a Wastewater Utility in San Mateo County

Silicon Valley Clean Water (SVCW) is a Joint Powers Authority (JPA) that owns and operates a regional wastewater treatment plant at the eastern end of Redwood Shores, within Redwood City, and related wastewater pumping and transmission facilities. SVCW treats the majority of the wastewater generated from the mid-peninsula of San Mateo County south of the San Mateo Bridge. The JPA members include the cities of Belmont, Redwood City, and San Carlos, and the West Bay Sanitary District (which provides sanitary sewer collection services to the cities of Menlo Park, Portola Valley, and portions of Atherton, Woodside, East Palo Alto, and unincorporated areas of San Mateo County).

The individual members of the JPA own and operate the sanitary sewer collection systems within their respective jurisdictions. West Bay Sanitary District (WBSD) also owns the existing flow equalization facility (FEF) that is leased to SVCW and used to store wastewater during wet weather conditions. SVCW owns and operates the wastewater treatment plant (WWTP) and the sanitary sewer force main and pump stations that convey the wastewater from the member agency connections to the treatment plant.

1.2. Existing Conveyance System

SVCW's existing conveyance system assets include four pump stations, one for each of the four member agencies, a wet weather booster station located in the San Carlos Pump Station, an influent lift station located at the WWTP, and an approximately ninemile-long force main. SVCW leases from the WBSD a flow equalization facility, which is an integral part of SVCW's existing conveyance system.

1.3. History of SVCW and the Conveyance System

To understand the need for the Wastewater Conveyance System and Treatment Reliability Improvement Project (the Project) it is useful to know the history of SVCW, the assumptions used during the original design of the conveyance system, why the various components were built, and why at different times. This description of the history of SVCW will illustrate that the conveyance system is being operated in a manner different than its original design intent and, now, beyond its useful life.

Until the mid-1960's the mid-peninsula cities had their own wastewater treatment plants. Redwood City Sanitary District owned and operated the Redwood City Sewage Treatment Facility. Belmont and San Carlos owned and operated the Belmont/San Carlos Joint Sewage Treatment Facility. The developer of Redwood Shores (Mobil Land) owned the Redwood Shores Treatment Plant and it was operated by Redwood City Sanitary District. The Redwood City and Belmont/San Carlos plants separately discharged effluent to San Francisco Bay. The Redwood Shores Plant consisted of oxidation ponds and had no discharge as all the wastewater was evaporated. The level of treatment provided by these three plants and the locations of their outfalls could not meet the new stricter wastewater treatment and disposal regulations being imposed and developed at the state (Porter-Cologne Act, 1969) and federal (Clean Water Act, 1972) levels.

The Regional Water Quality Control Board (Regional Board) ordered a 10-to-1 dilution requirement for San Francisco Bay discharges. With encouragement from the Regional Board, in June 1969, the three cities formed the *Strategic Consolidation Sewerage Plan Joint Powers Authority* (SCSP JPA) for the purpose of addressing the new water quality regulations on a regional basis. To meet the 10-to-1 dilution requirement as soon as possible, the SCSP JPA would build connecting pipelines and a deep-water outfall for discharging the effluent from the existing three small treatment plants in advance of constructing the regional treatment plant. The site of the regional treatment plant needed to be decided so design of the new outfall could begin. After considering several sites, the SCSP JPA selected the Redwood Shores Plant site at the mouth of Steinberger Slough for the regional plant.

The pipeline consisted of six miles of reinforced concrete pipe that connected the treatment plants to the deep-water outfall located at the mouth of Steinberger Slough[1]. This new conveyance system was designed as a low pressure force main. In 1969 designs were completed for the pipeline as well as for the Redwood City Pumping Plant

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[1] It should be noted that reinforced concrete pipe was the pipe of choice when the pipeline was designed in the early 1970's. High density polyethylene (HDPE) pipe was not available in large diameters at that time. The highly corrosive nature of the Redwood Shores saline soils made steel a poor candidate for this alignment.

and the San Carlos Pumping Plant. These pumping plants were built adjacent to the respective individual treatment plants. The pump stations, pipeline, and deep water outfall were put into service in 1971. The outfall, pipeline, and the Redwood City Pumping Plant (renamed Redwood City Pump Station) are still in use today.

Concurrent with the SCSP JPA improvement plans, Belmont's capital plans anticipated needing a new pump station and a pipeline that would connect it to the Belmont/San Carlos Joint Plant until the regional plant was operational. By the time the regional plant was operational and the Belmont/San Carlos Joint Plant closed, Belmont would also need a direct connection to the new SCSP force main. Design for a new pump station and direct connection forcemain on the west side of U.S. Highway 101 finished in 1973. The force main consisted of two segments. The first was from the new Belmont pump station to the point of the future connection to the 54-inch force main. This section was 1200 feet of 24-inch wrapped and cement lined steel pipe. The second segment was downstream of the future connection point and terminated at the San Carlos/Belmont Joint Plant. In this segment the pipe size was reduced to 20-inches and the material changed to asbestos cement pipe. This change in size and material was likely due to the City wanting to reduce costs for this segment that would be used for less than 10 years.

In the mid-1970's, in response to Regional Board direction, the service area for the regional plant originally envisioned by the SCSP JPA expanded to include the West Bay Sanitary District service area. In November 1975 the members of the SCSP JPA and West Bay Sanitary District (previous named Menlo Park Sanitary District) founded South Bay System Authority (SBSA, renamed in 2014 to Silicon Valley Clean Water) JPA as the successor to the Strategic Consolidation Sewerage Plan JPA.

This addition necessitated expanding the conveyance system to connect WBSD. Design of a 2.7-mile-long 33-inch diameter reinforced concrete pipe force main between the Redwood City Pump Station and the future Menlo Park Pump Station site was completed in 1976. The pipe was put into service when the regional plant became operational in 1982. The addition of WBSD to the system required that a booster pump station be added to the force main system, as the additional WBSD flows were not anticipated in the original forcemain headloss and pressure calculations.

The five segments of the existing force main, with year built, are described in Table 1.

Table 1
Existing Force Main Location, Size and Length

Segment	Location	Pipe Inside Diameter (ID) (in)	Year Built and Material	Age of Pipeline (years)	Length [(1)]	
					Lineal Feet	Miles
1	Between Menlo Park Pump Station and Redwood City Pump Station	33	1977 RCP	40	14,450	2.74
2	Between Redwood City Pump Station and San Carlos Pump Station	48	1971 RCP	46	12,950	2.45
3	Between San Carlos Pump Station and Belmont "T"	54	1971 RCP	46	3,550	0.67
4	Between Belmont Pump Station and Belmont "T"	24	1974 WSCL/C [(2)]	43	1,150	0.22
5	Between Belmont "T" and SBSA wastewater treatment plant	54	1971 RCP	46	15,500	2.94
Total Force Main					**47,600**	**9.0**

Based on: Table 6.1 of the SVCW Conveyance System Master Plan. Winzler & Kelly. 2011.
1. Lengths are rounded to the nearest 50 feet and tenth of a mile.
2. WSCL/C = Wrapped and cement-lined steel. Construction date estimated based on design drawings being completed in Feb. 1973.

In anticipation of higher flows and the higher water surface elevation of the regional WWTP, SBSA modified existing pump stations or built new one(s). The (1971) Redwood City and the (1974) Belmont Pump Stations were enlarged. A new San Carlos Pump station replaced the 1971 San Carlos Pump Station. The Menlo Park Pump Station was a new pump station that was subsequently modified in 1990 as part of WBSD's flow equalization project. Table 2 provides a summary of dates related to the pump stations.

Table 2
Age of Existing Pump Stations

Pump Station	Existing PS Operational	Enlarged, New or Modified	Years in Service
Menlo Park	1982	1990	35
Redwood City	1971	1982	46
San Carlos		1982 (new)	35
Belmont	1974[a]	1982	43

[a] 1974 is based on the date of the force main design drawings.

Design of SBSA's regional WWTP was completed in December 1977 and the new plant became operational in 1982. When the regional WWTP plant was put into service, the four smaller plants were decommissioned and the new and upgraded pump stations began to pump wastewater to the regional plant.

2. Reasons the Project is Needed

The SVCW Wastewater Conveyance System and Treatment Plant Reliability Improvement Project is necessary to eliminate ongoing reliability concerns and accommodate changes in wastewater flowrates. Replacement of the conveyance system is SVCW's highest priority due to its age and continual state of failure. The existing SVCW conveyance system components are beyond their useful life. The American Society of Civil Engineers published a report entitled "Failure to Act" with the purpose "to provide an objective analysis of the economic implications for the United States of its continued underinvestment in infrastructure." Table 3 lists the useful life for force mains and pump stations used in the ASCE report.

Table 3
Useful Lives of Wastewater
Pump Stations and Force Mains

Component	Useful Life (years)
Force Mains	25
Pumping Stations – Concrete Structures	50
Pumping Stations – Mechanical and Electrical	15

Source: Table 5 of *Failure to Act, the economic impact of current investment trends in water and wastewater treatment infrastructure*. American Society of Civil Engineers. 2011.

2.1. Force Mains

SVCW's 46-year-old concrete force main is in poor condition and needs to be replaced. The pipeline suffers from several problems caused by the soils in which it is installed and the sewage characteristics. Problems have compounded, resulting in a history of numerous leaks. These leaks range from minor to the occasional catastrophic failure. Leaks require repairs along streets and in backyards and sometimes within biologically sensitive environments.

One section of the original force main that had the most leaks was replaced in 2015 with a fused-jointed high density polyethylene (HDPE) pipe. This was a 1.7-mile long portion of the 48-inch diameter force main from the Redwood City Pump Station to the north end of Inner Bair Island. The Project will replace the remaining original force main that begins where the 48-inch replacement project ended (the north end of Inner Bair Island) and terminates at the WWTP.

Much of the existing force main is buried in young bay mud soils that are poorly suited to the existing pipeline material and joint system. Young bay mud has two main problems; it is expansive and corrosive. Expansive soils are weak, unstable, have high shrink-swell potential, and settle over time. The pipeline consists of 12-foot-long reinforced concrete pipe sections that are connected to each other with single non-restrained "O-ring" joints. The young bay mud soil does not provide sufficient support for the reinforced concrete pipe and its joints. This results in pipe movement and separation at the joints and is the cause of the majority of the leak events.

The bay mud soil is highly corrosive to buried steel and concrete that comes into direct contact with the soil. The pipe is also subjected to microbiologically influenced corrosion (MIC) from sewer gases inside the pipe. Internal and external corrosion of the concrete and reinforcing steel leads to more significant leaks. When surges in flow occur (such as during a power outage) the resulting pressure and vacuum surge conditions have broken the weakened pipeline resulting in major sewage spills. These types of leaks tend to be catastrophic with the potential of uncontrollable discharge of untreated wastewater to the environment.

The frequency of pipeline leaks is expected to increase as the pipe ages, given the current poor condition of the pipelines, continued movement of weak soils, and acceleration of the internal and external corrosion.

In addition to the problems related to the soil, the existing pipeline was designed as a low-pressure force main pipeline and not for typical force main pressures. When WBSD was added to the conveyance system and as wet weather flows have risen, flows in the force main have grown higher than the original design anticipated. When the WBSD flows were added, a booster pump station, and later a flow equalization facility, were added to the system.

With Herculean efforts, SVCW maintains pressures and surges in the conveyance system to within the force main’s pressure limits, though this approach comes with significant risk. SVCW must carefully manage the flow in the pipeline to minimize leaks by opening and closing valves, turning on and off pumps (including the booster and influent lift pumps), diverting flow to storage, and backing up sewage in member agency collection systems. During wet weather events, wastewater flows from the WBSD collection system are diverted to the WBSD flow equalization facilities. When flows subside, the WBSD wastewater is pumped from the flow equalization facilities through the Menlo Park Pump Station and to the treatment plant. Sometimes these pressure management efforts require using all available pumps and valves leaving limited or no backup equipment.

The reasons provided for replacing the pipelines are corroborated by industry accepted guidelines of useful life. The 46-years is well beyond a typical force main’s lifespan of 25 years.

2.2. Pump Stations

All five pump stations are in varying states of condition, ranging from poor to very poor. Despite system-wide repairs and regular maintenance, the pump stations are in need of replacement to provide safe and reliable operation and to accommodate the future projected flows through the system. Each pump station is at least 35 to 46 years old, well beyond the 15-year useful life for the mechanical and electrical components, and approaching the life of the concrete structure. In most instances the condition of the equipment has degraded to the extent that the systems require extensive maintenance to ensure functionality and reliability. To keep the pump stations operational, SVCW is spending millions of dollars to replace various pump station components, such as control systems, pumps, and valves. These components will not be used after the Project is completed.

The solution to the current conveyance system problems SVCW is facing is to replace the original pipeline with a new pipeline that is designed for local soils conditions and system flows, and to replace or rehabilitate the pump stations. The conveyance pipeline and the pumping system improvements are interconnected and need to be planned, designed, and constructed in tandem.

2.3. Headworks

The Project also includes construction of a headworks to house screening and grit removal facilities. This process will be the first step in treatment. It removes rags, sand, grit, and debris that damage pumps and other process equipment.

The original SVCW wastewater treatment facility was built with no headworks. The plant's current partial screening and grit removal processes continue to allow excessive downstream grit and unscreened material that cause premature wear on equipment and result in high maintenance and repair costs. Large debris and inorganic solids such as rags that are not removed by the existing screening equipment are removed manually. Manual removal of rags is labor intensive and places plant personnel in challenging work environments. SVCW recently installed new digester mix pumps, rotary screen presses, and gravity belt thickeners. This new equipment is very susceptible to damage caused by rags and debris. Without the headworks, this new equipment will experience the same premature wear as the older equipment.

SVCW's decision to install screening and grit removal facilities was made for purposes of protecting its employees, addressing the continued high costs for labor and equipment damage, and increase the reliability of the overall treatment process. Effective screening of incoming wastewater will save both operation and maintenance costs and improve SVCW's operational capabilities.

3. Proposed Conveyance System Project Overview

The Project proposes a combination of rehabilitating, repurposing, and decommissioning existing SVCW conveyance system assets, and the construction of replacement assets. Brief summaries of the major components included in the Project are provided in the following paragraphs.

3.1. Pipelines

A 15-foot outside diameter tunnel will be built using a tunnel boring machine to connect the recently constructed 48-inch replacement force main (located at the northern end of Inner Bair Island) to the WWTP. The distance between top of the tunnel and the ground surface will range from 20 to 52 feet. Inside this tunnel will be a new 11-foot inside diameter gravity pipeline. This new gravity pipeline will replace the remaining portion of the 48-inch and the entire existing 54-inch force main pipelines. The Belmont Pump Station would be connected to the new gravity pipeline by rehabilitating the existing 24-

inch pipeline and a portion of the 54-inch pipeline. The 33-inch force main pipeline that connects the Menlo Park Pump Station to the Redwood City Pump Station would remain as it exists.

3.2. Pump Stations

The Menlo Park Pump Station and the Belmont Pump Station will be rehabilitated and remain as part of the proposed project. A new pump station will be built on the existing Redwood City Pump Station site and the existing pump station building will be repurposed to house auxiliary equipment that supports the new Redwood City Pump Station. The San Carlos Pump Station will no longer be needed and will be decommissioned. Portions of the San Carlos Pump Station building and yard will be repurposed to house odor control and ancillary equipment needed by other elements of the proposed Project. At the downstream end of the gravity pipeline, a new deep pump station (called the receiving lift station) will be built to pump the wastewater from about 60 feet below grade to the new headworks.

3.3. Headworks

A headworks facility will be constructed downstream of the receiving lift station to provide coarse screening and grit removal from the raw wastewater. This is a new treatment process being added to the WWTP treatment train. Two new large-diameter pipes will be built to connect the headworks to the existing primary treatment process. Odor control facilities for the receiving lift station and headworks will be installed adjacent to the headworks facility.

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