PSOMAS

Balancing the Natural and Built Environment

July 12, 2011

City of Alameda
City Hall West
950 W. Mall Square, Room 110
Alameda, Ca 94501
Attention: Barbara Hawkins, City Engineer

RE: Assessment of the City of Alameda Storm Drain Pump Stations

Dear Barbara:

We are pleased to submit four (4) bound double-sided copies of the report entitled, "Storm Drain Pump Station Assessment", dated July 12, 2011, for your review and use. We are also enclosing a disc containing an electronic copy of the report and photos taken during this study. This final report incorporates comments provided on the draft version previously submitted (dated February 28, 2011).

This report includes detailed recommendations to replace or rehabilitate the nine storm drain pump stations evaluated as part of this study. Three pump stations were given a Level 1 priority rating based on very insufficient pumping capacities (as tested and/or estimated) as compared to estimated inflows provided by Schaaf & Wheeler. These three storm drain pump stations are:

1. Arbor-recommend full pump station replacement.
2. Central/Eastshore-recommend full pump station replacement.
3. Northside-Upgrades per City of Alameda Project No. PW 02-01-06.

Please contact us should you have any questions on the data presented in this report. We are also prepared to assist the City in developing detailed design plans for each of these pump stations.

I look forward to continuing our work with you and your staff.

Sincerely,
PSOMAS

Gregory Ow, PE
Project Manager

Enclosures

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FINAL REPORT

STORM DRAIN PUMP STATION ASSESSMENT
CITY OF ALAMEDA

July 12, 2011

Prepared for:
CITY OF ALAMEDA, PUBLIC WORKS DEPARTMENT
950 West Mall Square, Room 110
Alameda, California 94501-7575

Prepared by:
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Project No. P6DOD08719

TABLE OF CONTENTS

TABLES

FIGURES

APPENDICES

1.0 Executive Summary

The City of Alameda's existing storm drain pump stations were evaluated to determine their ability to convey storm water flows from a 10-year storm event during the current 10-year high tide, as well as during the anticipated future 10-year high tide. The reliability and capacity of these stations is of the utmost importance due to the low elevations in the majority of Alameda and potential for flooding from wet weather events during high tides. Chapter 2 contains a summary of stations that were evaluated for this study, along with a summary of design criteria for each station.

Another goal of the assessment was to identify needed improvements to provide reliable, safe, and efficient pump station facilities. Psomas worked closely with Fard Engineers, and The Crosby Group to determine the electrical and structural inadequacies at each station and to identify where improvements are needed. Pump station assessment and recommended improvements are provided in Chapter 5. Photographs taken during field assessments are included in Appendix C.

Psomas worked with Pumping Efficiency Testing Services (PETS) to perform field pump testing at most of the pump stations to determine actual pump flow rates and pump head, as well as pump efficiency. PETS used the field test data to provide an analysis of where pump rehabilitation and/or replacement could result in energy cost savings for the City. The results of the pump testing are presented in Chapter 3. Pump testing data sheets are included in Appendix A.

1.1 Capital Improvement Program

Chapter 6 presents the organization of the recommended improvements developed in Chapters 3 and 5 into capital improvement program (CIP) projects. The CIP projects were prioritized into the following three categories:

- Level 1 - High Priority – defined as projects which are necessary to prevent a significant risk of flooding from heavy storm water runoff events.
- Level 2 - Necessary Projects – defined as projects that must be done to improve pump station capacity and/or reliability or safety.
- Level 3 - Discretionary Projects – defined as those that are needed in the long-term, but where the City has a significant level of control as to when they should be implemented.

1.2 Cost Evaluation

All project costs presented herein were estimated at a planning-level of accuracy (plus 50 percent to minus 25 percent). The project costs include an estimating contingency of 30 percent and an implementation cost of 55 percent. Components of the implementation cost are as follows:

Engineering Design	10 %
Construction Contingency	30 %
Project Administration / Legal & Permitting	15%
Total	55 %

For more information concerning the estimated costs for improvements at each station, refer to Appendix D.

1.3 Recommended Improvements

A summary of the recommended improvements and their associated level of priority and estimated costs are listed in Table 1-1.

Table 1-1 Recommended Improvements

Station	Level of Priority	Summary of Improvements	Estimated Cost(1)
Arbor	1	Complete Pump Station Replacement. Outfall replacement. Install Standby Generator and Automatic Trash Rack.	$3,891,000
Central/Eastshore	1	Complete Pump Station Replacement. Outfall Replacement. Install Standby Generator and Automatic Trash Rack.	$2,805,000
Golf Course	2	Install Wiring in Conduit; Provide Anti-Slip Surfacing; Install Fire Extinguisher	$6,000
Golf Course	3	Install Paved Driveway, Standby Generator, and Fence Around Control Panel. Provide Site lighting and Wash Down Facilities. Coatings and Repairs.	$198,000
Harbor Bay System I	3	Provide Wash Down Facilities. Minor Structural Repair. Provide Control Panel Alarm and Fire Extinguisher.	$17,000
Harbor Bay System II	3	Replace Pump. Install Standby Generator. Replace hatches. Site Lighting and Alarms.	$257,000
Main Street	2	Install Ladder & Handrailing; Install Ventilation & Fire Extinguisher; Anchors for Control Panel & Pump Controller and Level Sensors	$84,000
Main Street	3	Install Standby Generator. Replace Hatches. Provide Station Wash Down Facilities.	$158,000
Northside	1	Replace Pumps. Other improvements per City of Alameda Northside Pump Station Upgrades Project No. PW 02-10-06.	$900,000(2)
Northside	2	Replace Pumps with New Pumps. Replace Checker Plate to Remove Trip Hazard.	$587,000
Third Street	2	Replace Hatch. Provide System for Wet Well Entry. Recoat piping. Replace Site Fence. Provide wash down facilities and Standby Generator.	$86,500

Station	Level of Priority	Summary of Improvements	Estimated Cost[1]
Webster	2	Complete Pump Station Replacement (Reuse Existing Pumps). Install Standby Generator and New Electrical Equipment.	$1,043,000

Notes:

1. Cost estimate in February 2011 Dollars.
2. Bid amount for Northside Pump Station Upgrades Project No. PW 02-10-06 per Schaaf & Wheeler. Does not include 55 % markup for related project costs.

2.0 Introduction

The City of Alameda's Storm Drain Pump Station Assessment includes nine of the City's ten storm water pump stations. The primary goal of the assessment is to ensure that the City's stations have the capacity to handle storm water flows from a 10-year storm event during the current 10-year high tide, as well as during the anticipated future 10-year high tide. The reliability and capacity of these stations is of the utmost importance due to the low elevations in the majority of Alameda and potential for flooding from wet weather events during high tides.

Another goal of the assessment is to identify needed improvements to provide reliable, safe, and efficient pump station facilities. Psomas worked closely with Fard Engineers, and The Crosby Group to determine the electrical and structural inadequacies at each station and to identify where improvements are needed. Psomas also worked with Pumping Efficiency Testing Services (PETS) to perform field pump testing at most of the pump stations to determine actual pump flow rates and pump head, as well as pump efficiency. PETS used the field test data to provide an analysis of where pump rehabilitation and/or replacement could result in energy cost savings for the City. The results of the pump testing are presented in Chapter 3. PETS pump testing data sheets are included in Appendix A.

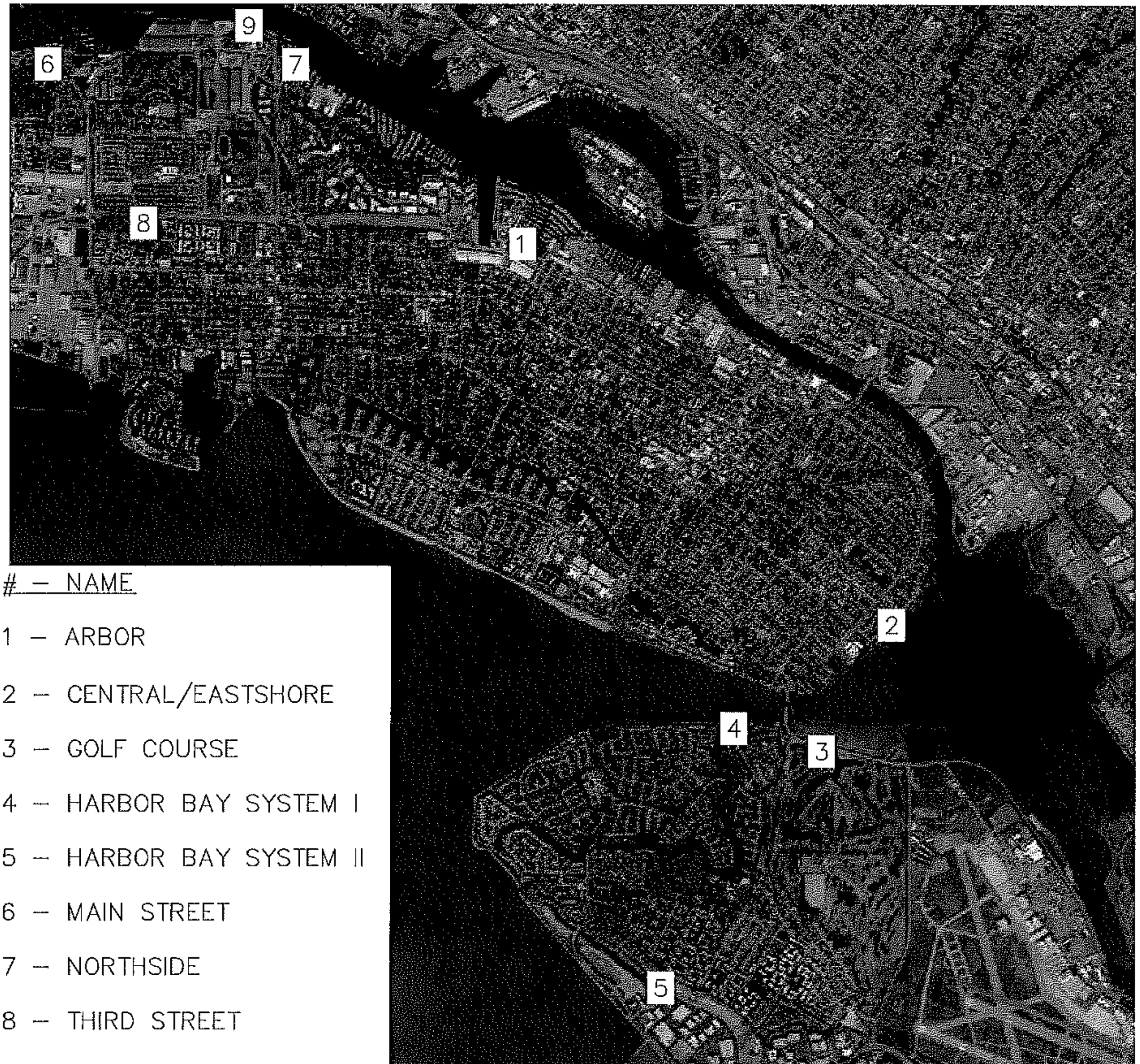
The City of Alameda's storm drain pump stations included in the assessment are:

- Arbor Pump Station
- Central/Eastshore Pump Station
- Golf Course Pump Station
- Harbor Bay System I Pump Station
- Harbor Bay System II Pump Station
- Main Street Pump Station
- Northside Pump Station
- Third Street Pump Station
- Webster Street Pump Station

The Bay Port Pump Station was not included in this assessment because it was recently renovated. According to the City, the Bay Port pump Station is in good working order. There are also privately operated pump stations located in the City that were not included in this assessment. Figure 2-1 shows the location of the pump stations included in this evaluation.

2.1 Summary of Existing Facilities

A brief summary of each pump station, including location, and station design criteria is presented herein.



– NAME

1 – ARBOR

2 – CENTRAL/EASTSHORE

3 – GOLF COURSE

4 – HARBOR BAY SYSTEM I

5 – HARBOR BAY SYSTEM II

6 – MAIN STREET

7 – NORTHSIDE

8 – THIRD STREET

9 – WEBSTER STREET

PSOMAS	CITY OF ALAMEDA STORM DRAIN PUMP STATION ASSESSMENT REPORT	PUMP STATION LOCATION MAP	FIGURE NO. 2–1 JOB NO. 6ALA010100

2.1.1 *Arbor Pump Station*

The Arbor Pump Station is located on the northern side of Alameda off of Buena Vista Avenue near the Alameda Yacht Club. The station was originally constructed in 1948 with two pumps located in a dry well. In 1994 the dry well was abandoned, and the wet well was modified for installation of four submersible pumps. Each pump discharges through individual 24-inch diameter pipes equipped with flaps gates into a discharge structure. Flow is conveyed from the discharge structure by gravity through a 54-inch outfall to the San Francisco Bay. Design criteria for the Arbor Pump Station is summarized in Table 2-1.

Table 2-1 Arbor Pump Station Design Criteria

Criteria	Value
Number of pumps	4
Type of pump	Submersible, propeller type
Manufacturer & Model	Paco Model SP16A
Pump barrel diameter (inches)	30
Pump discharge diameter (inches)	24
Pump capacity, each (gpm)	7,900[(1)]
Pump total dynamic head (feet)	15[(1)]
Total pump station capacity (gpm)	31,600[(1)]
Motor horsepower (hp)	40
Motor nameplate amperes (A)	53.3
Motor manufacturer	Reliance
Motor type	P
Motor frame	X320TY
Motor voltage & phase	460 volt, 3 phase
Motor revolutions per minute (rpm)	1170
Pump controls	Automatic; bubbler level control
Main Switchboard Electrical Criteria	
Enclosure type	NEMA 3R
Switchboard nameplate amperes (A)	400
Main breaker (A)	300
Power supply	480 volt, 3 phase, 4W
Inlet and Outlet Piping	
Inlet pipe diameter (inches)	54
Outfall pipe diameter (inches)	54

Notes:

1. Values for pump design capacity, total dynamic head (TDH), and station capacity provided by Schaaf and Wheeler.

2.1.2 Central/Eastshore Pump Station

The Central/Eastshore Pump Station is located on the eastern side of Alameda in a residential area off Eastshore Drive. The pump station was originally constructed in 1967 and housed two vertical turbine type pumps. The pump station was later modified to house submersible pumps with each pump discharging through individual 16-inch diameter pipes equipped with flap gates into a discharge structure. Flow is conveyed from the discharge structure by gravity through a 21-inch outfall to the San Francisco Bay. A 24-inch pipe gate between the wet well and pump discharge structure allows water to flow by gravity from the wet well to the discharge structure in the event of pump failure or power outage. Electrical controls for the station are located on top of the structure. Design criteria for the Central/Eastshore Pump Station is summarized in Table 2-2.

Table 2-2 Central/Eastshore Pump Station Design Criteria

Criteria	Value
Number of pumps	2
Type of pump	Submersible, axial flow type
Manufacturer & Model	Paco; model unknown
Pump barrel diameter (inches)	16
Pump discharge diameter (inches)	16
Pump capacity, each (gpm)	4,300[1]
Pump total dynamic head (feet)	15[1]
Total pump station capacity (gpm)	8,600[1]
Motor horsepower (hp)	25
Motor nameplate amperes (A)	70.4/35.2
Motor manufacturer	Reliance
Motor enclosure	TENV
Motor type	P
Motor frame	X025QTY
Motor voltage & phase	230/460 volt 3 phase
Motor revolutions per minute (rpm)	1160
Pump controls	Automatic; bubbler level control
Inlet and Outlet Piping	
Inlet pipe diameter (inches)	(1) 27-inch and (1) 21-inch
Outfall pipe diameter (inches)	21

Notes:

1. Values for pump design capacity, total dynamic head (TDH), and station capacity provided by Schaaf and Wheeler.

2.1.3 Golf Course Pump Station

The Golf Course Pump Station is located in the northeastern corner of Bay Farm Island at the Chuck Corica Municipal Golf Course off of Doolittle Drive. The station was originally constructed in 1985 with two vertical turbine type pumps designed to pump water as required from a collection pond at the golf course. The station was later modified to house two submersible pumps. The pump's discharges combine into a single forcemain (initially 24-inch increasing to 30-inch) prior to discharging to a storm drain manhole located across Doolittle Drive. From the manhole a 42-inch outfall conveys flow by gravity to the San Francisco Bay. Design criteria for the Golf Course Pump Station is summarized in Table 2-3.

Table 2-3 Golf Course Pump Station Design Criteria

Criteria	Value
Number of pumps	2
Type of pump	Submersible
Manufacturer & Model	Prime Pump Corporation Model 26SM14-14
Pump barrel diameter (inches)	18
Pump discharge pipe diameter (inches)	18
Forcemain diameter (inches)	24 increasing to 30
Pump capacity, each (gpm)	9,600[1]
Pump total dynamic head (feet)	5[1]
Total pump station capacity (gpm)	19,200[1]
Motor horsepower (hp)	50
Motor nameplate amperes (A)	67
Motor manufacturer	Reliance
Motor type	ID # P25G2712F
Motor voltage & phase	460 volt, 3 phase
Pump controls	Automatic; level control by float switches
Main Meter Panel	
Panel size (A)	600
Panel disconnect (A)	200
Power supply	277/480 volt, 3 phase, 4W

Notes:

1. Values for pump design capacity, total dynamic head (TDH), and station capacity provided by Schaaf and Wheeler.

2.1.4 Harbor Bay System I Pump Station

The Harbor Bay System I Pump Station, constructed in 1978, is located on the north side of Bay Farm Island on Harbor Bay Lagoon. The station consists of a single vertical propeller type pump mounted on a concrete structure located adjacent to the lagoon's outfall. Normally, the lagoon level is controlled by an outfall gate structure with gates that open and close to allow water to pass between the lagoon and San Francisco Bay. The pump station is used when the lagoon level must be lowered and the tide level is equal to or greater than the lagoon level, preventing the use of the outfall gates. The pump discharges through a 24-inch forcemain to the San Francisco Bay. Design criteria for the Harbor Bay System I Pump Station is summarized in Table 2-4.

Table 2-4 Harbor Bay System I Pump Station Design Criteria

Criteria	Value
Number of pumps	1
Type of pump	Vertical Propeller
Manufacturer & Model	Prime Pump Corporation Model 20P16A-11.5
Pump discharge pipe diameter (inches)	20
Forcemain diameter (inches)	24
Pump capacity (gpm)	10,000
Motor horsepower (hp)	60
Motor manufacturer	General Electric
Motor type	K
Motor frame	C404TP16
Motor voltage & phase	460 volt, 3 phase
Motor revolutions per minute (rpm)	1170
Pump controls	Manual with low level cut-off by float switch
Main Meter Panel	
Panel size (A)	200
Power supply	277/480 volt, 3 phase, 4W

2.1.5 Harbor Bay System II Pump Station

The Harbor Bay System II Pump Station, constructed in 1991, is located on the west side of Bay Farm Island off the cul-de-sac at the end of Ratto Road. Similar to Harbor Bay System I, Harbor Bay System II is used to draw down Harbor Bay Lagoon in the event that the lagoon level cannot be lowered by the outfall gate structure because of high tides. The station is located adjacent to the lagoon's outfall gate structure and is connected via a manually operated isolation gate. The station consists of one pump that discharges through a short 16-inch forcemain into a manhole on the east side of the station. From the manhole, flow is conveyed by gravity through a 48-inch outfall to the San Francisco Bay. Design criteria for the Harbor Bay System II Pump Station is summarized in Table 2-5.

Table 2-5 Harbor Bay System II Pump Station Design Criteria

Criteria	Value
Number of pumps	1
Type of pump	Submersible Axial Flow Propeller Type
Manufacturer & Model	Prime Model M10 (w/ 12 degree impeller blades)
Pump discharge pipe diameter (inches)	16
Forcemain diameter (inches)	16
Pump capacity (gpm)	unknown
Motor horsepower (hp)	10
Motor voltage & phase	208 volt, 3 phase
Motor revolutions per minute (rpm)	1180
Pump controls	Manual with low level cut-off
Main Meter Panel	
Panel size (A)	200
Power supply	120/208 volt, 3 phase, 4W

2.1.6 Main Street Pump Station

The Main Street Pump Station is located on the northwest side of Alameda off Main Street. The station was constructed in 1998 and has three submersible pumps housed in a concrete structure that extends partially above grade. Each pump is installed in a 28-inch diameter barrel and discharges through individual 16-inch diameter pipes equipped with flap gates into a discharge structure. Flow is conveyed from the discharge structure by gravity through two parallel 28-inch diameter HDPE outfall pipes to the San Francisco Bay. Design criteria for the Main Street Pump Station is summarized in Table 2-6.

Table 2-6 Main Street Pump Station Design Criteria

Criteria	Value
Number of pumps	3
Type of pump	Submersible, axial flow type
Manufacturer & Model	Flygt; Model unknown
Pump barrel diameter (inches)	28
Pump discharge diameter (inches)	16
Pump capacity, each (gpm) (1)	4,500(1)
Pump total dynamic head (feet)	13(1)
Total pump station capacity (gpm)	13,500(1)
Motor horsepower (hp)	25
Pump controls	Automatic; PLC Controlled
Main Switchboard Electrical Criteria	
Switchboard nameplate amperes (A)	400
Power supply	277/480 volt, 3 phase, 4W
Inlet and Outlet Piping	
Inlet pipe diameter (inches)	36
Outfall pipe diameter (inches)	Two 30-inch
Automatic Trash Rack	
Manufacturer	Duperon
Model	Flexrake
Bar Spacing (inches)	2
Motor Horsepower (hp)	1/8
Year Installed	2009

Notes:

1. Values for pump design capacity, total dynamic head (TDH), and station capacity provided by Schaaf and Wheeler.

2.1.7 Northside Pump Station

The Northside Pump Station is located on the northern side of Alameda off of Marina Village Parkway. The station was constructed in 1984 and has three vertical turbine pumps housed in a concrete structure that extends partially above grade. Each pump discharges into a common discharge box through 36-inch diameter discharge pipes equipped with flap valves. Flow is then conveyed by gravity through a 72-inch outfall pipe to the San Francisco Bay. Design criteria for the Northside Pump Station is summarized in Table 2-7.

Table 2-7 Northside Pump Station Design Criteria

Criteria	Value
Number of pumps	3
Type of pump	Vertical Axial Flow Type
Manufacturer & Model	Paco; Model unknown
Pump discharge diameter (inches)	36
Pump capacity, each (gpm) (1)	24,000(1)
Pump total dynamic head (feet)	10(1)
Total pump station capacity (gpm)	72,000(1)
Motor horsepower	75
Motor nameplate amperes (A)	137
Motor manufacturer	Reliance
Motor type	HU
Motor frame	Titan 5108-P
Motor voltage & phase	460 volt, 3 phase
Motor revolutions per minute (rpm)	505
Pump controls	Automatic; PLC Controlled (Pump Commander)
Main Switchboard Electrical Criteria	
Switchboard nameplate amperes (A)	400
Power supply	480 volt, 3 phase, 4W
Inlet and Outfall Pipe Diameter (inches)	72
Automatic Trash Rack	
Manufacturer	Duperon
Model	Flexrake
Bar Spacing (inches)	2
Motor Horsepower (hp)	1/8
Year Installed	2009

Notes:

1. Values for pump design capacity, total dynamic head (TDH), and station capacity provided by Schaaf and Wheeler.

2.1.8 Third Street Pump Station

The Third Street Pump Station is located on the northern side of Alameda near the intersection of Third Street and Ralph Appezzato Memorial Parkway. The station was constructed in 1993 and consists of a concrete wet well with one submersible pump. The pump is located in a steel barrel and discharges through a 12-inch steel pipe with equipped with a flap gate into an adjacent storm drain manhole. Design criteria for the Third Street Pump Station is summarized in Table 2-8.

Table 2-8 Third Street Pump Station Design Criteria

Criteria	Value
Number of pumps	1
Type of pump	Submersible, axial flow type
Manufacturer & Model	Unknown
Pump discharge diameter (inches)	12
Pump capacity (gpm) [1]	1,650[1]
Pump total dynamic head (feet)	8[1]
Motor horsepower	5
Motor manufacturer	Reliance
Motor type	P
Motor frame	ID # P18G27093
Motor voltage & phase	230 volt, 3 phase
Motor revolutions per minute (rpm)	1150
Pump controls	Automatic; bubbler level control
Main Meter Panel	
Panel size (A)	100
Power supply	120/240 volt, 3 phase, 4W
Inlet pipe diameter (inches)	15

Notes:

1. Values for pump design capacity, total dynamic head (TDH), and station capacity provided by Schaaf and Wheeler.

2.1.9 Webster Street Pump Station

The Webster Street Pump Station is located on the northern side of Alameda at the end of Mariner Square Drive. The station was constructed in 1947 and consists of a concrete structure that extends partially above grade containing a dry well on top of a wet well. The station has three submersible pumps that discharge through a 21-inch forcemain into the San Francisco Bay. To prevent backflow into the wet well under high tide conditions, each pump discharge is provided with a 10-inch Val-Matic swing-flex check valve. Design criteria for the Webster Street Pump Station is summarized in Table 2-9.

Table 2-9 Webster Street Pump Station Design Criteria

Criteria	Value
Number of pumps	3
Type of pump	Submersible, propeller type
Manufacturer & Model	Paco; Model unknown
Pump discharge diameter (inches)	10
Pump capacity, each (gpm) [1]	1,750[1]
Pump total dynamic head (feet)	10[1]
Total pump station capacity (gpm)	5,250[1]
Motor horsepower	7.5
Motor enclosure	TENV
Motor type	P
Motor frame	X0210TY
Motor nameplate amperes (A)	23
Motor manufacturer	Reliance
Motor voltage & phase	230 volt, 3 phase
Motor revolutions per minute (rpm)	1150
Pump controls	Automatic; PLC Controlled (Pump Commander)
Main Meter Panel	
Panel size (A)	200
Power supply	120/208 volt, 3 phase, 4W
Inlet and Outlet Piping	
Inlet pipe diameter (inches)	24
Forcemain diameter (inches)	21
Automatic Trash Rack	
Manufacturer	Duperon
Model	Flexrake
Bar Spacing (inches)	2
Motor Horsepower (hp)	1/8
Year Installed	2009

Notes:

1. Values for pump design capacity, total dynamic head (TDH), and station capacity provided by Schaaf and Wheeler.

3.0 Pump Station Hydraulic Capacity

Each storm water pump station's hydraulic capacity and ability to meet the design 10-year storm water flows at current 10-year high tide and future high tide was evaluated and is presented herein. Pump testing was conducted on some stations as well to compare actual pumping capacity against design pumping capacity. The method to determine the existing station's hydraulic capacity is presented first, followed by the results of the hydraulic analysis and pump testing for each station.

3.1 Storm Water Flow and High Tide Design Basis

The first step in assessing the City's storm water pump stations was to determine the required storm water volume the station must convey for the design 10-year storm event, and the ability of the pumps to convey that flow during the 10-year high tide and at the anticipated future 10-year high tide. The 10-year storm water flows were provided by Schaaf & Wheeler, and are summarized in Table 3-1. The 10-year high tide high tide level was determined from the 2008 Storm Drain Master Plan. The anticipated future high tide elevation was determined to be 18 inches above the current 10 year high tide, per "The Climate Change Impacts to Storm Drain Improvements Addendum to the Storm Drain Master Plan" prepared by Schaaf & Wheeler in 2009. The values for the 10-year high tide and anticipated future high tide were confirmed by communication with Schaaf and Wheeler and are as follows:

- The 10-year high tide elevation = 4.56 feet National Geodetic Vertical Datum (NGVD).
- The anticipated future high tide elevation = 6.06 feet NGVD (assumed to be 18 inches higher than current tide levels).

Table 3-1 Design 10-year Storm Water Flow Influent to Each Station

Pump Station	10-Year Storm Water Flow (gallons per minute)[1]
Arbor Pump Station	88,420[2]
Central/Eastshore Pump Station	19,750[2]
Golf Course Pump Station	5,390
Harbor Bay System I Pump Station	NA[3]
Harbor Bay System II Pump Station	NA[3]
Main Street Pump Station	2,560
Northside Pump Station	60,000[2]
Third Street Pump Station	2,065
Webster Street Pump Station	2,700

Notes:

1. Design 10-year storm water flows provided by Schaaf & Wheeler.
2. Design 10-year storm water flow into station following improvements to the storm water collection system and construction of a new outfall as recommended in Schaaf & Wheeler's storm drain master plan. Flow information provided by Schaaf & Wheeler.

3. NA = Not Applicable. Pumps are designed to maintain lagoon water surface levels and are not storm water pumps.

3.2 Hydraulic Analysis

3.2.1 Existing Pump Curves

A hydraulic analysis was performed for each pump station. Pump curves for all stations except Harbor Bay System I and II were created using data provided by Schaaf and Wheeler. Pump curves for Harbor Bay System I and II were developed based on record drawings and information provided from Prime Pump Corporation and the City.

3.2.2 System Curves

System curves were developed for pump discharges and forcemains (as applicable), and/or for determining outfall capacity (for gravity flow to the San Francisco Bay).

A hydraulic analysis of pump station gravity outfall piping was performed for the following stations:

- Arbor Pump Station
- Central/Eastshore Pump Station
- Golf Course Pump Station
- Main Street Pump Station
- Northside Pump Station

For the following stations, system curves were developed for pump forcemains only:

- Harbor Bay System I Pump Station
- Harbor Bay System II Pump Station
- Third Street Pump Station
- Webster Street Pump Station

The Harbor Bay System I Pump Station discharges into a small structure, which is located in the San Francisco Bay. It does not have an outfall. The Harbor Bay System II Pump Station discharges into a structure with an outfall. The outfall was not analyzed because it is a 48-inch diameter pipe, which is clearly more than adequate for the one 10 horsepower pump at the station. The Third Street Pump Station discharges into the storm drain collection system and the Webster Street Pump Station discharges through a forcemain into the San Francisco Bay.

In order to develop the system curves for each pump station, the following information was required:

- Pump static lift (determined from pump operating levels and the elevation at discharge)
- Outfall pipe length, diameter, and material
- Hazen-Williams Coefficient of Roughness (C-Value)

- Minor losses (K-Value)

3.2.2.1 Pump Static Lift

To develop system curves for the existing storm drain pump stations, the pump static lift must be determined. Static lift is the difference in suction and discharge elevation for the pump. To determine suction elevation, pump operating levels were added to the existing wet well floor elevations (obtained from record drawings) and adjusted to NGVD. Where possible, pump operating levels were determined from station pump control panels in the field. In some cases, actual operating levels were unknown, and record drawings were consulted for determining suction elevation.

The discharge elevation must be determined in one of two ways:

- For non-submerged discharges, the pump's discharge pipe centerline elevation is used for the discharge elevation.
- For submerged discharges, the discharge elevation is equal to the water surface elevation above the discharge.

For the pump stations with pump discharge structures, the water elevation at discharge is dependent upon outfall capacity. During a storm event and high tide, the water level in the pump discharge structure will rise to a level where there is sufficient head above the tide level to push incoming flow through the outfall. Water elevations in pump discharge structures were determined by calculating the head required to push incoming flows from a 10-year storm event through outfalls during the anticipated future 10-year high tide level. Table 3-2 summarizes suction and discharge elevations used for static lift. The minimum and maximum static lifts are used to determine pump and station operating flow ranges.

Table 3-2 Pump Suction and Discharge Elevations

Pump Station	Elevation Pumps On (ft NGVD)	Elevation Pumps Off (ft NGVD)	Discharge Elevation (ft NGVD)	Pump Discharge Pipe Centerline Elevation (ft NGVD)	Minimum Static Lift(1) (ft)	Maximum Static Lift(2) (ft)
Arbor	-0.4	-3.4	9.1(3)	3.8	4.2	12.5
Central / Eastshore	-1.7	-5.2	11.1(3)	4.1	5.8	16.3
Golf Course	-4.6(4)	-6.1(4)	6.2(3)	NA(5)	9.3(7)	12.3
Harbor Bay System I(8)	0.2	NA(5)	6.1(6)	NA(5)	4.4	5.9
Harbor Bay System II(8)	-0.1	NA(5)	6.1(6)	NA(5)	4.7	6.2
Main Street	-0.6	-3.1	6.7(3)	3.4	4.0	9.8

Pump Station	Elevation Pumps On (ft NGVD)	Elevation Pumps Off (ft NGVD)	Discharge Elevation (ft NGVD)	Pump Discharge Pipe Centerline Elevation (ft NGVD)	Minimum Static Lift(1) (ft)	Maximum Static Lift(2) (ft)
Northside	-0.3	-2.3	7.0(3)	4.5	4.8	9.3
Third Street	3.4(4)	-1.6(4)	3.7(9)	3.7	0.3	6.0
Webster	-3.0	-6.0	6.1(6)	NA(5)	7.2(7)	12.1

Notes:

1. Minimum static lift is equal to the pump centerline elevation minus the elevation when pumps turn on.
2. Maximum static lift is equal to the discharge elevation minus the elevation when pumps turn off.
3. Water elevation in pump discharge structure required to push incoming flows from a 10-year storm event through outfall during the anticipated future 10-year high tide level of 6.06 ft.
4. Data obtained from record drawings.
5. NA = Not applicable.
6. Discharge elevation equal to the anticipated future 10-year high tide level.
7. Because this is a forcemain, minimum static lift based on discharge water surface elevation rather than on pump discharge pipe centerline elevation.
8. Pump on elevation equal to average lagoon elevation from record drawings. Minimum static lift equal to 10-year high tide elevation minus pump on elevation. Maximum static lift equal to anticipated future high tide elevation minus pump on elevation.
9. Assumes free discharge into storm drain collection system. Discharge elevation equal to pump discharge pipe centerline elevation.

3.2.2.2 Pipe Length, Diameter, and Material

Pipe length, diameter, and material for pump discharges and forcemains/outfalls were determined at each station from the City's record drawings and field verified wherever possible. Outfall lengths could not be determined from record drawings for Arbor Pump Station and Golf Course Pump Station. For these stations, outfall lengths from Schaaf and Wheeler's model created for the 2008 "Storm Drain Master Plan" was used.

3.2.2.3 Hazen-Williams Coefficient of Roughness (C-Value)

To determine friction head loss in the system, a coefficient of roughness (C-value) must be determined for the piping. Higher C-values indicate less resistance to flow. New pipelines with cement mortar lining (CML) and cast iron pipe (CIP) with no lining are expected to have C-values in the vicinity of 120. C-values can be affected by corrosion, grease accumulation and air accumulation at high points. Pipelines in service for many years typically have C-values about 20 points below that of a new pipe. For the purposes of the hydraulic modeling, a C value of 100 was used. It was further assumed that outfall piping was clear and free of sediment accumulation for the entire length.

3.2.2.4 Minor Loss Coefficient (K-Value)

System curve development also requires that minor losses are taken into account. Minor losses occur in the system as a result of fittings in the line, changes in direction, valves, or pipe entrances or exits. The number and type of fittings and valves were determined from record drawings and verified in the field where possible.

3.3 Pump Station Hydraulic Capacity Summary

The results of the hydraulic analysis and pump testing for each station are presented in this section. The hydraulic analysis and pump testing results are compared to the design 10-year storm water flow and pump station design capacity in Table 3-3.

Table 3-3 Summary - Pump Station Hydraulic Capacity

Pump Station	10-Year Storm Water Flow (gpm)(1)	Pump Station Design Capacity (gpm)(2)	Hydraulic Model (gpm)	Pump Test Results (gpm)
Arbor	88,420	31,600	32,000	Confined space, unable to test
Central/Eastshore	19,750	8,600	8,000	5,000 gpm at 15 ft TDH
Golf Course(3)	5,390	19,200	13,000	8,000 gpm at 12 ft TDH
Harbor Bay System I	NA(3)	Unknown	12,500	13,600 gpm at 4 ft TDH
Harbor Bay System II	NA(3)	Unknown	1,500	740 gpm at 6 ft TDH
Main Street	2,560	13,500	15,750	Confined space, unable to test
Northside	60,000	72,000	59,000	51,400 gpm at 9 ft TDH
Third Street	2,065	1,650	1,800	1,600 gpm at 5 ft TDH
Webster	2,700	5,250	5,000	5,200 gpm at 10 ft TDH(4)

Notes:

1. Design 10-year storm water flows provided by Schaaf & Wheeler.
2. Station capacity obtained from the 2008 Schaaf and Wheeler Storm Drain Master Plan Report.
3. NA = Not Applicable. Pumps are designed to maintain lagoon water surface levels and are not storm water pumps.
4. One pump was out of service during testing. Pump test results assume pump that was not tested is refurbished and able to pump the average of the two tested pumps (1730 gpm at 10 ft TDH).

3.4 Arbor Pump Station

3.4.1 Pump Testing

The Arbor Pump Station pumps could not be safely tested because of limited access to discharge piping and confined space.

3.4.2 Pump Hydraulic Analysis

A hydraulic analysis of the Arbor Pump Station confirmed the design pump station capacity of approximately 32,000 gpm when all four pumps are operating (see Table 3-3). According to Schaaf and Wheeler (personal communication with Dan Schaaf), the design 10-year storm flow is estimated to be approximately 88,420 gpm (following completion of improvements to the storm water collection system leading into the pump station). Hydraulic limitations in the collection system upstream currently limit the influent flow to the station to approximately 64,600 gpm. The pump station is undersized to handle the design storm water flow of 88,420 gpm, as well as the current maximum flow of 64,600 gpm. Figure 3-1 (in Appendix B) shows required pump station capacity, pumping capacity when all 4 pumps are operational, and the system curve for the Arbor Pump Station.

3.4.3 Outfall Hydraulic Analysis

The existing 54-inch outfall and pump discharge structure were analyzed to verify capacity to handle the design storm water flow at the current 10-year high tide and future high tide.

Based on record drawings, the top of the pump discharge structure is at an elevation of approximately 6.4 feet NGVD, which would allow water to rise to an approximate elevation of 5.4 feet inside the structure. At the current 10-year high tide elevation of 4.56 feet, the existing pump discharge structure and outfall have approximately 40,000 gpm hydraulic capacity which exceeds the existing pumping capacity (32,000 gpm), but is insufficient to handle flows from the design 10-year storm (88,420 gpm). The anticipated future high tide elevation of 6.06 feet is higher than the ceiling elevation of the discharge structure (5.2 feet) which would lead to flooding in any storm event. Figure 3-2 (in Appendix B) shows the existing 54-inch outfall system curves and the water elevations within the discharge structure.

3.4.4 Recommendation

New pumps are required to convey the design 10-year storm water volume of 88,420 gpm. The outfall must be increased in size to 72-inches to convey this flow at a velocity of 7.0 feet per second or less. Figure 3-3 (in Appendix B) shows the system curves for the proposed 72-inch outfall and the elevation that the new pump discharge structure must exceed to avoid flooding. A completely new pump station and upsized outfall (72-inches) is recommended for the following reasons:

- Pumping capacity is inadequate to convey the design 10-year storm inflow.
- The existing pump barrel (30-inch) must be increased to 48-inch for the size pump required to convey the design storm water volume. The size of the station can not accommodate barrels of this size without compromising the integrity of the pump deck (only 6-inches of concrete would remain between pump barrels in the current configuration).
- The hydraulics of the pump station are not ideal. Influent enters the wet well perpendicular to the pumps and is not evenly distributed to the pumps. This can cause vortexing and/or other issues, which affects the efficiency of pump operation.
- A new discharge structure is required to accommodate the larger outfall pipe.
- Because the anticipated future high tide is higher than the top of the existing pump discharge structure, the station is subject to flooding during any storm event at the future high tide elevation.
- Additional operations and maintenance deficiencies are listed in Chapter 5.

A preliminary pump selection determined that four 90 hp pumps will be required to handle the 10-year storm water inflow. Information on the proposed 90 hp Flygt submersible propeller pumps is included in Appendix E.

3.5 Central/Eastshore Pump Station

3.5.1 Pump Testing

Results of the pump testing conducted at the Central/Eastshore Pump Station are summarized below in Table 3-4. Pump testing data sheets are included in Appendix A.

Table 3-4 Central/Eastshore Pump Testing

Pump	Flow (gpm)	Total Dynamic Head (TDH) (feet)
Pump No. 1	3,400	10
	3,000	12
	2,488	15
Pump No. 2	3,600	10
	3,051	13
	2,500	15

3.5.2 Pump Hydraulic Analysis

A hydraulic analysis of the Central/Eastshore Pump Station determined that the existing pumps should have a combined capacity of approximately 8,000 gpm which is close to the design capacity contained in the Schaaf and Wheeler 2008 Storm Drain Master Plan, but significantly less than the design 10-year storm flow of 19,750 gpm. Figure 3-4 (Appendix B) shows pump and system curves for the Central/Eastshore Pump Station when both pumps are running, as well as required station capacity.

The results of the pump testing indicate that the actual pumping rate when both pumps are operational is approximately 5,000 gpm which is significantly less than the station's design capacity. The lower pumping rate could be caused by inefficiencies in the installed system (pump and barrel configuration not compatible), or the pumps are in need of repair.

3.5.3 Outfall Hydraulic Analysis

The existing 21-inch outfall and pump discharge structure were analyzed to verify capacity to handle the incoming flow from a 10-year storm event during the current 10-year high tide and future high tide.

Based on record drawings, the top of the pump discharge structure is at an elevation of 9.6 ft NGVD, which would allow water to rise to an elevation of approximately 8.5 ft inside the structure. At the current 10-year high tide elevation of 4.56 feet, the existing pump discharge structure and outfall have approximately 10,000 gpm hydraulic capacity which is insufficient to handle the flows from the design 10-year storm (19,750 gpm). The anticipated future high tide elevation of 6.06 feet further limits the hydraulic capacity to 8,000 gpm. Figure 3-5 (in Appendix B) shows the existing 21-inch outfall system curves and the water elevations within the discharge structure.

3.5.4 Recommendation

New pumps are required to convey the design 10-year storm water volume of 19,750 gpm. A new larger outfall is therefore required to convey the design storm water volume. The outfall must be increased in size to 36-inches to convey this flow at a velocity of 7.0 feet per second or less. Figure 3-6 (Appendix B) shows system curves for an upsized 36-inch diameter outfall. A completely new pump station and upsized outfall (36-inches) is recommended for the following reasons:

- Installing two new larger pumps would require major structural modifications including installing larger openings in the roof deck, pump deck (to accommodate larger pump cans), and pump station wall (to accommodate larger diameter pump discharges).
- Installing larger openings in the pump deck is not possible due to the close proximity of openings to the discharge structure and wet well below the floor slab. A complete slab removal and replacement would likely be required to accommodate the larger submersible pumps which would require removing the existing concrete stairs and manual bar rack as well.
- Installing two rather than three pumps provides less reliable capacity in the event of a single pump failure (50 % versus 66.7 % reliable capacity). A minimum of three pumps is recommended where possible for each station. The existing wet well is too small to install three pumps.
- The existing station's manual bar screen is labor intensive and requires entry into the drywell/wet well. City operations and maintenance staff have expressed a desire to install an automatic trash rack at this station. There is insufficient space between the existing station structure and Eastshore Drive to install an automatic trash rack without major modifications to the existing structure.
- Additional operations and maintenance deficiencies are listed in Chapter 5.

A preliminary pump selection determined that three 75 hp pumps will be required to handle the 10-year storm water volume. Information on the proposed 75 hp Flygt submersible propeller pumps is included in Appendix E.

3.6 Golf Course Pump Station

3.6.1 Pump Testing

Results of the pump testing conducted at the Golf Course Pump Station are summarized below in Table 3-5. Pump testing data sheets are included in Appendix A.

Table 3-5 Golf Course Pump Testing

Pump	Flow (gpm)	Total Dynamic Head (TDH) (feet)
Pump No. 1	5,223	12
Pump No. 2	5,564	12

3.6.2 Pump Hydraulic Analysis

Hydraulic analysis of the Golf Course Pump Station pumps and forcemain system determined that the existing pumps should have a combined pumping capacity of over 13,000 gpm and can easily handle the required 5,390 gpm inflow from a 10-year storm event. Results of the pump testing are slightly lower than the flow predicted by the hydraulic model, however each pump operating alone is very near the design 10-year storm flow, and both pumps operating together provide more than enough capacity to convey the design storm water flow. Figure 3-7 (Appendix B) shows pump and system curves for the Golf Course Pump Station.

3.6.3 Outfall Hydraulic Analysis

The 42-inch outfall and discharge manhole have more than enough capacity to handle flows from a 10-year storm event during the current 10-year high tide and the anticipated future high tide. Hydraulic analysis of the outfall system shows that there will be nearly 10 ft of freeboard available in the existing discharge manhole during future high tides and the 10-year storm event. Figure 3-8 (Appendix B) shows the outfall system curves and the water level elevations required within the discharge manhole.

3.6.4 Recommendation

No improvements are necessary for pumping and/or outfall capacity at the Golf Course Pump Station. Pumps and outfall capacity are sufficient for the design 10-year storm water flow at current 10-year and future high tides.

3.7 Harbor Bay System I Pump Station

3.7.1 Pump Testing

Testing conducted for the 60 hp pump at the Harbor Bay System I Pump Station measured a pump flow rate of 13,600 gpm at a total dynamic head of 4 feet. This exceeds the flow rate predicted by the hydraulic model. Pump testing data sheets are included in Appendix A.

3.7.2 Pump Hydraulic Analysis

Hydraulic analysis determined that the existing pump has capacity for approximately 12,500 gpm during the anticipated future high tide. The actual pump flow rate of 13,600 gpm at 4 feet is close to that predicted by the model. Since the station is only used to lower lagoon levels if outfall gates cannot be used, it is not a storm drain pump station and does not need to meet capacity for a 10-year storm event. According to City operators, the capacity of the existing station is sufficient to lower lagoon levels as required. Figure 3-9 (Appendix B) shows pump and system curves for the Harbor Bay System I Pump Station.

3.7.3 Recommendation

No improvements are necessary to the pump or forcemain at the Harbor Bay System I Pump Station.

3.8 Harbor Bay System II Pump Station

3.8.1 Pump Testing

Testing conducted for the 10 hp pump at the Harbor Bay System II Pump Station measured a pump flow rate of 740 gpm at a total dynamic head of 6 feet. This is approximately half of the flow rate predicted by the hydraulic model. It was also observed that the 16-inch discharge pipe was not flowing full during the test, and therefore has excess capacity for the pump. Pump testing data sheets are included in Appendix A.

3.8.2 Pump Hydraulic Analysis

Limited information on the existing pump was available. The record drawings indicate that the pump is a 10 Hp submersible axial flow propeller pump model M10 as manufactured by Prime Corporation (see Table 2-5). Based on pump curves provided by Prime for this pump model, the pump should be capable of pumping approximately 1,500 gpm. This is significantly higher than the 740 gpm flow measured during pump testing. The difference in measured versus calculated flows could be due to the possibility that the actual pump installed differs from that indicated on the record drawings, the pump and barrel configuration are not compatible resulting in lowered efficiency, or the pump is in need of repair.

Because the pump controls the lagoon level and is not a storm drain pump, it does not need to meet capacity for a 10-year storm event. Figure 3-10 (Appendix B) shows pump and system curves for the Harbor Bay System II Pump Station.

3.8.3 Recommendation

Operators have noted the pump at this station takes a long time to affect the lagoon levels. A new pump is required to increase the pumping rate and lower the lagoon levels when necessary. A preliminary pump selection determined that a 27 hp Flygt submersible propeller pump could be used to pump approximately 6,000 gpm from the lagoon. The existing 16-inch discharge piping is adequately sized for this flow rate. Information on the proposed pump is included in Appendix E.

3.9 Main Street Pump Station

3.9.1 Pump Testing

The Main Street Station pumps could not be safely tested because of limited access to discharge piping and confined space.

3.9.2 Pump Hydraulic Analysis

Hydraulic analysis determined that the existing pumps have capacity for over 15,750 gpm and can easily handle the required 2,560 gpm incoming flow from a 10-year storm event. Figure 3-11 (Appendix B) shows pump and system curves for Main Street Pump Station.

3.9.3 Outfall Hydraulic Analysis

Hydraulic analysis was performed to verify that the two 30-inch outfalls and existing pump discharge structure have adequate capacity to handle incoming flow from a 10-year storm event during the current 10-year high tide and during the anticipated future high tide.

During the 10-year storm event and future high tide, the water level in the discharge structure would rise to an elevation only slightly higher than high tide (6.1 feet) which is well below the maximum allowable water surface elevation in the pump discharge structure of 8.8 feet (based on record drawings). Figure 3-12 (Appendix B) shows system curves for the outfalls and the water elevations required within the discharge structure to convey the 10-year storm water flow at current 10-year and future high tide.

3.9.4 Recommendation

No improvements are necessary for pumping and/or outfall capacity at the Main Street Pump Station. Pumps and outfall capacity are sufficient for the design 10-year storm water flow at current 10-year and future high tides.

3.10 Northside Pump Station

3.10.1 Pump Testing

Results of the pump testing conducted at the Northside Pump Station are summarized below in Table 3-6. Pump testing data sheets are included in Appendix A.

Table 3-6 Northside Pump Testing

Pump	Flow (gpm)	Total Dynamic Head (TDH) (feet)
Pump No. 1	19,433	6
	18,431	8
	18,825	9
Pump No. 2	18,571	6
	16,400	7
	16,200	8
Pump No. 3	18,978	7
	17,764	8
	16,578	9

3.10.2 Pump Hydraulic Analysis

Hydraulic analysis determined that the combined pumping capacity of the Northside pump station should be approximately 59,000 gpm which is less than the design station capacity of 72,000 gpm, and slightly less than the design60,000 gpm storm water flow into the station (following improvements to the storm water collection system per Schaaf & Wheeler's master plan report. Figure 3-13 (Appendix B) shows the pump and system curves when all three pumps are running, as well as the required station capacity at the Northside Pump Station. Pump testing results indicate the actual capacity of the pumps is insufficient to meet the design capacity of 60,000 gpm per Schaaf & Wheeler's storm drain master plan.

3.10.3 Outfall Hydraulic Analysis

A hydraulic analysis of the existing 72-inch outfall and pump discharge structure and verified that the existing outfall has sufficient capacity to handle flows from a 10-year storm event during current 10-year high tide and the anticipated future high tide. Figure 3-14 (Appendix B) shows the outfall system curves and the water elevations required within the pump discharge structure.

3.10.4 Recommendation

New pumps are required to bring the station capacity up to 60,000 gpm to meet the design 10-year storm water flow. No improvements are needed to the outfall or discharge structure. Preliminary pump selection provided by Schaaf and Wheeler for 75 hp Cascade pumps (Curve No. AP3612) is included in Appendix E.

3.11 Third Street Pump Station

3.11.1 Pump Testing

Results of the pump testing conducted at the Third Street Pump Station are summarized below in Table 3-7. Pump testing data sheets are included in Appendix A.

Table 3-7 Third Street Pump Testing

Flow (gpm)	Total Dynamic Head (TDH) (feet)
1,876	2
1,600	5
1,430	8

3.11.2 Pump Hydraulic Analysis

Hydraulic analysis of the station determined that the existing pump has capacity for 1,800 gpm to 2,000 gpm depending upon operating levels in the wet well. This capacity is slightly below the 2,065 gpm incoming flow from a 10-year storm event. Figure 3-15 (Appendix B) shows pump and system curves for the Third Street Pump Station. Pump testing results indicate the actual capacity of the pump is slightly less than the design capacity shown in Table 2-8 (1,650 gpm each at 8 feet TDH).

3.11.3 Recommendation

Both the pump testing and the hydraulic analysis determined that the existing pump capacity is very near the inflow from the 10-year storm event, though slightly insufficient. Because the pump nearly meets the capacity requirements, which are relatively low at this station, the replacement of the existing pump is currently a low priority.

3.12 Webster Street Pump Station

3.12.1 Pump Testing

Results of the pump testing conducted at the Webster Street Pump Station are summarized below in Table 3-8. Pump 1 was under repair at was not at the station at the time of testing. Pump testing data sheets are included in Appendix A.

Table 3-8 Webster Pump Testing

Pump	Flow (gpm)	Total Dynamic Head (TDH) (feet)
Pump No. 2	1,900	6
	1,874	8
	1,800	10
Pump No. 3	1,900	6
	1,779	8
	1,670	10

3.12.2 Pump Hydraulic Analysis

Hydraulic analysis of the station determined that the existing pumps have capacity to pump approximately 5,000 gpm at the current 10-year high tide level which exceeds the required 10-year storm water flow of 2,700 gpm. At the future high tide, the operating levels for the pumps may need to be adjusted to keep the pumps operating within the allowable range on the pump curve. Figure 3-16 (Appendix B) shows pump and system curves for the Webster Street Pump Station. Pump testing results indicate the actual combined pumping for the pump station should be close to the design capacity shown in Table 2-9 (5,250 gpm each at 10 feet TDH), assuming the pump under repair will pump the average of the two tested pumps following its repair (1730 gpm at 10 ft TDH).

3.12.3 Recommendation

Although the pumps and forcemain capacity are sufficient for the design 10-year storm water flow at current 10-year and future high tides, a completely new pump station is recommended due to operations and maintenance and safety deficiencies at the station (see Chapter 5).

The existing pumps could be reused with the new station. The new station should be designed to improve hydraulics. Currently, influent enters the wet well perpendicular to the pumps and is not evenly distributed to the pumps. Also, submersible propeller pumps are typically are not designed to combine flow into a common forcemain. The station in its current configuration may be causing vortexing that could reduce pump efficiency. The new station should be designed for hydraulics that better suit submersible propeller pumps.

4.0 Evaluation Criteria

Pump station evaluation criteria was developed by Psomas, Fard Engineers, The Crosby Group, and the City's operations and maintenance staff to address needed station improvements. Each pump station was evaluated in the following areas:

- Reliability and Redundancy
- Electrical and Instrumentation
- Operations and Maintenance
- Structural
- Site Security

4.1 Reliability and Redundancy

Designing the storm drain pump stations with enhanced reliability and pumping redundancy minimizes the probability of flooding resulting from equipment failure. Equipment reliability is required to reduce unscheduled maintenance. The following outlines design features that increase station reliability:

- Newly constructed storm drain pump stations should be provided with a minimum of three pumps, if possible, to minimize capacity lost from pump failure. Unlike sewer pump stations, storm water pump stations are not normally designed with redundant (or standby) pumping systems. Therefore, the more pumps provided to meet the design capacity, the less the impact on the station's overall capacity should any single pump fail to operate or happen to be off-line for maintenance.
- Sump pumps in dry wells (Only for dry well/wet well pump stations).
- Monitoring, SCADA, and alarms for equipment failures and out of range process conditions.
- Uninterruptible power supply for instrumentation, controls, and telemetry.
- Spare parts.
- Redundant critical auxiliary equipment (equipment essential to the operation of the pump station).
- Proven equipment from respected manufacturers.
- Standby power provided (either a permanent standby generator and/or a generator receptacle at the site). Permanently installed generators to be provided with weatherproof enclosure, a subbase diesel fuel tank sized for a minimum of 24 hours under full load, and an automatic transfer switch (ATS). An automatic transfer switch is an electrical switch that automatically reconnects electric power source from its primary source to a standby source. If the utility source fails, the ATS safely switches to the generator as a temporary source of electric power. The ATS will also command the backup generator to start.

4.2 Electrical and Instrumentation

Each pump station's electrical infrastructure and instrumentation systems were evaluated to determine if they meet the following criteria:

- Electrical design and installation based on the latest version of the National Electrical Code (NEC).
- Site provided with adequate lighting.
- Enclosures, components, anchors, and other hardware constructed of corrosion resistant material (Type 316 stainless steel) and/or provided with corrosion resistant coatings.
- Electrical service equipment housed in NEMA rated Type 316 stainless steel enclosures and/or provided with corrosion resistant coatings.
- Pump motors designed to match electrical service available to the pump station.
- Circuit breakers provided with lock-out mechanisms. Local equipment disconnects provided where needed.
- Motors provided with thermal sensors and where submersible also provided with moisture detection systems.
- Where corrosive or wet conditions prevail, conduit, fittings and boxes constructed of PVC coated rigid steel. Where possible, avoid installing junction boxes (or any type of connection or termination points) within wet wells or below high water levels.
  Pump stations provided with PLC control with remote status and alarm indication.
- Pump stations provided with high level alarms for remote indication, and low level cut-off to prevent pumps from running dry or at levels that may cause the pumps to cavitate.
- Pump level sensing accomplished by bubbler level monitoring systems.

4.3 Operations and Maintenance

Each pump station was evaluated from an operations and maintenance perspective (i.e., a user friendly pump station that can be safely, easily, and effectively operated and maintained). The following items were considered:

- Equipment access and clearances; ease of pump removal
- Lightweight and easy to open access hatches; ladders provided with ladder-up assistance.
- Site access (fuel trucks, cranes, parking, etc.).
- Automatic trash racks.
- Wash down facilities provided.
- Spare parts.
- Safety (tripping hazards).
- Ventilation; confined space entry.
- Handrails provided where needed (fall protection).
- Proper signage.
- Ladders meet OSHA requirements.
- Fire extinguishers provided.

4.4 Structural

Each pump station structural components were inspected with recommended improvements based on visual observation of areas where concrete has spalled, cracked, or where obvious signs of corrosion were observed.

4.5 Site Security

Each site was reviewed with respect to site security. Fencing and intrusion alarms were reviewed for each pump station including:

- Site fencing provided with barbed wire, slats, and pad lockable gates.
- Intrusion alarms provided on all access hatches and control panels.

5.0 Pump Station Evaluations & Recommendations

Each pump station was reviewed by Psomas, Fard Engineers, and The Crosby Group based on the evaluation criteria outlined in Chapter Four. Psomas and sub consultants visited each site and met with the City's operations & maintenance staff to discuss their concerns and inadequacies at each station. Results of the site evaluations and recommendations are presented herein.

5.1 Arbor Pump Station

A summary of the Arbor Pump Station evaluation and recommended improvements is presented in Table 5-1.

Table 5-1
Arbor Pump Station Evaluation & Recommendations

Evaluation Criteria	Evaluation Summary	Recommended Improvement
Pumping Systems and Capacity	The existing pump capacity is insufficient to handle the flow from a 10-year storm.	Provide new pump station (see Chapter 3).
	The existing 54-inch outfall does not have capacity to handle the flow from a 10-year storm at the current 10-year high tide or anticipated future high tide.	Provide new 72-inch outfall pipe (see Chapter 3).
Reliability and Redundancy	The station does not have standby power capabilities.	Provide new standby power generator. A 400 kilowatt (KW) generator was assumed for estimating purposes.
	The 30-inch pump barrel for pump 1 was recently replaced. Barrels for the other three pumps are corroded and in poor condition.	New pump barrels provided with new pump station. Inspect and salvage 30-inch barrel for future City projects.
SCADA System	SCADA system is in overall good condition.	Perform regular upgrades to the Wonderware system and radio communication upgrades to digital per Section 5.10.1.
Electrical and Instrumentation	An electrical junction box located between pump 3 and 4 makes access for maintenance purposes difficult. The box must be relocated in order to remove pump barrels.	Provide better access in design for new pump station.
	The existing pump controllers are old and it is hard to find spare parts.	Provide new pump "Vision" or pump commander controls with new pump station. Include electronic pressure transducers/ level transmitters to replace existing bubbler type level sensors.
	The main switchboard has inadequate clearance in front of it per NEC (< 42 inches).	Design new pump station's electrical switchgear to have the required minimum clearances per NEC.

Evaluation Criteria	Evaluation Summary	Recommended Improvement
	There are no exterior light fixtures or site lighting.	Design new station with exterior lighting.
	Existing 400 amp electrical service is insufficient for the proposed new pumps.	Provide new electrical service for new pumps and equipment. A 600 amp 480 volt service was assumed for estimating purposes.
Operations and Maintenance	Access to piping and pump barrels within the wet well is difficult and considered a confined space. One of the two hatches is difficult to open, and only one ladder is provided to enter the wet well.	Design new pump station to eliminate the need for confined space entry to access pumps and associated piping/instrumentation.
	The galvanized steel access hatch above the trash rack is heavy and requires two operators to lift. The grating located over the pumps is constructed of steel and is also heavy and difficult to remove.	Design new pump station with aluminum hatches with lift assist that can be easily opened.
	There is currently a manual trash rack that requires confined space entry. The rack is very labor intensive to clean.	Design new pump station with an automatic trash rack that dumps trash into dumpsters located above grade.
	The pump station does not have wash down facilities.	Design new pump station with backflow preventer and hose bib for station wash down.
	Ladders into the pump discharge box and the wet well do not have ladder up assistance.	Design new pump station with ladder up assistance provided on all ladders.
	There is currently no ventilation within the wet well or at the trash rack. The existing fan is not functional.	Design new pump station to eliminate confined space entry and/or with adequate ventilation to eliminate confined space hazards.
	Missing a fire extinguisher.	Provide fire extinguisher in design for new pump station.
Structural	There is an existing concrete pad that is cracked at two locations, and is not wide enough.	Provide new pump station.
Site Security	Access to the station is shared with the Alameda Yacht Club through a gate in the 6-foot tall wooden fence. The gate on this fence is often left open and allows access to the station's control panel and the Alameda Yacht Club storage area.	Design new pump station to have controls located integrally within the pump station site. Provide a PVC lined chain link fence with slats and barbed wire on all sides of the pump station.
	There are no alarms on hatches at the station.	Design new station to have intrusion alarms provided on all access points to the station.

5.2 Central/Eastshore Pump Station

A summary of the Central/Eastshore Pump Station evaluation and recommended improvements is presented in Table 5-2.

Table 5-2 Central/Eastshore Pump Station Evaluation & Recommendations

Evaluation Criteria	Evaluation Summary	Recommended Improvement
Pumping Systems and Capacity	The existing pump capacity is insufficient to handle the flow from a 10-year storm.	Provide new pump station (see Chapter 3).
	The existing 21-inch outfall does not have capacity to handle the flow from a 10-year storm at the current 10-year high tide or the anticipated future high tide.	Provide new 36-inch outfall pipe (see Chapter 3).
Reliability and Redundancy	The station does not have standby power capabilities.	Provide new standby power generator, capable of powering new pumps. A 250 kilowatt (KW) generator was assumed for estimating purposes.
SCADA System	SCADA system is in overall good condition.	Perform regular upgrades to the Wonderware system and radio communication upgrades to digital per Section 5.10.1.
Electrical and Instrumentation	New electrical and instrumentation will be required for new pump station.	Provide new electrical and instrumentation as required for new pump station. Provide new pump "Vision" or pump commander controls with new pump station. Include electronic pressure transducers/ level transmitters to replace existing bubbler type level sensors.
	Existing 200 amp electrical service is insufficient for the proposed new pumps and equipment.	Provide new electrical service for new pumps and equipment. An 800 amp 3 phase service was assumed for estimating purposes.
Operations and Maintenance	The galvanized steel access hatches above the pumps and discharge box are heavy and difficult to open.	Design new pump station with aluminum hatches with lift assist that can be easily opened.
	The trash rack must be manually cleaned.	Design new pump station with an automatic trash rack.
	The pump station does not have wash down facilities.	Design new pump station with wash down facilities.
	There is currently no ventilation within the wet well. Ventilation is provided by an open grate near the dry well access hatch and from the entry hatch into the wet well.	Design new pump station to eliminate entry into the wet well (for access to trash rack) and/or with adequate ventilation to eliminate confined space hazards.

Evaluation Criteria	Evaluation Summary	Recommended Improvement
Structural	Handrail anchorage at the base of the stairs is causing the concrete to spall.	New pump station will correct this deficiency.
Site Security	There is currently no fencing around the site.	Provide a PVC coated chain link fence with slats, barbed wire, and pad lockable gates.
	Station lacks intrusion alarms.	Design new station to have intrusion alarms provided on all access points to the station.

5.3 Golf Course Pump Station

A summary of the Golf Course Pump Station evaluation and recommended improvements is presented in Table 5-3.

Table 5-3 Golf Course Pump Station Evaluation & Recommendations

Evaluation Criteria	Evaluation Summary	Recommended Improvement
Pumping Systems and Capacity	No deficiencies.	None.
Reliability and Redundancy	Missing standby power capabilities.	Provide new standby power generator. A 125 kilowatt (KW) generator was assumed for estimating purposes.
SCADA System	SCADA system is in overall good condition.	Perform regular upgrades to the Wonderware system and radio communication upgrades to digital per Section 5.10.1.
Electrical and Instrumentation	Exposed wiring around pumps poses a safety hazard.	Reinstall wiring in rigid PVC coated steel conduit.
	Missing exterior site lighting.	Provide exterior pole lighting with either photocell and time clock control or manual controls from electrical panel.
	Metal cover over level sensor is severely corroded.	Replace cover with type 316 stainless steel cover.
Operations and Maintenance	Missing wash down facilities.	Install wash down facilities.
	Missing a driveway to access the station. Access currently requires staff to cross approximately 50 feet of grass which can not be driven on in the winter due to muddy conditions. Crane access to station for removing and/or installing pumps is hampered by the lack of a driveway.	Provide a paved driveway to access the station. Concrete encase the existing shallow water line as required to prevent damage from traffic from the new paved section.
	Existing exposed piping coating is chalked and cracking and piping is showing signs of corrosion. The 18-inch check valve on Pump No. 2's discharge piping is leaking.	Re-coat piping. Replace or repair check valve as required to eliminate leakage.
	The station floor is often slippery because of moss. This may be partly caused by the constant presence of moisture due to the leaking check valve.	Provide an anti-slip layer of grout or concrete coating. Fix the leaking check valve as noted above.
	Missing a fire extinguisher.	Install a fire extinguisher.
Structural	No deficiencies noted.	None.
Site Security	Missing fence around control panel.	Provide chain link fence with slats around the control panel.

5.4 Harbor Bay System I Pump Station

A summary of the Harbor Bay System I Pump Station evaluation and recommended improvements is presented in Table 5-4.

Table 5-4 Harbor Bay System I Pump Station Evaluation & Recommendations

Evaluation Criteria	Evaluation Summary	Recommended Improvement
Pumping Systems and Capacity	No deficiencies.	None.
Reliability and Redundancy	A generator receptacle for a portable generator to power the outfall gates and the pump station was recently installed at this site.	None.
	Pump was recently reconditioned.	None.
	The pump at this station is only used to lower the lagoon level under high tide conditions. Normally level is controlled by opening and closing the outfall gates.	None. Because the pump station is a backup to the outfall gate system, a redundant pump is not needed. The City could use a portable pump in the event the station's pump failed and the lagoon level needed to be lowered.
SCADA System	SCADA system is in overall good condition.	Perform regular upgrades to the Wonderware system and radio communication upgrades to digital per Section 5.10.1.
Electrical and Instrumentation	Missing exterior site lighting.	Since telemetry was recently added, Operators control the station from the corporate yard and are rarely at the site after dark. Site lighting is not a high priority improvement.
	Telemetry was recently added to allow pump control from the City's corporation yard.	None.
Operations and Maintenance	Missing wash down facilities.	Install wash down facilities.
	Missing a fire extinguisher.	Install a fire extinguisher.
Structural	The outfall gate structure has minor deterioration in the structural system including minor cracks developing at the cantilever section of the slab.	Inject cracks with epoxy to prevent water intrusion.
	The concrete has spalled off at the corner of the slab at the fence post connection.	Patch corner as required with concrete and re-attach fence post.
Site Security	Missing intrusion alarms at the station.	An intrusion alarm should be added to the pump control panel.

5.5 Harbor Bay System II Pump Station

A summary of the Harbor Bay System II Pump Station evaluation and recommended improvements is presented in Table 5-5.

Table 5-5 Harbor Bay System II Pump Station Evaluation & Recommendations

Evaluation Criteria	Evaluation Summary	Recommended Improvement
Pumping Systems and Capacity	Although the pump is used as a backup to the outfall gates, the pump station capacity is inadequate and can take several hours to noticeably lower the lagoon level when use of the pump is required.	This pump station is not a storm water station and does not need to be upgraded to handle storm water. However, the City should upgrade to improve the dewatering time on the lagoon.
Reliability and Redundancy	Missing standby power capabilities.	Provide new standby power generator. A 35 kilowatt (KW) generator capable of powering the proposed pump was assumed for estimating purposes.
	The pump at this station is only used to lower the lagoon level under high tide conditions. Normally level is controlled by opening and closing the outfall gates.	None. Because the pump station is a backup to the outfall gate system, a redundant pump is not needed. The City could use a portable pump in the event the station's pump failed and the lagoon level needed to be lowered.
SCADA System	SCADA system is in overall good condition.	Perform regular upgrades to the Wonderware system and radio communication upgrades to digital per Section 5.10.1.
Electrical and Instrumentation	Missing exterior site lighting.	Provide exterior pole lighting with either photocell and time clock control or manual controls from electrical panel.
Operations and Maintenance	Missing wash down facilities.	Install wash down facilities.
	The steel access hatch over the discharge vault is heavy and difficult to open.	Operators rarely need to access the discharge manhole, however an aluminum hatch with lift assist could be added to improve accessibility.
	The removable reinforced steel plates on the pump check valve vault are heavy and very difficult to remove. Also, the rectangular plates could fall into the vault and damage the piping or vault in the event of an operator error while removing/placing the plates.	Operators rarely are required to access the valve vault, but the steel plates could be replaced with an aluminum hatch with lift assist to improve accessibility. This would eliminate the possibility of dropping the plates into the vault.
Structural	There is rust developing on the pump barrel base plate.	Recoat barrel base plate.
Site Security	Missing intrusion alarms at the station.	An intrusion alarm should be added to the pump control panel.

5.6 Main Street Pump Station

A summary of the Main Street Pump Station evaluation and recommended improvements is presented in Table 5-6.

Table 5-6 Main Street Pump Station Evaluation & Recommendations

Evaluation Criteria	Evaluation Summary	Recommended Improvement
Pumping Systems and Capacity	No deficiencies.	None.
Reliability and Redundancy	Missing standby power capabilities.	Provide new standby power generator. An 80 kilowatt (KW) generator was assumed for estimating purposes.
SCADA System	SCADA system is in overall good condition.	Perform regular upgrades to the Wonderware system and radio communication upgrades to digital per Section 5.10.1.
Electrical and Instrumentation	Clearance from the pump control panel to the pump discharge box wall is approximately 39 inches. A minimum of 42-inches is required per NEC.	Due to the cost that would be required to move the control panel a few inches, this is a low priority improvement.
	Pump controls are by Tesco. Controller is the only one of it's kind in the City, and staff are not sure how to operate it. Existing bubbler level controls are outdated and in need of replacement.	Provide new pump "Vision" or pump commander controls to be consistent with other stations in the City. Include electronic pressure transducers/ level transmitters to replace existing bubbler type level sensors.
Operations and Maintenance	Missing wash down facilities.	Install wash down facilities.
	Plates over pumps are large and heavy and must be removed with a crane.	Replace with aluminum hatches with lift assist. This is a low priority improvement as the plates are infrequently removed and only for pump removal/replacement.
	Missing steps and/or ladder access to the top of the pump structure. The top of the pump structure is approximately 42-inches above grade in areas.	Provide ladder or steps for access to the top of the structure.
	Hand railing around the automatic trash rack blocks access between the pump side and the trash rack side of the structure. Operators must climb down and then climb back up to go from one side to the other.	Provide ladder or steps to improve access around the trash rack.

Evaluation Criteria	Evaluation Summary	Recommended Improvement
	The top of the station structure is approximately 42-inches above grade and lacks fall protection.	Provide aluminum handrail around top of structure.
	There are currently two vent pipes with "U" bends on top of the station to ventilate the wet well, but there are no ventilation fans.	Operators are rarely required to enter the wet well at this station, but a fan should be added to ventilate the wet well when access is required.
	Missing a fire extinguisher.	Install a fire extinguisher.
Structural	Control panel anchors appear to be missing.	Provide anchors as required per seismic design calculations.
Site Security	No deficiencies.	None.

5.7 Northside Pump Station

A summary of the Northside Pump Station evaluation and recommended improvements is presented in Table 5-7.

Table 5-7 Northside Pump Station Evaluation & Recommendations

Evaluation Criteria	Evaluation Summary	Recommended Improvement
Pumping Systems and Capacity	The existing pumps are undersized to handle incoming flow from a 10-year storm event during the anticipated future high tide.	Replace pumps with new pumps with adequate capacity to handle incoming flow from a 10-year storm (see Chapter 3).
Reliability and Redundancy	Missing standby power capabilities.	The City is in the process of adding a 230 kW standby power generator as part of the Northside Pump Station Upgrades Project No. PW 02-10-06.
SCADA System	SCADA system is in overall good condition.	Perform regular upgrades to the Wonderware system and radio communication upgrades to digital per Section 5.10.1.
Electrical and Instrumentation	This pump station is currently being renovated for new electrical service and standby generator.	New electrical equipment, conduits, and lighting are provided as part of the Northside Pump Station Upgrades Project No. PW 02-10-06.
Operations and Maintenance	The control room access hatch is difficult to close. If closed improperly, the intrusion alarm will remain on.	Addressed in the Northside Pump Station Upgrades Project No. PW 02-10-06.
	The top deck of the pump station is approximately 62 inches above grade and is missing handrail. Handrail is required per OSHA for surfaces 42-inches or higher above surrounding grade and where Operator access is required.	Addressed in the Northside Pump Station Upgrades Project No. PW 02-10-06..
	Lifting rings on checker plates at the top of the structure protrude above the surface of the plate and pose a tripping hazard.	Checker plate with lifting rings over electrical room removed as part of the Northside Pump Station Upgrades Project No. PW 02-10-06. Remaining checker plate over pumps should be replaced with new plate that has handles or rings that are flush with the surface to remove tripping hazard.
	Existing ventilation fan is not working.	Addressed in the Northside Pump Station Upgrades Project No. PW 02-10-06.
	There is a hose bib, but no rack or hose.	Install hose rack and hose.

Evaluation Criteria	Evaluation Summary	Recommended Improvement
Structural	The existing grating is corroded, and has a hole in it that has been covered up with a sheet of plywood.	Addressed in the Northside Pump Station Upgrades Project No. PW 02-10-06.
	The edge of the concrete deck is spalling at the back end of the pump station (above the steel grate).	Repair spalled concrete surfaces to prevent further deterioration of the structure. Should be included as part of the Northside Pump Station Upgrades Project No. PW 02-10-06 during installation of new FRP grating.
	The handrail and handrail baseplates are corroded, and there are several locations where the concrete has spalled at handrail anchorage locations.	Recoat handrail and baseplates, and repair spalled concrete surfaces to prevent further deterioration of the structure. Should be included as part of the Northside Pump Station Upgrades Project No. PW 02-10-06 during installation of new handrailing.
	There are several locations on the structure that exhibit rust staining that may be a result the steel reinforcement rusting within the concrete wall.	Repair cracks and seal at locations where rust staining is occurring.
Site Security	The existing fence is beginning to corrode and will need to be replaced in the near future.	Addressed in the Northside Pump Station Upgrades Project No. PW 02-10-06.
	An intrusion alarm is provided on the control room hatch, but not on pump entrance hatch or gates.	Addressed in the Northside Pump Station Upgrades Project No. PW 02-10-06.

5.8 Third Street Pump Station

A summary of the Third Street Pump Station evaluation and recommended improvements is presented in Table 5-8.

Table 5-8 Third Street Pump Station Evaluation and Recommendations

Evaluation Criteria	Evaluation Summary	Recommended Improvement
Pumping Systems and Capacity	The existing pump capacity is very near the inflow from the 10-year storm event, though slightly insufficient.	Because the pump nearly meets the capacity requirements, which are relatively low at this station, replacement of the existing pump is currently a low priority.
Reliability and Redundancy	Missing standby power capabilities.	Provide new standby power generator. A 10 kilowatt (KW) generator was assumed for estimating purposes. A Tier 4 rating is required due to the close proximity to the Wood Stock Education Center.
	No redundant pumping system. The existing manhole is not large enough to accommodate a second pump. In the event of pump failure, flooding may occur in the area. The station is located near the City's existing storm drain collection system which may limit the extent of the flooding in the event the station's pump failed.	The City could replace the existing station with a larger station capable of accommodating redundant pumping systems. However, with the low capacity requirements, a more economical option may be to have a portable pump that could handle capacity requirements in the event that the station's pump fails.
SCADA System	SCADA system is in overall good condition.	Perform regular upgrades to the Wonderware system and radio communication upgrades to digital per Section 5.10.1.
Electrical and Instrumentation	Clearance around main service meter meets code but is very tight.	None.
	The pump control panel contains control relays are old and fail often. The City has recently replaced the pump controls with the "Vision" or pump commander controls and has replaced the bubbler level controls with new electronic pressure transducers/ level transmitters.	None.
	The pump cables are exposed and are not installed in conduit or MC cable for proper protection.	Reinstall pump cables in conduit per NEC requirements.
Operations and Maintenance	There is no trash rack at the station. Floating debris must be manually removed from this station.	Due to the relatively small flows present at this station, the cost to install a new manual or automatic trash rack upstream of the station over periodic manual cleaning may not be economically justifiable.

Evaluation Criteria	Evaluation Summary	Recommended Improvement
	The piping within the wet well is corroded.	Remove and recoat piping. Replace if necessary.
	The existing flap gate at the discharge into the manhole is stuck in the open position.	Replace flap gate on pump discharge.
	The hatch for access to the ladder is only 18 inches deep and does not meet OSHA clearance requirements for ladder access. There is also no ladder up assistance on the ladder.	Install a larger access hatch that provides 24 inches clearance behind ladder rungs to meet OSHA requirements. Hatch should include a ladder up safety post.
	Removal of the pump barrel requires confined space entry into the wet well. There is insufficient room inside the fenced area at the station for a portable tripod to lower someone into the wet well. This presents an additional safety hazard for confined space entry.	Install a stainless steel sleeve for mounting a portable davit arm next to the wet well access hatch. A permanent davit arm could also be installed but is not recommended as it would further limit space within the fenced area.
	Missing a fire extinguisher.	Install a fire extinguisher.
Structural	The electrical control panel appears to be inadequately supported to the concrete base.	Provide new connection for the electrical box to the concrete base.
Site Security	The existing fence located above the station is in poor condition and needs to be replaced.	Provide new PVC coated chain link fence with barbed wire and slats.

5.9 Webster Street Pump Station

A summary of the Webster Street Pump Station evaluation and recommended improvements is presented in Table 5-9.

Table 5-9 Webster Street Pump Station Evaluation & Recommendations

Evaluation Criteria	Evaluation Summary	Recommended Improvement
Pumping Systems and Capacity	Although the pumps meet capacity requirements, the hydraulics of the pump station are not ideal for submersible propeller pumps.	A completely new pump station is recommended due to operations and maintenance and safety deficiencies at the station. Provide new pump station and reuse existing pumps. New station should be designed for hydraulics that better suit submersible propeller pumps (see Chapter 3).
Reliability and Redundancy	Missing standby power capabilities.	Provide new standby power generator. A 25 kilowatt (KW) generator was assumed for estimating purposes.
SCADA System	SCADA system is in overall good condition.	Perform regular upgrades to the Wonderware system and radio communication upgrades to digital per Section 5.10.1.
Electrical and Instrumentation	Missing exterior site lighting. Pump station bubbler controls and pump controller are aging and in need of replacement.	Design new station with exterior lighting. Provide new pump "Vision" or pump commander controls with new pump station. Include electronic pressure transducers/ level transmitters to replace existing bubbler type level sensors.
Operations and Maintenance	The existing piping in the dry well is showing signs of corrosion.	New piping provided with new station.
	The existing fan located inside the dry well is no longer operational.	Design new pump station to eliminate entry into the wet well.
	The hatch for entry into the dry well is awkwardly positioned in the corner of the station structure. It is a double leaf hatch that opens to the sides of the ladder, making it difficult to access the ladder into the dry well. The hatch does not meet OSHA requirements for clearance behind a ladder, which must be at least 24 inches from the center of the ladder rungs.	Design new pump station without a dry well and eliminate the need for entry into the wet well.

Evaluation Criteria	Evaluation Summary	Recommended Improvement
	The ladder that provides access to the top of the structure from the sidewalk is located directly in front of the dry well access hatch. The hatch position makes access to the top of the structure dangerous when the hatch is open.	Design new pump station so that structure is only approximately 12 inches above grade, eliminating the need for a ladder.
	The ladder for access into the dry well is located directly above the opening to the wet well below. The opening is currently not covered with grating or treadplate presenting a safety hazard for staff entering the pump station.	Design new pump station without a dry well and eliminate the need for entry into the wet well.
	The clearance behind the center of the ladder rungs to the opening in the wet well below is less than the required 24 inches per OSHA.	Design new pump station without a dry well and eliminate the need for entry into the wet well.
	Missing a fire extinguisher.	Provide a fire extinguisher with new station.
Structural	Exposed rebar at the manhole entrance is showing signs of rust at a few locations.	New pump station will correct this deficiency.
	The existing ships ladder appears to be rusted.	New pump station will correct this deficiency.
Site Security	There is currently no fencing around the site.	Provide a PVC coated chain link fence with slats, barbed wire, and pad lockable gates. Design new station to have intrusion alarms provided on all access points to the station.

5.10 SCADA System

5.10.1 Existing SCADA System

The SCADA system which monitors the City's storm water pump stations is made up of four components.

1. The control center: The control center is a SCADA software product called Wonderware, which is running on a windows based personal computer. Wonderware sends and receives data from the pump station controllers. It then displays this information to the operation's personnel on a graphical interface.
2. The communication method: The control center SCADA computer communicates with the pump stations using a licensed 900MHz Microwave Data System (MDS) analog radio system. The radios are currently being replaced with dual mode (analog/digital) radios. All radios will continued to be run in analog mode until they are all replaced, at which time all the radios will be converted to digital mode.
3. The pump station controller: There are currently two controllers at each pump station. A Motorola Moscad which handles the communication with the radio, and a controller to monitor/control the pumps and associated instrumentation. The connection between these two controllers is through their inputs and outputs (I/O). Any piece of information, for example pump run confirm, requires a separate I/O pair (output of one controller feeds the input of the other) to be wired together in order to communicate that information between the controllers, and then back to the control center. The City is in the process of upgrading the controllers (the Non-Moscad controller) with the "Pump Vision" controller. It is a Unitronics V350 Controller which is prepackaged as a "ready to go" pump station controller supplied by California Motor Control (CMC). It comes with standard pump control software and operator interface screens.
4. Instrumentation: The primary data monitored at the pump station is the wet well level. The pump station controller operates the pumps based on this level. The City is replacing the "bubbler type" level sensors with "electronic pressure transducers/ level transmitters" level sensors. The bubbler systems are outdated and have significant parts that could fail, making their reliability less than desirable.

5.10.2 Assessment

The City's SCADA system is in overall good condition. The physical condition of the control equipment is good; such as the pump station controllers, control enclosures and instrumentation. The antennas are mounted well and are also in good condition.

The City is in the process of standardizing their pump station controllers and level transmitters which will help Operators become familiar with the station controls and make system operation more reliable.

The most important observation is the use of two controllers at each storm water pump station which minimizes flexibility and adds costs to the operation of the stations. The City is not using the features of the Moscad Controller. All the pump logic and operator interaction is done with the "Pump Vision" Controller. Having the controllers in this configuration prevents the control center SCADA computer from accessing or changing all the control information that is in the "Pump Vision" controller, without installing more wired connections. Information such as:

- Viewing and changing the pump start/stop level set points.
- Changing the pump status (ON/OFF/AUTO).
- Viewing all the alarms monitored or derived by the controller.

5.10.2.1 Recommended Improvements:

The recommended improvements for the City of Alameda's SCADA system are outlined below.

- The City's existing Wonderware system meets the City's needs as long as the software and hardware are upgraded at intervals to remain supported by the vendor.
- The City's radio replacements should be completed and converted to digital. The City should prepare to split the frequency now before it's required by the FCC (in a year or two). Having two frequencies will improve the SCADA system performance. Once the split is made, the City should use both frequencies in their system so as not to lose one since frequencies in the 952/928 MHz range for data communication are extremely difficult to obtain.
- The City's level sensor replacements should be completed and the remnants of the bubbler systems should be removed.
- The City's upgrade to the "Pump Vision" controllers should be completed, to eliminate the very outdated pump station controllers which are at the end of their useful life.
- The City should prepare a SCADA System Strategic Plan. The City has varied needs for all the sites the SCADA system monitors. The best way to address these needs is to have a strategic plan so when changes are made they move toward an efficient, integrated system. The Strategic Plan should address the issues of:
  - Future FCC requirements
  - Future operational needs
  - The added complexities to monitoring and control caused by having two controllers at each station.

6.0 Capital Improvements Program (CIP)

The overall goal of the storm drain pump station assessment was to develop a plan for the City to fund necessary improvements to the City's storm drain pump stations. This chapter presents the improvements that are recommended for incorporation in the City's Capital Improvements Program (CIP). A prioritization guidelines and summaries of proposed CIP projects are presented herein.

6.1 CIP Prioritization Guidelines

Prioritizing projects allows the City to determine which projects should be funded within the CIP planning time-frame, as well as the order in which projects should be pursued within that time frame. The prioritization was focused on identifying projects that should be funded in the short-term (high priority), those that should be implemented to improve pump station reliability, capacity, or safety (necessary projects), and those that should be implemented as funding becomes available (discretionary projects).

The projects are prioritized into three main categories (in order of high priority to low priority):

- Level 1 - High Priority – defined as projects which are necessary to prevent a significant risk of flooding from heavy storm water runoff events.
- Level 2 - Necessary Projects – defined as projects that must be done to improve pump station capacity and/or reliability or safety.
- Level 3 - Discretionary Projects – defined as those that are needed in the long-term, but where the City has a significant level of control as to when they should be implemented.

6.2 Level 1 - High Priority Projects

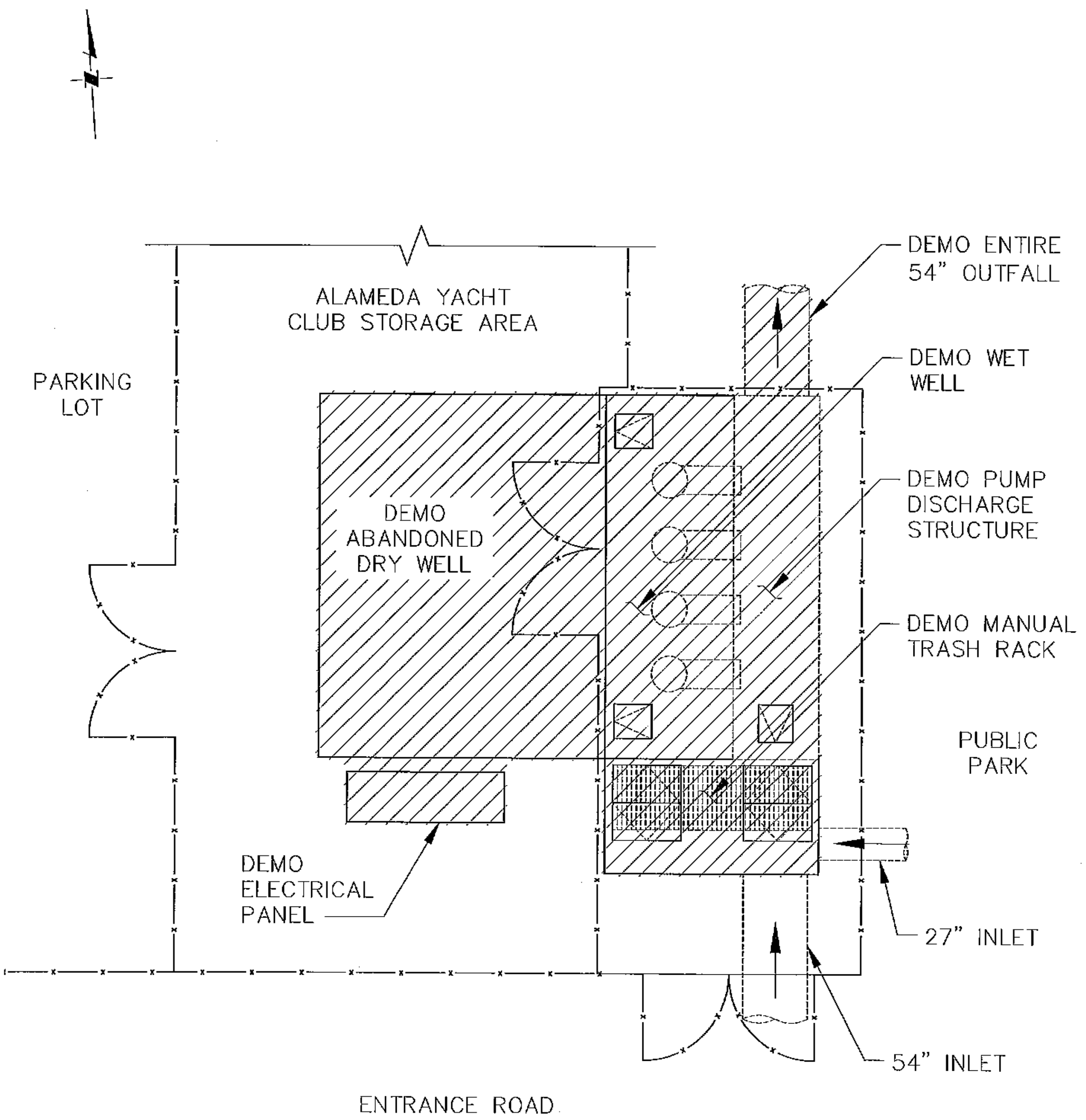
Level 1 or high priority projects are summarized in Table 6-1. For more information concerning the estimated costs for improvements at each station, refer to Appendix D.

Table 6-1 Summary of Level 1 High Priority Projects

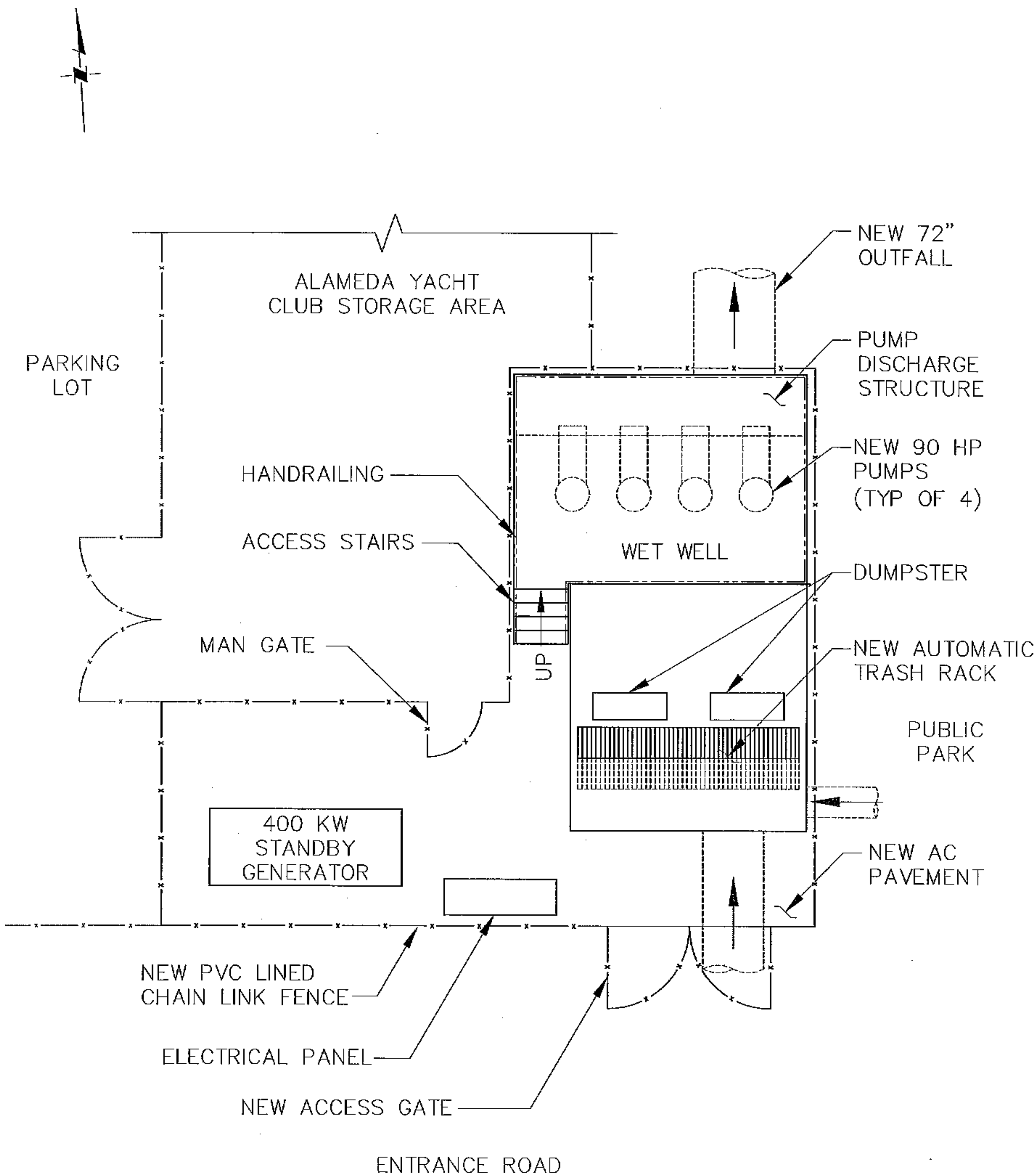
Pump Station	Summary of Recommended Improvements	Project Cost
Arbor	Complete Pump Station Replacement. Outfall replacement. Install Standby Generator and Automatic Trash Rack. The Existing Arbor Pump Station and Proposed Station are shown in Figures 6-1 and 6-2 respectively.	$3,891,000
Central/Eastshore	Complete Pump Station Replacement. Outfall Replacement. Install Standby Generator and Automatic Trash Rack. The Existing Central/ Eastshore Pump Station and New Proposed Pump Station are shown in Figures 6-3 and 6-4 respectively.	$2,805,000
Northside	Improvements to Northside constructed per the Northside Pump Station Upgrades Project No. PW 02-10-06.	$900,000[(1)]

Notes

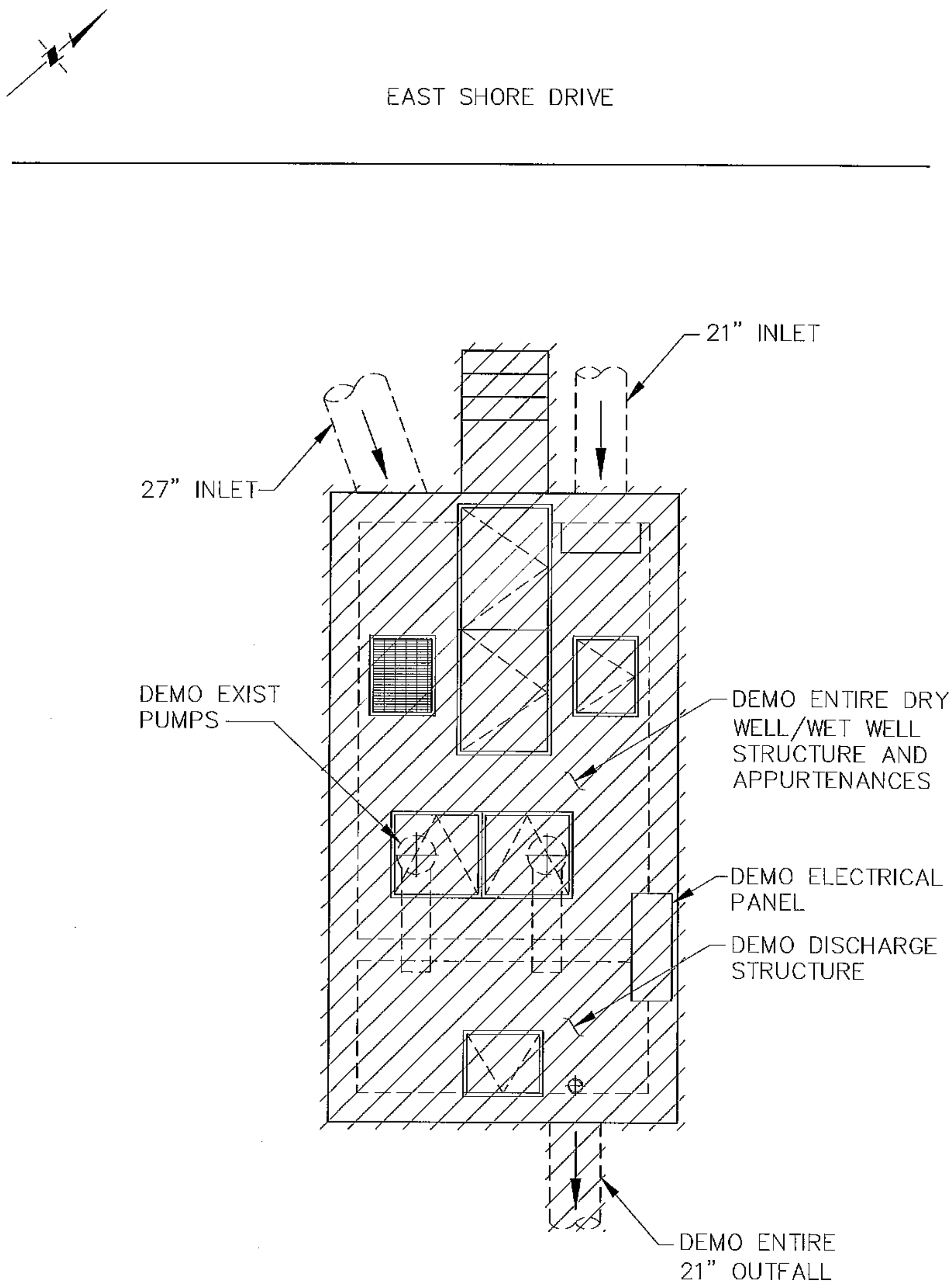
1. Bid amount for Northside Pump Station Upgrades Project No. PW 02-10-06 per Schaaf & Wheeler. Does not include 55 % markup for related project costs.



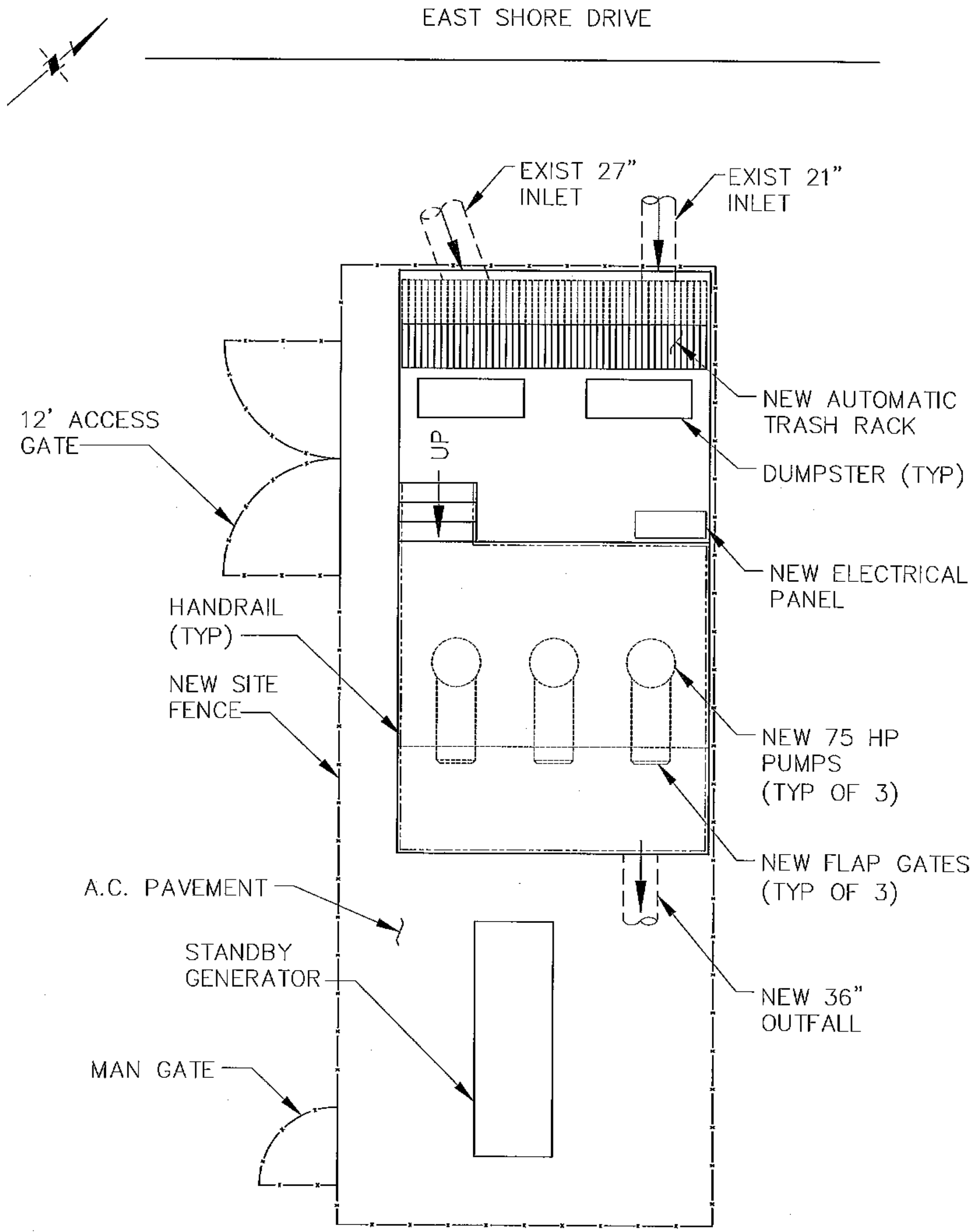
PSOMAS	CITY OF ALAMEDA STORM DRAIN PUMP STATION ASSESSMENT REPORT	EXISTING ARBOR PUMP STATION	FIGURE NO. 6–1 JOB NO. 6ALA010100



PSOMAS	CITY OF ALAMEDA STORM DRAIN PUMP STATION ASSESSMENT REPORT	PROPOSED ARBOR PUMP STATION	FIGURE NO. 6-2 JOB NO. 5ALA010100



PSOMAS	CITY OF ALAMEDA STORM DRAIN PUMP STATION ASSESSMENT REPORT	EXISTING CENTRAL/EASTSHORE PUMP STATION	FIGURE NO. 6-3 JOB NO. 6ALA010100



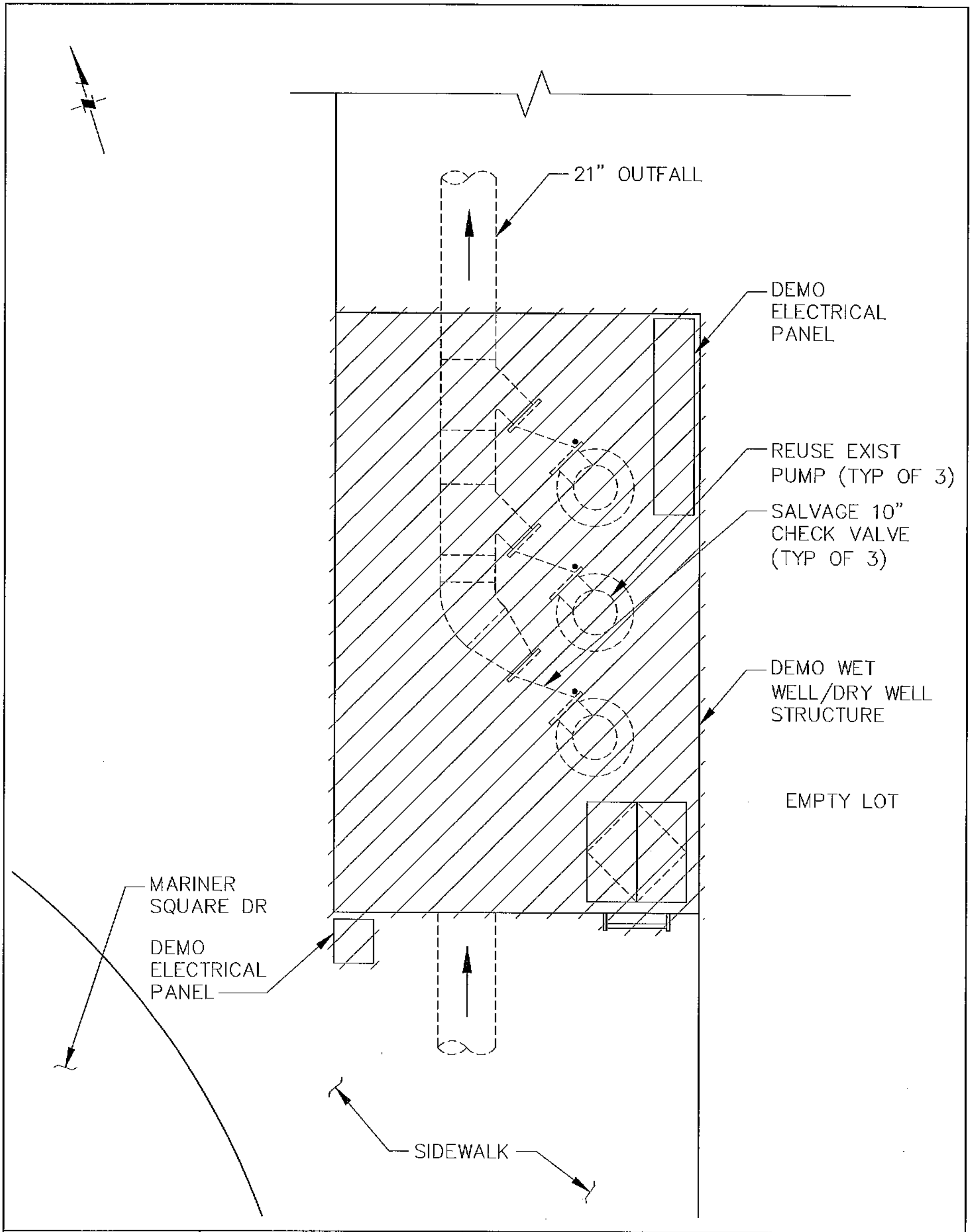
PSOMAS	CITY OF ALAMEDA STORM DRAIN PUMP STATION ASSESSMENT REPORT	PROPOSED CENTRAL/EASTSHORE PUMP STATION	FIGURE NO. 6–4 JOB NO. 6ALA010100

6.3 Level 2 - Necessary Projects

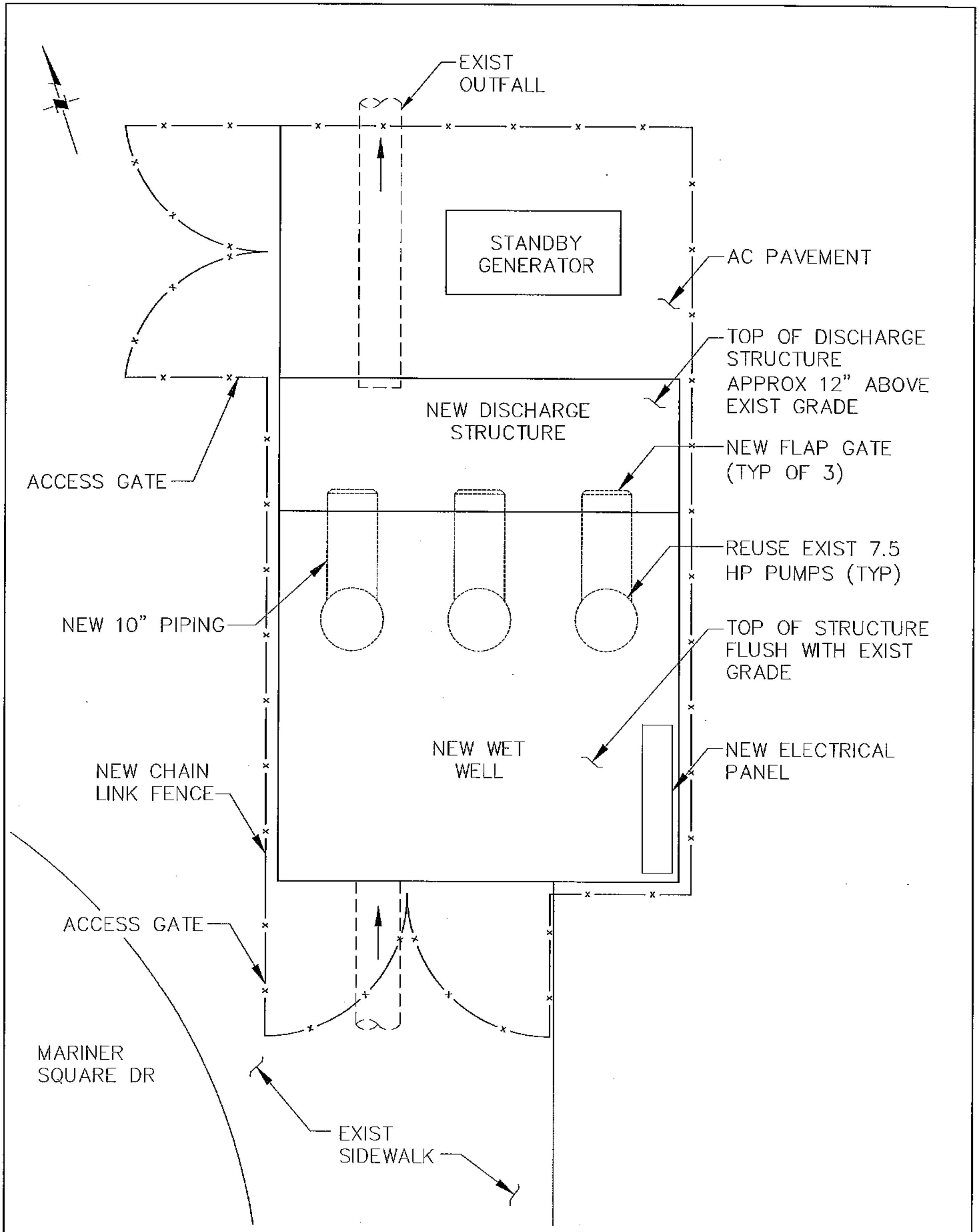
Level 2 or necessary projects are summarized in Table 6-2. For more information concerning the estimated costs for improvements at each station, refer to Appendix D.

Table 6-2 Summary of Level 2 Necessary Projects

Pump Station	Summary of Recommended Improvements	Project Cost
Golf Course	Install exposed wiring in rigid conduit. Provide anti-slip surfacing on existing station floor as required. Install fire extinguisher.	$6,000
Main Street	Install Ladder and Handrailing. Install Ventilation in Wet Well. Install Fire Extinguisher. Install Anchors for Control Panel. Replace Pump Controller with Pump Vision Controller. Replace Existing Bubbler Level Controls with Pressure Level Transmitters.	$84,000
Northside	Replace pumps with new pumps capable of handling design stormwater flows. Replace checker plate with new plate as required to remove tripping hazards.	$587,000
Webster Street	Complete Pump Station Replacement to address operations and maintenance and safety concerns (Reuse Existing Pumps). Install Standby Generator and New Electrical Equipment. The Existing Webster Street Pump Station and Proposed Station are shown in Figures 6-5 and 6-6 respectively.	$1,043,000
Third Street	Replace wet well hatch. Provide Davit Arm System for Wet Well Entry. Provide Standby Generator. Recoat piping (replace if required). Replace Flap Gate on Pump Discharge. Replace Site Fence. Provide wash down facilities. Install Fire Extinguisher. Install Pump Cables in Rigid Conduit. Improve Control Panel Anchorage to Slab.	$86,500



PSOMAS	CITY OF ALAMEDA STORM DRAIN PUMP STATION ASSESSMENT REPORT	EXISTING WEBSTER STREET PUMP STATION	FIGURE NO. 6-5 JOB NO. 6ALA010100



PSOMAS	CITY OF ALAMEDA STORM DRAIN PUMP STATION ASSESSMENT REPORT	PROPOSED WEBSTER STREET PUMP STATION	FIGURE NO. 6–6 JOB NO. 6ALA010100

6.4 Level 3 - Discretionary Projects

Level 3 or discretionary projects are summarized in Table 6-3. For more information concerning the estimated costs for improvements at each station, refer to Appendix D.

Table 6-3 Summary of Level 3 Discretionary Projects

Pump Station	Summary of Recommended Improvements	Project Cost
Golf Course	Install Paved Driveway, Standby Generator, and Fence Around Control Panel. Provide Site lighting and Wash Down Facilities. Coat Piping and Station Floor. Repair Check Valve. Replace Corroded Level Sensor Cover.	$198,000
Harbor Bay System I	Provide Wash Down Facilities. Inject grout into Cracks, Patch Concrete. Install Control Panel Intrusion Alarm and Fire Extinguisher.	$17,000
Harbor Bay System II	Replace Pump. Provide Wash Down Facilities. Install Standby Generator. Replace hatches. Install Site Lighting and Intrusion Alarms on Electrical Panel. Recoat Barrel Base Plate.	$257,000
Main Street	Install Standby Generator. Replace Hatches. Provide Station Wash Down Facilities.	$158,000

Appendix D

Capital Improvement

Cost Estimates

Arbor Pump Station

Capital Improvements Cost Estimate

Deficiency	Action Required	Cost Estimate
Insufficient Pump Capacity, Operations and Maintenance Issues, Safety Issues	Demo Existing Station and Abandoned Dry Well	$54,000
	Construct New Station Structure (wet well, discharge, and trash rack structure)	$367,000
	Install new pumps	$464,000
	Install New Pump Barrels, Piping, and Flap Gates. Install Backflow Preventer and Hose for Wash down	$111,000
	Install A.C Paving, Entire Site	$7,000
Insufficient Outfall Capacity	Install new 72-inch RCP outfall	$112,000
Lacks Backup Power	Install New Standby Generator and ATS	$155,000
Labor intensive manual trash rack	Install Automatic Trash Rack	$450,000
Lacks Private Fence Around Entire Station	Install New Site Fence	$20,000
Electrical, Instrumentation, SCADA required for New Equipment	Install new conduit, wiring, control panel, PLC, MCCs, site lighting (plus programming, testing and training)	$363,000
	Subtotal:	**$2,103,000**
	30% Estimating Contingency:	$631,000
	55% for Contingency, Admin., CM, and Engr:	$1,157,000
	Total w/ Contingency:	**$3,891,000**

1. Cost estimate in April 2011 dollars.

Central/Eastshore Pump Station

Capital Improvements Cost Estimate

Deficiency	Action Required	Cost Estimate
Insufficient Pump Capacity, Operations and Maintenance Issues, Safety Issues	Demo Existing Station and Abandoned Dry Well	$40,000
	Construct New Station Structure (wet well, discharge, and trash rack structure)	$307,000
	Install new pumps	$180,000
	Install New Pump Barrels, Piping, and Flap Gates. Install Backflow Preventer and Hose for Wash down	$79,000
	Install A.C Paving, Entire Site	$6,000
Insufficient Outfall Capacity	Install new 36-inch RCP outfall	$52,000
Lacks Backup Power	Install New Standby Generator and ATS	$119,000
Labor intensive manual trash rack	Install Automatic Trash Rack	$450,000
Lacks Fencing Around Station	Install Site Fence	$15,000
Electrical, Instrumentation, SCADA required for New Equipment	Install New Wiring, Motor Controls, New Transformer, Misc. Electrical Testing and Training	$268,000
	Subtotal:	**$1,516,000**
	30% Estimating Contingency:	$455,000
	55% for Contingency, Admin., CM, and Engr:	$834,000
	Total w/ Contingency:	**$2,805,000**

1. Cost estimate in April 2011 dollars.

Golf Course Pump Station

Capital Improvements Cost Estimate - Level 2 Projects

Deficiency	Action Required	Cost Estimate
Safety concerns (slippery floor, loose wires, lack of fire extinguisher)	Install Anti-Slip Coating to Floor, New Conduit for Loose Wires, Provide Fire Extinguisher	$3,000
	Subtotal:	**$3,000**
	30% Estimating Contingency:	$1,000
	55% for Contingency, Admin., CM, and Engr:	$2,000
	Total w/ Contingency:	**$6,000**

Capital Improvements Cost Estimate - Level 3 Projects

Deficiency	Action Required	Cost Estimate
Existing Coating on Piping is Chalked and Cracking	Recoat Piping	$2,000
Existing Check Valve is leaking	Repair Existing Check Valve	$2,000
Lacking Backup Power Supply	Install New Standby Generator and ATS	$75,000
Muddy site that cannot be driven on	Install Paved Driveway, Encase Existing Water Line	$15,000
Lacking Station wash down facilities	Install Backflow Preventer and Hose	$4,000
Lacking Fence Around Control Panel	Provide chain link fence with slats.	$6,000
Lacking Site Lighting	Install Site Lighting	$3,000
	Subtotal:	**$107,000**
	30% Estimating Contingency:	$32,000
	55% for Contingency, Admin., CM, and Engr:	$59,000
	Total w/ Contingency:	**$198,000**

1. Cost estimate in April 2011 dollars.

Harbor Bay System I Pump Station

Capital Improvements Cost Estimate

Deficiency	Action Required	Cost Estimate
Minor Cracks in Structure, Fence Post Spalled	Inject Grout Into Cracks, Patch Concrete Fence Post	$3,000
Lacks Station Wash Down Facilities	Provide Backflow Preventer and Hose bib	$4,000
Lacks Intrusion Alarm and Fire Extinguisher	Install Intrusion Alarm on Control Panel, Provide Fire Extinguisher	$2,000
	Subtotal:	**$9,000**
	30% Estimating Contingency	$3,000
	55% for Contingency, Admin., CM, and Engr:	$5,000
	Total w/ Contingency:	**$17,000**

1. Cost estimate in April 2011 dollars.

Harbor Bay System II Pump Station

Capital Improvements Cost Estimate

Deficiency	Action Required	Cost Estimate
Insufficient Pump Capacity	Replace Pump	$53,000
Lacks Backup Power	Install New Standby generator and ATS	$45,000
Existing Steel Plates on Valve Vault and Hatch on Discharge Structure are Heavy and Difficult to Open	Install Aluminum Hatches	$7,000
Lacks Wash Down Facilities	Install Backflow Preventer and Hose	$4,000
Lacks Site Lighting	Install Site Lighting	$3,000
Misc. Electrical Work Required For New Pumps and Generator	Install New Wiring, Motor Controls, Misc. Electrical Testing and Training	$25,000
Lacks Alarm on Control Panel	Install Alarm on Control Panel	$2,000
	Subtotal:	**$139,000**
	30% Estimating Contingency:	$42,000
	55% for Contingency, Admin., CM, and Engr:	$76,000
	Total w/ Contingency:	**$257,000**

1. Cost estimate in April 2011 dollars.

Main Street Pump Station

Capital Improvements Cost Estimate - Level 2 Projects

Deficiency	Action Required	Cost Estimate
No Ventilation in Wetwell	Install Ventilation in Wetwell	$2,500
Pump Controller Different from Standard Being Used by City. Existing Bubbler Level Controls Outdated.	Install New Pump Controller and Level Controls.	$15,000
No Ladder to Access Pump Side of Structure	Install Ladder	$2,000
Handrailing Required to Meet OSHA Requirements	Install Handrailing Around Structure	$25,000
No Fire Extinguisher	Install Fire Extinguisher	$250
Install Anchors for Control Panel	Provide Anchors for Control Panel	$500
	Subtotal:	**$45,000**
	30% Estimating Contingency:	$14,000
	55% for Contingency, Admin., CM, and Engr:	$25,000
	Total w/ Contingency:	**$84,000**

Capital Improvements Cost Estimate - Level 3 Projects

Deficiency	Action Required	Cost Estimate
Lacks Backup Power	Install New Standby generator and ATS	$70,000
Existing Plates above Pumps are Difficult to Remove	Install New Aluminum Hatches	$11,000
Lacks Wash Down Facilities and Fire Extinguisher	Install Backflow Preventer, Hose, and Fire Extinguisher	$3,750
	Subtotal:	**$85,000**
	30% Estimating Contingency:	$26,000
	55% for Contingency, Admin., CM, and Engr:	$47,000
	Total w/ Contingency:	**$158,000**

1. Cost estimate in April 2011 dollars.

Northside Pump Station

Capital Improvements Cost Estimate

Schaaf and Wheeler Designed Improvements	**Cost**
Schaaf and Wheeler Designed Improvements, under construction (Cost from Schaaf and Wheeler):	**$900,000**

Additional Improvements		
Deficiency	**Action Required**	**Cost Estimate**
Insufficient Pump Capacity	Install new pumps	$320,000
Checker Plate with Lifting Eyes Presenting Trip Hazard	Replace with Checker Plate with Recessed Lifting Eyes	$25,000
	Subtotal:	**$345,000**
	15% Estimating Contingency:	$52,000
	55% for Contingency, Admin., CM, and Engr:	$190,000
	Additional Improvements w/ Contingency:	**$587,000**

Total Cost (Including Schaaf and Wheeler Improvements)	**$1,487,000**

1. Cost estimate in April 2011 dollars.

Third Street Pump Station

Capital Improvements Cost Estimate - Level 2 Projects

Deficiency	Action Required	Cost Estimate
Lacks Backup Power	Install New Standby Generator and ATS	$13,000
Hatch Access Does Not Meet OSHA Requirements	Replace Hatch With Larger Hatch	$3,000
Unsafe Confined Space Entry in Wet Well	Install Sleeve for Removable Davit Arm. Provide Davit Arm For Fall Protection and Operator Removal	$8,000
Electrical Control Panel not Anchored Properly	Anchor Electrical Control Panel to Concrete Base	$1,000
Wet Well Piping is Corroded	Perform Pipe Corrosion Assessment. Recoat piping (replace if necessary)	$3,000
Existing Flap Gate Stuck Open	Replace Flap Gate	$4,500
Lacks Wash down Facilities and Fire Extinguisher	Install Backflow Preventer and Hose bid, and Fire Extinguisher	$4,000
Existing Fence is Falling Apart	Replace Fencing, Increasing Fenced Area to Include New Generator	$10,000
	Subtotal:	**$46,500**
	30% Estimating Contingency:	$14,000
	55% for Contingency, Admin., CM, and Engr:	$26,000
	Total w/ Contingency:	**$86,500**

1. Cost estimate in April 2011 dollars.

Webster Street Pump Station

Capital Improvements Cost Estimate

Deficiency	Action Required	Cost Estimate
Operations and Maintenance Issues, Safety Issues	Demo Existing Station and Abandoned Dry Well	$40,000
	Construct New Station Structure (wet well, discharge, and trash rack structure)	$239,000
	Install New Pump Barrels, Piping, and Flap Gates (Reuse existing pumps)	$69,000
	Install A.C Paving	$3,000
Lacks Backup Power	Install New Standby Generator and ATS	$45,000
Lacks Fencing Around Station	Install New Site Fence	$15,000
Electrical & Instrumentation	Install new conduit, wiring, ATS, control panel, site lighting	$153,000
	Subtotal:	**$564,000**
	30% Estimating Contingency:	$169,000
	55% for Contingency, Admin., CM, and Engr:	$310,000
	Total w/ Contingency:	**$1,043,000**

1. Cost estimate in April 2011 dollars.