FINAL REPORT

SEAWATER INTAKE FACILITY CONCEPTUAL DESIGN REPORT

scwd^2 REGIONAL SEAWATER DESALINATION PROJECT

Prepared for:

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TABLE OF CONTENTS

Section 1 Introduction 1-1

1.1 Project Description 1-1
1.2 Purpose 1-1
1.3 Report Organization 1-1

Section 2 Summary of Previous Technical Memorandums 2-1

2.1 TM 1: Geologic, Geotechnical, and Seismic Review 2-1
2.2 TM 2: Assessment of Existing Facilities and Landside Sites 2-1
2.3 TM 3: Conceptual Design of Pipelines and Intake Structures 2-2
2.4 Site Alternative Summary 2-3

Section 3 Intake Facilities Conceptual Design 3-1

3.1 Intake Structure Conceptual Design 3-1
3.1.1 Screen Assembly Components 3-1
3.1.2 Operations & Maintenance 3-2
3.1.3 Construction Considerations 3-3

3.2 Intake Pipeline Conceptual Design 3-3
3.2.1 Pipeline Construction 3-3
3.2.2 Pipeline Maintenance 3-5
3.3 Transfer Pipeline Design Assumptions 3-6
3.4 Intake Pump Station Conceptual Design 3-6
3.4.1 Capacity and Demand Requirements 3-7
3.4.2 Pump Station Hydraulics 3-8
3.4.3 Pump Selection 3-8
3.4.4 Pump Station Layout 3-9
3.4.5 Pump Station Design Elements 3-10
3.4.6 Construction Considerations 3-12
3.4.7 Startup and Testing 3-12
3.4.8 Operations and Maintenance 3-13

Section 4 10% Conceptual Design Documents 4-1

4.1 Cost Estimate 4-1
4.2 Contract Specifications 4-1
4.3 Contract Drawings 4-1

Section 5 Conclusions and Recommendations 5-1

5.1 Conclusions 5-1
5.2 Recommendations for Final Design 5-1

Section 6 Limitations 6-1

Section 7 References 7-1

TABLE OF CONTENTS

Tables

2-1 Summary of Pump Station Site Alternatives

2-2 Remaining Site Groups

3-1 Intake Pipeline Construction Approach Summary

3-2 Pump Station Demand and Capacity

3-3 Hydraulic Characteristics

4-1 Summary of Planning-Level Capital Costs

Figures

2-1 Potential Intake Facility Alignments

3-1 Intake Screen Assembly Schematic

3-2 Intake Pump Station Conceptual Layout

Appendices

A Technical Memorandum No. 1: Geologic, Geotechnical, and Seismic Review

B Technical Memorandum No. 2: Assessment of Existing Facilities and Landside Sites

C Technical Memorandum No. 3: Conceptual Design of Pipeline and Intake Structures

D Conceptual Level – List of Technical Specifications

E Conceptual Level – 10% Design Drawings

bgs	below ground surface
CDFG	California Department of Fish and Game
CDR	Conceptual Design Report
cfm	cubic feet per minute
EIR	Environmental Impact Report
fps	feet per second
ft	feet
HDD	horizontal directional drilling
HDPE	high density polyethylene
HP	horsepower
ID	inside diameter
ITFS	Intake Technical Feasibility Study
in	inches
kW	kilowatt
MBNMS	Monterey Bay National Marine Sanctuary
MCC	motor control center
MGD	million gallons per day
MSL	mean sea level
MT	microtunneling
NEMA	National Electrical Manufacturers Association
OD	outside diameter
OGS	Offshore Geophysical Survey
O&M	operation and maintenance
PLC	programmable logic controller
psi	pounds per square inch
PVC	polyvinyl chloride
SCADA	supervisory control and data acquisition
scwd^2	Santa Cruz Water Department and the Soquel Creek Water District
TBM	tunnel boring machine
TM	technical memorandum
URS	URS Corporation

1.1 PROJECT DESCRIPTION

The **scwd²** Desalination Program prepared a planning level Intake Technical Feasibility Study (ITFS; Kennedy/Jenks Consultants 2011) that identified screened, open-ocean intake systems as the recommended apparent best intake approach to provide the **scwd²** Desalination Program with seawater. Subsequently, **scwd²** initiated an Intake Conceptual Design Study (Study) to further evaluate project intake component locations and design elements to support the work of the project Environmental Impact Report (EIR). The Study consisted of preparation of three technical memoranda (TMs) and this summary Conceptual Design Report (CDR).

1.2 PURPOSE

The purpose of the CDR is to present the recommended conceptual design, construction approach, and site locations for three primary facility components: Intake Screens, Intake Pipeline and the Intake Pump Station.

The CDR incorporates the findings of the three preliminary TMs that were prepared as part of the study. The TMs are provided in Appendices A, B and C. The TMs focused on the following technical areas:

- TM 1: Geologic, Geotechnical, and Seismic Review
- TM 2: Assessment of Existing Facilities and Landside Sites
- TM 3: Conceptual Design of Pipelines and Intake Structures

During the study, 18 site locations were evaluated along the Santa Cruz Coast from the San Lorenzo River to Natural Bridges State Beach. Ten of the 18 sites were screened out in the TMs as being infeasible for various reasons. Therefore, this CDR presents conceptual designs for the eight sites determined to be feasible.

The facilities for the eight sites were developed with the similar design, construction and operations assumptions. The eight sites do have variations in physical setting and distance from the desalination plant, which both have ramifications for costs and construction impacts. Therefore, it is expected that as the project moves forward, some of the eight site alternatives will be removed from consideration. For the purpose of this report, it is advisable to carry forward these eight site alternatives into the EIR, as they are technically feasible from the standpoint of design, construction and operation.

1.3 REPORT ORGANIZATION

This CDR is organized into the following sections:

- Section 1 – Introduction
- Section 2 – Summary of Previous Technical Memorandums

- Section 3 – Intake Facilities Conceptual Design
- Section 4 – 10% Conceptual Design Documents
- Section 5 – Conclusions and Recommendations
- Section 6 – Limitations
- Section 7 – References

This section summarizes the three preliminary technical memorandums.

2.1 TM 1: GEOLOGIC, GEOTECHNICAL, AND SEISMIC REVIEW

The purpose of this TM was to review existing documentation and develop a preliminary geologic profile of the intake facility site alternatives. A copy of TM 1 is provided in Appendix A. Notable findings included:

- Identification of the eastern sandy soil zone and the western bedrock zone, which is delineated on Figure 2 in TM 1. These soil profiles were used to develop foundation criteria for each of the facility components.
- Development of seismic design approaches for the facility components. Components located in sandy soils will be placed on top of the soils, unanchored. Flexible couplings will be used on the intake screens and pipeline to control movement and allow adjustment after a seismic event. Components located in bedrock zones will be anchored.
- Identification of the wave-cut bedrock platform which supports kelp forest habitat. In the western bedrock areas, wave energy has been removing the sandy soils and exposing the rocky ocean floor to which the kelp attaches. As the wave energy is depleted offshore, the sand re-accumulates, buries the bedrock and marks the limit of the kelp forest.

2.2 TM 2: ASSESSMENT OF EXISTING FACILITIES AND LANDSIDE SITES

The purpose of this TM was to evaluate locations for intake screens in the water and pump stations on land. A copy of TM 2 is provided in Appendix B. Notable findings included:

- The limits of the kelp forests were mapped based on reviewing the extent of kelp measured by the California Department of Fish and Wildlife (CDFW)[1] over 9 different years (1989, 1999, 2002-2006, 2008 and 2009) and recent aerial photographs. This was done to take into account that the extent of kelp shifts slightly from year to year. For the purposes of CDR, intake screens adjacent to the kelp forest were conservatively placed an additional 100 feet beyond these assumed forest limits. Final design and permitting may define this buffer zone differently.
- Intake screens are not the critical facility component that will determine the most favorable alternative. Intake screens are simple structures that can be assembled on land then lowered into the water with a crane on a barge at an optimum location.
- The intake pump station is also a straightforward facility component that can be universally applied to each site. Eighteen pump station locations were evaluated. Of those, two sites were

[1] Prior to December 31, 2012, the California Department of Fish and Wildlife (CDFW) was known as the California Department of Fish and Game (CDFG). Throughout the CDR and supporting documentation, the name CDFW is used to refer to interactions with the organization or documentation developed after this date, while the name CDFG is used to refer to documentation produced by the organization prior to this date.

removed from consideration due to space constraints (Sites 2 and 8) and two sites were removed due to current uses or other planned development (Sites 1 and 10).

- The intake pipeline is the most critical facility component to the overall design and location of the intake system because a specific construction approach must be developed for each site. Preliminary pipeline alignments were evaluated for each pump station site. After this evaluation, and additional pump station site, Site 6a, was removed from consideration due to inadequate space for pipe installation equipment.

2.3 TM 3: CONCEPTUAL DESIGN OF PIPELINES AND INTAKE STRUCTURES

The purpose of this TM was to evaluate the intake pipeline in further detail with consideration of the other facility components. In addition, this TM considered a fourth facility component: the transfer pipeline, the connecting pipeline between the intake pump station and the desalination plant. A copy of TM 3 is provided in Appendix C. Notable findings included:

- Intake pipeline construction methods were evaluated including dredging, hydraulic directional drilling (HDD), micro-tunneling (MT) and tunnel boring machine (TBM). In sandy offshore soil areas, dredging is the recommended construction method. In bedrock areas, MT or TBM is the recommended construction method. Some sites may require a combination of construction methods. Specific construction approaches were developed for each site.
- Two types of pump stations were evaluated: gravity and suction. Suction-type pump stations work well with HDD constructed pipelines. Gravity-type pump stations work well with MT and TBM constructed pipelines, but MT construction has limited range. Since gravity-type systems are applicable at all locations, the conceptual design will move forward with that type of pump station.
- An evaluation was conducted of the transfer pipeline alignments from each alternative pump station site to the desalination plant. The evaluation indicated that all of the site alternatives have feasible alignments except Sites 11, 12 and 13. For these sites, the best alignment is down Beach Street which is congested with existing underground utilities and many surface features including railroad tracks. Construction activity in this area would be challenging. Pushing the alignment north to Second Street would place the pipeline over Beach Hill which would introduce hydraulic losses requiring larger pumps and energy consumption. For those reasons, Sites 11, 12, and 13 were removed from further consideration.
- Sites 3a, 3b and 6b were also dropped from consideration. Site 3a was dropped due to construction constraints from the geologic transition zone at the edge of the Kelp forest. Site 3b has an intake location that may interfere with Steamer's Lane, the popular surf location. Site 6b was dropped due to construction constraints at the cliff face and through the Kelp forest.

2.4 SITE ALTERNATIVE SUMMARY

The site alternatives are summarized in Table 2-1; the site alternatives and potential pipeline alignments are shown on Figure 2-1. The eight sites still under consideration are shown in boldface font in Table 2-1.

Table 2-1. Summary of Pump Station Site Alternatives

Site #	Site Description or Address	Status
1	City Parking Lot, Adjacent to Wharf Entrance, City ROW	Dropped from consideration in TM 2. The City does not want to lose revenue from parking at this critical lot.
2	City Parking Lot, Adjacent to Railroad Tracks, 25 Beach St.	Dropped from consideration in TM 2. Site too small for construction. Cannot lose any parking spaces for new museum across the street.
3a	Undeveloped Area at St. Joseph Church, 544 W. Cliff Dr.	Dropped from consideration in TM 3. Varying geology between eastern sandy area and western bedrock area will create complications for tunneling.
3b	Undeveloped Area at St. Joseph Church, 544 W. Cliff Dr.	Dropped from consideration in TM 3. Construction and maintenance conflicts at intake location (Steamers Lane Surf Area).
4	**Woodrow Avenue @ W. Cliff, Small Park on City ROW**	**Retained**
5	**1102 David Way @ W. Cliff**	**Retained**
6a	Abandoned Sanitary Outfall, Sunset Ave. @ W. Cliff, install second pipeline by tunneling	Dropped from consideration in TM 2. Inadequate space to install pipeline by tunneling. Construction constraints adjacent to cliff face and through kelp forest.
6b	Abandoned Sanitary Outfall, Sunset Ave. @ W. Cliff, install second pipeline by dredging	Dropped from consideration in TM 3. Construction constraints adjacent to cliff face and through kelp forest.
7	**1700 W. Cliff Drive @ Merced**	**Retained**
8	Stockton at W. Cliff Drive	Dropped from consideration in TM 2. Site too small for construction.
9	**Motel parking lot at 525 2nd St, facing Beach Street, East of Pacific Avenue**	**Retained**
10	Vacant Lot at the Intersection of Main Street at First Street, 215 Beach St	Dropped from consideration in TM 2. There is planned development at this site.
11	523 Beach St. at Riverside Ave., Boardwalk Parking Lot	Dropped from consideration in TM 3. Transfer pipeline construction will encounter excessive conflicts in streets.
12	711 Beach St., Boardwalk Parking Lot	Dropped from consideration in TM 3. Transfer pipeline construction will encounter excessive conflicts in streets.
13	Beach St. at Third St., Boardwalk Parking Lot	Dropped from consideration in TM 3. Transfer pipeline construction will encounter excessive conflicts in streets.
14	**Candidate Desal Plant Area A: 2240 Delaware Ave.**	**Retained**

Table 2-1. Summary of Pump Station Site Alternatives

Site #	Site Description or Address	Status
15	Candidate Desal Plant Area B: Shaffer Rd at Delaware Ave.	Dropped from consideration in TM 3. No longer under consideration for treatment plant site.
16	**255 Swift St.: Pacific Collegiate School sports field**	**Retained**
17	**End of Municipal Wharf**	**Retained**
18	**City Corporation Yard**	**Retained**

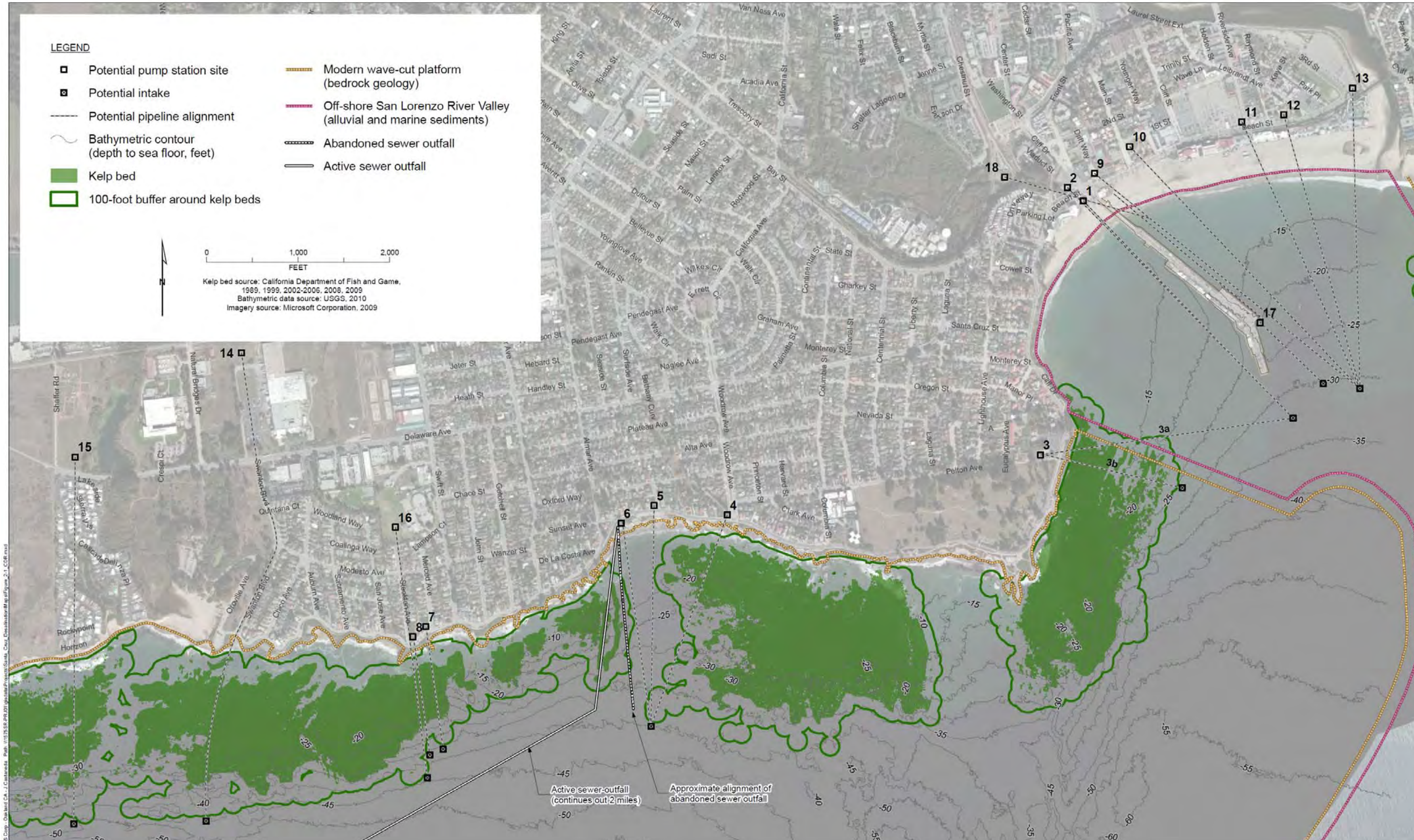

Figure 2-1. Potential Intake Facility Alignments

This section presents the conceptual design for the three main components of the intake facility: screens, pipeline and pump station. In addition, preliminary design assumptions for the transfer pipeline are presented. These assumptions were needed to support the conceptual design of the intake pump station.

3.1 INTAKE STRUCTURE CONCEPTUAL DESIGN

A dual screen intake system has been selected to facilitate operations and maintenance. A dual intake system allows one screen/pipeline to be out of service for maintenance while the other screen/pipeline is in service, thereby providing service reliability.

A universal design approach has been developed for the intake screens for all eight alternatives. A schematic of the intake screen assembly is shown in Figure 3-1 and an engineering drawing is included on drawing M04 in Appendix F.

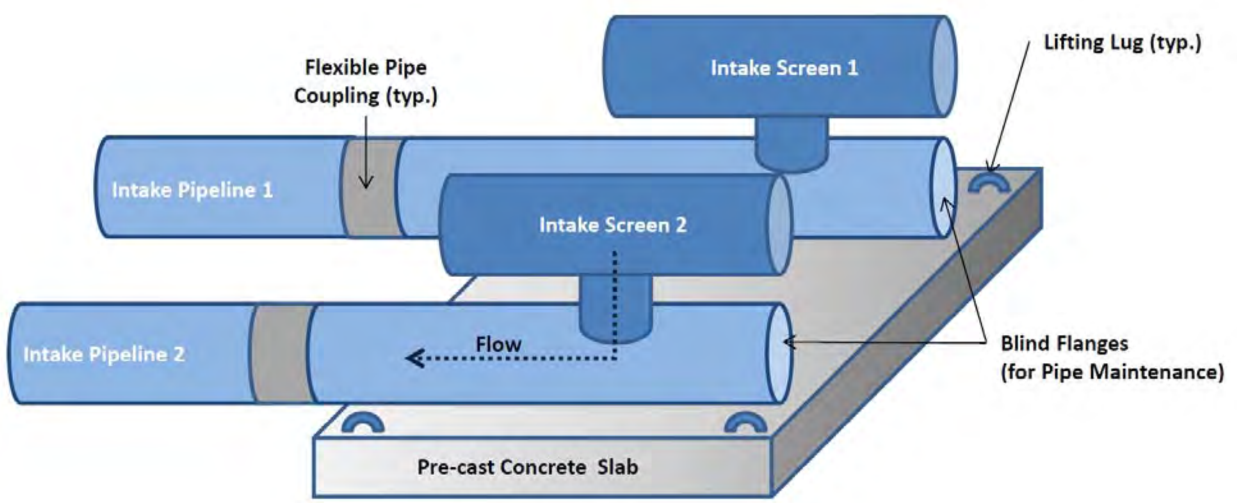

Figure 3-1. Intake Screen Assembly Schematic

3.1.1 Screen Assembly Components

The intake screen assembly has three major mechanical components: screens, pipeline and foundation.

3.1.1.1 Intake Screens

The conceptual design of the intake screens is based on the ITFS and the **scwd^2** Open Ocean Intake Effects Study (Tenera Environmental, 2010) and is consistent with CDFW intake screen criteria. The intake screens are wedgewire screens: manufactured with wire wrapped over a metal cylindrical frame. The wedgewire is spaced tightly to reduce entrainment of fish and other marine life. For marine environments, fabrication of the screens with copper alloy materials is recommended to resist corrosion and biological growth that clogs screen openings. The Intake Effects Study demonstrated that Z-alloy has superior resistance to biological growth. Screens are manufactured by Johnson Screen Co., Hendrick Screen Co. and others. Manufacturer contact information is included in Section 7.

The preliminary screen dimensions are 3-foot (ft) diameter by 12-foot length. This size screen provides an intake capacity of 7 MGD and a low approach velocity of less than or equal to 0.33 feet per second (fps).

The ITFS recommended a dual, redundant screen design and also a dual, redundant pipeline design in order to facilitate maintenance without taking the system off-line. Since the 12 ft by 3 ft intake screens described in the ITFS are sized for 7 MGD, one screen can be used for the currently proposed intake facility capacity. A second screen will likely need to be added if the desalination plant is ever expanded in the future.

3.1.1.2 Pipeline and Appurtenances

The pipeline used on the intake screen assembly needs to be suitable for marine environments. A pipeline manufactured of high-density polyethylene (HDPE) would be suitable. The screens will attach to the top of the pipeline with a tee-type connection. The tee and the screens typically have flanged fittings for bolted fastening which allow removal of the components for maintenance activities.

The screen assembly will connect to the intake pipeline with a flexible coupling. These types of couplings are used to allow movement between major facility components and provide a controlled point of separation in seismic events.

3.1.1.3 Screen Foundation

The mechanical components will be attached to a precast reinforced concrete base slab with pipe supports. The concrete base will have lifting lugs at each corner to allow placement into the water with a crane. The pipe supports will be metallic; either stainless steel or alloy to resist corrosion and biogrowth.

There are two general geologic locations for the intake screens; the eastern sandy soils area and the western bedrock areas. As described in TM 2, in the eastern sandy areas (Sites 9, 17, and 18), the design approach is to set the screen assembly on the sandy ocean floor unanchored. In the western bedrock areas (Sites 4, 5, 7, 14, and 16), the design approach is to anchor the screen assembly.

3.1.2 Operations & Maintenance

Regular maintenance will be required on the screens and intake pipeline. The initial anticipated schedule is quarterly but will be updated according to site specific conditions, seasonal variations and inspection findings.

The maintenance approach for the screens is manual. Although alloy materials are recommended to minimize bio-growth, divers will be required to visit the screens and manually remove materials from the screen with brushes. If the screens are extremely fouled (or damaged); the screens can be unbolted from the pipeline and lifted up to a barge for service.

Automated screen cleaning devices were evaluated including mechanical brushes and compressed air-burst systems. Due to the screen distance far off-shore, automated systems are not practical. In addition, automated systems might create bubbles and noise at the ocean surface above the intake, when in use.

Discussion about intake pipeline maintenance is presented in Section 3.2.2.

3.1.3 Construction Considerations

The intake screen assemblies are well suited for factory construction. All of the components can be assembled on land and then placed in the ocean with a barge and crane. This approach will allow a high degree of precision for locating the screens in an optimum location. Furthermore, this approach will allow for easier O&M activities should the screens need to be brought up to the surface for maintenance (less underwater work). Finally, if necessary, adjustments after a seismic event will be easier.

3.2 INTAKE PIPELINE CONCEPTUAL DESIGN

A dual pipe intake system is recommended. This system allows one pipeline to be in service at all times while the second pipeline (and screen) can be taken off-line for maintenance. This design approach ensures service reliability.

3.2.1 Pipeline Construction

The conceptual design of the intake pipelines is primarily determined by the geologic profile for each site alternative location. In this study area, there are two primary offshore geologic soil types: sandy soils and bedrock.

Pipeline Construction in Eastern Sandy Areas

The recommended intake pipeline construction in the eastern sandy area would be completed in two phases. In Phase 1, the first segment would be constructed using tunneling methods and would address the portion of the alignment from the pump station site, under Beach Street, through the Boardwalk area and surf zone. This work would be done during the winter months. The Phase 1 work would extend the new intake pipelines out past the surf zone and then stop without penetrating the ocean floor. Work activity from the land side would end and the new intake pipelines sealed with bulkheads.

In Phase 2, the second segment would be constructed using dredging methods and would address the portion of the alignment in the ocean from just past the surf zone to the intake screens. Construction would begin just off shore using a barge and clamshell-type dredging equipment to expose the intake pipeline previously installed in Phase 1. A new trench would be dredged for the intake pipelines to a location adjacent to the end of the municipal pier at a depth of approximately 25 to 30 feet. Finally, the new intake screens would be lowered into place and attached to the intake pipelines.

Pipeline Construction in Western Bedrock Areas

The recommended intake pipeline construction in the western bedrock area would also be completed in two phases. In Phase 1, the first segment would be constructed using tunneling methods and would address the portion of the alignment from the pump station site on shore, through the surf zone and out past the kelp forest. Again, the Phase 1 work would stop without penetrating the ocean floor. Land side work would end and the new intake pipelines sealed with bulkheads.

In Phase 2, the second segment would be constructed using dredging methods and would address the short connecting pipeline to the intake screens. Construction would include removal of the sandy layer and excavation of bedrock to expose the intake pipeline previously installed in Phase 1. This work in the ocean would be contained within a turbidity curtain. Finally, the new intake screens would be lowered into place and attached to the intake pipelines.

Possible alternative construction approaches include placement of a portion of the intake pipeline directly on the sea floor or partially buried and covered with a protective rock layer (similar to the sanitary outfalls). This approach could be used on the eastern sandy side.

Another construction alternative is a device used to cross surf zones called a trestle. It is a temporary wharf foundation with piers and truss-like members. The trestle improves control of the construction dredging equipment and placement of the pipeline in the turbulent surf waters. A trestle was used to install the sanitary sewer outfall. The use of a trestle is not needed for the remaining sites, given the recommended construction approach for each location.

A summary of the recommended construction approach for each intake pipeline location is presented in Table 3-1.

Table 3-1. Intake Pipeline Construction Approach Summary

Site No.	Recommended Approach	Estimated Length of Phase 1	Estimated Length of Phase 2
4	Phase 1: Tunnel from shore out past kelp forest. Phase 2: Controlled excavation of intake pipelines within turbidity curtain and connection of screens.	2,300 ft	100 ft
5	Phase 1: Tunnel from shore out past kelp forest. Phase 2: Controlled excavation of intake pipelines within turbidity curtain and connection of screens.	2,300 ft	100 ft
7	Phase 1: Tunnel from shore out past kelp forest. Phase 2: Controlled excavation of intake pipelines within turbidity curtain and connection of screens.	1,150 ft	100 ft
9	Phase 1: Tunnel from shore out past surf zone. Phase 2: Dredging of intake pipelines and connection of	1,000 ft	2,750 ft

Table 3-1. Intake Pipeline Construction Approach Summary

Site No.	Recommended Approach	Estimated Length of Phase 1	Estimated Length of Phase 2
	screens.		
14	Phase 1: Tunnel from shore out past kelp forest. Phase 2: Controlled excavation of intake pipelines within turbidity curtain and connection of screens.	4,850 ft	100 ft
16	Phase 1: Tunnel from shore out past kelp forest. Phase 2: Controlled excavation of intake pipelines within turbidity curtain and connection of screens.	2,300 ft	100 ft
17	Phase 1: Tunnel from shore out past surf zone. Phase 2: Dredging of intake and transfer pipelines. Connection of screens.	1,000 ft	2,600 ft
18	Phase 1: Tunnel from shore out past surf zone. Phase 2: Dredging of intake pipelines and connection of screens.	2,000 ft	2,750 ft

3.2.2 Pipeline Maintenance

Due to the marine environment of the intake facilities, a robust maintenance program is anticipated. Therefore, the conceptual design of the intake pipeline is based on a maintenance approach called “pigging”. This maintenance approach uses an interior scrubbing device called a “pig” that would be launched from the intake pump station through the pipeline towards the screens. The pig has an abrasive coating that scrubs the pipeline walls, removing any natural buildup of ocean sediments, mineral deposits and biogrowth.

Detailed information is not available at this stage of preliminary design regarding the frequency of pipeline cleanings, volumes of flush water that would be generated, and characteristics and volumes of debris that would be produced. These items and other issues are being further investigated by **scwd^2** and results will be incorporated into the final design of the facilities.

However, the pipeline maintenance approach for the intake piping is expected to be somewhat different than for the transfer piping between the pump station and the desalination plant. As noted previously, a primary reason for the dual intake system is to facilitate maintenance activities. In a dual system, the intake pumps can be used to draw in seawater in through one intake pipe and flush it out the other intake pipe. This pipeline arrangement eliminates the need for using potable water for maintenance purposes, saving thousands of gallons of water on each maintenance cycle. The interior of the intake pipelines would be cleaned with pigging, as described above.

It is also likely that the transfer pipeline will require pigging as well, although this would be needed less frequently than for the intake pipelines. If a site with a very long transfer pipeline is selected, such as Site 9, 17, or 18, then pigging will be more complicated and may require an intermediate receiving/launching station. Regular cleaning of the transfer pipeline and the discharge path of the flush water will be considered during final design (i.e., the flush water could be stored and blended with treated wastewater effluent or sent directly out from the plant to the Monterey Bay through the pigging process). Another option being considered for the transfer pipeline is the addition of fresh water or chlorine to the flush water, between the intake pump station and the desalination plant, to prevent biological growth and aid the removal of biofilm and other nuisance growths during pipeline cleanings. If chlorine was added, provisions would be made during final design to apply sodium bisulfite, a dechlorinating agent, to the flush water to eliminate chlorine residuals in the discharges to Monterey Bay.

Drawing M03 in the 10% design drawings presented in Appendix E shows the mechanical piping layout for an intake pipeline pigging system.

3.3 TRANSFER PIPELINE DESIGN ASSUMPTIONS

The conceptual design of the transfer pipeline will be completed separately. However, in order to complete the conceptual design of the intake pump station, several assumptions had to be made regarding alignment, capacity, and an O&M approach.

- Alignment – Preliminary alignment routes were established from each pump station site to the desalination plant. Alignments are shown in Drawing G05 in Appendix E.
- Flow/Velocity – Initial pump station capacity is 7 MGD with potential future expansion to 12.5 MGD. A scouring velocity is needed to keep the pipeline clean (between 4 and 10 fps). In order to meet the flow and velocity criteria, a dual pipeline is assumed with an inside internal diameter of 16 inches.

3.4 MAINTENANCE – THE INTAKE PUMP STATION PIPING HAS BEEN CONFIGURED TO ALLOW PIGGING OF THE TRANSFER PIPELINES FROM THE INTAKE PUMP STATION TO THE PLANT. INTAKE PUMP STATION CONCEPTUAL DESIGN

A universal pump station design has been developed for this conceptual phase of the project. For the final design phase, the pump station dimensions will be tailored to the site. The pump stations are different in depth of the wet well. Elevation data for each site location is provided on drawing M02.

The 2,500-square-foot pump station could be an enclosed, below-grade facility, to reduce its visibility from surrounding locations. With this approach, some components would still need to be placed above grade, such as access hatches, electrical transformers, parking, driveways, and fencing. The pump station could also be constructed in an above-grade structure, which could be considered during final design.

The Site17 pump station alternative would be located immediately adjacent to the Municipal Wharf, near the mid-point bend of the existing wharf. The 2,500-square-foot pump station would be surrounded by new decking. The pump station and decking combined would be approximately 7,000 square feet in area. A short ramp between the new decking and the existing wharf would be the only connection between the two structures. The pump station facilities (e.g., pumps, electrical controls) would be located below the surface of the new decking, but access points and maintenance hatches would be installed on the surface of the new pump station structure. A pump station at this location would extend 10 to 15 feet below the decking surface. The pump station wet well would extend from the pump station down to the ocean floor. The pump station and wet well would be made of concrete with surface color and texture designed to blend with the materials of the existing wharf. The pump station would be faced toward the ocean so as to be less visible from points onshore.

The 10% design drawings presented in Appendix E show the pump station plans on drawing M01 and sections on drawing M02.

3.4.1 Capacity and Demand Requirements

The proposed pump station design capacity is up to 7 MGD with potential future expansion to 12.5 MGD only if the desalination plant were considered for expansion in the future. At this time, the recommended design approach for the intake pump station is to use constant speed pumps. Fine tuning with variable speed pumps can be considered during the final design phase. For the proposed design capacity of 7 MGD, three service pumps are recommended with a fourth standby pump. If potential future expansion of the intake system to 12.5 MGD is pursued in the future, a high capacity pump is recommended with a standby. The pumping scheme is presented in Table 3-2 that shows which pumps would be activated to meet the demand required by the desalination plant.

Table 3-2. Pump Station Demand and Capacity

		Seawater Intake at ~50% Recovery (MGD)					
Pump #	**Capacity (MGD)**	**2.3**	**4.6**	**7**	**8.9**	**10.5**	**12.6**
1	2.3	X	X	X	X	X	X
2	2.3		X	X		X	X
3	2.3			X			X
4	2.3	Standby					
5	6.3				X	X	X
6	6.3	Standby					

Table 3-2 shows a typical day of operation for any demand situation. In actuality, as the pump station moves through an annual schedule, the pumps would be operated on a rotating cycle (including the standbys) to ensure even wear of the equipment.

3.4.2 Pump Station Hydraulics

Although the capacity and demand would be the same at all of the site alternative locations, the hydraulic profiles would be different due to elevation changes and length of the transfer pipeline. Preliminary hydraulic profiles have been developed for the eight site alternatives. The hydraulic profile identifies the work a pump would need to do to move water from the wet well to the desalination plant. The work includes lifting the water to a higher elevation and moving the water through a pipeline. The total work performed by a pump is identified as total dynamic head (TDH). Table 3-3 provides hydraulic characteristics for each site alternative and the estimated TDH.

Table 3-3. Hydraulic Characteristics

Site Location	Site Elevation (ft)	Elevation Head (ft)	Transfer Pipeline (ft)	TDH Range (ft)
4	30	30	7,920	107 – 170
5	30	30	6,336	106 – 159
7	30	30	4,752	104 – 145
9	30	30	11,088	110 – 194
14	60	0	3,168	102 – 136
16	60	0	0	100 – 113
17	20	40	11,500	115 – 200
18	20	30	11,500	110 – 194

3.4.3 Pump Selection

Vertical turbine pumps are the recommended pump style for the intake pump station. Gravity lift-type pumps are needed to coincide with the construction method of the intake pipeline.

The pumps selected need to be rated for marine environments and capable of processing seawater. Several manufacturers provide these types of pumps including Flowserve model VPT, Sulzer model SJT and others.

3.4.4 Pump Station Layout

The pump station layout was developed considering two primary design criteria: demand requirements of the desalination plant and maintenance requirements of the pipelines. The layout of the equipment is symmetrical to coincide with the dual pipeline approach for the intake pipeline and transfer pipeline. The pump station layout is shown schematically in Figure 3-2 and in drawing M01 of the 10% engineering drawings in Appendix E,.

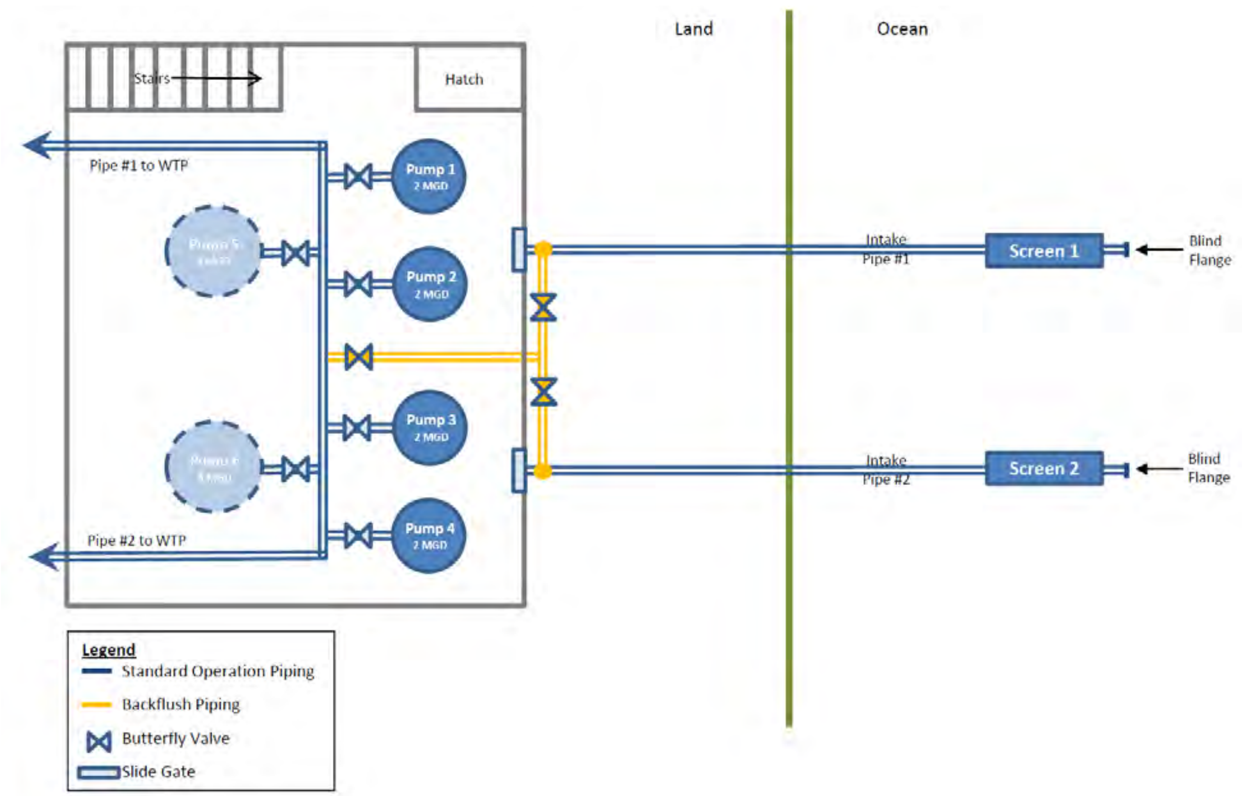

Figure 3-2. Intake Pump Station Conceptual Layout

A secondary design consideration for the intake pump station is for an enclosed, below grade facility. Although not required, some site locations may benefit aesthetically by placing some pump station components below ground. The 10% conceptual design drawings included in Appendix E show placement of the pumps and control equipment below grade. However, some components will still need to be placed at surface level. Civil site plans for each pump station site included in the 10% conceptual drawings show preliminary locations of surface features including access hatches, electrical transformers, parking areas, driveways and fencing.

Alternatively, the pump station equipment could be placed at grade and enclosed in a small single-story building (approximate size: 40’ x 60’). Equipment manufacturers can also provide equipment suitable to be placed in an outdoor environment, if necessary.

3.4.5 Pump Station Design Elements

The pump station is the most complex intake facility component. The primary design elements are discussed in this section.

3.4.5.1 Structural Design

The walls and floors of the pump station will be constructed of reinforced concrete. Site alternatives 4, 5, 7, 9, 14 and 16 are located in bedrock zones, so foundations can be well anchored. Site alternatives 17 and 18 are located in sandy soils and will require supplemental pile foundations.

The walls, ceiling, and floor of the wet well will need to be strong enough to hold up the pump room above it. Since the pump station is buried, buoyant forces will need to be considered in the structural design of the wet well. The exterior coating of the buried walls of the pump station will be important for waterproofing and corrosion protection.

The ceiling of the pump station will need to be designed to accommodate truck traffic since trucks will be required to line up over the access hatches to remove the pumps for maintenance every 5 years or so. The hatches will also need to be traffic-rated.

Since Santa Cruz is located in a seismically-active region, the structure will need to be designed to meet current seismic standards. It is also assumed that the pump station would not be considered a critical facility for **scwd²,** given that it would be providing a supplemental water supply.

3.4.5.2 Mechanical Design

Check valves, isolation valves, flow meter and other instrumentation would be located downstream from each pump. An air release/vacuum valve would be used to vent air from the pump column upon pump startup. To minimize water-hammer effects, slow closing and air throttling devices would be incorporated into the air/vacuum valve design. This would regulate the exhaust rate and closure speed of the valve.

Special slide-gate valves would be located on each intake pipeline where they enter at the very bottom of the wet well, so each pipe could be isolated during pigging. These valves would need to be operable from the pump station, requiring long shafts and possibly motorized operation. Since these valves sit in seawater, they would need superior corrosion protection. Since the valves would be close to the pump discharge during pigging, they would need a high pressure rating of at least 150 psi.

At the beginning of each transfer pipeline, a strainer will be placed in-line, in the pump station. 80-micron plastic disk strainers will remove barnacle and other larvae that would grow in the pipelines. One example is an Amiad Filter Model EBS 10000. These strainers will backflush automatically into each of the intake pipelines. The backflushing of each strainer can be timed to coincide with pipe pigging, so that the strainer backwash can be flushed out to sea. Alternately, the strainer backflush line could be piped to the brine line from the desalination plant, allowing the strainer to be backflushed at any time. Having a strainer should significantly reduce the maintenance frequency of the transfer pipeline.

All mechanical devices and piping will need to be made of the most corrosion-resistant materials possible since they will be transporting seawater (e.g., duplex stainless steel, alloys or plastic.).

3.4.5.3 Corrosion Control

Corrosion control is critical for a seawater pump station located below ground at the coast. Without proper corrosion control, maintenance will become excessive and in the worst case, the pump station may be forced to operate without proper instrumentation or be down for extended periods of time. Corrosion control would be accomplished by using proper coating and lining material, electrical and mechanical isolation, electrical bonding, cathodic protection as necessary, and materials selection.

The material selection will include corrosion-resistant materials like HDPE, PVC and stainless steel.

Corrosion is inevitable, and therefore for metallic components, a corrosion monitoring system will be installed and regular inspections scheduled. It will be assumed that vulnerable components will need to be replaced on a routine basis. These components may include level, flow, and pressure sensors.

3.4.5.4 Electrical/Motor Control

The pumps will be powered by a high voltage motor control center (MCC) located in the pump room. The MCC will include surge suppression, programmable logic controller (PLC) and supervisory control and data acquisition (SCADA) consistent with the City’s current systems, automatic transfer switch, and valve actuators.

The pump operation will be controlled to serve the demands of the desalination plant. Switches will be incorporated into the design for safety to shut down pumps in cases of high and low pressure, temperature, etc. Remote control of the pump station from the desalination plant is likely.

The electrical equipment will have a National Electrical Manufacturers Association (NEMA) rating providing for corrosion, windblown dust and rain, splashing water, hose-directed water, and damage from external ice formation (NEMA 4X) or also the entry of water during prolonged submersion at a limited depth (NEMA 6P).

A low voltage electrical panel will provide power to devices such as security systems, smoke detectors, and lighting.

3.4.5.5 Power Supply

The pump station will require a new 3-phase, 480-volt power supply. Sites 4, 5, and 7 are located in residential areas and it is possible that sufficient power supply is not available and an upgrade may be required. The electrical upgrade is assumed to require hanging new 12 kV conductors on existing power poles with some minimal trenching in the vicinity of the site. Sites 9, 14, 16, 17, and 18 are located in areas that have existing industrial and commercial type infrastructure, so an upgrade is not anticipated.

The peak power demand for the pumps sized for 7 MGD is 245 HP, which will require 183 kW total. In addition, the pump station will require general power to supply lighting, instrumentation, valve actuators, etc. The demand for the general power is estimated to be approximately 200 kW. Therefore a 400 kW power supply from PG&E is recommended.

A connector will be required at the ground surface so that a portable generator (400 kW) can be brought to the site to power the station during power outages or other emergencies. An uninterruptable power supply (UPS) will be required to serve some equipment in the event of a power loss. The systems currently envisioned needing UPS power include the SCADA, PLC and security systems.

3.4.6 Construction Considerations

Construction of the pump station will be completed in stages. Specialty contractors will be brought in to complete specific tasks.

The initial activity will be site clearing followed by construction of a launch shaft for tunneling the intake pipeline. The launch shaft should be designed to accommodate installation of the pump station wet well. If the pump station will use cast-in-place concrete, the excavation will need to be sized large enough to accommodate installation of the forms.

Once the structural work is complete, pipe fitters will be brought in to install the discharge header, piping associated with the pigging and other appurtenances. This piping is shown in the 10% design drawings on sheet M01. The electricians would follow to install the power supply and site wiring. Equipment technicians would then install the valve actuators, lighting, control systems and communications. Finally, the pumps would be installed through the surface-mounted access hatches.

On the surface, site improvements would include final grading, paving for driveway and parking spaces, fencing and gates. Some minor landscaping may be required, but it could consist of low maintenance or no maintenance zones.

3.4.7 Startup and Testing

The contractor and design engineer will coordinate a startup and testing plan. The plan includes running the pumps and controls in various modes to determine that the pump station meets the design requirements. The pump station may be run at various capacities to measure power usage and pump efficiencies. Pump control programming will be confirmed as well as remote control capabilities. Emergency shut downs will be simulated to ensure the pump station will not be damaged from sudden pressure surges like water hammer. The contractor and manufacturer representatives will be required to train designated **scwd²** staff how to operate all of the equipment and provide support services for 1-year or longer, if necessary.

3.4.8 Operations and Maintenance

It is expected that the intake pump station will be operated remotely by staff at the desalination plant or the GHWTP. This is a common practice and the pump station will include monitors to ensure proper performance plus safeguards and alarms to alert operators if anything is out of order.

Periodic visits to the pump station by **scwd²** staff is anticipated to confirm the site is secured and in good condition (requiring about 1 hour or less). Staff will likely enter the below grade control room, but not the wet well. The control room will have an active ventilation system so it would not be classified as a confined space. The wet well however, would likely be considered a confined space. Access into the wet well would follow a typical confined space permit process. Entry into the wet well is anticipated to be on a quarterly basis to evaluate debris accumulation and perform maintenance. It is inevitable that some debris and encrustation will accumulate on pipes or in corners and maintenance staff will need to wash down the wet well walls and floor. The wet well can be isolated from the intake pipelines with slide gates and the main pumps can remove most of the water. A sump drain is included at the bottom of the wet well to allow removal of all the water and a ladder is provided to access the floor. The walls and floor of the pump station will be coated with an epoxy layer to help resist accumulation of debris and marine growth and the floor will be sloped towards the sump.

Life expectancy for the intake pump station is expected to be lessened due to corrosion in the marine environment. The non-moving components (e.g., pipelines, building, etc.) should last 50 to 75 years. Plumbing and electrical equipment are expected to last 25 to 40 years.

This section presents the 10% conceptual design documents including cost estimate, technical specifications and design drawings.

4.1 COST ESTIMATE

Preliminary cost estimates for all of the site alternatives were provided in TM3. The cost estimates for the remaining eight sites are summarized in Table 4-1.

Table 4-1. Summary of Planning-Level Capital Costs (Millions)

Site No.	Total Costs	Hard Costs					Soft Costs
		Intake Pipeline	Intake Screens	Pump Station	Transfer Pipeline	Land	
4	$30.0	$8.0	$1.0	$4.4	$2.0	$0	$14.7
5	$31.0	$8.0	$1.0	$4.7	$1.8	$0.8	$14.7
7	$25.0	$5.0	$1.0	$4.6	$1.2	$2.3	$11.0
9	$33.0	$7.3	$0.8	$4.6	$3.5	$1.6	$15.3
14	$42.0	$15.2	$1.0	$5.3	$0.0	$0.4	$20.1
16	$30.0	$8.0	$1.0	$5.0	$0.9	$0.8	$14.3
17	$26.0	$2.0	$0.8	$4.0	$6.7	$0	$12.5
18	$36.0	$9.8	$0.8	$4.6	$3.5	$0.4	$17.0

4.2 CONTRACT SPECIFICATIONS

A list of the potential contract specifications sections is presented in Appendix D. The sections are provided in Construction Specifications Institute format.

4.3 CONTRACT DRAWINGS

The 10% conceptual design drawings for the eight candidate sites are presented in Appendix E.

The work completed to develop the CDR (including the TMs) has produced many useful findings to help guide the **scwd^2** Desalination Program. This section summarizes the major findings and includes recommendations for moving forward with the final design of the intake facilities.

5.1 CONCLUSIONS

The major finding of the CDR is that eight sites are technically feasible for the intake facilities, from design, construction, and operational perspectives. Other significant findings and elements of the design include:

- Identification of the offshore eastern sandy soil zone and the western bedrock zone.
- Identification of the wave-cut bedrock platform which supports kelp forest habitat.
- Development of seismic design approaches for the facility components.
- Development of a simple approach for the construction of the intake screens.
- Development of a universal design for intake screens and the intake pump station.
- Development of design and construction approaches for intake pipeline alignments.
- Development of operation and maintenance schemes for the facility components.
- Development of cost estimates and 10% contract documents.

The City of Santa Cruz and the Soquel Creek Water District will consider selection of an intake facility site as part of their overall decision-making on the project.

5.2 RECOMMENDATIONS FOR FINAL DESIGN

Moving forward into the final design phase of the selected site, the following activities should be considered:

- Preparation of a geotechnical investigation to support the design process.
- Perform an ocean floor diver survey to confirm the limits of the kelp forest and seafloor conditionsnear the selected intake location.
- Develop a plan for the ocean floor work activity and construction containment.
- Confirm and review the intake pipeline diameter.
- Confirm the design of the transfer pipeline and review the pump station hydraulics.
- Evaluate factory construction of the pump station and screen components.
- Prepare a construction schedule.
- Update cost estimates accordingly.

This study is intended for conceptual purposes only. The opinions, conclusions, and recommendations presented herein are based on a review of available information in URS' files and from other outside sources. No physical exploration was performed as part of this study. The preliminary recommendations presented in this report are based on the assumption that the soil and geologic conditions do not deviate substantially from those anticipated by the information contained in the existing logs of test borings and other subsurface studies. Additional site specific exploration and analysis should be completed prior to the development of final design recommendations.

The opinions and recommendations presented in this conceptual report were developed with the standard of care commonly used by other professionals practicing at the same time, within the same locality and under the same limitations. No other warranties are included, either expressed or implied, as to the professional advice included in this conceptual report.

Archibald Consulting. 2010. Palencia Consulting Engineers, and Starr Consulting. Proposed **scwd^2** Desalination Project Watershed Sanitary Survey. July.

Brabb, E.E. 1997. Geologic map of Santa Cruz County, California: U.S. Geologic Survey Open File Report, 97-489, scale 1: 62,500.

Bradley, W.C. 1957. Origin of Marine-Terrace Deposits in the Santa Cruz Area, California, Geologic Society of America Bulletin, 1957; 68; 421-444.

California State Lands Commission and Monterey Bay National Marine Sanctuary (Lead Agencies). 2005. Draft Environmental Impact Report/Environmental Impact Statement for the Monterey Accelerated Research System Cabled Observatory. March.

EcoSystems Management Associates, Inc. (Eco-M). 2010. **scwd^2** Seawater Desalination Program Offshore Geophysical Study, Unpublished Technical Report for the City of Santa Cruz, Water Department.

Harding Lawson Associates. 1986. Geotechnical Investigation, Santa Cruz Outfall, Santa Cruz, California. Unpublished Technical Report, Job # 2665, 015.04.

Harding Lawson Associates. 1976. Geotechnical Study, Santa Cruz Wastewater Facilities Program. Unpublished Technical Report.

Hopkins Groundwater, Inc. 2001. Technical Memorandum, Feasibility Evaluation of Beach Wells for Seawater Intake and Brine Discharge. Memorandum final version submitted to City of Santa Cruz Water Department, November 27.

Jenkins, Scott, PhD and Joseph Wasyl. 2010. Dilution Analysis for Source and Receiving Water for the Santa Cruz Seawater Desalination Project. March 15.

Kennedy/Jenks Consultants. 2011. **scwd^2** Seawater Desalination Intake Technical Feasibility Study (ITFS). September 21.

Kennedy/Jenks Consultants in conjunction with CH2MHill. 2007. Marin Municipal Water District Engineering Report, Seawater Desalination Pilot Program. January 26.

NOAA. 2010. Guidelines for Desalination Plants in the Monterey Bay National Marine Sanctuary. May.

Perg, L.A., Anderson, R.S., and Finkel, R.C. 2001. Use of a new 10 Be and 26 Al inventory method to date marine terraces, Santa Cruz, California. Geology, Vol. 29, pp. 879-882.

scwd^2. 2008. Request for Proposals for Investigation of Abandoned Outfall, Seawater Desalination Program. July 15.

scwd^2. 2010. Notice of Preparation/Initial Study for scwd^2 Regional Seawater Desalination Project. November 15.

Tenera Environmental. 2010. City of Santa Cruz Water Department and Soquel Creek Water District **scwd^2** Desalination Program, Open Ocean Intake Effects Study. December.

URS. 2006. Draft Environmental Impact Report for the proposed Trans Bay Cable Project, Prepared for the City of Pittsburg, CA. 2006.

Von Langen, P. 1991. Unpublished Bachelor's Thesis, University of California, Santa Cruz.

Manufacturers

Flowserve Pumps: http://www.flowserve.com

Hendrick Screens: http://www.waterintake.com/fishdiversion.htm

Johnson Screens: http://www.johnsonscreens.com/content/fish-diversion-screens

Ranney Collector: http://www.laynechristensen.com/Brands/Ranney-Collector-Wells.aspx

Romac Industries (fittings): http://www.romac.com/

Sulzer Pumps: http://www.sulzerpumps.com/desktopdefault.aspx

Amiad Filters: http://www.amiad.com/

Standards

American Water Works Association: http://www.awwa.org/index.cfm?showLogin=N

Construction Specifications Institute: http://www.csinet.org/