City of Santa Cruz
Desalination Feasibility Update Review

FINAL

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ACRONYMS AND ABBREVIATIONS

Acronym/Abbreviation	Definition
ACAYY	annualized cost per million gallons of average year yield
ACOE	U.S. Army Corps of Engineers
AF	acre feet
AFY	acre-feet per year
APF	area of production foregone
bgy	billion gallons per year
CCC	California Coastal Commission
CCF	100 cubic feet
CDFW	California Department of Fish and Wildlife
CEQA	California Environmental Quality Act
City	City of Santa Cruz
CSLC	California State Lands Commission
EIR	environmental impact report
EIS	Environmental Impact Statement
ETM	Empirical Transport Model
HDD	Horizontal Directional Drilling
IRP	Integrated Resources Plan
IWP	Integrated Water Plan
JPA	joint powers authority
Master Plan	Santa Cruz Wharf Master Plan
MBNMS	Monterey Bay National Marine Sanctuary
MBRWP	Monterey Bay Regional Water Project
MG	million gallons
mgd	million gallons per day
n/a	not applicable
NEPA	National Environmental Policy Act
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
NPDES	National Pollutant Discharge Elimination System
OPA	Amendment to the Water Quality Control Plan for Ocean Waters of California Addressing Desalination Facility Intakes, Brine Discharges, and the Incorporation of Other Non-Substantive Changes
RWFPS	Recycled Water Facilities Planning Study
RWQCB	Regional Water Quality Control Board
SCCRTC	Santa Cruz County Regional Transportation Commission
SCWD	Santa Cruz Water Department
scwd^2	Santa Cruz Water Department/Soquel Creek Water District
scwd^2 DEIR	scwd^2 Regional Seawater Desalination Project Draft Environmental Impact Report
SLVWD	San Lorenzo Valley Water District
SqCWD	Soquel Creek Water District
SUP	special use permit
SVWD	Scotts Valley Water District
SWRCB	State Water Resources Control Board
SWRO	seawater reverse osmosis

Acronym/Abbreviation	Definition
UWMP	Urban Water Management Plan
Wharf	Santa Cruz Municipal Wharf
WSAC	Water Supply Advisory Committee
WSAC Final Report	Water Supply Advisory Committee's Final Report on Agreements and Recommendations
WWTF	wastewater treatment facility

EXECUTIVE SUMMARY

This report provides a review of the feasibility, cost, timeliness, and approach for pursuing a seawater desalination facility for use by the City of Santa Cruz (City). This review will support the City's selection of a supplemental or replacement supply according to the City Water Supply Advisory Committee's Final Report on Agreements and Recommendations (WSAC Final Report) (WSAC 2015). The recommended strategies in the WSAC Final Report include conservation to reduce demand, passive and active groundwater recharge, and supply augmentation using advanced-treated recycled water with desalination as a backup if the use of advanced-treated recycled water is not feasible (WSAC 2015).

This report describes the water supply planning background and need for this report (Section 1); provides as assessment of changed conditions that may affect the design, environmental review, and permitting of a seawater desalination project (Section 2); describes a City seawater desalination project based on changed conditions (Section 3); provides a California Environmental Quality Act/National Environmental Policy Act (CEQA/NEPA) compliance and permitting approach (Sections 4 and 5); assesses the timeliness of implementation (Section 6); presents opportunities for regional collaboration (Section 7); and provides conclusions about the ability of a City seawater desalination project to meet current City objectives (Section 8).

As a result of the assessment of changed conditions, a City seawater desalination project would involve construction and operation of a seawater reverse osmosis (SWRO) desalination plant and related facilities to provide up to 3.3 million gallons per day (mgd) of potable water to the City. The water supply from the project would help the City meet its water needs during periods of water supply shortages as a result of drought and reduced surface-water diversions needed to provide improved river and stream flows for fish and to plan for climate change. The four basic functional components of a City seawater desalination project would be similar to those considered for the Santa Cruz Water Department/Soquel Creek Water District (scwd^2) Desalination Program and would consist of the following (see Figure 1):

- A seawater intake and conveyance system consisting of a screened open-ocean intake system, intake piping, pump station, and transfer piping. An update to the scwd^2 Seawater Desalination Intake Technical Feasibility Study (Intake Technical Feasibility Study Update) would be required to specifically address the California Ocean Plan requirements and feasibility definitions, as discussed in Section 2 and Appendix A. Because of the requirements of the California Ocean Plan, a subsurface radial collector well system may need to be considered as an intake design option even though it was not previously recommended for the scwd^2 Desalination Program. If such a subsurface intake system were pursued by the City, it would need to be constructed and tested in stages and may need to be augmented with a screened open-ocean intake that would be used to provide supplemental water if the subsurface intake system loses production capacity or requires significant maintenance. Although a number of alternative locations for the seawater intake and conveyance system were evaluated in the scwd^2 DEIR, this report updates and evaluates three intake alternatives based on the assessment of changed conditions provided in Section 2.

- A seawater desalination plant that would provide for pretreatment processing, desalination treatment and energy recovery, post-treatment processing and distribution, brine storage, residuals handling and disposal, chemical systems, and their associated support facilities. The three plant sites considered for the scwd^2 Desalination Program would continue to be considered for a City seawater desalination project. However, as discussed in Section 2 and Appendix A, an update to the scwd^2 Site Selection for Seawater Desalination Treatment Plant report would be required to make specific reference to the California Ocean Plan siting criteria.
- A brine storage, disposal, and conveyance system consisting of brine storage at the desalination plant, a new pipeline to the City's wastewater treatment facility (WWTF) outfall, and outfall improvements. An update to the scwd^2 Desalination Program Dilution Analysis would be required to specifically address the California Ocean Plan requirements regarding discharge and reduced wastewater flow associated with potential recycled water projects, as discussed in Section 2 and Appendix A. An update to the dilution analysis would also determine the need for a multi-port diffuser on the outfall to provide for adequate mixing at the discharge point.
- Potable water distribution system improvements consisting of a new connection to the City distribution system near the seawater desalination plant site. Interconnections with the Soquel Creek Water District (SqCWD) are not considered for a City seawater desalination project, but such connections with this and other water agencies are reviewed in Section 7 in support of current objectives promoting regional collaboration.

This report provides CEQA/NEPA compliance and permitting approaches and indicates that the primary permitting constraint for the project would be proposing to use an open-ocean seawater intake, because the California Ocean Plan requires a subsurface intake unless such an intake is determined not to be feasible by the Regional Water Quality Control Board (RWQCB). As indicated above, the project includes options for use of an open-ocean intake only and also for a hybrid system where radial collector wells are used in combination with an open-ocean screened intake. As stated in Section 2, on-going consultation with the State Water Resources Control Board (SWRCB) and the RWQCB is recommended during the implementation of the Marine Work Plan (see Appendix A), which was developed after meeting with the SWRCB, RWQCB and the California Coastal Commission (CCC). This consultation and the Intake Technical Feasibility Study Update will determine whether the radial collector well option requires further evaluation via a site-specific marine geophysical study to assess the feasibility of this option.

A City seawater desalination project would meet most of the City's WSAC objectives, as described in Sections 3 and 8. Such a project is technically feasible, as previously determined for the scwd[2] Desalination Program, and could provide sufficient water supply capacity to fill the identified supply-demand gap of 1.2 billion gallons per year (bgy), which equates to approximately 3.3 mgd. While such a project is technically feasible, additional feasibility review of radial collector wells may be required for the project, as noted above.

A City seawater desalination project would not meet the City's timeliness objective because it would not be completed and operational by 2025, as shown in Section 6. The project's estimated completion date is at the end of 2026, assuming a start date of early 2019.

It is not yet known whether a City seawater desalination project would meet the cost-effectiveness objective because this objective is not evaluated in this report. A subsequent analysis will be prepared by the Santa Cruz Water Department (SCWD) to compare seawater desalination to other alternatives under review by the City using the annualized cost per million gallons of average year yield (ACAYY). Also, while the City will consider energy use, public health, and environmental impacts in selecting a supplemental water supply, a comparison of desalination to other alternatives for these factors is not provided in this report.

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1 INTRODUCTION

1.1 Purpose and Organization of Report

This report provides a review of the feasibility, cost, timeliness, and approach for pursuing the final planning and design, construction, and operation of a seawater desalination facility for use by the City. This review will support the City's selection of a supplemental or replacement supply per the WSAC Final Report (WSAC 2015). The WSAC Final Report provides strategies for addressing the identified worst year water supply gap or shortage. The recommended strategies in the WSAC Final Report include conservation to reduce demand, passive and active groundwater recharge, and supply augmentation using advanced-treated recycled water with desalination as a back-up if the use of advanced-treated recycled water not be feasible (WSAC 2015).

The SCWD is currently assessing the feasibility of supply augmentation with advanced-treated recycled water in the event that groundwater recharge strategies prove to be insufficient to meet the WSAC Final Report's stated goals. Because desalination is identified as a backup to the use of advanced-treated recycled water, this report will support the City's selection of its supply augmentation approach (advanced-treated recycled or desalination). Refer to Section 1.2.2 for additional information.

This report is organized to provide the information necessary to support the City's selection of its supply augmentation approach and includes the following sections:

1. **Introduction** – Describes the purpose of the report, the water supply planning background, and the need for the feasibility update for seawater desalination.
2. **Assessment of Changed Conditions** – Provides an assessment of changed conditions since the pursuit of seawater desalination was suspended in 2013 that may affect a possible City seawater desalination project or influence potential environmental review and/or permitting requirements if such a project is pursued by the City.
3. **City Seawater Desalination Project Characteristics** – Presents a City seawater desalination project developed based on review of the changed conditions in Section 2.
4. **CEQA/NEPA Compliance Approach** – Describes the CEQA and NEPA lead agencies for a City seawater desalination project, the CEQA and NEPA compliance approach, and the need for new or updated studies and consultations if such a project is pursued.
5. **Permitting Approach** – Presents a list of required permits for a City seawater desalination project and discusses permitting constraints associated with pursuit of such a project.

6. **Timeliness of Implementation** – Provides a schedule for a City seawater desalination project and assesses whether such a project would meet the City's timeliness objective of having a fully functional water system able to meet the supply-demand gap by 2025.
7. **Opportunities for Regional Collaboration** – Presents regional seawater desalination opportunities consistent with the WSAC Final Report guiding principle regarding promoting regional collaboration to improve water supplies, reverse or slow seawater intrusion, and support habitat restoration.
8. **Conclusions** – Presents the conclusion of the report and the ability of a City seawater desalination project to meet current City objectives.
9. **References** – Provides the cited references used to prepare this report.

1.2 Water Supply Planning Background

1.2.1 Integrated Water Plan

The City has been pursuing possible new water supplies for the past several decades. In 1997, the City initiated an "integrated water planning" approach to consider all practical options for balancing its water supply by decreasing demand and increasing supply. The City Council adopted the City's Integrated Water Plan (IWP) in November 2005 (Gary Fiske & Associates 2003). The City's IWP objectives were to (1) reduce near-term drought shortages, and (2) provide a reliable supply that meets long-term needs while ensuring protection of public health and safety. The IWP components identified to meet these objectives included water conservation, curtailment of water deliveries during drought, and a new supplemental water supply. Water supply alternatives considered in the IWP and related background studies included but were not limited to seawater desalination, reclamation/recycled water, various groundwater options, conjunctive use with SqCWD, maximizing storage in Loch Lomond Reservoir, and reservoir storage in the Olympia Quarry (Gary Fiske & Associates 2003).

Based on the outcome of the IWP and related background studies, seawater desalination was determined to be the most feasible and reliable alternative for a supplemental supply of drinking water. A cooperative operational scenario that involved partnering with SqCWD and constructing a 2.5-mgd seawater desalination plant and related facilities (with the ability to expand the plant up to a maximum of 4.5-mgd to meet future needs through 2030) was selected by the City Council as the preferred alternative. The IWP Program Environmental Impact Report (EIR), certified in 2005, provided a programmatic analysis of a 2.5-mgd desalination facility and incremental expansions up to 4.5 mgd (City of Santa Cruz 2005). The results of the IWP process were incorporated into the City's 2010 Urban Water Management Plan (UWMP) (City of Santa Cruz 2011).

The City and SqCWD partnered to undertake environmental review for the proposed scwd² Desalination Program, which involved the construction and operation of a SWRO desalination plant and related facilities to provide up to 2.5 mgd of potable water. Between 2007 and 2013, desalination background studies on treatment, brine disposal,[1] energy use, intake design, and offshore geophysical conditions, and as well as other studies, were conducted to support the development of the scwd² Regional Seawater Desalination Project Draft EIR (scwd² DEIR) (URS 2013a). The scwd² DEIR (URS 2013a), which evaluated the scwd² Desalination Program, was released for public review and comment in May 2013. The City chose to suspend the pursuit of seawater desalination in late 2013 to allow for a broader public discussion on the topic of water supply for the City.

1.2.2 WSAC Final Report and Urban Water Management Plan

After the pursuit of seawater desalination was suspended in 2013, the City Council approved membership of the WSAC in 2014. The WASC's charge was to "explore, through an iterative, fact-based process, the City's water profile, including supply, demand and future risks; analyze potential solutions to deliver a safe, adequate, reliable, affordable and environmentally sustainable water supply; and, to develop recommendations for City Council consideration" (WSAC 2015). The WSAC developed the WSAC Final Report, which was accepted by the City Council in November 2015. The WSAC Final Report was incorporated by reference into the 2015 UWMP, and the guiding recommendations were presented as the future water supply management strategy for the City (City of Santa Cruz 2016).

The overarching goal of the WSAC Final Report's Water Supply Augmentation Strategy is to provide significant improvement in the sufficiency and reliability of the City water supply by 2025. The recommendations in the WSAC Final Report reflect consensus among WSAC members on how best to address an agreed-upon worst-year gap of 1.2 bgy during modeled worst-year conditions by 2025. As presented in the 2015 UWMP, the Water Supply Augmentation Strategy portfolio elements include the following (WSAC 2015):

- **Element 0:** Additional water conservation with a goal of achieving an additional 200 to 250 million gallons per year of demand reduction by 2035 by expanding water conservation programs.
- **Element 1:** Passive recharge of regional aquifers by working to develop agreements for delivering surface water as an in lieu supply to the SqCWD and/or the Scotts Valley Water District (SVWD) so they can rest their wells, help the aquifers recover, and effectively store water for use by SCWD in drought years.

[1] Brine is the byproduct of desalinated water having a salinity concentration greater than a desalination facility's intake source water (i.e., seawater).

- **Element 2:** Active recharge of regional aquifers by using existing infrastructure and potential new infrastructure in the regionally shared Purisima aquifer in the Soquel-Aptos Basin and/or in the Santa Margarita/Lompico/Butano aquifers in Scotts Valley area to store water that can be available for use by the City in drought years.
- **Element 3:** A potable water supply using advanced-treated recycled water as its source as a supplemental or replacement supply in the event the groundwater storage strategies described above prove insufficient to meet the goals of cost-effectiveness, timeliness, or yield. In the event advanced-treated recycled water does not meet the City's needs, desalination would become Element 3.

See Section 3 for additional information about the Water Supply Augmentation Strategy's goals and objectives. The Work Plan incorporated in the Water Supply Augmentation Strategy recommends selection of the preferred Element 3 by the end of 2017 (WSAC 2015).

To make the selection of the preferred Element 3, the SCWD is completing high-level feasibility studies, conceptual level design, and definition of environmental permitting processes for each option. To facilitate comparative analysis by metrics such as cost, timeliness, and yield, the SCWD is developing the two Element 3 options in a consistent manner to the extent possible. This report presents the framework for review of the seawater desalination option. Unlike the previously considered scwd^2 Desalination Program, the primary focus is on the consideration of a City seawater desalination project to allow for direct comparison with the City's Element 3 recycled water option, review of which is proceeding along a parallel track.

1.3 Need for Feasibility Update

While desalination was previously determined to be feasible by the City during its IWP and scwd^2 planning processes, information developed during the WSAC planning process may influence the size and/or viability of a potential desalination facility or components of such a facility. Other changed environmental conditions and/or regulatory requirements may also influence the viability of, or approach to, pursuing such a facility.

Therefore, this report evaluates these and other changed conditions and provides a modified desalination project description and conceptual-level design information, updated cost estimates, a high-level evaluation of environmental review and permitting approaches, and an assessment of the timeliness of implementing such a project. Opportunities for regional collaboration with other water agencies are also presented based on goals identified in the WSAC Final Report. This information will support the City's selection of its backup source of water.

2 ASSESSMENT OF CHANGED CONDITIONS

The section includes an assessment of changed conditions since the pursuit of seawater desalination was suspended by the City in late 2013. In considering the pursuit of a possible City seawater desalination project, the scwd^2 Desalination Program is evaluated and considered throughout this section, based on the changed conditions presented, to determine the characteristics of a possible City seawater desalination project. Section 3 presents the City seawater desalination project developed based on review of the changed conditions discussed in this section.

This section also reviews changed conditions that may influence potential environmental review and/or permitting requirements if the City pursues a City seawater desalination project.

2.1 scwd^2 Desalination Program Overview

As indicated in Section 1, the City and SqCWD previously partnered to implement the scwd^2 Desalination Program. The program proposed to construct and operate an SWRO desalination plant and related facilities to provide up to 2.5 mgd of potable water. There were the following four basic functional components of a proposed seawater desalination project as part of the program: (1) seawater intake; (2) pretreatment and salt removal through reverse osmosis filtration; (3) disposal of by-products, including brine and solids that are removed in the pretreatment and SWRO processes; and (4) conveyance and delivery of the product water to existing City and SqCWD water distribution systems. Given these functional components, the scwd^2 Desalination Program consisted of the following (URS 2013a):

1. A seawater intake and conveyance system consisting of an intake structure, intake piping, pump station, and transfer piping
2. A seawater desalination plant that would provide for pretreatment processing, desalination treatment and energy recovery, post-treatment processing and distribution, brine storage, residuals handling and disposal, chemical systems, and their associated support facilities
3. A brine storage, disposal, and conveyance system consisting of brine storage at the desalination plant, a new pipeline to the City's WWTF outfall, and outfall improvements
4. Potable water distribution system improvements consisting of a new connection to the City distribution system and a new intertie system between the City and SqCWD service areas, including new pipelines and pump station improvements

Figures 2 and 3 show an overview of the scwd^2 Desalination Program.

2.2 Project Objectives

The prior objectives of the proposed scwd^2 Desalination Program, as presented in the scwd^2 DEIR, address the need for a supplemental water supply, as identified by the City's IWP and the SqCWD's Integrated Resources Plan (IRP) (ESA 2006). The scwd^2 Desalination Program was designed as a joint project for cooperative use by both agencies. The scwd^2 Desalination Program project objectives were developed primarily to achieve the broad policy and planning objectives of the IWP and IRP. The primary objectives for the two agencies, as presented in the scwd^2 DEIR, are as follows (URS 2013a):

1. Provide for a supplemental water supply in a timely manner that meets the IWP and IRP program objectives and provides for the amount of supplemental water supply identified as necessary in the City and SqCWD 2010 UWMPs and/or in other available City and SqCWD reports that complements on-going and future water conservation and drought curtailment efforts. The City and SqCWD need the supplemental water supply for the following reasons:
   - City – During the dry season of dry and critically dry years, a supplemental supply is needed to limit peak season shortages to 15 percent of normal water needs currently projected through 2030, which is the reliability objective set by the City in the long term. The supplemental supply needs to support potable uses given that irrigation and other outdoor uses will already be restricted during these periods.
   - SqCWD – A supplemental supply is needed in the near term to meet the SqCWD's target groundwater yield during the time period in which the basin recovers from overdraft and in the long term to provide for currently projected water demand through 2030.

The City's water supply planning objectives have changed since the adoption of the IWP and with the completion of the WSAC Final Report and 2015 UWMP:

1. The scwd^2 Desalination Program was a regional project with the SqCWD, whereas the WSAC Final Report and 2015 UWMP consider City supply reliability, although regional collaboration is also supported.
2. The scwd^2 Desalination Program was sized based on an objective of limiting peak season shortage to 15%, whereas WSAC supply alternatives are aimed at eliminating peak season shortages (water supply gap of 1.2 bgy during modeled worst-year conditions) by 2025. It should be noted that, while the WSAC objectives are based on zero peak season shortages, future studies will compare the cost of allowing for shortages with allowing for no shortages.

3. Desalination is being pursued as a supplemental or replacement supply only if the groundwater storage strategies and advanced-treated recycled water prove to be insufficient to meet the WSAC Final Report/2015 UWMP Water Supply Augmentation Strategy's goals, as described in Section 1.2.2.

The City's new objectives, based on the WSAC Final Report and the 2015 UWMP, are presented in Section 3.

2.3 OPA Requirements and Project Analysis

2.3.1 Requirements

In effect since 2016, the Amendment to the Water Quality Control Plan for Ocean Waters of California Addressing Desalination Facility Intakes, Brine Discharges, and the Incorporation of Other Non-Substantive Changes (OPA) is now included in the California Ocean Plan (SWRCB and CalEPA 2015). For a RWQCB to make a California Water Code, Section 13142.5(b), determination based on the new requirements under the OPA, it must first analyze a range of feasible alternatives for the following four factors: the best site, design, technology, and mitigation measures. The RWQCB involved in reviewing a particular desalination project (Central Coast RWQCB for a project in the City) will then consider these factors collectively to determine the best combination of feasible alternatives that minimize the mortality of all forms of marine life, including plankton and larvae. While these are permitting requirements, they may influence the location, design, and characteristics of a desalination project and, therefore, are considered here to support the development of the modified desalination project description presented in Section 3.

Site

According to the OPA, a desalination plant's site is the general location of its onshore facilities (e.g., filtration facility) and offshore facilities (e.g., intake and discharge). To determine whether a desalination facility is located at the "best available site feasible," the following questions must be answered:

- Are subsurface intakes feasible at the site?
- Is there an identified need for the desalinated water according to an UWMP or other water planning documents?
- Does the site avoid impacts to sensitive habitats and species, including Marine Protected Areas and State Water Quality Protection Areas, such as Areas of Special Biological Significance?

- What are the direct and indirect effects to all forms of marine life from construction and operation in the cumulative project area?
- Considering the oceanographic, geologic, hydrogeologic, and seafloor topographic conditions, how can the facility be sited to minimize the intake and mortality of all forms of marine life?
- Is there existing discharge infrastructure and sufficient wastewater available to feasibly dilute the desalination plant's brine discharge?

Design

According to the OPA, a desalination facility's design must consider its size, layout, form, and function, as well as the capacities of its intake and discharge facilities. A given site may have several possible configurations for the best available design feasible.

To determine whether a desalination facility's design is the best available design feasible to minimize mortality to all forms of marine life, the OPA requires that the general design configurations be evaluated. For intakes, if subsurface intakes are not feasible, as defined by the California Ocean Plan and as determined by the RWQCB, the evaluation must also analyze the design configurations to minimize mortality of all forms of marine life. For outfalls, the brine discharge must be designed so the brine mixing zone does not adversely affect sensitive habitats and the discharge does not cause negatively buoyant plumes and minimizes the suspension of benthic sediments.

Technology

The OPA defines technology as the type of equipment, materials, and methods used to construct and operate a desalination facility's design components. Similar to a facility's design, the OPA requires an evaluation of the technology to determine the "best available technology feasible" to minimize mortality of all forms of marine life.

The OPA specifies particular criteria for determining the best available technology feasible for desalination facility intakes and discharges separately. These criteria are presented below.

<u>Intakes</u>

The OPA requires subsurface intakes unless they are deemed infeasible based on geotechnical data, hydrogeology, benthic topography, oceanographic conditions, the presence of sensitive habitats and species, energy use for the entire facility, design constraints, and the project's life-cycle cost demonstrating that a subsurface intake would not be economically viable.

However, subsurface intakes cannot be determined infeasible by only demonstrating that their individual design capacity would not meet the identified need for desalinated water. Instead, an evaluation is required to determine if subsurface intakes would be feasible to meet a reasonable range of alternative intake design capacities. Additionally, this analysis may determine that a combination of both subsurface and surface intakes may be the best feasible alternative to minimize intake and mortality of marine life while meeting the identified desalinated water need. Surface intakes are referred to as open-ocean intakes in the $scwd^2$ Desalination Program documents and in this report.

If subsurface intakes are deemed infeasible, the open-ocean intake must avoid disturbing sensitive habitats and species to the maximum extent feasible. If open-ocean intakes are used, they are required to be screened with a 1-millimeter or smaller slot size screen and have a through-screen velocity below 0.5 feet per second, unless it can be demonstrated that an alternative method of preventing entrainment[2] would provide equivalent or better protection of marine life mortality from the intake of seawater.

Discharges

The OPA mandates analyzing the potential to commingle the facility's brine discharge with existing wastewater discharge under two conditions: there is adequate wastewater flow for sufficient salinity dilution, and the discharge does not preclude future wastewater recycling.

If commingling with wastewater is not feasible, a multi-port diffuser must be used for brine discharge and must be designed with sufficient flow velocity to rapidly mix the brine with ambient ocean water and avoid a negatively buoyant plume that could impact the ocean floor. Multi-port diffusers must maximize dilution, minimize the size of the brine mixing zone,[3] minimize suspension of benthic sediments, and minimize the mortality of marine life.

Regardless of the brine discharge technology, studies or modelling must be conducted to estimate the degradation of all forms of marine life from elevated salinity within the brine mixing zone, including osmotic stresses and duration of exposure to toxic conditions. If high-velocity jets are included, the effect of velocity shear and turbulence on organisms entrained in such jets must also be provided.

[2] Entrainment is the passage of planktonic organisms through a water intake system (URS 2013a).
[3] The brine mixing zone is an allocated impact zone where there may be toxic effects on marine life due to elevated salinity. This zone is the area where salinity may exceed 2.0 parts per thousand above natural background salinity. The standard brine mixing zone shall not exceed 100 meters (328 feet) laterally from the points of discharge and throughout the water column unless an alternative brine mixing zone is approved.

Mitigation Measures

Mitigation involves replacing all marine life or habitats lost from constructing and operating a desalination facility. The OPA requires the best available mitigation measures feasible to minimize the mortality of all forms of marine life after determining the best available site, design, and technology feasible.

To determine the level of mitigation required, a Marine Life Mortality Report must be submitted to the RWQCB that quantifies the construction and operational impacts of the desalination facility on all forms of marine life. For example, for construction impacts, the disturbance of habitat would be quantified. For operational impacts, entrainment- and elevated-salinity-related marine life mortality would also be quantified. The entrainment study and sampling period shall be at least 12 months. The Marine Life Mortality Report will translate the mitigation requirement to the area of production foregone (APF)[4] and mitigate the impacts through a mitigation project as a fee-based mitigation program is currently not available.

Monitoring and Reporting Plan

Under the OPA, a Monitoring and Reporting Plan must be submitted to the RWQCB to determine the baseline biological conditions before and after constructing and operating the desalination facility. The Monitoring and Reporting Plan must describe ways to monitor for benthic health, aquatic life toxicity, hypoxia, and receiving-water characteristics to demonstrate compliance with receiving-water limitations, including salinity.

2.3.2 Project Analysis of Ocean Plan Amendment

This section evaluates the prior scwd[2] Desalination Program based on the OPA to determine if any modifications need to be considered to pursue a seawater desalination project under current regulatory requirements. The need for additional technical study is also identified, where warranted, to comply with the OPA.

Need for Desalinated Water

The use of desalinated water is identified as a potential supplemental or replacement supply of potable water in the City's 2015 UWMP. As indicated in Section 1.2.2, the WSAC Final Report and the 2015 UWMP identify Water Supply Augmentation Plan portfolio elements to fill the worst-year gap of 1.2 bgy during modeled worst-year conditions by 2025. The elements include

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[4] APF is an estimate of the area that is required to produce (replace) the same amount of larvae or propagules that are removed through entrainment at desalination facility intakes. APF is calculated by multiplying the proportional mortality by the source water body, which are both determined using an empirical transport model (ETM).

expanding water conservation and implementing passive and active recharge of regional aquifers to store water for use by the City in drought years. In the event the groundwater storage strategies prove insufficient to meet the City's goals, a potable water supply using advanced-treated recycled water would be developed as a supplemental or replacement supply. Desalination would become the supplemental or replacement supply if advanced-treated recycled water is determined not to meet the City's needs. See Section 1.2.2 for additional information.

> ***Conclusion – Need for Desalinated Water:*** Adequate information exists in the City's 2015 UWMP (City of Santa Cruz 2016) to show the need for desalinated water as a back-up source of supplemental or replacement supply of potable water. Desalinated water would become the supplemental or replacement supply if advanced-treated recycled water is determined not to meet the City's needs. The City's 2020 UWMP will reflect the City's ultimate determination on this matter and could further document the need for desalinated water, if that is the decision made by the City. It will also report on the status of the preferred approach of using passive and active recharge of regional aquifers and whether this approach can meet the City's needs.

Plant Site Location

To determine whether the desalination plant site is located at the best available site feasible, the OPA looks at whether subsurface intakes are feasible and whether there is existing discharge infrastructure and sufficient wastewater available to feasibly dilute the desalination plant's brine discharge. The plant site location would also be evaluated in terms of the ability to avoid impacts to sensitive habitats and species, including Marine Protected Areas and State Water Quality Protection Areas, and to minimize the intake and mortality of all forms of marine life.

After evaluating three areas in the IWP EIR (Areas A, B, and C), all in the westside of the City (as shown on Figures 4 and 5), the scwd^2 DEIR considered three plant site location alternatives in the Industrial Park Area (Area A) after conducting an expanded site selection technical review (see scwd^2 DEIR, Appendix K). The sites in Area A were in the closest proximity to the City's existing WWTF outfall structure and possible intake locations; were of adequate size; had consistent land use designations, zoning, and surrounding land uses; and avoided environmental constraints and regulatory requirements of Areas B and C. The Area A plant location alternatives allow for the brine from a desalination plant to be blended with the effluent from the City's WWTF and returned to the Monterey Bay through the City's existing outfall to the southeast of Area A, which is an OPA priority. Additionally, Area A is in proximity to screened, open-ocean intake locations and a potentially viable subsurface intake location to the south and east in the Monterey Bay (URS 2013a).

Consideration of other desalination plant sites in the broader region does not appear to be warranted to provide for a desalination plant site considered the best available site feasible. Therefore, the Area A plant location alternatives should continue to be considered if the City pursues a desalination project.

> ***Conclusion – Plant Site Location:*** Adequate analysis of plant sites exists in the scwd^2 DEIR and appendices to support a permitting package for the RWQCB to make a California Water Code, Section 13142.5(b), determination. However, updating of the information presented may be required to make specific reference to the OPA siting criteria identified above to support the RWQCB findings on whether the plant and intake sites constitute the best available site feasible. A Site-Selection for Seawater Desalination Treatment Plant Update Review should be prepared to document this updated information (see Appendix A, Seawater Desalination Marine Work Plan). The scope of work for this update should be reviewed with the agencies, prior to launching the update review.

Intake Sites, Design, and Technology

Intake Design/Technology

As described in the scwd^2 DEIR (URS 2013a), two fundamental types of intake technologies were evaluated by the scwd^2 Desalination Program: subsurface intakes, and screened, open-ocean intakes.[5] As summarized in the scwd^2 DEIR, a number of studies have been conducted since 2001 that informed the scwd^2 Desalination Program about the types of intake structures and possible locations that could be considered. See also Appendix A, Seawater Desalination Marine Work Plan for a summary of prior marine-related studies conducted for or referenced in the scwd^2 DEIR.

In 2001, a conceptual-level hydrogeological study was conducted in support of the IWP to evaluate the potential for vertical beach-well intakes (Black and Veatch Engineers and Hopkins Groundwater Consultants 2002), which is a type of subsurface intake. The report concluded that the City coastline from the beachfront adjacent to the City Boardwalk to Rio Del Mar does not have suitable geology and hydrogeological conditions for vertical beach wells to produce sufficient source water for a 2.5-mgd desalination plant. In 2008, in support of the scwd^2 Desalination Program, a review of new technologies and approaches to subsurface intakes being developed in California and other areas of the world was conducted (Kennedy/Jenks Consultants 2008). Because of the potential advantages of sub-seafloor intake technologies in providing passive protection of marine organisms,

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5 Subsurface intakes can draw in brackish groundwater and/or seawater from beneath the seafloor. Screened, open-ocean intakes draw seawater from an open-ocean environment through protective, fine-mesh screens.

the previously referenced study recommended that additional investigation and evaluation of subsurface intake systems be conducted.

In general, deep sand and gravel alluvium that is hydraulically connected to the ocean is required for subsurface intakes to function reliably over time. With that consideration, the scwd^2 Desalination Program conducted a detailed offshore geophysical study to identify the location, dimensions, and depth of the probable offshore portion of an alluvial basin associated with the San Lorenzo River, and to provide an initial characterization of the type of sediment filling the basin (EcoSystems Management Associates Inc. 2010). The offshore portion of this alluvial basin was the focus of the study, based on the results of the 2001 Hopkins study and consultation with U.S. Geological Survey staff, which excluded areas to the north above Wilder Ranch State Park and to the south down to Capitola.[6] The geophysical and hydrogeological data and information obtained[7] were used in the evaluation of the technical and engineering feasibility of the sub-seafloor intake approaches provided in Appendix H of the scwd^2 DEIR (Kennedy/Jenks Consultants 2011).

The Intake Technical Feasibility Study evaluated the feasibility and site-specific requirements of both sub-seafloor and screened, open-ocean intake approaches. Based on specific design, operational, and/or siting requirements for the type of intake, the Intake Technical Feasibility Study concluded that a screened, open-ocean intake is the "apparent best intake approach" in terms of engineering feasibility (Kennedy/Jenks Consultants 2011). The sub-seafloor options, including vertical beach wells, slant wells, and offshore-engineered infiltration gallery, were determined to be not feasible for the scwd^2 Desalination Program. Criteria used in reaching these conclusions included: production capacity and reliability; proven technology and track record (risk); energy use; permitting; operational flexibility and maintainability; constructability; and project lifecycle costs. scwd^2 DEIR, Section 8.1, and Appendix H provide detailed information about these feasibility determinations.

As described below, offshore radial collector wells were determined to be potentially viable; however, they were not recommended for the scwd^2 Desalination Program. Given that the OPA

6 The City and SqCWD staff met with local U.S. Geological Survey scientists to discuss and re-evaluate potential locations for subsurface intakes along the coast near the City. The coastline from above Wilder Ranch State Park down to Capitola was evaluated. To the west of the City and offshore of Wilder Ranch State Park, the streams that discharge into the ocean are too small to have carved out an alluvial channel that could be suitable for a subsurface intake system. Likewise, beaches and locations where streams discharge into the ocean south of the City are also too shallow to have enough sediment for a subsurface intake system. Because of these disadvantages, these locations were not considered further (Kennedy/Jenks Consultants 2011).

7 Seismic reflection data were collected and interpreted to estimate the thickness of alluvial sediment. Sediment vibracores were obtained and tested to identify geotechnical properties (i.e., soil type, grain size, density, and hydraulic conductivity).

requires subsurface intakes unless they are deemed infeasible, as previously described, radial collector wells are further reviewed below and in the remainder of this report.

Radial collector wells consist of large, vertical concrete shafts (caissons) sunk down into the seafloor, with well screens extending from the caisson in a radial pattern. Seawater flows through the seafloor alluvial materials and into horizontal well screens that connect to the caisson. The collector pumps at the intake pump station would draw water from the caisson. As noted in the Intake Technical Feasibility Study (Kennedy/Jenks Consultants 2011), an offshore sub-seafloor radial collector well system could be constructed in the offshore alluvial basin, off the San Lorenzo River, out past the end of the Santa Cruz Municipal Wharf (Wharf). The Intake Technical Feasibility Study concluded that, although offshore radial collector wells are potentially viable, they are not recommended for the scwd[2] Desalination Program, because they (Kennedy/Jenks Consultants 2011):

- May not be able to reliably provide the required production capacity. The mobile sediment layer and the heterogeneous nature of the offshore alluvial channel sediment will limit the vertical and horizontal movement of water to the collectors. Therefore, it is expected that multiple collector wells (two, three, or more) would be needed to provide the required flow rates. Multiple wells would have significant capital costs, and there may not be space for more than two or three collector wells in the offshore alluvial channel. To understand the actual production capabilities from a radial collector well, a full-size system would need to be constructed, operated, and monitored. This very expensive information gathering exercise would carry the risk that, after committing significant resources to construct the system, the intake may not provide the required production capacity.
- Are an unproven technology in an offshore marine environment. While radial collector wells have been used in rivers and on beaches, there have not been any radial collector wells installed in offshore locations. Therefore, there is no long-term radial collector well operational track record in offshore, open seawater locations.
- Provide low operational flexibility. Radial collector wells have limited operational flexibility and relatively complex maintenance requirements if they clog up or lose production capacity because of their buried nature. If a collector well irreversibly clogs up and loses capacity, there is no way to increase production other than through installation of additional new collector wells, which would require significant construction, expense, and time. Such additional new collector wells could also be subject to similar operational problems.
- Are the most complex to construct. Radial collector wells have the highest degree of construction complexity compared to other subsurface intake configurations because this

type of system has never been constructed in ocean environments, and it would require the construction and connection of multiple offshore radial wells.

Because of the recent requirements of the OPA, a subsurface radial collector well system may need to be reconsidered as an intake design option even though it was not previously recommended for the scwd^2 Desalination Program as described above. For this report, the subsurface radial collector well system has been included as an intake alternative (See Section 3 for additional details). However, significant additional study would be required to confirm the overall feasibility of this potential intake approach. Additionally, conclusions about feasibility for all subsurface intake options studied would need to be made within the context of the definition of "feasible" per the OPA (see below):

Conclusions – Intake Design and Technology: The prior scwd^2 Offshore Geophysical Study (EcoSystems Management Associates Inc. 2010) and Intake Technical Feasibility Study (Kennedy/Jenks Consultants 2011) provide substantive information on which to base future CEQA evaluation and permitting. For permitting through the RWQCB, conclusions about feasibility for all subsurface intake options previously studied will need to be made initially by City and ultimately by the RWQCB within the context of the definition of "feasible" per the OPA, which is "capable of being accomplished in a successful manner within a reasonable period of time, taking into account economic, environmental, social, and technological factors" (SWRCB and CalEPA 2015). Discussions with the SWRCB and RWQCB during the preparation of this report (see Appendix A) indicate that an update to the Intake Technical Feasibility Study would be required to specifically address the California Ocean Plan requirements and feasibility definitions, and any new technologies since the prior study, including horizontal directional drilling (HDD) systems.[8] For this report, it is assumed that similar conclusions would be reached about the infeasibility of vertical beach wells, slant wells, and offshore-engineered infiltration gallery, as were reached in the Intake Technical Feasibility Study and that HDD systems would also be determined to be infeasible. As indicated above, radial collector wells were determined to be potentially viable, but an assessment of feasibility under the OPA definition will need to be provided. To assess the technical feasibility of radial collector wells, substantive additional study would be required, which would likely include the following:

[8] HDD systems (e.g., Neodren) consist of a series of horizontal drains extending seaward from the shore, fanned out to provide adequate separation. Individual porous pipes deliver water into a common wet well. Due to the limited extent of the subsurface alluvial channels associated with the San Lorenzo River Alluvial Basin and other beaches in the area, a HDD system would not likely be feasible.

1. Conduct offshore geotechnical borings in the areas of the proposed radial collector wells to confirm and better characterize the offshore, sub-seafloor alluvial hydrogeological properties.
2. Drill offshore test wells in the areas of the proposed radial collector wells to conduct pump draw-down and water production testing of the sub-seafloor alluvial basin. (While the Intake Technical Feasibility Study indicated that a full-size system would need to be constructed, operated, and monitored [Kennedy/Jenks Consultants 2011], to understand the actual production capabilities from a radial collector well, the offshore test wells proposed here should provide sufficient information to estimate production capabilities.)
3. Conduct alluvial draw-down and water production testing. These are standard tests that are conducted for onshore radial collector wells, which would need to be modified and adapted for an offshore environment.
4. Analyze the data and prepare a report on the expected production from an offshore radial collector well in the alluvial basin off the Wharf.
5. Conduct water quality testing to understand the constituent makeup of the subsurface water (e.g., salt levels, turbidity, iron, and manganese) and determine source-water suitability and/or any issues.

Regulatory permitting, planning, and conducting of the borings, tests, and reporting could take 2 to 3 years to complete. The testing would provide an indication of how much water could be collected through radial collector wells and whether the system would be reliable. It is likely that if such a system were pursued, an open-ocean screened intake would also need to be installed as part of the overall system to provide supplemental intake water, should the radial collector wells lose production capacity and/or require significant maintenance.

Overall, it is unclear if radial collector wells would be determined by the RWQCB to meet the OPA definition of "feasible," given the substantial investment in time and costs to accomplish the testing, the substantial additional capital costs associated with implementing radial collector wells (35% of capital costs, as shown in Section 3.4), and the lack of confidence about production capabilities and reliability. The Intake Technical Feasibility Study Update scope of work should be coordinated with the involved agencies (see Appendix A for the study description). Ultimately, the review of the updated study will determine whether the above additional in-water work would be required to further assess the feasibility of radial collector wells.

Intake Sites

After the conclusion of the scwd[2] Intake Technical Feasibility Study and the City's selection of the open-ocean intake approach, 18 site locations for a screened, open-ocean intake were evaluated in the scwd[2] Regional Seawater Desalination Project Seawater Intake Conceptual Design Report (URS 2013b) along the coastline from the San Lorenzo River to Natural Bridges State Beach. Eight locations were determined to be feasible and were the subject of the conceptual design process and the EIR evaluation. This area was selected due to its proximity to the plant site location in Area A.

Discussions with the SWRCB and the RWQCB during the preparation of this report (see Appendix A) indicate that additional intake locations may need to be evaluated to ensure that the best available intake site is selected, if an open-ocean intake is pursued. The need to evaluate additional open-ocean intake locations will be assessed during the preparation of the Intake Technical Feasibility Study Update.

> ***Conclusions – Intake Sites:*** A Intake Technical Feasibility Study Update would be required to determine whether additional open-ocean intake locations should be considered and evaluated (see Appendix A for study descriptions).

Discharge Sites, Design, and Technology

As described in the scwd[2] DEIR (URS 2013a), brine would be generated from the SWRO process and would be approximately twice as saline as seawater or about 60 parts per thousand. The scwd[2] Desalination Program proposed to blend (commingle) the brine with treated wastewater effluent from the City's WWTF and return it to Monterey Bay through the City's existing outfall, which is consistent with the requirements of the OPA.

As indicated above, the OPA mandates commingling the desalination facility's brine discharge with existing wastewater discharge if there is adequate wastewater flow for sufficient salinity dilution, and the discharge does not preclude future wastewater recycling. The adequacy of wastewater flow to provide sufficient salinity dilution in combination with one or more recycled water projects would depend on the size and type of project. The City is reviewing various recycled water projects in the Recycled Water Facilities Planning Study (RWFPS) to determine whether such projects would meet the City's identified worst year gap. Additionally, SqCWD is currently pursuing its Pure Water Soquel Project as its preferred supplemental water supply. These projects would use secondary treated wastewater from the City's WWTF and further treat that wastewater, as specified for each project. There may be adequate wastewater remaining to provide for dilution of brine from a seawater desalination project if the City implements the two recommended smaller projects from the RWFPS,[9] which would use approximately 0.5 mgd of secondary effluent, and SqCWD implements the Pure Water Soquel Project, which would use approximately 2.0 to 3.0 mgd of secondary effluent.

A Dilution Analysis conducted to support the scwd^2 DEIR concluded that the WWTF National Pollutant Discharge Elimination System (NPDES) discharge permit minimum initial dilution requirement and ambient salinity at the outfall could be maintained with the scwd^2 Desalination Program. An update or revision to the Dilution Analysis would be required to specifically address the OPA requirements regarding discharge and potentially reduced wastewater flow associated with possible City recycled water projects and the SqCWD's Pure Water Soquel Project.

> ***Conclusions – Discharge Sites, Design, and Technology:*** An update or revision of the scwd^2 Dilution Analysis would be required to address OPA requirements and potentially reduced wastewater flow due to implementation of one or more recycled water projects. Such a revised study would also determine whether a multi-port diffuser on the WWTF outfall would be required under the OPA and if so determine the best available diffuser to minimize the intake and mortality of all forms of marine life (see Appendix A for study description). If secondary effluent is not adequate to provide for dilution of brine on a year-round or seasonal basis, a multi-port diffuser would provide for adequate mixing in no to low wastewater blending conditions.

Mitigation, Monitoring, and Reporting

A Marine Life Mortality Report would be required by the RWQCB if a City desalination project were to go forward to permitting. The OPA calls for the use of an Empirical Transport Model (ETM)/APF approach to estimating entrainment of a broad range of species, species morphologies, and sizes under representative environmental and operational conditions. However, to date, the ETM/APF approach has focused on species of fish eggs and larvae as representative species to provide a conservative approach to the impacts assessment. The methodology for conducting this analysis is currently under review by the RWQCB. An issue is whether and how to quantitatively estimate the mortality of all forms of marine life, including sensitive and special-status species that may not be identified through the ETM/APF approach, as well as meroplankton (non-fish larvae forms of planktonic life) that are not measureable using ETM/APF.

The scwd^2 Desalination Program prepared an Open Ocean Intake Effects Study (Tenera 2010) (see scwd^2 DEIR, Appendix G) that evaluated the impacts to marine life from the previously proposed open-ocean intake, specifically from the intake of raw seawater. Update or expansion of this study

[9] A seawater desalination project could also be considered in combination with the two recommended smaller projects from the RWFPS.

would be required to specifically address both the construction and operational impacts of a newly proposed desalination facility based on its specific intake and discharge design. The operational impacts would include those associated with intake (entrainment) and discharge (entrainment/shear and elevated salinity). The need to conduct new source-water sampling at the proposed intake locations or to study additional locations will need to be determined in consultation with the SWRCB and the RWQCB. As indicated previously, the Marine Life Mortality Report will translate the mitigation requirement to the APF and mitigate the impacts through a mitigation project as a fee-based mitigation program is not currently available.

> ***Conclusions – Mitigation, Monitoring, and Reporting:*** A Marine Life Mortality Report would be required by the RWQCB if a City desalination project were to go forward to permitting. Update or expansion of the scwd[2] Desalination Program Open Ocean Intake Effects Study would be required to specifically address both the construction and operational impacts of a newly proposed desalination facility based on its specific intake and discharge design (see Appendix A for study description). The operational impacts would include those associated with intake (entrainment) and discharge (entrainment/shear and elevated salinity).

Overall Conclusion Related to the OPA

While the OPA is fairly explicit in terms of the information that will be needed to make a determination under California Water Code, Section 13142.5(b), neither the State Water Resources Control Board (SWRCB) nor any of the RWQCBs have completed a determination for a desalination project to date. Additionally, the process for the RWQCB reaching conclusions on feasibility of any of the factors identified in the OPA is not entirely clear. However, there may be precedent established with other desalination projects between the time that this report is issued and submittal of an application to the RWQCB for a potential City desalination project. Such precedent may provide some assistance and clarity about the information required to support the determination. Early consultation with the SWRCB, RWQCB and other involved agencies was conducted during the preparation of this report and resulted in the Marine Work Plan presented in Appendix A. If the City decides to pursue a desalination project, ongoing consultation with these agencies is recommended to get input on updated study scopes of work, draft reports, and decisions about the need for additional study.

2.4 Review of Other Changed Conditions

This section reviews other changed conditions that may affect the design, location, environmental review, and/or permitting of a City seawater desalination project.

2.4.1 scwd^2 DEIR Public Comments Review

The scwd^2 DEIR was released for public review in May 2013. Approximately 300 separate agencies, organizations, and individuals commented on the scwd^2 DEIR. In total, 18 comment letters were received from agencies, including almost all of the federal, state, regional, and local agencies that would have been involved in the scwd^2 Desalination Program as permitting, trustee, or responsible agencies (listed in Section 5). Comments were also received from non-profit groups, attorneys, businesses, and individuals. A high-level review of these comments was conducted during the preparation of this report to determine whether they may have potential implications for the design, location, environmental review, and/or permitting of a City seawater desalination project. The list below summarizes the key comments made by agencies, organizations, and individuals that may have implications for a City seawater desalination project if pursued. It should be noted that not every topic raised in the comments is reflected in the following list:

1. **Need for the Project/Other Water Supply Alternatives**
   - Exploration/evaluation of other land-based sources of water, including various sources of water or infrastructure improvements alone or in combination. Many individual commenters also disagreed with the conclusions made about the alternatives evaluated in detail in the scwd^2 DEIR (Monterey Bay National Marine Sanctuary [MBNMS], National Marine Fisheries Service [NMFS], California Department of Fish and Wildlife [CDFW], California Coastal Commission [CCC], and various other public commenters).
   - Consideration of opportunities being investigated by County of Santa Cruz Conjunctive Use Program, a combination of infrastructure improvements and upgrades to the City's water facilities, a smaller desalination project in combination with other sources, use of subsurface intakes if a smaller desalination project is pursued in combination with another source (NMFS, CDFW, CCC, CDFW, and various other public commenters).
   - Many commenters questioned the basis for the stated water supply need for the scwd^2 Desalination Program, including indicating that the project objectives were too narrowly defined (various public commenters).
2. **Marine Components and Associated Impacts**
   - Use of the Wharf intake site alternatives for the seawater intake (SI-9 and SI-18) is preferred because the area is sandy habitat with less larval densities than rocky reef habitat, provides maximum separation from the Natural Bridges State Marine Reserve, has already been altered by long-standing infrastructure and activity, and provides

better protection than the exposed coastline along West Cliff Drive (MBNMS, NMFS, and CDFW).

- Use of the Wharf intake site alternatives is required to avoid take in the Natural Bridges State Marine Reserve according to the California Fish and Game Code, Section 28 (CDFW).
- SI-17, constructing a pump station adjacent to the Wharf, was not preferred as the alternative requires new Wharf piles and the other alternatives do not (MBNMS).
- Clarification on how the 100-foot buffer from the kelp beds was determined to be the appropriate buffer distance for the intake structures. Provision of further analysis of locating the intake in deeper water because this may have less of an impact on nearshore marine resources. Involved regulatory agencies should be consulted on the buffer distance (CCC and CDFW).
- Provision of additional details about marine construction activities (dredging, drilling, anchoring, tunneling, pipeline armoring, and installation of Red Valves on the WWTF outfall diffuser ports) and quantification of associated impacts and biological loses. The EIR should include proposed plans for addressing impacts, such as Anchoring Plan, Spill Prevention and Response Plan, "Frac-Out" Prevention and Response Plan, Fish and Marine Mammal Hydroacoustic Monitoring Plan, and Rocky Nearshore Habitat Monitoring Plan (MBNMS, CCC, CDFW, and California State Lands Commission [CSLC]).
- Provision of specific analysis of impacts to larvae at a local scale (by intake locations) from entrainment and impingement[10] and quantification of "habitat production foregone." Descriptions of whether locating intakes farther offshore or in deeper areas might reduce entrainment. California Coastal Act, Section 30231, should be cited as the basis for assessing all feasible means for minimizing entrainment (MBNMS, CCC, and CDFW).
- Evaluation of other listed species or species that may be listed, including pinto abalone (*Haliotis kamtschatkana*), Central California Coast coho salmon (*Oncorhynchus kisutch*), Xantus's murrelet (*Endomychura hypoleucus*), and white shark (*Carcharodon carcharias*). Impacts on marbled murrelet (*Brachyramphus marmoratus*), southern sea otter (*Enhydra lutris nereis*), and brown pelican (*Pelecanus occidentalis*) require additional analysis (NMFS, U.S. Fish and Wildlife Service, and CDFW).

10 Impingement occurs when organisms that are sufficiently large enough to avoid going through the screens are trapped against them by the force of the flowing source water. Entrainment occurs when marine organisms enter the desalination plant intake, are drawn into the intake system, and pass through to the treatment facilities (WateReuse 2011).

- Use of CCC's more stringent underwater noise thresholds for fish and marine mammals in the hydroacoustic analysis of marine construction (MBNM and CCC).
- Assessment of the potential release of buried contaminants into the water column during construction, especially for sites adjacent the Wharf (MBNMS).
- Consideration of the effects of sea-level rise on all resource categories potentially affected by the $scwd^2$ Desalination Program (CSLC).
- The incorrect depiction of the MBNMS boundary in the DEIR and the Wharf area, located inside the Monterey Bay National Marine Sanctuary (MBNMS).

3. Desalination Plant Site Locations

- Elimination of desalination plant site A-2 from further consideration due to habitat constraints associated with monarch butterfly (*Danaus plexippus*) habitat and the site's proximity to Natural Bridges State Park (CCC and California Department of Parks and Recreation).

4. Seawater Intake Pump Station Sites in Neighborhoods

- Many neighbors in the westside of the City expressed concern about the seawater intake pump station locations located in neighborhoods along West Cliff Drive. Concerns about noise, vibration, aesthetics, loss of recreational space, and other types of land use conflicts were raised (various public commenters).

5. Terrestrial Biological Resources

- Provision of additional mitigation for riparian habitat and San Francisco dusky-footed woodrat (*Neotoma fuscipes annectens*) (CDFW).

6. Greenhouse Gas Reduction Strategy

- Inclusion of the Greenhouse Gas Emission Reduction Plan in the EIR that details the greenhouse gas emissions expected to be generated due to the facility and the measures proposed to meet the criteria for reducing those emissions. Additional information about the use of carbon offsets was requested. Methods of calculating greenhouse gas emissions and inclusion of various greenhouse gas emissions reduction projects were also discussed and questioned (CCC, CSLC, and various other public commenters).

7. Growth Inducement

- Comments were received indicating that the $scwd^2$ Desalination Program would be growth inducing and/or disagreeing with all or portions of the growth inducement analysis in the $scwd^2$ DEIR (various public commenters).

8. Transportation

- The City's level of service standard of significance is not appropriate (California Department of Transportation).
- Potential project increases in vehicles, pedestrians, and bicycles and associated safety impacts at or near at-grade rail crossings should be evaluated (California Public Utilities Commission).

9. Water Rights

- The intertie between the two water systems creates the potential for water diverted under the City's water rights to be delivered to SqCWD's service area, which is not included in the authorized place of use. This would be a violation of the City's water rights. The City should collect information to show that the amount of water delivered through the intertie would not exceed the amount of water generated by the plant (SWRCB).

10. Water Quality

- Concerns were raised about the quality of the drinking water produced from the $scwd^2$ Desalination Program (SWRCB).

Conclusions – $scwd^2$ DEIR Public Comments Review: The comments raised regarding consideration of other water supply alternatives have largely been addressed through the WSAC Final Report and implementation of the Water Supply Augmentation Strategy, which is underway. If the City selects desalination as its supplemental or replacement water supply (see Section 1), the key comments above are useful in the development of a City seawater desalination project and in the environmental review and permitting processes.

There was a strong preference by the regulatory agencies for the seawater intake system to be located near the Wharf to avoid the rocky kelp forest off West Cliff Drive and the Natural Bridges State Marine Reserve. Additionally, many concerns about land use conflicts with pump station locations in neighborhoods along West Cliff Drive were raised by Westside neighbors. Given the above, consideration should be given to reducing the number of seawater intake site alternatives along West Cliff Drive if a desalination project is pursued.

While several commenters indicated that Plant Site Alternative A-2 should be removed from further consideration, it is recommended that this site be retained because the City does not own the properties included in Plant Sites A-1, A-2, and A-3. Flexibility in the siting of a desalination plant on one of these sites will be required going forward if a desalination project is pursued.

The other comments above will be useful in refining the scope of work and study requirements for a CEQA or NEPA document if a desalination project is pursued. See Section 4 for additional information about new and updated studies and consultations that may be required during environmental review and permitting if a desalination project is pursued.

2.4.2 City of Santa Cruz Wharf Master Plan

In July 2013, the City embarked on preparation of the Santa Cruz Wharf Master Plan (Master Plan; Roma Design Group 2014). Because one of the alternative seawater intake and pump station locations (SI-17 as shown in Figure 2) was sited on the Wharf in the scwd^2 DEIR, a discussion of the Master Plan is provided below.

The Master Plan was prepared with federal funds through the U.S. Department of Commerce Economic Development Administration and completed in October 2014, including an engineering review that assessed the condition of the piles; the overall integrity of the Wharf structure; and the paving and substrate condition of roadways, parking areas, and sidewalks. In October 2014, the City Council accepted the Master Plan and directed staff to proceed with environmental review. Environmental review is in progress; release of a Public Review DEIR is expected in fall of 2017. The DEIR and Master Plan will likely go to public hearings for ultimate City Council approval in early 2018. If adopted, it is expected that the City will submit the Master Plan as a Public Works Plan to the CCC for approval since the CCC retains jurisdiction over the Wharf (Roma Design Group 2014).

The Master Plan includes the following elements and recommendations (Roma Design Group 2014):

1. *Policies and actions*
2. *Recommendations for expansion, new construction, and improvements*
    - *Wharf expansion and new facilities.* New proposed facilities include a new promenade on the eastern side of the Wharf, a new walkway on the west side of the Wharf, three new public use buildings, and two new accessible boat landings.
    - *Structural Wharf improvements.* Recommended improvements include installation of new and replacement Wharf support piles, lateral bracing, and roadway and utility improvements (i.e., improvements to the Wharf's pavement, drainage system, and trash collection system).
3. *Circulation/parking circulation/parking.* Improvements are proposed to more efficiently use the existing circulation area and encourage alternative transportation, including relocation of the Wharf entrance further south onto the Wharf. Other improvements include restriping of existing parking areas that would result in approximately 45–65

additional parking spaces, widening of existing sidewalks for improved pedestrian access, and provision for up to 150 bicycle parking spaces.

4. *Design standards.* Design standards that address building design elements, including height, materials, design, windows, roofs, and displays, are included.

A key element of the Master Plan is expansion of the Wharf on the east side for the East Promenade that will provide dedicated pedestrian access. This would expand the Wharf by approximately 2.5 acres, and as a result, sections of the Wharf devoted to public access, recreation, and open space would increase. The East Promenade is one of two near-term projects that the City envisions as the first projects to be implemented. However, funding has not yet been secured for this project.

The Master Plan identifies two Wharf improvements in the area of the SI-17 pump station location that was formerly considered on the Wharf in the $scwd^2$ DEIR. The East Promenade would require extension of the Wharf approximately 26 to 30 feet along the majority of the east side of the Wharf and in the formerly proposed SI-17 pump station location. The area immediately adjacent to the pump station location on the south is planned for a new boat landing.

Conclusions – City of Santa Cruz Wharf Master Plan: The Master Plan does not identify a potential future site for a desalination pump station or related facilities on the Wharf or contain policies or language that support or prohibit water system infrastructure improvements. However, the former SI-17 intake pump station location is within the area of the Wharf on the eastern side proposed for expansion (East Promenade) and the proposed new boat landing (South Landing). Discussions with the City Economic Development staff indicate that a pump station location could potentially be sited adjacent to the East Promenade if it is designed to be visually unobtrusive and not interfere with public uses. An alternate configuration to the one previously considered would be needed to achieve compatibility with the new Wharf improvements.

One constraint would be the timing of design and construction of Wharf improvements and a potential intake pump station. If an intake pump station were designed and constructed prior to the East Promenade, there would be a potential for interruption of pump station use and relocation with future construction of the East Promenade proceeds. Likewise, if the East Promenade were designed and constructed prior to an intake pump station, it could be difficult to achieve compatibility with the new Wharf improvements. While the concept of an intake pump station location on the Wharf has not been fully reviewed by the City at this time, for this report, it remains potentially feasible, as determined during the $scwd^2$ DEIR preparation process, and will continue to be considered as a possible pump station location. However, an exact site on the Wharf is not known at this time, and as noted above, the Master Plan does not address desalination facility components.

2.4.3 MBNMS Special Use Permit

On September 7, 2017, the National Oceanic and Atmospheric Administration (NOAA) published a final notice in the Federal Register creating a special use permit (SUP) related to the operation of desalination facilities (82 Federal Register 42298–42306). The NOAA Office of National Marine Sanctuaries adopted this new SUP category pursuant to the requirements of Section 310 of the National Marine Sanctuaries Act. The SUP category is for the continued presence of a pipeline transporting seawater to or from a desalination facility.[11]

Because most proposed desalination activity in sanctuaries occurs in the MBNMS, and the scientific studies used for environmental impact and comparative cost analyses are regionally based, the SUP category only applies to the MBNMS. NOAA determined that pipelines transporting seawater for onshore desalination that have been laid on, attached to, or drilled or bored within the submerged lands of a national marine sanctuary after appropriate environmental review, application of best management practices, and compliance with *MBNMS Desalination Guidelines* (MBNMS and NMFS 2010) could remain in place without causing injury to sanctuary resources. New desalination pipelines are manufactured with high tensile stainless steel to avoid breakage or corrosion in seawater and would be monitored annually under the SUP to evaluate their continued integrity. Submerged pipelines should also have little propensity for movement or shifting.

Conclusions – MBNMS SUP: If the City were to pursue a seawater desalination project, a SUP would have to be obtained from the NOAA Office of National Marine Sanctuaries as coordinated through MBNMS. This new requirement is reflected in Section 5.

[11] For this SUP category, NOAA is using "transporting seawater to or from a desalination facility" to mean water being pumped from MBNMS or the submerged lands of MBNMS into a facility and/or concentrated brine water being pumped out of a facility through a pipe and into MBNMS (82 Federal Register 42298–42306).

3 CITY SEAWATER DESALINATION PROJECT CHARACTERISTICS

This section provides a description of a City seawater desalination project (project) and includes information about project objectives, overview, location, and characteristics. Information in Section 2 was considered in the development of the project.

3.1 Project Objectives

The objectives of the project presented below address the need for a supplemental water supply as identified in the WSAC Final Report. These objectives were developed primarily to achieve the broad policy and planning objectives of providing a reliable water supply for the City. The objectives include the following:

1. Provide for a supplemental water supply that provides approximately 3.3 mgd of supplemental potable water supply identified as necessary for the City and that complements ongoing and future water conservation efforts. The supply should support system robustness, redundancy, and adaptive flexibility.
2. Meet the following cost-effectiveness, yield, and timeliness thresholds identified in the WSAC Final Report (WSAC 2015):
   - 2.1 Cost-effectiveness – Compare favorably to other alternatives using the ACAYY.
   - 2.2 Yield – Fill the supply-demand gap of 1.2 bgy during modeled worst-year conditions based on 2015 Confluence modeling of the frequency and severity of shortages, inclusive of DFG-5 fish flows and a plausible estimate of climate change impacts. This equates to approximately 3.3 mgd. Periodic updating of Confluence modeling of the frequency and severity of shortages may result in modifications to the supply-demand gap.
   - 2.3 Timeliness – Support a fully functional water system able to meet the supply-demand gap by 2025.
3. Consider technical feasibility in selecting a supplemental water supply.
4. Consider energy use, public health, and environmental impacts in selecting a supplemental water supply.
5. Where consistent with the goal of achieving a sufficient water supply, promote regional collaboration to improve water supplies, reverse or slow seawater intrusion, and support habitat restoration.

If the City decides to pursue a desalination project and launches the CEQA process, additional project objectives will likely be developed to support the CEQA document preparation process.

3.2 Project Overview

A City seawater desalination project would construct and operate an SWRO desalination plant and related facilities to provide up to 3.3 mgd of potable water to the City. The water supply would help the City meet its water needs during periods of water supply shortages as a result of drought and reduced surface water diversions needed to provide improved river and stream flows for fish and to plan for climate change.

There are the following four basic functional components of the project: (1) seawater intake; (2) pretreatment and salt removal through reverse osmosis filtration; (3) disposal of by-products, including brine and solids that are removed in the pretreatment process; and (4) conveyance and delivery of the product water to existing City water distribution system. Because of these functional components, the project[12] would consist of the following (see Figure 1):

- A seawater intake and conveyance system consisting of a screened open-ocean intake system, intake piping, pump station, and transfer piping. Because of the requirements of the OPA, a subsurface radial collector well system may need to be considered as an intake design option even though it was not previously recommended for the scwd[2] Desalination Program.[13] If such a subsurface intake system were to be pursued by the City, it would need to be constructed and tested in stages and may need to be augmented with a screened open-ocean intake that would be used to provide supplemental water if the subsurface intake system loses production capacity or requires significant maintenance.
- A seawater desalination plant that would provide for pretreatment processing, desalination treatment and energy recovery, post-treatment processing and distribution, brine storage, residuals handling and disposal, chemical systems, and their associated support facilities.
- A brine storage, disposal, and conveyance system consisting of brine storage at the desalination plant, a new pipeline to the City's WWTF outfall, and outfall improvements.

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12 The term "project" is used throughout this document to refer to all components of the project, including the desalination plant and the other related components, as described above.

13 Of the subsurface intake design options investigated, an offshore radial collector well system was the only option considered potentially technically feasible based on the results of the Offshore Geophysical Study (EcoSystems 2010) and input from the technical working groups and engineering evaluation in the Intake Technical Feasibility Study (Kennedy/Jenks Consultants 2011). However, it was not recommended for the scwd[2] Desalination Program because it had the lowest production reliability, an unproven approach in the offshore ocean environment, and low operational flexibility; is most complex to construct; and has the highest capital and life-cycle costs. See Section 2 for additional information about this and other subsurface intake options previously considered.

- Potable water distribution system improvements consisting of a new connection to the City distribution system near the seawater desalination plant site.

The following sections describe the various project components and component alternatives. These component alternatives are based on the various alternatives that were presented in the scwd^2 DEIR, as modified, because of the review of changed conditions in Section 2.

The scwd^2 DEIR looked at the construction of a 2.5-mgd seawater desalination plant and related facilities with the ability to expand the plant up to 4.5 mgd. This report is updating the concepts and costs for an approximately 3.3-mgd-capacity project to achieve the updated project objectives. Because the product water capacities are relatively similar, the size of the major components of the project would be similar to the scwd^2 Desalination Program components, and the project design characteristics and cost estimating for the scwd^2 Desalination Program can be updated for this study. The major elements of the project are shown on Figures 4 and 5.

3.3 Project Location and Characteristics

As described above, the project would consist of (1) a seawater intake and conveyance system; (2) a seawater desalination plant; (3) a brine storage, disposal, and conveyance system; and (4) potable water distribution system improvements. These project components include different types of facilities, such as buildings, pumps, pipelines, and other equipment. Alternative sites for the seawater intake system and desalination plant are identified. The location and general characteristics of the facilities are summarized below.

3.3.1 Seawater Intake and Conveyance System

The seawater intake and conveyance system would be composed of a seawater intake structure (or structures) in the Monterey Bay to draw in raw seawater (source water), an intake pipeline to deliver the seawater to the shore, and a pump station to pump the seawater to the desalination plant through transfer piping. To produce approximately 3.3 mgd of treated product water, the seawater intake system would be designed to provide a maximum flow of approximately 8.3 mgd of raw seawater based on an overall facility minimum recovery of 40%. The desalination plant could operate with higher recoveries for periods of time and withdraw lower rates of seawater but would also operate at lower recoveries for some periods. Therefore, the intake conveyance system would be designed to accommodate the larger volumes of intake water to cover the range of production and overall facility recoveries.

The feasibility and site-specific requirements of subsurface and screened, open-ocean intake approaches were investigated during the preparation of the scwd^2 DEIR in the scwd^2 Intake Technical Feasibility Study (Kennedy/Jenks Consultants 2011). Based on specific design, operational, and/or siting requirements for the type of intake, a screened, open-ocean intake was determined to be the apparent best intake approach in terms of engineering feasibility. Recent updates to the California Ocean Plan included in the OPA require that seawater desalination facilities use subsurface intake systems unless they are not feasible, as discussed in Section 2. As discussed previously, a feasibility analysis may determine that a combination of both subsurface and surface intakes may be the best feasible alternative to minimize intake and mortality of marine life while meeting the identified desalinated water need. Therefore, an offshore radial collector well subsurface intake system, with a supplemental 1-millimeter screened intake component, was re-evaluated as a design option in this report.

As indicated in Section 2.3.2 an Intake Technical Feasibility Study Update would be required for the project to specifically address the OPA requirements and feasibility definitions, and any new technologies since the prior study, including HDD systems. For the purposes of defining a City seawater desalination project in this section of the report, it is assumed that the Intake Technical Feasibility Study update makes the same findings and conclusions as the original report and that no new technologies or intake sites are determined to be feasible.

The seawater intake and conveyance system would be located between an offshore location in the Monterey Bay and the desalination plant site. A number of alternative locations for the seawater intake and conveyance system were evaluated in the scwd^2 DEIR. This report will update and evaluate three intake alternatives based on the assessment of changed conditions provided in Section 2. Only one of the following alternatives would be implemented:

- **Seawater Intake Alternative 1 (SI-1), Screened Open-Ocean Intake (Westside)** – A screened open-ocean intake located offshore on the westside of the City is considered for the project because a subsurface intake in this location is not feasible due to shallow bedrock offshore. The intake screens would have 1-millimeter openings. The intake pump station would be located at the seawater desalination facility. This is similar to seawater intake alternative number SI-14 from the scwd^2 DEIR.
- **Seawater Intake Alternative 2 (SI-2), Screened Open-Ocean Intake (Wharf Area)** – A screened open-ocean intake located offshore near the Wharf is considered for the project. The intake screens would have 1-millimeter openings. The intake pump station would be located at the Santa Cruz County Regional Transportation Commission (SCCRTC) property located south of Depot Park. This is similar to seawater intake alternative number SI-18 from the scwd^2 DEIR.
- **Seawater Intake Alternative 3 (SI-3), Subsurface Intake System (Wharf Area)** – The subsurface intake system would consist of one or two offshore radial collector wells that would draw seawater through the alluvial material beneath the seafloor. The radial collector wells would be constructed in the alluvial channel that is near the Wharf, where there is deep enough sand to make this approach potentially feasible. The subsurface intake

would also have an open-ocean screened intake element as part of the overall system that would be used to provide supplemental intake water if the subsurface intake system loses production capacity and/or requires significant maintenance. The intake pump station would be located at the SCCRTC property located south of Depot Park. This is similar to the location of seawater intake alternative SI-18 from the scwd[2] DEIR but is distinct in design since it includes a subsurface intake with a screened open-ocean intake as a back-up source of raw seawater.

For SI-2 and SI-3, a pump station and raw water pipeline on the Wharf could also be considered as a backup to the pump station location at the SCCRTC property south of Depot Park. However, as indicated in Section 2.4.2, an exact site on the Wharf is no longer known because of planned improvements identified in the City's Wharf Master Plan.

3.3.2 Seawater Desalination Plant

As indicated in Section 2, the Industrial Park Area (Area A) would continue to be considered for a desalination plant, and three alternative plant site locations within this area (A-1, A-2, and A-3) are considered in this report, similar to the scwd[2] DEIR. The approximately 4- to 8-acre sites are located on mostly undeveloped, private land on infill parcels. These sites are generally bounded by the Santa Cruz Branch Rail Line tracks to the north, Natural Bridges Drive to the west, Delaware Avenue to the south, and the realigned Arroyo Seco Stream to the east, as shown on Figure 5. Only one of these location alternatives would be implemented.

The 3.3-mgd desalination plant would provide for the equipment used for the desalination process, except for the seawater intake system and pipeline conveyance systems for source water, brine disposal, and potable water. The plant would provide for the following primary systems:

- **Pretreatment Processing** – Pretreatment refers to the removal of suspended solids from ocean source water to reduce fouling, clogging, and scaling of the SWRO membranes used for desalination.
- **Seawater Desalination Treatment** – The plant would use a SWRO system to desalinate raw seawater. SWRO is a pressure-driven process using semi-permeable membranes. SWRO membranes separate water molecules from impurities in the seawater by permitting water to pass and limiting the passage of salts and other constituents. The results are a permeate stream (or product water) and a concentrate stream (or brine). The desalination system would have the ability to operate with a recovery rate from 40% to 50% (40 to 50 gallons of fresh drinking water per 100 gallons of seawater).

- **Post-Treatment Processing and Distribution –** Reverse osmosis removes many of the minerals from the water. Lack of hardness and alkalinity makes the water more corrosive to the water delivery system. Post-treatment is required to control the corrosiveness of the water and provide adequate disinfection prior to distribution, which is common for potable water generated from surface and/or groundwater sources.
- **Residuals Handling and Disposal** – Operation of the desalination plant would generate solids from the pretreatment processing. Two options for handling solids, including sanitary sewer disposal and landfill disposal, are considered for the project.
- **Chemical Systems** – A variety of chemicals would be required for treatment, disinfection, and membrane cleaning at the desalination plant. The chemicals would be stored in accordance with applicable building and seismic codes and applicable regulatory requirements for hazardous materials storage.

Similar to the proposed $scwd^2$ Desalination Program, the final desalination plant design will consider space for other related and support uses, including but not limited to (1) operations and control systems, (2) maintenance and facilities storage, (3) electrical operations and utility connections, (4) parking and access, (5) stormwater detention and treatment, (6) landscaping, and (7) outdoor viewing and gathering areas. A photovoltaic system could also be included at the proposed plant, as contemplated for the $scwd^2$ Desalination Program.

3.3.3 Brine Storage, Disposal, and Conveyance System

During the SWRO process at the desalination plant, brine would be generated and approximately twice as saline as seawater. Brine storage would be provided on the desalination plant site to allow for controlled release of the brine. A pipeline would convey the brine from the desalination plant to the City's WWTF outfall pipeline where it would be blended with effluent from the City's WWTF and returned to Monterey Bay through the City's existing outfall. The WWTF outfall diffuser ports would be improved by adding new valves (Red Valves) to the ports. A Dilution Analysis conducted to support the $scwd^2$ DEIR concluded that the WWTF NPDES discharge permit minimum initial dilution requirement and ambient salinity at the outfall could be maintained with the above improvements. An update to the Dilution Analysis would be required to specifically address the OPA requirements regarding discharge and reduced wastewater flow associated with the SqCWD's Pure Water Soquel Project and possible City recycled water projects, as discussed in Section 2. An update to the Dilution Analysis would also determine the need for a multi-port diffuser on the outfall to provide for adequate mixing at the discharge point.

3.3.4 Potable Water Distribution System

The pipeline to convey the product water from the plant to the City's existing potable water distribution system would run from the desalination plant location in Area A (see Figure 5) to the existing adjacent potable water distribution pipe located within Delaware Avenue or Natural Bridges Drive adjacent to the alternative plant site locations. Recent analysis has been conducted to begin to re-examine the impacts to the City's existing potable water distribution system of introducing desalinated seawater at plant location Area A (see Figures 4 and 5). For the purpose of this initial analysis, it was assumed that the connection point would be in Natural Bridges Drive.

Hydraulic modeling was performed for a variety of scenarios including a 3.3 mgd desalination plant that would serve the City's needs during drought, a 4.6 mgd plant which includes meeting the SqCWD's needs as well, and a 5.6 mgd plant which adds to this the needs of SVWD and SLVWD. (It should be noted that should such a project be pursued, it is likely that a smaller facility could be designed that met the seasonal demands of participating agencies much like the scwd^2 Desalination Program.) For the majority of the scenarios it was assumed that the City would not operate its Beltz groundwater well system. Findings for a regional project, which would require service area interconnections with other water agencies, are described in more detail in Section 7.

For the City seawater desalination project operating at 3.3 mgd, the City's system appears to be able to function within normal operating parameters without modifications. That being said, it appears the system pressures, velocities and water age in the nearby Bay Street Tanks would increase due to this project. Additional analysis would be warranted to determine what system modifications (e.g., new transmission mains) and/or operational changes (e.g., operating the Beltz well system) would reduce and potential negative impacts.

3.4 Engineers Opinion of Probable Capital and Lifecycle Costs

Table 1 provides the engineer's opinion of probable cost, which is based on information and costs developed in technical studies conducted by the City and SqCWD as part of the scwd^2 Desalination Program (Kennedy/Jenks 2011; CDM Smith 2012; URS 2013b) and supplemented with cost estimates from similar projects and professional experience. These studies were used to generate estimated construction costs for the project, assuming the three seawater intake alternatives being considered. Costs from these prior studies are updated to current day using Engineering News-Record cost indices and are scaled to reflect a capacity of 3.3 mgd. All costs are conceptual and order of magnitude type costs at an Association for the Advancement of Cost Estimating Class 5 level, representing planning to feasibility level information with an estimated accuracy range between −30% and +50%. These costs are intended to be used for comparison purposes between alternatives.

The detailed cost table templates and assumptions applied herein are consistent with those developed for the RWFPS to allow for a comparison of costs for desalination and recycled water projects. Appendix B, prepared by Kennedy/Jenks Consultants, provides the detailed cost estimates that support the cost summary in Table 1.

Table 1. Summary of Capital and Life Cycle Costs for Desalination Facility Components (2017 Dollars)

Project Components (3.3 MGD Facility)	Alternative 1 Screened Open-Ocean Intake (Westside)	Alternative 2 Screened Open-Ocean Intake (Wharf Area)	Alternative 3 Subsurface Intake System (Wharf Area)
Seawater Intake and Conveyance System			
Open Ocean Intake[1]	$60,100,000	$58,900,000	$52,800,000
Radial Well Collectors	n/a	n/a	$76,600,000
Seawater Desalination Plant	$77,800,000	$77,800,000	$77,800,000
Brine Storage, Disposal, and Conveyance System	$10,500,000	$10,500,000	$10,500,000
Potable Water Distribution System Improvements	*(Included in Desalination Plant costs)*		
Total Capital Cost ($)	**$148,400,000**	**$147,200,000**	**$217,700,000**
Estimated Capital Cost ($mil)	**$148.4**	**$147.2**	**$217.7**
Annualized Capital Cost ($mil/yr)	$7.8	$7.7	$11.9
Desalinated Water Produced (AFY)	3,696	3,696	3,696
Annual Unit Capital Cost ($/AF)	**$2,100**	**$2,100**	**$3,200**
Annual O&M Cost ($mil/yr)	$5.4	$5.6	$5.7
Annual O&M Cost ($/AF)	$1,470	$1,510	$1,530
Life Cycle Unit Cost ($/AF)	**$3,570**	**$3,610**	**$4,730**
($/MG)	**$11,000**	**$11,100**	**$14,500**
($/CCF)	**$8.20**	**$8.30**	**$10.90**

Source: Appendix B.

Notes: AF = acre feet; AFY = acre feet per year; CCF = 100 cubic feet; MG = million gallons; n/a = not applicable

[1] Includes intake structure, screens, pipelines and pump station.

3.5 Soft Costs Estimates

Soft costs include SCWD staff time, program costs, design, survey work, geotechnical analyses, utility location, land transactions, environmental review, permitting, mitigation and monitoring fees, construction management and engineering services during construction. Soft costs were estimated for the City seawater desalination project and the three intake alternatives using standard percentages of capital costs for each category developed by HDR, the City's Program Manager. Some adjustments were made in the standard percentages to account for the high capital costs of desalination and associated technical equipment. Appendix C, prepared by Dudek and Kennedy/Jenks Consultants, provides the detailed soft cost estimates that support Table 2.

Table 2. Summary of Soft Costs (2017 Dollars)

Project Components (3.3 MGD Facility)	Alternative 1 Screened Open-Ocean Intake (Westside)	Alternative 2 Screened Open-Ocean Intake (Wharf Area)	Alternative 3 Subsurface Intake System (Wharf Area)
Capital Costs (from Table 1)	$148,400,00	$147,200,000	$217,700,000
Soft Cost % of Capital Costs	39%	39%	28%
Soft Costs	**$57,505,000**	**$57,040,000**	**$61,935,650**

Source: Appendix C.

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4 CEQA/NEPA COMPLIANCE APPROACH

4.1 Lead Agencies

4.1.1 CEQA Lead Agency

When more than one public agency is, or may, be involved in a project subject to CEQA, the "lead agency" is the public agency that has the primary responsibility for approving a project and, therefore, oversees the CEQA process.

The City and SqCWD were joint lead agencies under CEQA for the scwd^2 DEIR since both agencies were sponsoring the scwd^2 Desalination Program, and there was mutual interest in acting as joint lead agencies. If the project (see Section 3) goes forward as a City project, the City would be the CEQA lead agency. If there is regional participation in the project (see Section 7), the City would still likely be the CEQA lead agency unless there was strong interest by SqCWD or SVWD to participate as a lead agency with the City. A list of other state and local agencies that would be involved in the project is provided in Section 5.

4.1.2 Federal Lead Agency for NEPA

For the scwd^2 Desalination Program, the federal lead agency under NEPA was initially determined, and assumed to be, the U.S. Army Corps of Engineers (ACOE) because they had two federal permits to issue for the scwd^2 Desalination Program. These included a Clean Water Act, Section 404, permit for the discharge of dredged or fill material into waters of the United States and a Rivers and Harbors Act, Section 10, permit for the building of pipelines or other in-water structures in navigable waters. These permits would have been required for the components of the scwd^2 Desalination Program that would be installed in the marine environment. Initial consultation with the ACOE during the scwd^2 DEIR preparation process seemed to confirm that initial determination; however, the ACOE had not yet received a permit application for the scwd^2 Desalination Program and had not conducted interagency consultations related to NEPA compliance because the scwd^2 Desalination Program was put on hold.

The MBNMS was not previously considered to be a likely federal lead agency for NEPA compliance because they authorize other agencies' approvals and, at the time, did not issue their own permit. However, since 2013, the MBNMS has taken the federal lead agency role under NEPA for two desalination projects in the Monterey Bay area including the CalAm Monterey Peninsula Water Supply Project EIR/Environmental Impact Statement (EIS) and the DeepWater Desal LLC Monterey Regional Water Project EIR/EIS. Additionally, as of September 2017, there is a SUP pursuant to the National Marine Sanctuaries Act that would need to be obtained from the MBMNS for the project to approve the operation of desalination pipelines in the MBNMS, as described in Section 2. Therefore, the MBNMS has a permit that must be issued for the project.

After consulting with MBNMS staff in September 2017 during the preparation of this report, it is understood that the MBNMS's more recent role came after consultation with the ACOE, where it was determined that the MBNMS would take the federal lead agency role for the previously mentioned projects (Grimmer and Hoover, pers. comm. 2017). If the project was to go forward, a similar consultation between the MBNMS and ACOE would likely be conducted to determine which agency would serve as the federal lead agency role for the project. Because the MBNMS's current role in other desalination projects in this region, it is likely that they would also serve as the federal lead agency for the project. The ACOE would likely act as a cooperating agency under NEPA due to their discretionary approvals for construction of the marine portions of the project. A list of other federal agencies that would be involved in the project is provided in Section 5.

4.2 CEQA and NEPA Compliance

4.2.1 CEQA and NEPA Compliance Approach

A stand-alone CEQA document (i.e., EIR) was being prepared for the prior scwd^2 Desalination Program. The ACOE was expected to prepare their own NEPA document during permitting if they were to serve as the NEPA lead agency, which was the likely case for the scwd^2 Desalination Program. For the project, and based on recent precedent as described previously, the MBNMS would likely serve as the NEPA lead agency. The City would serve as the sole CEQA lead agency for a City seawater desalination project.

After consulting with MBNMS staff during the preparation of this report, the following two options exist for CEQA and NEPA compliance for the project if the MBNMS were to serve as the NEPA lead agency:

1. Prepare a joint CEQA/NEPA document (EIR/EIS) with the MBNMS
2. Prepare a stand-alone CEQA document (i.e., EIR) before or while the MBNMS prepares the NEPA document (EIS) for the project

While the joint EIR/EIS may take longer to prepare than a stand-along EIR and may take more time to launch initially, a joint EIR/EIS approach has the following advantages:

- Provides for efficiency in effort and may save time overall through the permitting process
- Results in one set of mitigations to implement and monitor
- Involves MBNMS oversight of evaluation and documentation process in collaboration with the City, which could improve public confidence regarding the results

- Potentially improves the usefulness of the document for CCC and RWQCB in their subsequent CEQA responsible agency actions (i.e., issuing a coastal development permit and making the California Water Code, Section 13142.5(b), determination)

4.2.2 CEQA and NEPA Compliance Actions

If a joint CEQA/NEPA document is pursued for the project, the following likely actions would be completed during the compliance process. Some actions may take place concurrently.

1. **Agency Consultations/NEPA Lead Agency Confirmation**. The City would meet with the MBNMS and ACOE to confirm the MBNMS's role as the NEPA federal lead agency and to confirm study requirements for the EIR/EIS. The City and MBNMS would conduct other consultations with RWQCB, CCC, and potentially other regulatory agencies to confirm study requirements.
2. **MBNMS Application.** The City would submit an application to the MBNMS for the marine portion of the project that includes activities that are prohibited in the MBNMS. The City would work with the MBNMS to provide any additional required information for them to deem the application complete. The City would coordinate with the MBNMS to determine whether a separate application is required for the SUP and, if so, whether it should be completed at the same time.
3. **Notice of Preparation, Notice of Intent, Public Scoping**. The City and MBNMS would prepare the Notice of Preparation of an EIR and Notice of Intent to prepare an EIS, which would launch the CEQA and NEPA compliance processes, respectively. The Notice of Preparation would be filed with the State Clearinghouse, and the Notice of Intent would be published in the Federal Register. Federal and state scoping requirements would be implemented, and a scoping period of 30 days would be held to provide an adequate opportunity for agencies and other interested parties to comment on the scope of the EIR/EIS.
4. **Draft EIR/EIS**. The City and MBNMS would prepare, file, and distribute a Draft EIR/EIS document and related notices. The Draft EIR/EIS, along with a Notice of Completion, would be filed with the State Clearinghouse for CEQA compliance. A Notice of Availability is also sent to agencies and interested parties to notify them of the availability of the document, the public review period, and public meetings. The Draft EIR/EIS would also be filed with the U.S. Environmental Protection Agency and a federal Notice of Availability would be published in the Federal Register. These notices would start a minimum 45-day public review and comment period.
5. **Final EIR/EIS**. The City and MBNMS would prepare the Final EIR/EIS based on assessment and consideration of the comments received during the public review period.

The Final EIR/EIS would be posted on the City's website in advance of any consideration of certifying the document under CEQA, and a Notice of Availability of the Final EIR/EIS would be sent to involved agencies and interested parties. The Final EIR/EIS would be filed with the U.S. Environmental Protection Agency. The U.S. Environmental Protection Agency would publish a Notice of Availability for the Final EIR/EIS, and the MBNMS may recommend other notification methods.

6. **Notice of Determination and Record of Decision.** Once the City has approved the project and certified the Final EIR, it would file a Notice of Determination with the State Clearinghouse and the County Clerk's office. Once the SUP and permit authorizations are approved, a Record of Decision and a notice of the Record of Decision availability would be provided to the public. Although not required, the publication of the notice in the Federal Register would be encouraged (NOAA 2017).

4.2.3 Need for New/Updated Studies and Consultations

Substantial information was presented as the basis for the scwd^2 DEIR. This information includes design-related studies, studies that support the evaluation of alternatives, and technical environmental studies. The preparation of an EIR/EIS for the project would involve the use of the prior scwd^2 information to the extent possible. However, the following new or updated studies or information would likely be required to complete an EIR/EIS:

- Implement the Marine Work Plan (see Appendix A) to determine the need for and timing of additional marine studies/surveys to support the project design, EIR/EIS and permitting in consultation with the MBNMS.
- Conduct new biological resource records searches and terrestrial surveys.
- Conduct new cultural resource records searches, surveys, and Native American consultations adequate for National Historic Preservation Act, Section 106, compliance, which is required when federal agencies are issuing permits for a project or are otherwise involved. Assembly Bill 52 consultations related to tribal cultural resources may also be required.
- Conduct new ambient noise measurements and updated noise impact analysis.
- Conduct updated air quality and greenhouse gas impact analyses based on the project and updated and refined construction assumptions.
- Coordinate with various City departments and gather information to update topics related to population, land use, transportation, and public service and utilities for the EIR/EIS.

5 PERMITTING APPROACH

5.1 Potential Permits

Table 3 provides an updated list of permits likely to be required for the project.

5.2 Permitting Constraints

The primary permitting constraint for the project would be pursuing an open-ocean intake because the OPA requires a subsurface intake unless such an intake is determined not to be feasible by the RWQCB under the OPA definition of "feasible" (see Section 2). The project includes options for use of an open-ocean intake only and for a hybrid system where radial collector wells are used with an open-ocean screened intake if the radial collector wells lose production capacity and/or require significant maintenance. As indicated in Section 2, continued consultation with the SWRCB and RWQCB is recommended to discuss the scope of work for the Intake Technical Feasibility Study Update and other studies identified in the Marine Work Plan (Appendix A). If the radial collector well option is required to be considered further in detail after completion of the update, substantial additional testing in the marine environment would be required. See Section 2 for additional information.

Table 3. Potential Permits, Authorizations, or Approvals

Regulatory Agency	Potential Regulatory Permit, Authorization, or Approval	Reason Permit/Approval is Required	Relevant Project Components
FEDERAL AGENCIES			
Monterey Bay National Marine Sanctuary	Authorization of relevant federal permits under the MBNMS Management Plan and the National Marine Sanctuary Program	Required for proposed facilities located in the MBNMS.	Intake pipelines and intake structure Installation of new valves on the WWTF outfall diffuser ports Discharge of brine in WWTF effluent Project construction, operation, and maintenance related to the project components
	Review and potentially condition renewals/amendments of the Section 402 of the Clean Water Act NPDES permit for ongoing ocean discharges from the WWTF (see Central Coast RWQCB permits below)	Required for discharge of brine into the City's WWTF outfall and for maintenance of the seawater intake. The City's existing NPDES permit could potentially be used or modified to address the above.	Brine discharge Seawater intake maintenance
	SUP	Required for ongoing operation of desalination pipelines and facilities in the MBNMS.	Intake pipelines and intake structure
U.S. Army Corps of Engineers	Section 404 Clean Water Act Nationwide or Individual Permit	Required for discharges of dredged or fill material into waters of the United States. ACOE would establish the basis of the permit and scope of their analysis depending upon the area and extent of fill.	Intake pipelines and intake structure (all alternatives) Installation of new valves on the WWTF outfall diffuser ports Plant Site A-3
	Section 10 Rivers and Harbors Act Individual Permit	Required for building any pipelines, piers, wharfs, or other in-water structures in navigable waters.	Intake pipelines and intake structure (all alternatives) Installation of new valves on the WWTF outfall diffuser ports
National Oceanic and Atmospheric Administration	Section 7 Consultation under the Endangered Species Act	Required for any federal permitting agency that may adversely affect federally listed marine species or designated critical habitat. MBNMS	Intake pipelines and intake structure (all alternatives) Discharge of brine in WWTF effluent

Table 3. Potential Permits, Authorizations, or Approvals

Regulatory Agency	Potential Regulatory Permit, Authorization, or Approval	Reason Permit/Approval is Required	Relevant Project Components
/National Marine Fisheries Service		and ACOE would conduct Section 7 Consultation with NMFS for their permits.	Installation of new valves on the WWTF outfall diffuser ports
	Section 305(b) Consultation under the Magnuson-Stevens Fishery Conservation and Management Act (also known as the Sustainable Fisheries Act)	Required for any federal or state approval that may adversely affect designated essential fish habitat.	Intake pipelines and intake structure (all alternatives) Discharge of brine in WWTF effluent Installation of new valves on the WWTF outfall diffuser ports
U.S. Fish and Wildlife Service	Section 7 Consultation under the Endangered Species Act	Required for any federal permitting agency that may adversely affect federally listed terrestrial or freshwater species or their designated critical habitat. ACOE and MBNMS would conduct Section 7 Consultation with U.S. Fish and Wildlife Service for their permits.	Potentially warranted if Plant Site A-2 is selected.
STATE AGENCIES			
California Coastal Commission	Coastal Development Permit Federal Consistency Review	Required for the portions of the project that lie within the CCC's areas of retained jurisdiction, such as the offshore components of the project.	Pump station on Wharf (Intake Site SI-17), if pursued Intake pipelines and intake structure (all alternatives) Installation of new valves on the WWTF outfall diffuser ports Project construction, operation, and maintenance related to the project components

Table 3. Potential Permits, Authorizations, or Approvals

Regulatory Agency	Potential Regulatory Permit, Authorization, or Approval	Reason Permit/Approval is Required	Relevant Project Components
California State Lands Commission	Land Use Lease (Right-of-Way Permit) or modification of an existing lease	Required for the use of state tidelands and submerged lands within 3 nautical miles seaward of the ordinary high water mark. CSLC has granted public trust lands to the City near the Wharf so facilities in this area would not require CSLC approval.	Intake pipelines and intake structure (Intake Sites SI-1) Installation of new valves on the WWTF outfall diffuser ports Project construction, operation, and maintenance related to the project components
California Department of Fish and Wildlife	Incidental Take Permit under the California Endangered Species Act	Required if “take” of state-listed endangered, threatened, or candidate species may occur.	Not anticipated to be required for the project
	Streambed Alteration Agreement	Required if a project would alter the flow, bed, channel, or bank of a stream or lake.	Not anticipated to be required for the project
California Department of Transportation	Encroachment Permit	Required if the project would encroach upon any portion of a state highway right-of-way, such as State Highway 1.	Not anticipated to be required for the project
California Department of Public Health	Permit to Operate a Public Water System	Required to operate a public water system.	Applies to project overall, not individual components
California Department of Parks and Recreation, Office of Historic Preservation	Section 106 of the National Historic Preservation Act Coordination	Required for any federal permit or project that may adversely affect properties listed or eligible for listing on the National Register of Historic Places. MBNMS and ACOE would conduct Section 106 Coordination with California Department of Parks and Recreation, Office of Historic Preservation for their permits.	Intake pipelines and intake structure (all alternatives) Installation of new valves on the WWTF outfall diffuser ports Plant Site A-3
REGIONAL AGENCIES			
Central Coast Regional Water Quality Control Board	California Water Code, Section 13142.5(b) Determination	Required for each new or expanded coastal power plant or other industrial installation using seawater for cooling, heating or industrial processing. The best available site, design, technology and mitigation measures feasible	Desalination plant (all alternatives) Intake pipelines, intake structure and intake volume (all alternatives) Brine discharge structure and discharge

Table 3. Potential Permits, Authorizations, or Approvals

Regulatory Agency	Potential Regulatory Permit, Authorization, or Approval	Reason Permit/Approval is Required	Relevant Project Components
		shall be used to minimize the intake and mortality of all forms of marine life.	
	NPDES General Permit For Stormwater Discharges Associated With Construction Activity	Required for stormwater discharges associated with construction activity over 1 acre.	All components involving ground-disturbing activities
	Section 402 of the Clean Water Act, NPDES Permit Amendment	Required for discharge of brine into the City's WWTF outfall and for maintenance of the seawater intake. The City's existing NPDES permit could potentially be used or modified to address the above.	Brine discharge Seawater intake maintenance
	Section 401 of the Clean Water Act, Water Quality Certification	Required for Section 404 permits (see above) to certify that the activity meets water quality standards.	Intake pipelines and intake structure (all alternatives) Installation of new valves on the WWTF outfall diffuser ports Plant Site A-3
Monterey Bay Unified Air Pollution Control District	Authority to Construct and Permit to Operate	Required for backup sources of power that could emit air contaminants.	Emergency generators would be located at the desalination plant
LOCAL AGENCIES			
County of Santa Cruz	Encroachment Permit	Required where the project would encroach upon any portion of a County of Santa Cruz right-of-way. This would include any right-of-way encroachments of the SCCRTC Branch Line.	City-SqCWD intertie pipeline on County right-of-way Seawater intake and transfer pipelines under SCCRTC rail lines in the beach area (Intake Sites SI-2 and SI-3)
	Grading Permit	Required for grading in areas under County jurisdiction for which an EIR was prepared.	Seawater intake and transfer pipelines under SCCRTC rail lines in the beach area (Intake Sites SI-2 and SI-3)

Table 3. Potential Permits, Authorizations, or Approvals

Regulatory Agency	Potential Regulatory Permit, Authorization, or Approval	Reason Permit/Approval is Required	Relevant Project Components
City of Santa Cruz	Coastal Permit under the City's Local Coastal Program	Required for development in the Coastal Zone where the City has jurisdiction under its adopted Local Coastal Program.	Plant Sites A-1, A-2, and A-3 Pump stations for Intake Sites SI-1, SI-2, and SI-3 Onshore piping within Coastal Zone
	Administrative Use Permit or SUP	Required for the authorization of land uses in accordance with the City's Municipal Code.	Plant Sites A-1, A-2, and A-3 Intake pump stations Onshore piping
	Design Permit	Required review of architectural and site development proposals for buildings.	Plant Sites A-1, A-2, and A-3 Intake pump stations
	Building, Electrical, Grading Permit, Fire Department Approvals	Required for authorization of building, electrical, and grading activities.	Plant Sites A-1, A-2, and A-3 and intake pump station sites
	Heritage Tree Removal Permit	Required for removal or pruning of heritage trees or shrubs under the City's Municipal Code.	Plant Site A-2
	Sewer Connection Permit	Required for connection to the City's sanitary sewer system under the City's Municipal Code.	Plant Sites A-1, A-2, and A-3
	Wastewater Discharge Permit	Required for discharge of process wastewater under the City's Municipal Code.	Plant Sites A-1, A-2, and A-3
		Required for discharge of groundwater from construction dewatering under the City's Municipal Code.	All onshore project components within the City requiring ground disturbance

Source: URS 2013a, as updated by Dudek in 2017.
Notes: CCC = California Coastal Commission; CDFW = California Department of Fish and Wildlife; CSLC = California State Lands Commission; EIR = environmental impact report; MBNMS = Monterey Bay National Marine Sanctuary; NMFS = National Marine Fisheries Service; NOAA = National Oceanic and Atmospheric Administration; NPDES = National Pollutant Discharge Elimination System; RWQCB = Regional Water Quality Control Board; SCCRTC = Santa Cruz County Regional Transportation Commission; SUP = special use permit; ACOE = U.S. Army Corps of Engineers; WWTF = wastewater treatment facility

6 TIMELINESS OF IMPLEMENTATION

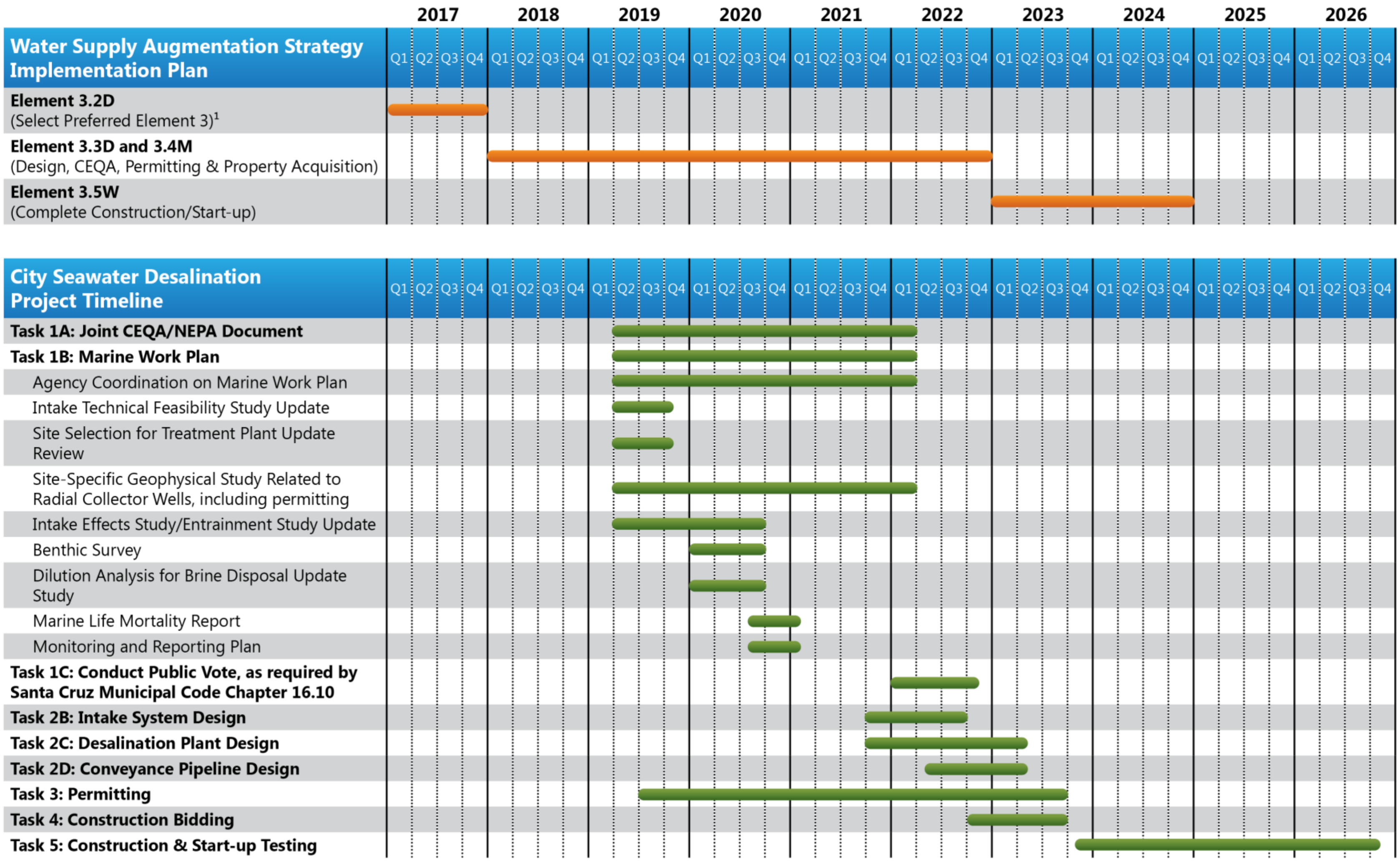
6.1 Initial Schedule

Table 4 provides an anticipated schedule for major milestones related to design, environmental review, permitting, construction bidding, and construction of a City seawater desalination project. The WSAC Water Supply Augmentation Strategy Implementation Plan and Timeline is also provided in Table 3 to allow for a comparison of the two timelines.

6.2 Timeliness of Implementation

According to Table 4, design, environmental review, permitting, and construction bidding would occur over a 5-year period between 2019 and 2023. This timeframe starts and ends one year later than the WSAC Water Supply Augmentation Strategy Implementation Plan and Timeline for these tasks. Construction of a City seawater desalination project would likely take longer than anticipated in the WSAC timeline—3 years instead of 2 years. According to the schedule, a City seawater desalination project could be operational by 2026, assuming project activities begin in early 2019. This would not meet the City's timeliness objective of having a fully functional water system able to meet the supply-demand gap by 2025.

Table 4. City Seawater Desalination Project Schedule



[1] This decision deferred approximately 12 months for the conclusion of this study and the Recycled Water Feasibility Planning Study.

7 OPPORTUNITIES FOR REGIONAL COLLABORATION

7.1 Background

As discussed in Section 1, the SCWD is completing high-level feasibility studies, conceptual level design, and definition of environmental permitting processes for both recycled water and desalination to support the City's selection of the preferred Element 3 of the Water Supply Augmentation Strategy. This report provides this assessment for a City seawater desalination project to meet the City's identified need and to allow for direct comparison with the City's Element 3 recycled water option, review of which is proceeding along a parallel track.

At the direction of the City Water Commission, the SCWD is also evaluating regional seawater desalination opportunities as a component of this report. This is consistent with the following WSAC Final Report guiding principle (WSAC 2015): "Where consistent with the goal of achieving a sufficient water supply, the City should promote regional collaboration to improve water supplies, reversing or slowing seawater intrusion, and support habitat restoration."

While it will be more difficult to directly compare analytical metrics for these opportunities, they provide real potential for collaborative solutions to widely recognized regional water supply challenges. Additionally, the Guidelines for Desalination Plants in the MBNMS emphasizes collaborations with other water agencies considering water supply options in the area to evaluate the potential for an integrated regional water supply project (MBNMS and NMFS 2010).

The SCWD recognizes that additional information, agreements, and time would be needed to more fully understand the opportunities and limitations to providing improved regional connectivity and long-term resiliency through seawater desalination. Due to the recent drought, regional water suppliers have an increased interest and need to work together to optimize collaborative use of resources and infrastructure. However, the current water systems for the City, SqCWD, SVWD, and San Lorenzo Valley Water District (SLVWD) are not sized for, or in some cases, not connected for, water exchanges across service area boundaries. Varying levels of regional infrastructure improvements would be required for any of the regional collaboration opportunities considered here.

A regional desalination project would require cooperation and coordination between multiple agencies regarding interagency infrastructure challenges related to ownership, operations, and construction. However, this type of project would also offer the potential for cost-sharing and opportunities for pursuing funding as a region. Similar to other regional water supply concepts, there may be challenges associated with distribution system compatibilities, operational complexities, and potentially high-energy requirements for conveyance of water to distant places of use. Water transfer agreements would need to be developed along with future studies to confirm project feasibility. This section is intended to support future consideration of potential opportunities for regional collaboration in seawater desalination.

7.2 Regional Participation in City Seawater Desalination

The project could be scaled up to offer additional supply above City requirements to offer desalinated seawater for purchase to neighboring water districts. Conceptually, each agency would provide this water for customer use, allowing for decreased use of currently over-used groundwater or surface-water sources. Two potential scenarios are described below and shown on Figure 6.

An option for scaling up the capacity of the project would be to enter into operations agreements, similar to the scwd^2 Desalination Program, that would allow for the size of the plant to be maintained at approximately 3.3 mgd. Deliveries to interested agencies would take first priority unless there was a drought, in which case deliveries to the City would take first priority. This would involve the same components and associated sizing described in Section 3, with the addition of the interconnections described below, as part of the potable water distribution systems.

7.2.1 SqCWD, SVWD, and SLVWD Participation

If the project plant capacity were increased from the proposed 3.3 mgd to 5.6 mgd, desalinated seawater could be made available to regional water suppliers as follows: 3.3 mgd for City use, 1.3 mgd for SqCWD use, and 1.0 mgd for SVWD use with a portion provided for SLVWD use. These quantities are consistent with the amounts being considered by the SCWD for regional recycled water alternatives. The SqCWD amount of 1.3 mgd is consistent with their proposed Pure Water Soquel Project.

To implement a regional project with SqCWD, SVWD, and SLVWD, necessary infrastructure would include the following modified project components compared to the project:

- **Seawater System and Conveyance System** – These systems could be constructed as proposed in Section 3 but would need to be designed for increased capacity to produce 5.6 mgd. To produce approximately 5.6 mgd reliably, the seawater intake system would need to be designed to provide maximum flow of approximately 14.1 mgd of raw seawater based on an overall desalination facility minimum recovery of 40%.
- **Seawater Desalination Plant** – A larger capacity plant could be constructed within the space provided at any of the three identified alternative sites. The treatment capacity would need to be increased above the proposed 3.3 mgd capacity to an increased total

capacity of up to 5.6 mgd. Two-story facilities may be required to accommodate the additional equipment for a 5.6-mgd facility.

- **Brine Storage, Disposal, and Conveyance System** – Brine disposal would still occur through blending with effluent from the City's wastewater treatment plant and returned to the Monterey Bay through the existing outfall. An updated Dilution Analysis per the requirements of the OPA would be required to ensure minimum dilution requirements and other OPA requirements would be met
- **Potable Water Distribution System** – This component includes the following:
  - A new pipeline would be required to convey the desalinated water to the City's potable water distribution system.
  - As described in the scwd² DEIR, interconnection to provide 1.3 mgd to SqCWD could be provided by the SCWD upgrading approximately 12,000 linear feet of existing pipeline capacity to 24-inch diameter pipes. SqCWD would also need to upgrade approximately 4,000 linear feet of existing pipeline to 16-inch diameter pipes and approximately 2,500 linear feet of existing pipeline to 12-inch diameter. The Soquel Drive intertie between the two service areas may require an upgrade. Although no new pump stations would be required, upgrades to the SCWD's Morrissey pump station and the SqCWD's McGregor and Aptos pump stations would be needed as described in the scwd² DEIR (URS 2013a).

    Since the analysis that informed the scwd² DEIR was completed, several actions have occurred that would reduce the additional infrastructure improvements required to deliver water to SqCWD. First, many of the recommended improvements in the SqCWD service area have been implemented; SqCWD proceeded with these improvements to overall system operations. Second, water demands in the City's service area have declined. This affected the ability to meet the SqCWD demands with fewer improvements in the City's service area. For example, recent hydraulic modeling has shown that, without any improvements related to the interconnection, the City could deliver 1.1 mgd under 2035 average day demand conditions. However, additional analyses would be required if there is interest in pursuing this alternative to refine pipeline improvements to intertie flows and any other operational issues in the City's service area that may result from such a regional project.
  - Interconnection to provide 1.0 mgd to SVWD could be provided by installation of approximately 8,000 linear feet of new 12-inch diameter intertie and construction of a new pump station, based on the 2012 Scotts Valley Multi-Agency Regional Intertie Project Technical Report (Kennedy/Jenks Consultants 2012).

  - Interconnection of the SVWD and SLVWD systems has already been constructed and permitted for emergency use. Additional permitting would be required to use the existing intertie for non-emergency use.

7.2.2 SqCWD-Only Participation

If the project were increased to a capacity of 4.6 mgd, desalinated seawater could be provided as follows: 3.3 mgd for City use and 1.3 mgd for SqCWD use. This distribution would match the City's expected yield considered by the SCWD for the regional recycled water alternatives and the yield planned for SqCWD's Pure Water Soquel Project.

To implement a regional project with SqCWD only, necessary infrastructure would include the following modified project components compared to the project:

- **Seawater System and Conveyance System** – These systems could be constructed as proposed in Section 3 but would need to be designed for increased capacity to produce 4.6 mgd. To produce approximately 4.6 mgd reliably, the seawater intake system would need to be designed to provide maximum flow of approximately 11.5 mgd of raw seawater based on an overall facility minimum recovery of 40%.
- **Seawater Desalination Plant** – A larger capacity plant could be constructed within the space provided at any of the three identified alternative sites. The treatment capacity would need to be increased above the proposed 3.3 mgd capacity to an increased total capacity of up to 4.6 mgd.
- **Brine Storage, Disposal, and Conveyance System** – Brine disposal would still occur through blending with effluent from the City's wastewater treatment plant and returned to the Monterey Bay through the existing outfall. A revised Dilution Analysis per the requirements of the OPA would be required to ensure minimum dilution requirements and other OPA requirements would be met.
- **Potable Water Distribution System** – This component includes the following:
  - A new pipeline would still be required to convey the desalinated water to the City's potable water distribution system.
  - As described in the scwd² DEIR, interconnection to provide 1.3 mgd to SqCWD could be provided by the SCWD upgrading approximately 12,000 linear feet of existing pipeline capacity to 24-inch diameter pipes. SqCWD would also need to upgrade approximately 4,000 linear feet of existing pipeline to 16-inch diameter pipes and approximately 2,500 linear feet of existing pipeline to 12-inch diameter. The Soquel Drive intertie between the two service areas may require upgrade. While no new pump stations would be required, upgrades to the SCWD's Morrissey pump station

and the SqCWD's McGregor and Aptos pump stations would be needed as described in the scwd^2 DEIR (URS 2013a).

As described in Section 7.2.1, the SqCWD demands could be met with fewer improvements in the City's and SqCWD's service areas because many of the recommended improvements have already been implement by the SqCWD, and demand in the City's service area has declined. However, additional analyses would be required if there is interest in pursuing this alternative to refine pipeline improvements to improve intertie flows and any other operational issues in the City's service area that may result from such a regional project.

7.3 City Participation in MBRWP

Deepwater Desal LLC has proposed the Monterey Bay Regional Water Project (MBRWP) at Moss Landing in Monterey County. As described on the Deepwater Desal website (DeepWater Desal 2017), the project would consist of an SWRO desalination facility, a colocated data center, intake and outfall facilities, a power substation, and a hydroacoustic water quality monitoring system. One of MBRWP's stated goals is to make a new supply of potable water available north to the City, east to Salinas, and south to the Monterey Peninsula. It would initially have an annual production capacity of approximately 10,000 acre-feet (9 mgd), with potential future expansion of an annual capacity of up to 25,000 acre-feet (22 mgd). The capacity of intake and outlet facilities would be initially sized to accommodate future expansion capacity (Deepwater Desal 2017). SCWD staff reviewed existing sources of information to develop the information in this section and coordinated with DeepWater Desal LLC to get a current assessment of schedule and costs.

The MBRWP is proposed as a public-private partnership. Deepwater Desal LLC would form a joint powers authority (JPA) composed of public water agencies to finance and operate the desalination facility. They also propose to privately design, finance, construct, and operate a colocated, seawater-cooled data center that would share infrastructure and provide high-speed Internet servers for the region. The intake and outfall infrastructure would be financed with the data center and would not fall under the JPA. Warmed seawater from the data center would feed the desalination facility, which may lower the operating costs of each facility (Kennedy/Jenks Consultants 2014a).

The JPA structure for the desalination facility would be consistent with the Monterey County requirement that water providers be public agencies. Under this model, Deepwater Desal LLC and an engineering/construction partner would fund permitting, design, and construction of the desalination facility. The JPA would be responsible for financing the desalination facility capital costs of construction, as well as operation and maintenance costs. Deepwater Desal LLC would plan to operate the facility for an agreed upon amount of time before selling to a JPA or wholesale agency that would then take ownership of the facility (Kennedy/Jenks Consultants 2014a).

For the City to purchase water from the MBRWP, the City would need to become part of a successfully formed JPA and pay associated costs. Deepwater Desal LLC and the JPA would in turn need to be successful in financing, designing, permitting, constructing, and operating the project. Negotiation would be necessary to determine if supply of 3.3 mgd would be available to the City and at what cost. City costs would also include pumping and conveyance of the treated water from Moss Landing to the City's distribution system. If SqCWD and the City were both to purchase water from the MBRWP, there would be some potential for shared conveyance infrastructure costs.

Based on recent input provided to SCWD by DeepWater Desal LLC, the current schedule indicates a 2020 construction date, with water available in 2022. Current price for water is $2,000–$2,500 per acre-foot at the fence. This price assumes no data center participation in the project; therefore, cost sharing for the data center could possibly lower the cost (Adamson, pers. comm. 2017).

In addition to JPA financial commitments for water delivery at the fence, necessary infrastructure for water delivery to the City would include the following:

- **Potable Water Distribution System** – This component includes the following:
    - Interconnection from the lower portion of SqCWD's distribution system to the MBRWP would require up to approximately 15.2 miles (approximately 80,000 linear feet) of new pipeline and a pump station (see Figure 6). Pipeline capacity for this intertie would need to be determined based on ultimate delivery requirements.
    - Additional system improvements, including pipe capacity upgrades, intertie upgrade, and new/upgraded pump stations, may also be necessary to transfer the water through the SqCWD distribution system to the City's distribution system and to move the desalinated water through the City's service area (Kennedy/Jenks Consultants 2014b).

8 CONCLUSIONS

As shown in this report, a City seawater desalination project would meet most of the City's WSAC objectives as presented in Section 3 and Table 5. The project is technically feasible and could provide sufficient water supply capacity to fill the identified supply-demand gap of 1.2 bgy during modeled worst-year conditions, which equates to approximately 3.3 mgd. While the project is technically feasible, additional feasibility review of radial collector wells may be required for the project to determine the feasibility of this subsurface intake approach.

Seawater desalination can also support system robustness, redundancy, and adaptive flexibility. Redundancy can be built into design, and capacity can be modified, if needed, during design with updated Confluence modeling. A City seawater desalination project would come close, but would not meet the City's timeliness objective since it would not be completed and operational by 2025, as shown in Section 6. The project's estimated completion date is at the end of 2026, assuming a start date of early 2019. Such a project could also be a regional project with SVWD and/or SqCWD with the inclusion of intertie components, which would meet the objective of promoting regional collaboration to improve water supplies, reversing or slowing seawater intrusion, and supporting habitat restoration.

It is not yet known whether the project would meet the cost-effectiveness objective because this objective is not evaluated in this report. A subsequent analysis will be prepared by the SCWD to compare seawater desalination to other alternatives using the ACAYY. Also, while the City will consider energy use, public health, and environmental impacts in selecting a supplemental water supply, a comparison of desalination to other alternatives for these factors is not provided in this report.

Table 5. Ability of City Seawater Desalination Project to Meet Objectives

Objective	Does Project Meet Objective?
1. Provide for a supplemental water supply that provides approximately 3.3 mgd of supplemental potable water supply identified as necessary for the City and that complements ongoing and future water conservation efforts. The supply should support system robustness, redundancy, and adaptive flexibility.	Yes
2. Meet the following cost-effectiveness, yield, and timeliness thresholds identified in the WSAC Final Report:	
2.1 Cost-effectiveness – Compare favorably to other alternatives using the ACAYY.	To Be Determined
2.2 Yield – Fill the supply-demand gap of 1.2 bgy during modeled worst-year conditions based on 2015 Confluence modeling of the frequency and severity of shortages, inclusive of DFG-5 fish flows	Yes

Table 5. Ability of City Seawater Desalination Project to Meet Objectives

Objective		Does Project Meet Objective?
	and a plausible estimate of climate change impacts. This equates to approximately 3.3 mgd. Periodic updating of Confluence modeling of the frequency and severity of shortages may result in modifications to the supply-demand gap.	
2.3	Timeliness – Support a fully functional water system able to meet the supply-demand gap by 2025.	No
3.	Consider technical feasibility in selecting a supplemental water supply.	Yes Additional feasibility review of radial collector wells may be required.
4.	Consider energy use, public health, and environmental impacts in selecting a supplemental water supply.	To Be Determined
5.	Where consistent with the goal of achieving a sufficient water supply, promote regional collaboration to improve water supplies, reverse or slow seawater intrusion, and support habitat restoration.	Yes If the project is expanded to include interties with other water districts.

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FIGURES

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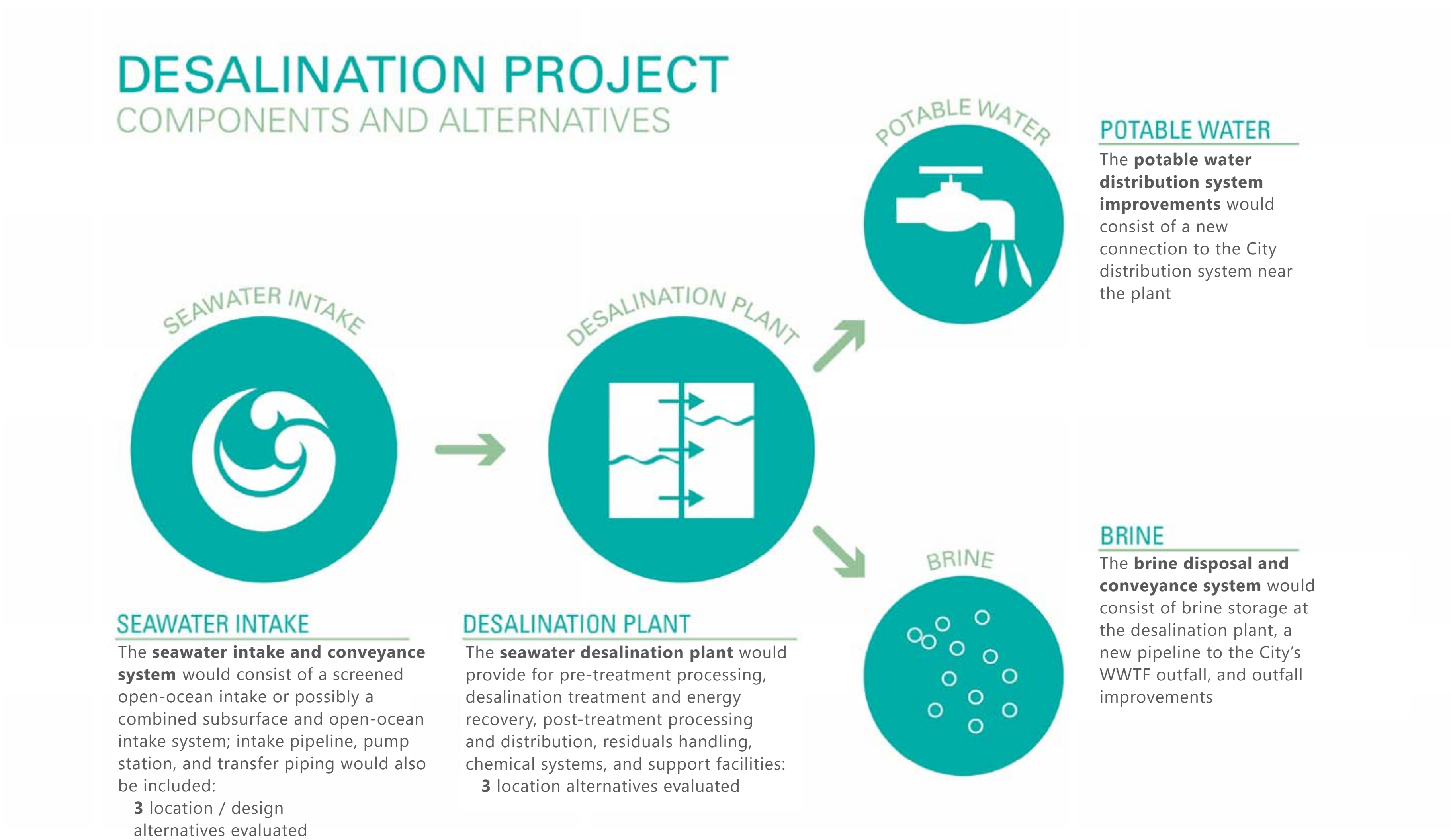


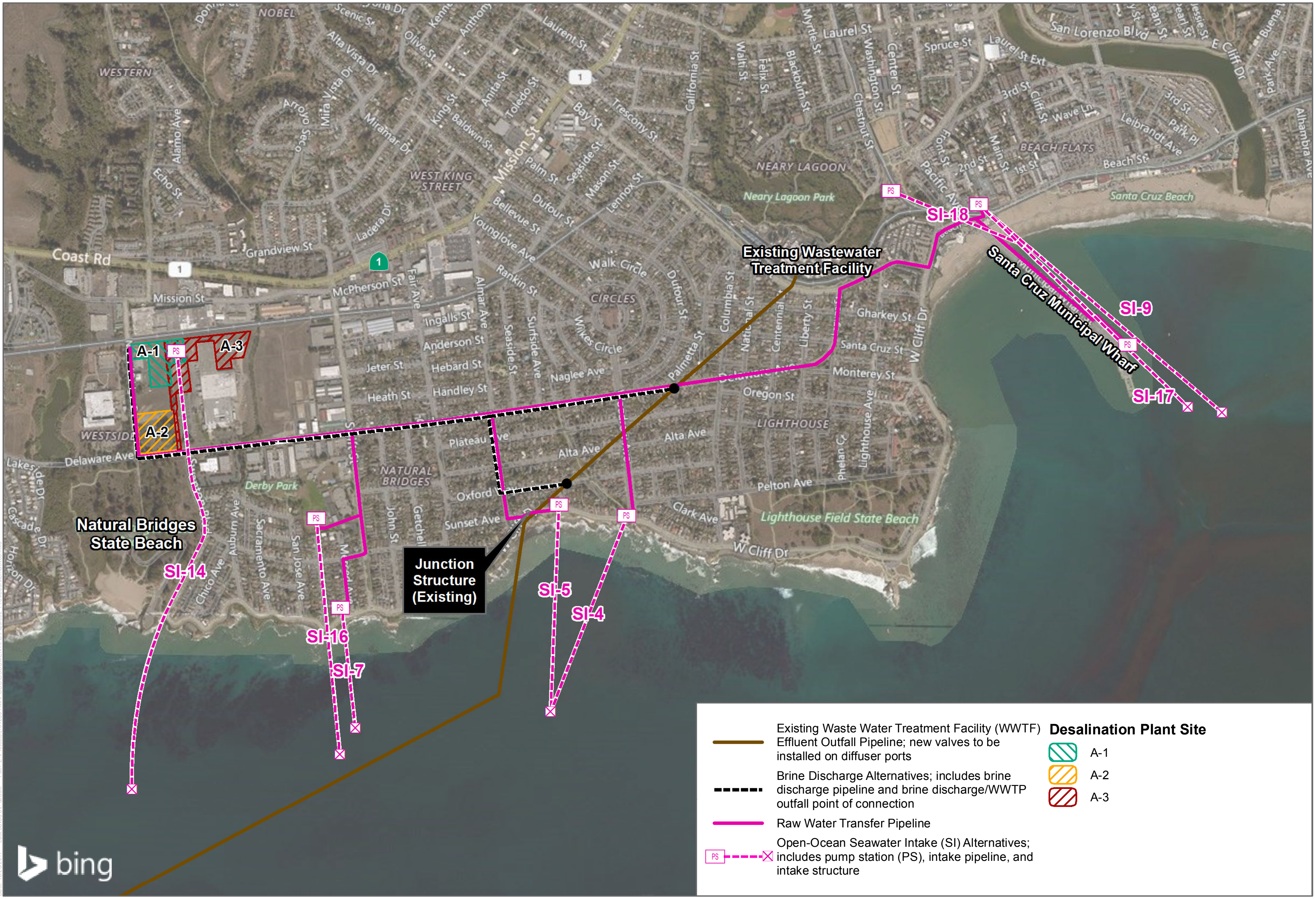
SOURCE: URS 2013; Updated by Dudek in 2017

DUDEK

FIGURE 1

Desalination Project Components and Alternatives

City of Santa Cruz Seawater Desalination Project



SOURCE: URS 2013, Bing 2017

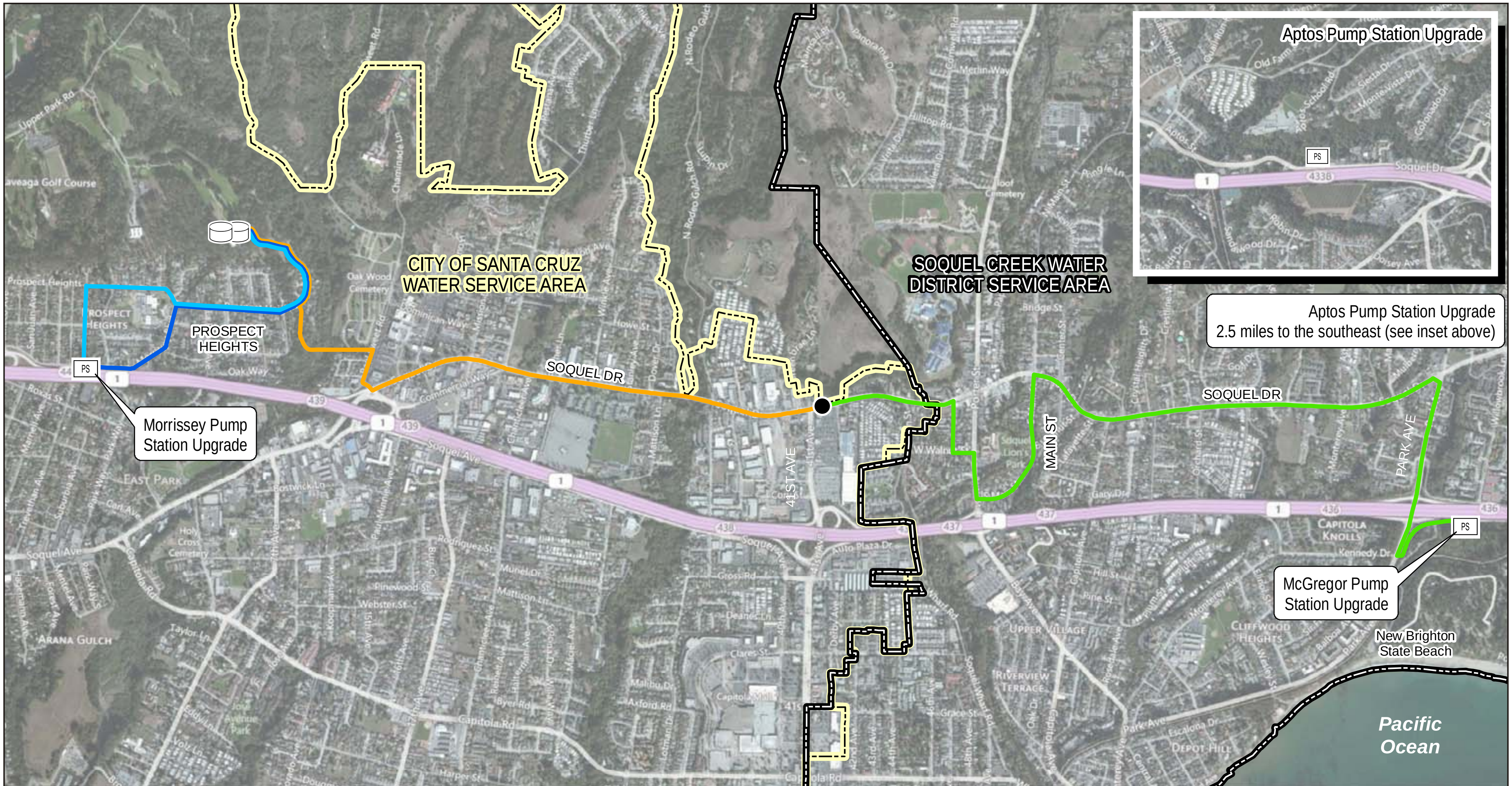
DUDEK

0 750 1,500 Feet

FIGURE 2

Previously Proposed scwd² Regional Seawater Desalination Project Overview

City of Santa Cruz Seawater Desalination Project



Potable Water Pipeline Alignments

- Morrissey PS to DeLaveaga Tanks - Morrissey Alignment Option
- Morrissey PS to DeLaveaga Tanks - Trevethan Alignment Option
- DeLaveaga Tanks to City-District Intertie
- City-District Intertie to McGregor PS

- DeLaveaga Tanks
- Pump Station (PS)
- Intertie location at Soquel Dr
- Soquel Creek Water District Service Area Boundary
- City of Santa Cruz Water Service Area Boundary

N

0 0.5 1

SCALE IN MILES

Base map source:
Microsoft Bing Maps

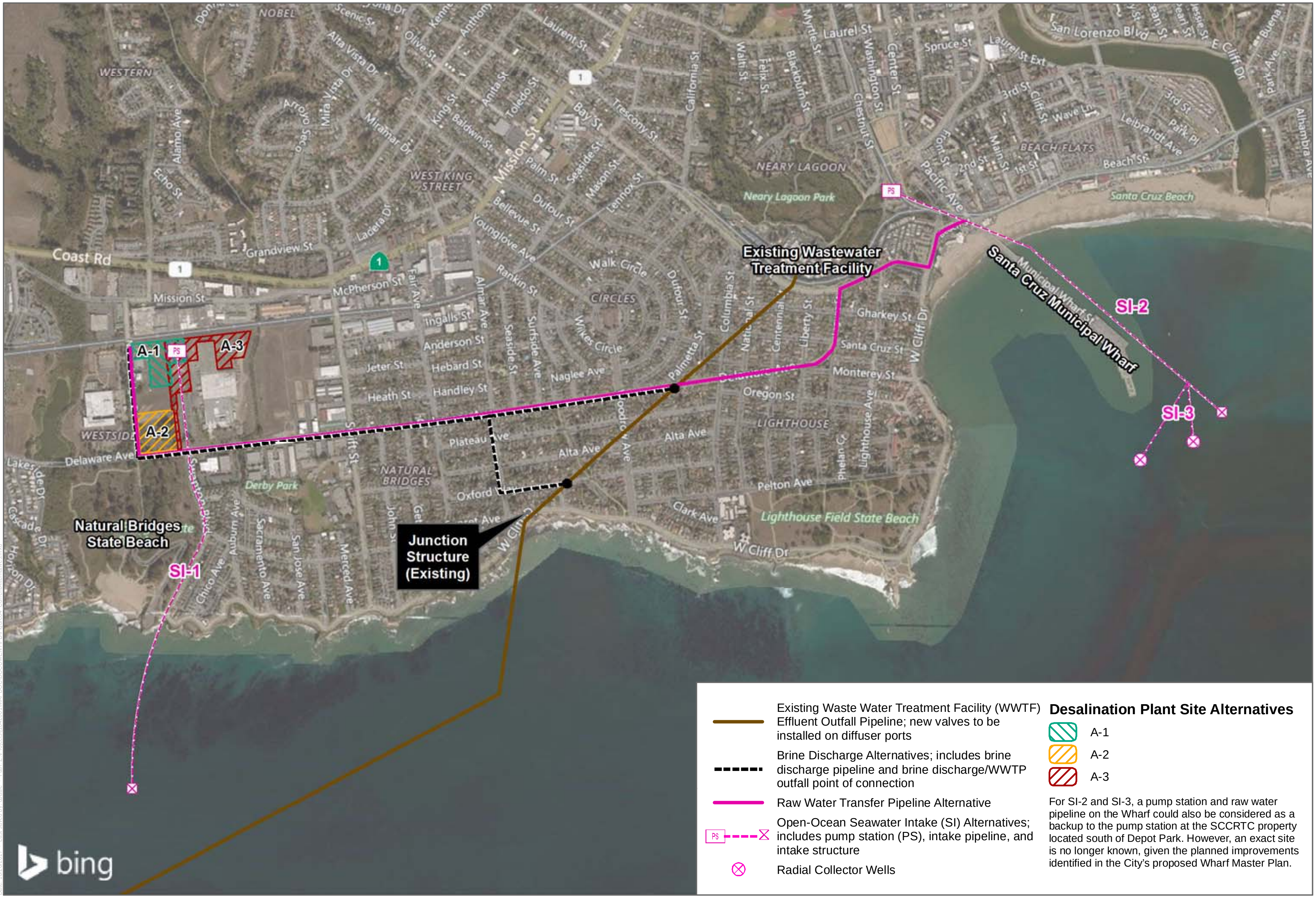
SOURCE: URS 2013

DUDEK

FIGURE 3

City-District Intertie Systems Area

City of Santa Cruz Seawater Desalination Project



SOURCE: URS 2013; Updated by Dudek in 2017, Bing 2017

DUDEK

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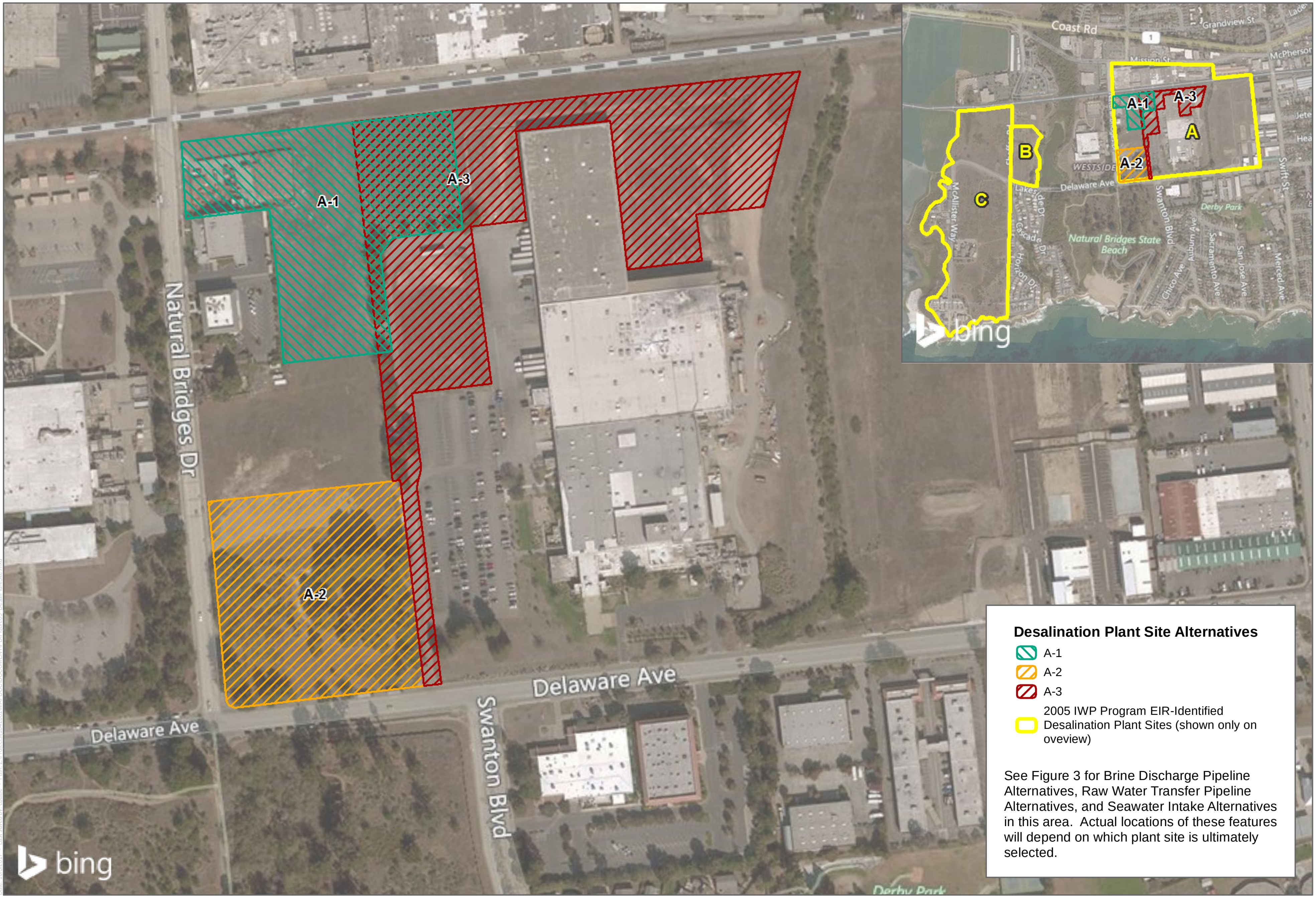
FIGURE 4

Updated Seawater Desalination Project Overview

City of Santa Cruz Seawater Desalination Project



SOURCE: URS 2013, Bing 2017

DUDEK

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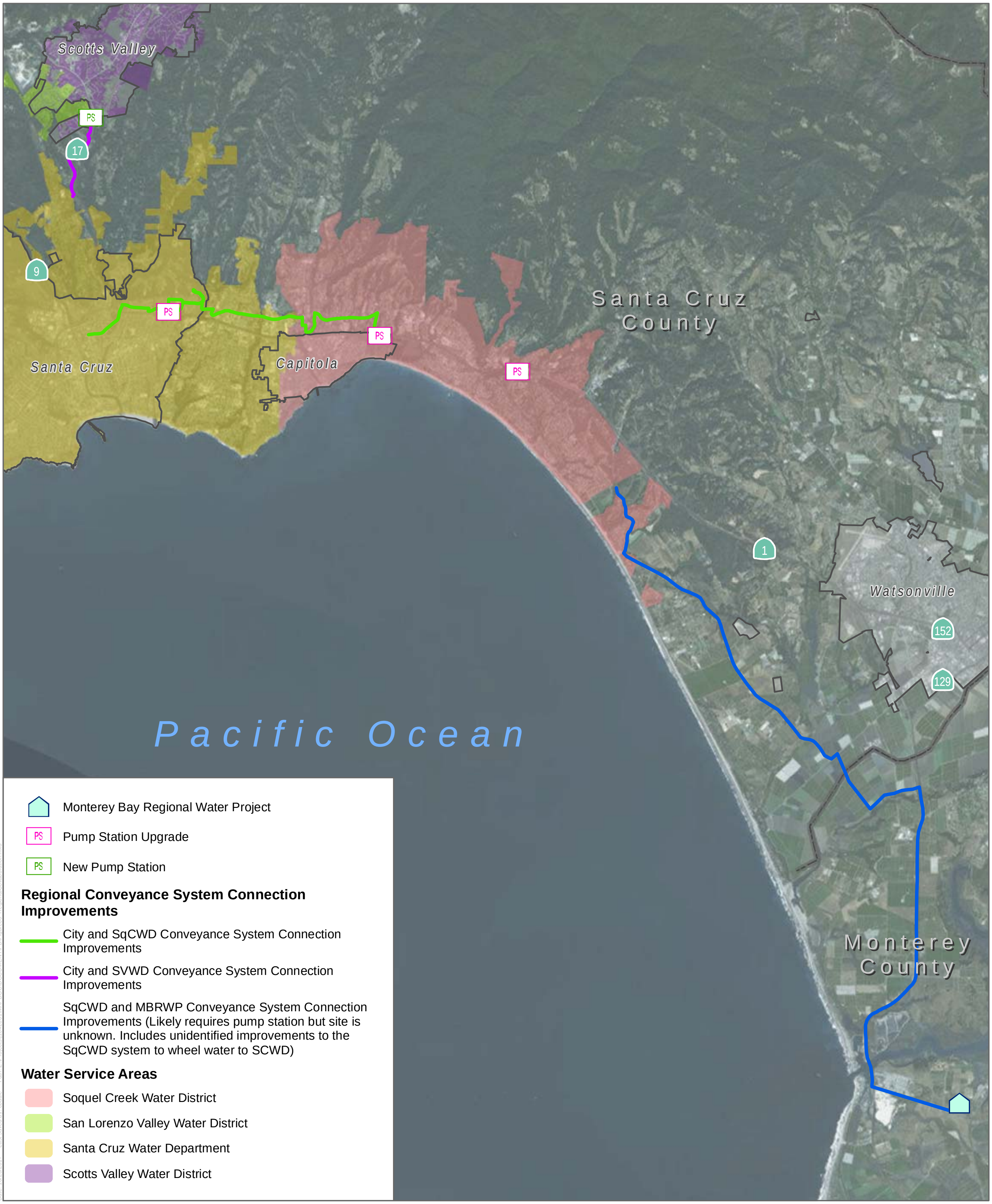
FIGURE 5

Desalination Plant Site Alternatives

City of Santa Cruz Seawater Desalination Project



SOURCE: Bing Maps (Accessed 2017); Kennedy/Jenks Consultants (2012 and 2014); URS (2013)

FIGURE 6

Opportunities for Regional Participation

City of Santa Cruz Seawater Desalination Project

DUDEK

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APPENDIX A
Marine Work Plan

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APPENDIX A

SEAWATER DESALINATION MARINE WORK PLAN

JULY 30, 2019

Introduction

Over the next 10 years the City will be studying, considering, and selecting its back up supplemental or replacement supply[1] per the City's Water Supply Advisory Committee's Final Report on Agreements and Recommendations (WSAC's Final Report). To support that decision in part, the City is preparing an updated feasibility review of pursuing a seawater desalination project. This information will allow the City to provide a comparison of desalination to the other alternatives identified through the WSAC process.

During the preparation of the updated feasibility review, the City and it's consultant team met with State Water Resources Control Board (SWRCB), Central Coast Regional Water Quality Control Board (CCRWQCB) and California Coastal Commission (CCC) staff on March 14, 2018 to determine what additional marine-related studies or analyses would be needed, if any, over and above prior marine studies performed for the Integrated Water Plan and the scwd[2] Regional Seawater Desalination Project. As marine-related studies and analyses to pursue and permit seawater desalination projects can have substantial cost and schedule implications, understanding the need for additional studies is a priority. It was collectively determined in this meeting that a marine work plan should be developed for review by the above agencies. This document constitutes the marine work plan prepared by Dudek and the City Water Department staff. The marine work plan was reviewed by the SWRCB, CCRWQCB, CCC and the Monterey Bay National Marine Sanctuary (MBNMS) and their comments were incorporated into the work plan. The marine work plan results were also incorporated into the final draft of the Desalination Feasibility Update Review.

This memorandum provides a listing of prior studies and key conclusions and outlines the marine work plan for additional studies and analyses, based on input from the above agencies. The work plan would be used as a guide if the City decides to pursue a seawater desalination project.

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[1] As presented in the 2015 UWMP, the Water Supply Augmentation Strategy portfolio elements include conservation and passive and active groundwater recharge. Advanced-treated recycled water or desalination would be selected as a supplemental or replacement supply in the event the groundwater storage strategies prove insufficient to meet the identified goals.

Key Prior Desalination Studies

Table 1 provides key desalination studies and associated conclusions as they relate to seawater desalination from the prior 2005 Integrated Water Plan (IWP) and the scwd[2] Regional Seawater Desalination Project.

Table 1. Prior Key Desalination Studies

#	Study Name	Study Description	Key Conclusions
		Integrated Water Plan	
1	City of Santa Cruz/Soquel Creek Water District Alternative Water Supply Study: Evaluation of Regional Water Supply Alternatives, March 2002	A conceptual-level hydrogeological study evaluates the potential for vertical beach-wells, horizontal/radial wells and infiltration galleries.	• The Santa Cruz coastline from the beachfront adjacent to the Santa Cruz Boardwalk and 10 to 12 miles south to Rio Del Mar generally does not have suitable geology and hydrogeological conditions for subsurface intakes: o Beach areas typically comprise fine to coarse grained materials ranging from 10 to 20 feet thick. o Seasonal wave action periodically alters the average beach profile making it thinner in winter. o The entire section of coastline is underlain by the Purisima Formation; flat bedrock shelfs extend offshore in most of the study area. o Larger alluvial deposits contained in the infilled drainage channels along the coast provide a greater opportunity to produce an uninterrupted supply of sea water. o San Lorenzo River Alluvial Basin was identified but the study indicated that the predominantly fine-grained nature of the materials and the basin geometry (shallow and narrow) would impede vertical infiltration of saltwater. o Site-specific evaluation of San Lorenzo River Alluvial Basin through field-testing would be required to determine aquifer yield.
2	Review of Subsurface Intake Studies and Recommendations for Additional Investigations, September 2008	A review of new technologies and approaches to sub-seafloor intakes being developed and provides recommendations for further study.	• Due to potential advantages of sub-seafloor intake technologies in providing passive protection of marine organisms, this study recommended that additional investigation and evaluation of sub-seafloor intake systems be conducted (see #5 and #6 below).
		scwd[2] Desalination Program*	
3	Seawater Reverse Osmosis Desalination Pilot Test Program Report, April 2010	Results of 2008-2009 pilot plant testing program to evaluate alternative treatment systems for a SWRO plant.	• Seawater desalination will be a safe and reliable source of supply. • Pretreatment and SWRO treatment recommendations were provided.

Table 1. Prior Key Desalination Studies

#	Study Name	Study Description	Key Conclusions
4	Proposed scwd² Desalination Project Watershed Sanitary Survey, July 2010	Survey to identify potential sources of contamination and investigate the quality of the source water.	• Hazardous materials spill in the vicinity of the intake was the only contaminant source identified that could significantly affect SWRO. • Large algal blooms could be handled through plant design.
5	scwd² Seawater Desalination Program Offshore Geophysical Study, August 2010	Study of the sediment offshore in the San Lorenzo River alluvial channel and Neary and Woods/Schwan paleochannels - Involved Technical Working Group.	• The sub-seafloor geology and characteristics of the offshore alluvial channel are highly variable. • Neary and Woods/Schwan paleochannels were not recommended for further study as they have shallow sediment, are filled with mostly fine-grained sediment (i.e., mud, clay and silt) and contain significant quantities of gas. • The San Lorenzo River paleochannel contains sand, silt, clay and gravel: o A mobile, active layer of fine sand and silt on the seabed could act as a confining layer to the movement of seawater through alluvial materials. o Some layers have medium and coarse-grained sand that would allow water to move toward a subsurface intake, but fine sands, silts and clay layers could inhibit water movement. o Hydraulic conductivity of the layers was found to vary significantly with thin layers of moderate to low permeability. o The narrow, shallow, winding paleochannel may restrict the lateral movement of seawater. • The study recommended that SCWD: (1) consider other factors that may increase the risk of developing a subsurface intake in this location, including water quality concerns and O&M costs, which could impact the feasibility of these source water alternatives; (2) develop an understanding of the required test program that must be conducted to prove the availability of any of the subsurface intake alternatives; (3) identify the unknowns that will still remain after performance of those programs; and (4) develop an understanding of the estimated costs to construct a subsurface intake.
6	scwd² Seawater Desalination Intake Technical Feasibility Study, September 2011	Provides an evaluation of the technical feasibility of the alternative intake approaches - Involved Technical Working Group.	• Conditions above Wilder Ranch, east through the City of Santa Cruz, to Capitola were evaluated for potential subsurface intake locations, based on input from local USGS scientists • The streams north and south of Santa Cruz (north to Wilder Ranch and south to Capitola), that discharge into the ocean at these locations are too small to have carved out an alluvial channel that could be suitable for a subsurface intake system and therefore, they were not considered further. • Alluvial channels near the mouth of the San Lorenzo River and the Santa Cruz Municipal Wharf were the only potentially viable location for subsurface intakes:

Table 1. Prior Key Desalination Studies

#	Study Name	Study Description	Key Conclusions
			o Vertical beach wells, slant wells and engineered infiltration galleries were determined not to be technically feasible due to capacity limitations, risk of damage from storms, impacts on coastal groundwater levels, and poor sub-seafloor alluvial conditions. o Offshore radial collector wells were determined to be potentially viable, but not recommended because they may not provide reliable production capacity, they are unproven in an offshore marine environment, they provide low operational flexibility, they are the most complex to construct, and they have the highest capital and life-cycle cost. o Screened, open-ocean intake was identified as the "apparent best intake approach."
7	scwd[2] Regional Seawater Desalination Project Seawater Intake Conceptual Design Report, May 2013	Presents conceptual design, construction approach and site locations for intake screens, intake pipeline, intake pump station and transfer pipeline.	• 18 site locations for a screened, open-ocean intake were evaluated along the coastline from the San Lorenzo River to Natural Bridges State Beach. • 10 site locations were determined to be infeasible and 8 were determined to be feasible and the subject of the conceptual design process and the EIR evaluation. • The reuse of the existing WWTF abandoned outfall pipeline and Junction Structure at Mitchell's Cove Beach, previously identified in the IWP Program EIR, was recommended for elimination because there would be construction and operational problems with a pump station at the existing Junction Structure, and there was not enough land area onshore to allow for the installation of the intake pipeline.
8	scwd[2] Desalination Program Open Ocean Intake Effects Study	Presents assessment of potential impacts to marine life from proposed screened, open-ocean intake, based on 13-month plankton sampling, consistent with 316(b) protocols and current Ocean Plan requirements, at then proposed intake location at abandoned outfall and nearby locations - Involved Technical Working Group.	• Nine taxa were chosen for detailed assessment including seven types of fishes, cancrid crabs and caridean shrimps. • No endangered, threatened, or listed species were collected. • The estimated percent incremental mortality for the most abundant fishes, shrimps and crabs was 0.063% (gobies), 0.053% (white croaker), 0.047% (northern anchovy), 0.033% (sanddabs), 0.029% (sculpins), 0.027% (California halibut) 0.010% (KGB rockfishes), and 0.022% (caridean shrimps and cancer crab megalops). • These species would have less than about six-hundredths of one percent of their populations (0.0006) within the source water at risk of entrainment. • These low values do not represent a significant source of mortality on these populations. • The natural mortality rate of larvae from these species is approximately 99.9%, and the natural mortality of juvenile fishes of these species is approximately 98%.

Table 1. Prior Key Desalination Studies

#	Study Name	Study Description	Key Conclusions
9	Estimated Cumulative Effects of scwd[2] Desalination Plan Intake on Fish Populations, May 2013	Assessment of potential cumulative impacts due to the scwd[2] intake in Monterey Bay and coastal waters up to Point Año Nuevo.	• Cumulative effects of all the intake sources in nearshore coastal waters of Santa Cruz and Monterey Bay represent an increase to natural and other sources of mortality for the studied larval populations in the coastal areas of Santa Cruz and Monterey Bay of 3%. • The scwd[2] intake represents 3.5% of the above increase.
10	Dilution Analysis for Brine Disposal via Ocean Outfall, August 2011	Evaluation to determine how the comingling of brine and Wastewater Treatment Facility (WWTF) effluent would achieve dilution requirements of the City's existing NPDES permits.	• Installation of new valves (Red Valves©) over existing outfall ports was recommended to allow the City to open all diffuser ports, which would spread the effluent along the entire diffuser. • Providing for brine storage during periods of low WWTF effluent flows allows for brine discharge when the WWTF has adequate flow rates. • With the above, the NPDES dilution requirements could be maintained and the combined discharge would not exceed the salinity of receiving water.
11	Site Selection for Seawater Desalination Treatment Plant, April 2013	Evaluation of a range of plant site alternative locations.	• Identified three top-ranked desalination treatment plant sites for further evaluation in the EIR, of the ten sites evaluated.
12	scwd[2] Seawater Desalination Plant Phase 1 Preliminary Design	Provides for preliminary design for the desalination plant.	• Provides site planning, architecture and landscape concepts for a 2.5-mgd plant on 3 alternative sites. • Developed preliminary construction schedule. • Provided construction and operations & maintenance costs.
13	Preliminary Assessment for Disposal of Waste Flows from the Proposed scwd[2] Seawater Desalination Plant to the City of Santa Cruz Sanitary Sewer System	Assesses the potential impacts of the plant with respect to disposal of waste flows to the City's WWTF.	• Disposal of waste flows would increase salinity somewhat, but would not significantly impact the treatment or performance of the WWTF. • There is a potential for solids to settle in several segments of sewer pipe, as the pipe segments currently produces velocities below the recommended minimum.
14	Summary of scwd[2] Energy and GHG Reduction Approach	Distills relevant information from the in-progress Energy Plan needed to support the EIR.	• Demonstrates that net-carbon neutral objective could be achieved. • Quantifies maximum energy and GHG emissions associated with Project operation. • Identifies the basis for identifying, assessing and recommending feasible and reliable GHG reduction projects. • Identifies accounting procedures and annual true-up approach.

*Additional studies and calculations were also performed, related to the following: stormwater regulations and drainage requirements, project construction assumptions, water quality data, terrestrial biological resources, air quality and climate calculations, noise

Table 1. Prior Key Desalination Studies

#	Study Name	Study Description	Key Conclusions
	measurement data, cultural resources study, paleontological records search, potential hazardous materials release sites, and a range of studies addressing alternatives to the scwd[2] Project.		

Marine Work Plan

Based on review of the prior studies, understanding of the 2016 Ocean Plan and input from SWRCB, CCRWQCB, CCC and MBNMS staff, a marine work plan was prepared (see Table 2).

The marine work plan would serve as a guide if the City decides to pursue a seawater desalination project. The studies and analyses in Table 1, along with those in Table 2, would support the completion of both the California Environmental Quality Act/National Environmental Policy Act process and the regulatory permitting process for a seawater desalination project.

Table 2. Marine Work Plan for Seawater Desalination Project

#	Study Name	Study Description	Purpose of Study
1	Seawater Desalination Intake Technical Feasibility Study Update	Update the prior scwd[2] Seawater Desalination Intake Technical Feasibility Study by: • Providing further documentation of conditions north and south of Santa Cruz and basis for excluding these areas from further study, if needed (see Table 1, Items #1, #5 and #6). • Reviewing any new technologies since the prior study at the request of the agencies, including horizontal directional drilled systems (HDD systems),[2] covering any advancements in this or other technologies over the past several years, examining case studies and comparisons of where the HDD technology has been implemented is similar conditions. Due to the limited extent of the subsurface alluvial channels associated with the San Lorenzo River Alluvial Basin and other beaches in the area, a HDD system would not likely be feasible. • Addressing a reasonable range of intake design capacities for viable subsurface intakes will be evaluated. • Providing initial feasibility determinations for all subsurface intake technologies evaluated based on the Ocean Plan definition of "feasible", understanding that the CCRWQCB makes the ultimate determination of feasibility under the Ocean Plan. • If needed, based on the feasibility conclusions above, agency staff recommended further evaluating the radial collector well	To provide a reasonable range of sites that could potentially support a subsurface intake, per the Ocean Plan.

[2] HDD systems (e.g., Neodren) consist of a series of drains extending seaward from the shore, fanned out to provide adequate separation. Individual porous pipes deliver water into a common wet well.

Table 2. Marine Work Plan for Seawater Desalination Project

#	Study Name	Study Description	Purpose of Study
		option by considering one or more radial collector well sites in the alluvial channel on the west side of the municipal wharf.	
2	Site-Specific Geophysical Study	Depending on the outcome of the feasibility determinations from #1 above, additional site-specific offshore geotechnical borings could be conducted to further assess the technical feasibility of radial collector wells by: • Conducting offshore geotechnical borings in the areas of the proposed radial collector wells to confirm and better characterize the offshore, sub-seafloor alluvial hydrogeological properties. • Drilling offshore test wells in the areas of the proposed radial collector wells. • Conducting alluvial draw-down and water production testing to determine how much water could be collected through radial collector wells and whether the system would be reliable. • Modifying and adapting the alluvial draw-down and water production testing for an offshore environment. • Analyzing the data and preparing a report on the expected production from an offshore radial collector well in the alluvial basin off the Wharf. • Conducting water quality testing to understand the constituent makeup of the subsurface water (e.g., salt levels, turbidity, iron, and manganese) and determine source-water suitability and/or any issues. • Conducting all regulatory permitting for the off-shore geophysical work, planning, borings, tests, and reporting could take 2 to 3 years to complete. It is likely that if such a system were pursued, an open-ocean screened intake would also need to be installed as part of the overall system to provide supplemental intake water, should the radial collector wells lose production capacity and/or require significant maintenance.	To provide a reasonable range of sites that could potentially support a subsurface intake, per the Ocean Plan.
3	Intake Effects Study/Entrainment Study Update	Update the prior scwd[2] Open Ocean Intake Effects Study by: • Incorporating all available data from the immediate area and further alongshore and offshore. This information will be shared with the agencies at the outset to determine if additional intake locations need to be evaluated. • Confirming with agencies that a reasonable range of locations for screened open-ocean intake have been identified. • Coordinating with agencies to determine the appropriate level of study to characterize larval entrainment at different. locations	To provide a reasonable range of sites for an open ocean intake and update the entrainment study, per the Ocean Plan.

Table 2. Marine Work Plan for Seawater Desalination Project

#	Study Name	Study Description	Purpose of Study
		• Evaluating the currently proposed capacity of the desalination facility (3.3 mgd) and the associated intake of raw seawater.	
4	Benthic Survey	Conduct a benthic survey to provide sufficient understanding of the types of seafloor habitats and associated marine communities in the offshore portions of the project area to support a description of baseline conditions and analysis of project impacts on benthic resources.	This survey is expected to be required by the Monterey Bay National Marine Sanctuary.
5	Dilution Analysis for Brine Disposal Update Study	Update the prior scwd[2] Dilution Analysis for Brine Disposal via Ocean Outfall by: • Evaluating the currently proposed capacity of the desalination facility (3.3 mgd). • Evaluating all applicable requirements of the Ocean Plan related to discharge and water quality. • Evaluating potentially reduced wastewater flow due to implementation of one or more recycled water projects. • Determining whether a multi-port diffuser on the WWTF outfall would be required under the OPA to provide for adequate mixing to avoid a negatively buoyant plume. • Evaluating shear-related mortality if a multi-port diffuser is required using methodologies by Dr. Phil Roberts and determining the best available diffuser to minimize intake and mortality of all forms of marine life. The same methodology can be used to assess any incremental increase in mortality resulting from commingling brine with wastewater.	To meet analysis requirements of the Ocean Plan.
6	Marine Life Mortality Report	This new study will quantify the construction and operational impacts of the desalination facility on all forms of marine life. For construction impacts, the disturbance of habitat will be quantified. For operational impacts, entrainment- and elevated-salinity-related marine life mortality from intake of source water and discharge of brine will also be quantified. The Marine Life Mortality Report, required under the Ocean Plan, will translate the mitigation requirement to the area of production foregone (APF)[3] and the associated effects will be addressed through a mitigation project, as a fee-based mitigation program is currently not available.	To determine the level of mitigation required, per the Ocean Plan.
7	Monitoring and Reporting Plan	This new plan will be submitted to the RWQCB to determine the baseline biological conditions before and after constructing and operating the desalination facility. The plan will describe ways to monitor for benthic health, aquatic life toxicity, hypoxia, and	Plan is a requirement of the Ocean Plan and monitoring is a requirement in the

[3] APF is an estimate of the area that is required to produce (replace) the same amount of larvae or propagules that are removed through entrainment at desalination facility intakes. APF is calculated by multiplying the proportional mortality by the source water body, which are both determined using an empirical transport model (ETM).

Table 2. Marine Work Plan for Seawater Desalination Project

#	Study Name	Study Description	Purpose of Study
		receiving-water characteristics to demonstrate compliance with receiving-water limitations, including salinity.	MBNMS Desalination Guidelines.
8	Site Selection for Seawater Desalination Treatment Plant Update Review	Update the prior scwd[2] Site Selection for Seawater Desalination Treatment Plant evaluation to provide an updated review based on Ocean Plan siting criteria to support the RWQCB findings on whether the plant and associated intake sites constitute the best available site feasible.	To meet analysis requirements of the Ocean Plan.

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APPENDIX B

Engineer's Opinion of Probable Capital and Lifecycle Costs for 3.3 MGD Alternatives

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23 October 2017

Technical Memorandum – SCWD Desal Update Cost Estimates

To:	Heidi Lukenbach, PE, City of Santa Cruz
	Ann Sansevero, AICP, DUDEK
From:	Dawn Taffler, PE and Alex Page, Kennedy/Jenks Consultants
Review:	Todd Reynolds, PE, Kennedy/Jenks Consultants
Subject:	City of Santa Cruz Desalination Feasibility Update Review - Cost Estimates
	K/J 1768015*00

The City of Santa Cruz (City) is reviewing the facility, cost, timeliness and approach for pursuing the construction and operation of a City Seawater Desalination Project. This effort will support the City's selection of a supplemental or replacement supply per the City Water Supply Advisory Committee's Final Report on Agreements and Recommendations (WSAC's Final Report) (WSAC 2015). The overarching goal of the WSAC's Final Report is to provide significant improvement in the sufficiency and reliability of the Santa Cruz water supply by 2025. The recommended strategies in the WSAC's Final Report include conservation to reduce demand; passive and active groundwater recharge; and supply augmentation using advanced-treated recycled water with desalination as a back-up, should the use of advanced-treated recycled water not be feasible.

This Technical Memorandum (TM) supports the Desalination Feasibility Update Review Report by providing cost estimates for desalination alternatives being investigated for the City Seawater Desalination Project.

1. Overview

The City Seawater Desalination Project consists of four major project components:

(1) a seawater intake and conveyance system;
(2) a seawater desalination plant;
(3) a brine storage, disposal, and conveyance system; and
(4) potable water distribution system improvements.

These project components include different types of facilities, such as buildings, pumps, pipelines, and other equipment. Three desalination alternatives being investigated for the City Seawater Desalination Project. Each alternative considers the same facility location, brine disposal conveyance and potable water distribution system improvements. The alternatives differ on the type of seawater intake system to extract seawater for desalination.

For the purpose of this TM, costs estimates are developed for three alternatives based on different seawater intake design options:

- Alternative 1 - Screened Open-Ocean Intake (Westside)
- Alternative 2 - Screened Open-Ocean Intake (Wharf Area)
- Alternative 3 - Subsurface Intake System (Wharf Area)

Cost estimates are prepared based on prior conceptual design drawings, assumptions from prior studies and adherence to project objectives. Facilities are sized to accommodates a 3.3 MGD desalination facility, seawater intake, and brine disposal conveyance system. No new component site locations (e.g., plant sites, intake locations), over those previously considered, are identified or assessed for the three alternative cost estimates.

2. Project Component Characteristics

The general characteristics for each project component are summarized in the following sections.

2.1 Seawater Intake and Conveyance System

The seawater intake and conveyance system would be comprised of a seawater intake structure or structures in the Monterey Bay to draw in raw seawater (source water), an intake pipeline to deliver the seawater to the shore, and a pump station to pump the seawater to the desalination plant via transfer piping. To produce approximately 3.3 mgd of treated product water reliably, the seawater intake system would be designed to provide a maximum flow of approximately 8.3 mgd of raw seawater, based on an overall facility minimum recovery of 40%. The desalination plant could operate with higher recoveries for periods of time and withdraw lower rates of seawater, but would also operate at lower recoveries for some periods. Therefore, the intake conveyance system would be designed to accommodate the larger volumes of intake water to cover the range of production and overall facility recoveries.

The seawater intake and conveyance system would be located between an offshore location in the Monterey Bay and the desalination plant site. A number of alternative locations for the seawater intake and conveyance system were evaluated in the scwd² Draft Environmental Impact Report (DEIR) (URS 2013). Thee intake options were evaluated and updated, based on the assessment of changed conditions. Only one of these options would be implemented:

- **Seawater Intake Alternative 1, Screened Open-Ocean Intake (Westside)** – A screened open-ocean intake located offshore on the Westside of Santa Cruz is considered for the Project, as a sub-surface intake in this location is not feasible due to shallow bedrock offshore. The intake screens would have 1-mm openings. The intake pump station would be located at the seawater desalination facility. This is similar to seawater intake alternative number SI-14 from the scwd[2] DEIR.

- **Seawater Intake Alternative 2, Screened Open-Ocean Intake (Wharf Area)** – A screened open-ocean intake located offshore near the City Wharf is considered for the Project. The intake screens would have 1-mm openings. The intake pump station would be located at the Santa Cruz County Regional Transportation Commission (SCCRTC) property located south of Depot Park. This is similar to seawater intake alternative number SI-18 from the scwd[2] DEIR.

- **Seawater Intake Alternative 3, Subsurface Intake System (Wharf Area)** – The sub-surface intake system would consist of one or two offshore radial collector wells that would draw seawater through the alluvial material beneath the seafloor. The radial collector well(s) would be constructed in the alluvial channel that is near the Wharf, where there is deep enough sand to make this approach potentially feasible. The sub-surface intake would also have an open-ocean screened intake element as part of the overall system that would be used to provide supplemental intake water, should the sub-surface intake lose production capacity and/or require significant maintenance. The intake pump station would be located at the SCCRTC property located south of Depot Park. This is similar to the location of seawater intake alternative number SI-18 from the scwd[2] DEIR, but is distinct in design given that it includes a sub-surface intake, with a screened open-ocean intake as a back-up source of raw seawater.

2.2 Seawater Desalination Plant

The desalination plant is assumed to be located in the Industrial Park on the westside of the City on approximately 4- to 8-acres of mostly undeveloped private land on infill parcels bounded by the Santa Cruz Branch Rail Line tracks on the north, Natural Bridges Drive on the west, Delaware Avenue on the south, and the realigned Arroyo Seco stream on the east. Though three locations are being considered only one would be implemented.

The 3.3-mgd capacity desalination plant would provide for all the equipment used for the desalination process, except for the seawater intake system and pipeline conveyance systems for source water, brine disposal, and potable water. The plant would provide for the following primary systems:

- **Pre-treatment Processing -** Pretreatment refers to the removal of suspended solids from ocean source water to reduce fouling, clogging, and scaling of the seawater reverse osmosis (SWRO) membranes used for desalination.

- **Seawater Desalination Treatment -** The plant would use a SWRO system to desalinate raw seawater. SWRO is a pressure-driven process using semi-permeable membranes. SWRO membranes separate water molecules from impurities in the seawater by permitting water to pass, and limiting the passage of salts and other constituents. The results are a permeate stream (or product water) and a concentrate stream (or brine). The desalination system would have the ability to operate with a recovery rate ranging from 40 to 50 percent (40 to 50 gallons of fresh drinking water per 100 gallons of seawater).

- **Post-treatment Processing and Distribution** - Reverse osmosis removes many of the minerals from the water. Lack of hardness and alkalinity makes the water more corrosive to the water delivery system. Post-treatment is required to control the corrosiveness of the water and provide adequate disinfection prior to distribution, as is common for potable water generated from surface and/or groundwater sources.

- **Residuals Handling and Disposal** - Operation of the desalination plant would generate solids from the pre-treatment processing. Two options for handling solids are considered (1) sanitary sewer disposal and (2) landfill disposal.

- **Chemical Systems -** A variety of chemicals would be required for treatment, disinfection, and membrane cleaning at the desalination plant. The chemicals would be stored in accordance with applicable building and seismic codes, and applicable regulatory requirements for hazardous materials storage.

Similar to the proposed scwd² Desalination Program, the final desalination plant design would consider space for other related and support uses, including but not limited to: (1) operations and control systems; (2) maintenance and facilities storage; (3) electrical operations and utility connections; (4) parking and access; (5) stormwater detention and treatment; (6) landscaping; and (7) outdoor viewing and gathering areas. A photovoltaic (PV) system could also be included at the proposed plant, as was contemplated for the proposed scwd² Desalination Program.

2.3 Brine Storage, Disposal and Conveyance System

During the SWRO process at the desalination plant, brine would be generated, and would be approximately twice as saline as seawater. Brine storage would be provided on the desalination plant site to allow for controlled release of the brine. A pipeline would convey the brine from the desalination plant to the City's wastewater treatment facility (WWTF) outfall pipeline where it would be blended with effluent from the City's WWTF and returned to Monterey Bay via the City's existing ocean outfall. The WWTF outfall diffuser ports would be improved by adding new valves (Red Valves) to the ports. A Dilution Analysis conducted to support the scwd² DEIR concluded that the WWTF National Pollutant Discharge Elimination System (NPDES) discharge permit minimum initial dilution requirement and ambient salinity at the outfall could be maintained with the above improvements. An update to the Dilution Analysis would be required to specifically address the California Ocean Plan Amendment (OPA) requirements regarding discharge and reduced wastewater flow associated with the Soquel Creek Water District's Pure Water Soquel Project.

2.4 Potable Water Distribution System

The pipeline to convey the product water from the desalination facility to the City's existing potable water distribution system would run from the desalination plant location to the existing adjacent potable water distribution pipe located within Delaware Avenue or in Natural Bridges Drive.

Given that the WSAC Final Report focuses on meeting the City's water supply needs, the previously contemplated intertie system between the City and Soquel Creek Water District service areas, consisting of new and replacement pipelines and pump station improvements, would not be a component of the Desalination Project.

3. Engineers Opinion of Probable Costs

The engineer's opinion of probable cost is based on information and costs developed in technical studies conducted by the City and Soquel Creek Water District as part of their integrated water plans and the **scwd²** Desalination Program (Kennedy/Jenks 2011, CDM 2012, URS 2012 and Kennedy/Jenks 2013), and supplemented with cost estimates from similar projects and professional experience. These studies are used to generate estimated construction costs for the three desalination alternatives being considered.

Costs from these prior studies are updated to current day using ENR cost indices and are scaled to reflect a capacity of 3.3 mgd. All costs are conceptual and order of magnitude type costs at an Association for the Advancement of Cost Estimating (AACE) Class 5 level, representing Planning to Feasibility level information with an estimated accuracy range between -30 percent and +50 percent. These costs are intended to be used for comparison purposes between alternatives.

The detailed cost table templates and assumptions applied herein are consistent with those developed for the City's Regional Recycled Water Facilities Planning Study (RWFPS) to allow for a comparison of costs for desalination and advanced-treated recycled water projects. Planning-level opinions of capital, operations and maintenance (O&M), and lifecycle unit costs are developed to facilitate an economic comparison of the three desalination alternatives to the other recycled water alternatives.

Capital, annual and life cycle unit costs are estimated based on the following assumptions.

- **Capital Cost:** based on unit construction costs, prior studies and recent project experience were used to estimate desalination facility costs, sea water intake pipelines, radial collector wells and brine disposal pipelines.
    - **Additional facility costs** apply the following percentages to the subtotal of facility costs: site development costs at 5%, yard piping at 5% and electrical, instrumentation and controls (I&C) at 15%.

- **Sales tax** of 8.75% is applied to materials (estimated at 40% of the total facility cost).
- **Allowance for unlisted items** includes a markup of 5% for mobilization, bonds and permits and 15% for contractor overhead and profit are applied to the facility direct costs.
- **An estimate contingency** of 35% has been applied to the facility direct costs. The assumed contingency is in the range of contingencies associated with an AACE Class 5 level opinion of probable cost, and is also comparable to the contingency percentage utilized for the RWFPS.
- **Escalation to midpoint of construction** is not assumed at this time.

- **O&M Cost:** The estimated O&M costs include energy cost, labor costs, chemical costs and maintenance costs associated with the desalination facility operation (CDM 2012) and for the operation of the intake facility (Kennedy/Jenks 2011), with a contingency of 10% applied to all O&M costs.
- **Life Cycle Unit Cost:** Costs are then converted to annualized lifecycle costs using basic assumptions about discount rates (estimated at 4%) and the life expectancy of project components (30-years for desalination facility and radial collector wells and 50-years for all other components). Total annualized costs are divided by the desalinated water delivered over the life of the project to obtain a uniformly derived unit cost of water in dollars per acre-foot ($/AF), dollars per million gallons ($/MG) and dollars per one hundred cubic feet ($/CCF).

Table 1 summarizes the engineer's opinion of probable costs for the three desalination alternatives. Project component costs listed are loaded based on the markups and contingency assumptions described above.

Detailed summary sheets for each alternative can be found in Attachment A to this technical memorandum.

Table 1 - Summary of Costs for Desalination Facility Components (2017 dollars)

Project Components (3.3 MGD Facility)	Alt 1 Screened Open-Ocean Intake (Westside)	Alt 2 Screened Open-Ocean Intake (Wharf Area)	Alt 3 Subsurface Intake System (Wharf Area)
Seawater Intake and Conveyance System			
Open Ocean Intake System[1]	$60,100,000	$58,900,000	$52,800,000
Radial Well Collectors	n/a	n/a	$76,600,000
Seawater Desalination Plant	$77,800,000	$77,800,000	$77,800,000
Brine Storage, Disposal and Conveyance System	$10,500,000	$10,500,000	$10,500,000
Potable Water Distribution System Connection	*(Included in Desalination Plant costs)*		
Total Capital Cost ($)	**$148,400,000**	**$147,200,000**	**$217,700,000**
Estimated Capital Cost ($mil)	**$148.4**	**$147.2**	**$217.7**
Annualized Capital Cost ($mil/yr)	$7.8	$7.7	$11.9
Desalinated Water Produced (AFY)	3,696	3,696	3,696
Annual Unit Capital Cost ($/AF)	**$2,110**	**$2,090**	**$3,210**
Annual O&M Cost ($mil/yr)	$5.4	$5.6	$5.7
Annual O&M Cost ($/AF)	$1,470	$1,510	$1,530
Life Cycle Unit Cost ($/AF)	**$3,570**	**$3,610**	**$4,730**
($/MG)	**$11,000**	**$11,100**	**$14,500**
($/CCF)	**$8.20**	**$8.30**	**$10.90**

[1] Includes intake structure, screens, pipelines and pump station.

References

CDM Smith. 2012. scwd² Regional Desalination Plant, Phase I Preliminary Design Report. October 2012. CDM Smith, Walnut Creek, CA.

Kennedy/Jenks Consultants (Kennedy/Jenks), 2011. scwd² Seawater Desalination Intake Technical Feasibility Study. prepared by Kennedy/Jenks Consultants for the City of Santa Cruz Water Department. September 2011.

Kennedy/Jenks, 2013. Technical Memorandum - Conceptual-Level Cost Comparison of Water Supply Alternatives. Prepared for City of Santa Cruz and Soquel Creek Water District scwd² Desalination Program. April 17, 2013

URS, 2013. scwd² Regional Seawater Desalination Project Draft Environmental Impact Report (DEIR), prepared by URS for the City of Santa Cruz, May 2013.

Water Supply Advisory Committee (WSAC). 2015. "City of Santa Cruz – Water Supply Advisory Committee- Final Report on Agreements and Recommendations ". October 2015. http://www.santacruzwatersupply.com/sites/default/files/resource-files/WSAC%20Final%20Report%20October%202015.pdf

Attachment A: Detailed Cost Sheets

This attachment includes detailed cost sheets for the following desalination project alternatives:

- Alternative 1 - Screened Open-Ocean Intake (Westside)
- Alternative 2 - Screened Open-Ocean Intake (Wharf Area)
- Alternative 3 - Subsurface Intake System (Wharf Area)

Engineers Opinion of Probable Cost
Alternative 1 - Screened Open-Ocean Intake (Westside)

KENNEDY/JENKS CONSULTANTS

Study:	Santa Cruz Desalination Update (3.3 MGD)	**Prepared By:**	AP, DTT, TKR		3.30	mgd
Project:	Alternative 1 - Screened Open-Ocean Intake (Westside)	**Date Prepared:**	Sep-2017	**Average Annual Ocean Water Delivered**	3696	AFY
Supply:	Ocean Water	**K/J Proj. No.**	1768015.00	**August 2017 ENR**	**12,037.27**	
Estimate:	Conceptual Level Cost-Analysis	**ENR**	2017	**February 2012 ENR**	**10,207.79**	
				June 2014 ENR	**10,899.59**	

Item No.	Description	Qty	Units	$/Unit	Total Costs (w/o mark-up) Capital Cost (2.5 MGD, 2012 USD)	Capital Cost (3.3 MGD, 2012 USD)	Capital Cost (3.3 MGD, 2017 USD)	Notes/Source
Facility Capital Costs								
								Source: (CDM, 2012) scwd2 Regional Desal Report
1.0	**Desalination Facility**				**$ 28,460,000**	**$ 33,460,000**	**$ 39,450,000**	Scaled to reflect increased flow and ENR index (as shown)
1.1	Site Work	1	LS	$ 1,728,024	$ 1,728,024	$ 1,728,024	$ 2,037,727	
1.2	Landscape	1	LS	$ 600,000	$ 600,000	$ 600,000	$ 707,534	
1.1	Control Building	1	LS	$ 1,144,391	$ 1,144,391	$ 1,144,391	$ 1,349,493	Assumed same size building for 2.5 MGD or 3.3 MGD facility
1.2	DAF Basins	1	LS	$ 2,229,269	$ 2,229,269	$ 2,675,123	$ 3,154,569	
1.3	Membrane Building (and Chemical Storage Area)	1	LS	$ 16,383,930	$ 16,383,930	$ 19,660,716	$ 23,184,386	
1.4	Calcite Contactors	1	LS	$ 1,240,895	$ 1,240,895	$ 1,489,074	$ 1,755,952	
1.5	Chlorine Contact Tank/Clearwell and HSPS	1	LS	$ 1,265,587	$ 1,265,587	$ 1,518,704	$ 1,790,893	
1.6	Concentrate EQ Basin and Pump Station	1	LS	$ 1,860,070	$ 1,860,070	$ 2,232,084	$ 2,632,127	
1.7	Clarifiers/Thickeners	1	LS	$ 927,039	$ 927,039	$ 1,112,447	$ 1,311,824	
1.8	Pump Station	1	LS	$ 1,079,011	$ 1,079,011	$ 1,294,813	$ 1,526,875	
2.0	**Sea Water Intake (Site 14)**				**$ 21,470,000**	**$ 25,830,000**	**$ 30,450,000**	Source: (URS, 2012)
2.1	Microtunnel/HDD two 36-in pipes in 8-ft casing	4,875	LF	$ 2,500	$ 12,187,500	$ 14,625,000	$ 17,246,150	Scaled to reflect increased facility size and ENR index (as shown)
2.2	Intermediate Shafts	2	EA	$ 500,000	$ 1,000,000	$ 1,200,000	$ 1,415,069	
2.3	Landside Mobilization	1	LS	$ 1,000,000	$ 1,000,000	$ 1,000,000	$ 1,179,224	
2.4	Waterside Mobilization	1	LS	$ 1,000,000	$ 1,000,000	$ 1,000,000	$ 1,179,224	
2.5	Intake Screen and Structure	1	LS	$ 800,000	$ 800,000	$ 1,920,000	$ 2,264,110	Ratio increase and doubled original 2012 cost due to decrease in screen
2.6	Excavation and Anchorage in Bedrock	1	LS	$ 200,000	$ 200,000	$ 200,000	$ 235,845	opening from 2mm to 1mm
2.7	Intake Pump Station - Rock Excavation	80	FT (depth)	$ 27,000	$ 2,160,000	$ 2,160,000	$ 2,547,124	
2.8	Intake Pump Station - Rock Disposal	80	FT (depth)	$ 1,500	$ 120,000	$ 120,000	$ 141,507	
2.9	Intake Pump Station Facility and Equipment	1	LS	$ 3,000,000	$ 3,000,000	$ 3,600,000	$ 4,245,206	
	Transfer Pipeline to the Plant	0	LF	$ 500	$ -	$ -	$ -	No transfer pipeline for alternative 1
3.0	**Radial Well Collectors**						**$ -**	
	None for this alternative	0			$ -			not included
4.0	**Brine Disposal**				**$ 4,190,000**	**$ 4,630,000**	**$ 5,310,000**	Source: (URS, 2012)
4.1	Brine Line Installation	7,300	LF	$ 300.00	$ 2,190,000.00	$ 2,628,000.00	$ 3,099,090.43	Brine Line length from URS Figure 4-3. Assumed same unit cost as Transfer
4.2	Intertie with WWTP Effluent Outfall Pipeline	1	LS	$ 2,000,000.00	$ 2,000,000.00	$ 2,000,000.00	$ 2,208,756.48	Pipeline to Plant cost for other location
	Subtotal Facility Costs				**$54,120,000**	**$63,920,000**	**$75,210,000**	
Additional Facility Capital Costs								
5.0	Site Development Costs	@	5%		2,706,000	3,196,000	3,760,500	% of Subtotal facility, sea water intake, and brine costs
								(Includes grading, erosion control, cut/fill, etc.)
6.0	Yard Piping	@	5%		2,706,000	3,196,000	3,760,500	% of Subtotal facility, sea water intake, and brine costs
7.0	Electrical, I&C, and Remote (low-tech) Control	@	15%		8,118,000	9,588,000	11,281,500	% of Subtotal facility, sea water intake, and brine costs
	Subtotal Additional Facility Costs				**$13,530,000**	**$15,980,000**	**$18,802,500**	
	Facility Direct Costs				**$67,650,000**	**$79,900,000**	**$94,012,500**	
	Taxes	@	8.75%		1,894,200	2,237,200	2,632,350	apply taxes to 40% of the Subtotal Facility Costs
	Mobilization/Bonds/Permits	@	5%		3,382,500	3,995,000	4,700,625	% of Facility Direct Costs
	Contractor Overhead & Profit	@	15%		10,147,500	11,985,000	14,101,875	% of Facility Direct Costs
	Estimate Contingency	@	35%		23,677,500	27,965,000	32,904,375	% of Facility Direct Costs
Subtotal with Contractor Markups and Contingency					**$106,751,700**	**$126,082,200**	**$148,351,725**	
								Escalation to Midpoint of Construction not applied
	Escalation to Midpoint of Construction				0	0	0	assume 2% percent over 10
								construction start = 2025 end = 2027
	Project Capital Cost Total				**$106,800,000**	**$126,100,000**	**$148,400,000**	2012 Cost is comparable to CDM Desal Construction Cost ($66mil) + URS Intake Construction Cost ($42mil). Eng/Design and Environmental Permitting not included.
	Annualized Capital Cost ($mil/year)						**$7.8**	assume discount rate (i = 4%) and facility life (n = 30 to 50 years)

Item No.	Description	Lump Sum Annual Costs ($/year)	
Annual Operations and Maintenance Costs			
			Source: (CDM, 2012), Includes escalation to 2017; scaled to reflect increased flow
8.0	**Energy Costs**		CDM Report (Table 5-4)
8.1	Energy Costs - Facility	$2,690,000	CDM Report (Table 5-4) - not incl raw water pumping
8.2	Raw Water Pumping Cost (from intake)	$200,000	CDM Report (Table 5-4)
9.0	**Labor Costs (Facility)**	$670,000	CDM Report (Table 5-5)
10.0	**Maintenance (Facility)**		
10.1	Consumable Replacements	$350,000	CDM Report (Table 5-7)
10.2	Solids Disposal	$270,000	CDM Report (Table 5-8)
10.3	Intake Component - Open Screen	$240,000	K/J Report (Table 12-3) - incl cleaning, maintenance, inspections
11.0	**Chemicals (Facility)**	$530,000	CDM Report (Table 5-6)
12.0	**Contingency**	$495,000	at 10% of above O&M costs
	Annual O&M Costs ($/year)	**$5,445,000**	
	Annual Unit O&M Costs ($/AF)	**$1,470**	

Engineers Opinion of Probable Cost
Alternative 2 - Screened Open-Ocean Intake (Wharf Area)

KENNEDY/JENKS CONSULTANTS

Study:	Santa Cruz Desalination Update (3.3 MGD)	**Prepared By:**	AP, DTT, TKR
Project:	Alternative 2 - Screened Open-Ocean Intake (Wharf Area)	**Date Prepared:**	Sep-2017
Supply:	Ocean Water	**K/J Proj. No.**	1768015.00
Estimate:	Conceptual Level Cost-Analysis	**ENR**	2017

Average Annual Ocean Water	3.30	mgd
Delivered	3696	AFY
August 2017 ENR	**12,037.27**	
February 2012 ENR	**10,207.79**	
September 2011 ENR	**10,192.79**	
June 2014 ENR	**10,899.59**	

Item No.	Description	Qty	Units	$/Unit	Total Costs (w/o mark-up) Capital Cost (2.5 MGD, 2012 USD)	Capital Cost (3.3 MGD, 2012 USD)	Capital Cost (3.3 MGD, 2017 USD)	Notes/Source
Facility Capital Costs								
								Source: (CDM, 2012) scwd2 Regional Desal Report
								Scaled to reflect increased flow and ENR index (as shown)
1.0	**Desalination Facility**				**$ 28,460,000**	**$ 33,460,000**	**$ 39,450,000**	
1.1	Site Work	1	LS	$ 1,728,024	$ 1,728,024	$ 1,728,024	$ 2,037,727	
1.2	Landscape	1	LS	$ 600,000	$ 600,000	$ 600,000	$ 707,534	
1.1	Control Building	1	LS	$ 1,144,391	$ 1,144,391	$ 1,144,391	$ 1,349,493	Assumed same size building for 2.5 MGD or 3.3 MGD facility
1.2	DAF Basins	1	LS	$ 2,229,269	$ 2,229,269	$ 2,675,123	$ 3,154,569	
1.3	Membrane Building (and Chemical Storage Area)	1	LS	$ 16,383,930	$ 16,383,930	$ 19,660,716	$ 23,184,386	
1.4	Calcite Contactors	1	LS	$ 1,240,895	$ 1,240,895	$ 1,489,074	$ 1,755,952	
1.5	Chlorine Contact Tank/Clearwell and HSPS	1	LS	$ 1,265,587	$ 1,265,587	$ 1,518,704	$ 1,790,893	
1.6	Concentrate EQ Basin and Pump Station	1	LS	$ 1,860,070	$ 1,860,070	$ 2,232,084	$ 2,632,127	
1.7	Clarifiers/Thickeners	1	LS	$ 927,039	$ 927,039	$ 1,112,447	$ 1,311,824	
1.8	Pump Station	1	LS	$ 1,079,011	$ 1,079,011	$ 1,294,813	$ 1,526,875	
2.0	**Sea Water Intake (Site 18)**				**$ 20,900,000**	**$ 25,320,000**	**$ 29,850,000**	Source: (URS, 2012)
2.1	Microtunnel/HDD two 36-in pipes in 8-ft casing	2,000	LF	$ 2,500	$ 5,000,000	$ 6,000,000	$ 7,075,343	Scaled to reflect increased facility size and ENR index (as shown)
2.2	Dredging for two 36-in pipes	2,750	LF	$ 1,000	$ 2,750,000	$ 3,300,000	$ 3,891,439	
2.3	Landside Mobilization	1	LS	$ 1,000,000	$ 1,000,000	$ 1,000,000	$ 1,179,224	
2.4	Waterside Mobilization	1	LS	$ 1,000,000	$ 1,000,000	$ 1,000,000	$ 1,179,224	
2.5	Intake Screen and Structure	1	LS	$ 800,000	$ 800,000	$ 1,920,000	$ 2,264,110	Ratio increase and doubled original 2012 cost due to decrease in screen
2.6	Intake Pump Station - Rock Excavation	56	FT (depth)	$ 27,000	$ 1,512,000	$ 1,512,000	$ 1,782,987	opening from 2mm to 1mm
2.7	Intake Pump Station - Rock Disposal	56	FT (depth)	$ 1,500	$ 84,000	$ 84,000	$ 99,055	
2.8	Intake Pump Station Facility and Equipment	1	LS	$ 3,000,000	$ 3,000,000	$ 3,600,000	$ 4,245,206	
2.9	Transfer Pipeline to the Plant	11,500	LF	$ 500	$ 5,750,000	$ 6,900,000	$ 8,136,645	
3.0	**Radial Well Collectors**						**$ -**	
	None for this alternative	0			$ -			
4.0	**Brine Disposal**				**$ 4,190,000**	**$ 4,630,000**	**$ 5,310,000.00**	
4.1	Brine Line Installation	7,300	LF	$ 300.00	$ 2,190,000.00	$ 2,628,000.00	$ 3,099,000.43	Brine Line length from URS Figure 4-3. Assumed same unit cost as Transfer Pipeline to Plant cost for other location b/c in same area
4.2	Intertie with WWTP Effluent Outfall Pipeline	1	LS	$ 2,000,000.00	$ 2,000,000.00	$ 2,000,000.00	$ 2,208,756.48	ENR Index 2014; Source (Power, 2014)
	Subtotal Facility Costs				**$53,550,000**	**$63,410,000**	**$74,610,000**	
Additional Facility Capital Costs								
5.0	Site Development Costs	@	5%		2,677,500	3,170,500	3,730,500	% of Subtotal facility, sea water intake, and brine costs
								(Includes grading, erosion control, cut/fill, etc.)
6.0	Yard Piping	@	5%		2,677,500	3,170,500	3,730,500	% of Subtotal facility, sea water intake, and brine costs
7.0	Electrical, I&C, and Remote (low-tech) Control	@	15%		8,032,500	9,511,500	11,191,500	% of Subtotal facility, sea water intake, and brine costs
	Subtotal Additional Facility Costs				**$13,387,500**	**$15,852,500**	**$18,652,500**	
	Facility Direct Costs				**$66,937,500**	**$79,262,500**	**$93,262,500**	
	Taxes	@	8.75%		1,874,250	2,219,350	2,611,350	apply taxes to 40% of the Subtotal Facility Costs
	Mobilization/Bonds/Permits	@	5%		3,346,875	3,963,125	4,663,125	% of Facility Direct Costs
	Contractor Overhead & Profit	@	15%		10,040,625	11,889,375	13,989,375	% of Facility Direct Costs
	Estimate Contingency	@	35%		23,428,125	27,741,875	32,641,875	% of Facility Direct Costs
Subtotal with Contractor Markups and Contingency					**$105,627,375**	**$125,076,225**	**$147,168,225**	
								Escalation to Midpoint of Construction not applied
	Escalation to Midpoint of Construction				0	0	0	assume 2% percent over 10
								construction start = 2025 end = 2027
	Project Capital Cost Total				**$105,600,000**	**$125,100,000**	**$147,200,000**	2012 Cost is comparable to CDM Desal Construction Cost ($66mil) + URS Intake Construction Cost ($36mil). Eng/Design and Environmental Permitting not included.
	Annualized Capital Cost ($mil/year)						**$7.7**	assume discount rate (i = 4%) and facility life (n = 30 to 50 years)

Annual Operations and Maintenance Costs

Item No.	Description	Lump Sum Annual Costs ($/year)	
			Source: (CDM, 2012), Includes escalation to 2017; scaled to reflect increased flow
8.0	**Energy Costs**		Intake Source: (K/J, 2011) Inflated using ENR CI; sclaed to reflect increased flow
8.1	Energy Costs - Facility	$2,690,000	CDM Report (Table 5-4) - not incl raw water pumping
8.2	Raw Water Pumping Cost (from intake)	$300,000	K/J Report (Table 12-3)
9.0	**Labor Costs**	$670,000	CDM Report (Table 5-5)
10.0	**Maintenance**		
10.1	Consumable Replacements	$350,000	CDM Report (Table 5-7)
10.2	Solids Disposal	$270,000	CDM Report (Table 5-8)
10.3	Intake Component - Open Screen	$260,000	K/J Report (Table 12-3) - incl cleaning, maintenance, inspections
11.0	**Chemicals**	$530,000	CDM Report (Table 5-6)
12.0	**Contingency**	$507,000	at 10% of above O&M costs
	Annual O&M Costs ($/year)	**$5,577,000**	
	Annual Unit O&M Costs ($/AF)	**$1,510**	

Engineers Opinion of Probable Cost
Alternative 3 - Subsurface Intake System (Wharf Area)

KENNEDY/JENKS CONSULTANTS

Study:	Santa Cruz Desalination Update (3.3 MGD)	**Prepared By:**	AP, DTT, TKR
Project:	Alternative 3 - Subsurface Intake System (Wharf Area)	**Date Prepared:**	Sep-2017
Supply:	Ocean Water	**K/J Proj. No.**	1768015.00
Estimate:	Conceptual Level Cost-Analysis	**ENR**	2017

Average Annual Ocean Water Delivered	3.30	mgd
	3696	AFY
August 2017 ENR	**12,037.27**	
February 2012 ENR	**10,207.79**	
September 2011 ENR	**10,192.79**	
June 2014 ENR	**10,899.59**	

Item No.	Description	Qty	Units	Total Costs (w/o mark-up) $/Unit	Capital Cost (2.5 MGD, 2012 USD)	Capital Cost (3.3 MGD, 2012 USD)	Capital Cost (3.3 MGD, 2017 USD)	Notes/Source
Facility Capital Costs								
								Source: (CDM, 2012) scwd2 Regional Desal Report
								Scaled to reflect increased flow and ENR index (as shown)
1.0	**Desalination Facility**				**$ 28,460,000**	**$ 33,460,000**	**$ 39,450,000**	
1.1	Site Work	1	LS	$ 1,728,024	$ 1,728,024	$ 1,728,024	$ 2,037,727	
1.2	Landscape	1	LS	$ 600,000	$ 600,000	$ 600,000	$ 707,534	
1.1	Control Building	1	LS	$ 1,144,391	$ 1,144,391	$ 1,144,391	$ 1,349,493	Assumed same size building for 2.5 MGD or 3.3 MGD facility
1.2	DAF Basins	1	LS	$ 2,229,269	$ 2,229,269	$ 2,675,123	$ 3,154,569	
1.3	Membrane Building (and Chemical Storage Area)	1	LS	$ 16,383,930	$ 16,383,930	$ 19,660,716	$ 23,184,386	
1.4	Calcite Contactors	1	LS	$ 1,240,895	$ 1,240,895	$ 1,489,074	$ 1,755,952	
1.5	Chlorine Contact Tank/Clearwell and HSPS	1	LS	$ 1,265,587	$ 1,265,587	$ 1,518,704	$ 1,790,893	
1.6	Concentrate EQ Basin and Pump Station	1	LS	$ 1,860,070	$ 1,860,070	$ 2,232,084	$ 2,632,127	
1.7	Clarifiers/Thickeners	1	LS	$ 927,039	$ 927,039	$ 1,112,447	$ 1,311,824	
1.8	Pump Station	1	LS	$ 1,079,011	$ 1,079,011	$ 1,294,813	$ 1,526,875	
2.0	**Sea Water Intake**				**$ 20,900,000**	**$ 22,710,000**	**$ 26,780,000**	Source: (URS, 2012) and (K/J, 2011)
2.1	Microtunnel/HDD two 36-in pipes in 8-ft casing	2,000	LF	$ 2,500	$ 5,000,000	$ 6,000,000	$ 7,075,343	Scaled to reflect increased facility size and ENR index (as shown)
2.2	Dredging for two 36-in pipes	2,750	LF	$ 1,000	$ 2,750,000	$ 1,650,000	$ 1,945,719	Cost halved because only for back up screened intake
2.3	Landside Mobilization	1	LS	$ 1,000,000	$ 1,000,000	$ 1,000,000	$ 1,179,224	
2.4	Waterside Mobilization	1	LS	$ 1,000,000	$ 1,000,000	$ 1,000,000	$ 1,179,224	
2.5	Intake Screen and Structure	1	LS	$ 800,000	$ 800,000	$ 960,000	$ 1,132,055	Overall Cost is Halved from Alt 1 and 2 b/c assumed half of the screen structure would be installed with the Radial Collector Wells
2.6	Intake Pump Station - Rock Excavation	56	FT (depth)	$ 27,000	$ 1,512,000	$ 1,512,000	$ 1,782,987	
2.7	Intake Pump Station - Rock Disposal	56	FT (depth)	$ 1,500	$ 84,000	$ 84,000	$ 99,055	
2.8	Intake Pump Station Facility and Equipment	1	LS	$ 3,000,000	$ 3,000,000	$ 3,600,000	$ 4,245,206	
2.90	Transfer Pipeline to the Plant	11,500	LF	$ 500	$ 5,750,000	$ 6,900,000	$ 8,136,645	
3.0	**Radial Well Collectors**				**$ 32,880,000**	**$ 32,880,000**	**$ 38,830,000**	Source (K/J, 2011)
3.1	Radial Well Collector Installation	1	LS	$ 19,600,000	$ 19,600,000	$ 19,600,000	$ 23,146,802	
3.2	Offshore Intake Pipeline	1	LS	$ 7,400,000	$ 7,400,000	$ 7,400,000	$ 8,739,099	
3.4	Radial Well Collector Installation Contingency	30%			$ 5,880,000	$ 5,880,000	$ 6,944,041	30% Contingency for installing collector wells in a manner they have not been installed before
4.0	**Brine Disposal**				**$ 4,190,000**	**$ 4,630,000**	**$ 5,310,000**	Brine Line length from URS Figure 4-3. Assumed same unit cost as Transfer Pipeline to Plant
4.1	Brine Line Installation	7,300	LF	$ 300	$ 2,190,000	$ 2,628,000	$ 3,099,000	cost for other location b/c in same area
4.2	Intertie with WWTP Effluent Outfall Pipeline	1	LS	$ 2,000,000	$ 2,000,000	$ 2,000,000	$ 2,208,756	ENR Index 2014; Source (Power, 2014)
	Subtotal Facility Costs				**$86,430,000**	**$93,680,000**	**$110,370,000**	
Additional Facility Capital Costs								
5.0	Site Development Costs	@	5%		4,321,500	4,684,000	5,518,500	% of Subtotal treatment, pump station, storage, discharge facility and well costs
								(Includes grading, erosion control, cut/fill, etc.)
6.0	Yard Piping	@	5%		4,321,500	4,684,000	5,518,500	% of Subtotal treatment, pump station, storage, discharge facility and well costs
7.0	Electrical, I&C, and Remote (low-tech) Control	@	15%		12,964,500	14,052,000	16,555,500	% of Subtotal treatment, pump station, storage, discharge facility and well costs
	Subtotal Additional Facility Costs				**$21,607,500**	**$23,420,000**	**$27,592,500**	
	Facility Direct Costs				**$108,037,500**	**$117,100,000**	**$137,962,500**	
	Taxes	@	8.75%		3,025,050	3,278,800	3,862,950	apply taxes to 40% of the Subtotal Facility Costs
	Mobilization/Bonds/Permits	@	5%		5,401,875	5,855,000	6,898,125	% of Facility Direct Costs
	Contractor Overhead & Profit	@	15%		16,205,625	17,565,000	20,694,375	% of Facility Direct Costs
	Estimate Contingency	@	35%		37,813,125	40,985,000	48,286,875	% of Facility Direct Costs
Subtotal with Contractor Markups and Contingency					**$170,483,175**	**$184,783,800**	**$217,704,825**	
								Escalation to Midpoint of Construction not applied
	Escalation to Midpoint of Construction				0	0	0	assume 2% percent over 10
								construction start = 2025 end = 2027
	Project Capital Cost Total				**$170,500,000**	**$184,800,000**	**$217,700,000**	2012 Cost is comparable to CDM Desal Construction Cost ($66mil) + URS Intake Construction Cost ($36mil) + K/J Redial Well Construction Cost ($37mil). Eng/Design and Environmental Permitting not included.
	Annualized Capital Cost ($mil/year)						**$11.9**	assume discount rate (i = 4%) and facility life (n = 30 to 50 years)

Item No.	Description	Lump Sum Annual Costs ($/year)	
Annual Operations and Maintenance Costs			
			Source: (CDM, 2012), Includes escalation to 2017, scaled to reflect increased flow
8.0	**Energy Costs**		Intake Source: (K/J, 2011) Inflated using ENR CI; sclaled to reflect increased flow
8.1	Energy Costs - Facility	$2,690,000	CDM Report (Table 5-4) - not incl raw water pumping
8.2	Raw Water Pumping Cost (from intake)	$300,000	K/J Report (Table 12-3) - based on conveyance from Warf area
9.0	**Labor Costs - Facility**	$670,000	CDM Report (Table 5-5)
10.0	**Maintenance**		
10.1	Consumable Replacements	$350,000	CDM Report (Table 5-7)
10.2	Solids Disposal	$270,000	CDM Report (Table 5-8)
10.3	Intake Component - Radial Wells	$200,000	K/J Report (Table 12-3) - incl cleaning, maintenance, inspections
10.4	Intake Component - Open Screen	$130,000	K/J Report (Table 12-3) - redundant smaller open screen area assumed
11.0	**Chemicals**	$530,000	CDM Report (Table 5-6)
12.0	**Contingency**	$514,000	at 10% of above O&M costs
	Annual O&M Costs ($/year)	**$5,654,000**	
	Annual Unit O&M Costs ($/AF)	**$1,530**	

APPENDIX C

Estimate of Soft Costs for 3.3 MGD Alternatives

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City Seawater Desalination Project Soft Costs

Prepared by Dudek and Kennedy/Jenks Consultants, July 2018

Alternative 1: Screened Open-Ocean Intake (Westside)				Capital Costs[1] $148,400,000
Description	HDR %	Adjusted %	Category	Soft Costs
City Staff Costs/Measure D Vote	2.0%	2.0%	Project Wide Admin	$2,968,000
City Staff Augmentation	2.0%	2.0%	Project Wide Admin	$2,968,000
Program Costs Allocations	1.5%	1.5%	Project Wide Admin	$2,226,000
Design	10.0%	10.0%	Planning and Design	$14,840,000
Survey	1.0%	0.5%	Planning and Design	$742,000
Geotech	2.0%	1.0%	Planning and Design	$1,484,000
Utility Location	0.5%	0.5%	Planning and Design	$742,000
Construction Management	8.0%	8.0%	Construction	$11,872,000
Engineering Services During Construction	2.0%	2.0%	Construction	$2,968,000
Environmental & Permitting (CEQA/NEPA)	3.0%	4.0%	CEQA	$5,936,000
Phase 1/Phase 2 Environmental	0.3%	0.3%	CEQA	$371,000
Mitigation Fees	3.0%	2.0%	Construction	$2,968,000
Environmental Monitoring Fees	3.0%	3.0%	Construction	$4,452,000
Land Transactions	2.0%	2.0%	ROW and Easements	$2,968,000
Total Soft Costs	40.3%	39%		$57,505,000

Alternative 2: Screened Open-Ocean Intake (Wharf Area)				Capital Costs[1] $147,200,000
Description	HDR %	Adjusted %	Category	Soft Costs
City Staff Costs/Measure D Vote	2.0%	2.0%	Project Wide Admin	$2,944,000
City Staff Augmentation	2.0%	2.0%	Project Wide Admin	$2,944,000
Program Costs Allocations	1.5%	1.5%	Project Wide Admin	$2,208,000
Design	10.0%	10.0%	Planning and Design	$14,720,000
Survey	1.0%	0.5%	Planning and Design	$736,000
Geotech	2.0%	1.0%	Planning and Design	$1,472,000
Utility Location	0.5%	0.5%	Planning and Design	$736,000
Construction Management	8.0%	8.0%	Construction	$11,776,000
Engineering Services During Construction	2.0%	2.0%	Construction	$2,944,000
Environmental & Permitting (CEQA/NEPA)	3.0%	4.0%	CEQA	$5,888,000
Phase 1/Phase 2 Environmental	0.3%	0.3%	CEQA	$368,000
Mitigation Fees	3.0%	2.0%	Construction	$2,944,000
Environmental Monitoring Fees	3.0%	3.0%	Construction	$4,416,000
Land Transactions	2.0%	2.0%	ROW and Easements	$2,944,000
Total Soft Costs	40.3%	39%		$57,040,000

Alternative 3: Subsurface Intake System (Wharf Area)				Capital Costs[1] $217,700,000
Description	HDR %	Adjusted %	Category	Soft Costs
City Staff Costs/Measure D Vote	2.0%	1.4%	Project Wide Admin	$3,047,800
City Staff Augmentation	2.0%	1.4%	Project Wide Admin	$3,047,800
Program Costs Allocations	1.5%	1.5%	Project Wide Admin	$3,265,500
Design	10.0%	8.0%	Planning and Design	$17,416,000
Survey	1.0%	0.5%	Planning and Design	$1,088,500
Geotech	2.0%	1.0%	Planning and Design	$2,177,000
Utility Location	0.5%	0.5%	Planning and Design	$1,088,500
Construction Management	8.0%	6.0%	Construction	$13,062,000
Engineering Services During Construction	2.0%	2.0%	Construction	$4,354,000
Environmental & Permitting (CEQA/NEPA)	3.0%	2.0%	CEQA	$4,354,000
Phase 1/Phase 2 Environmental	0.3%	0.3%	CEQA	$653,100
Mitigation Fees	3.0%	0.5%	Construction	$1,088,500
Environmental Monitoring Fees	3.0%	2.0%	Construction	$4,354,000
Land Transactions	2.0%	1.4%	ROW and Easements	$2,938,950
Total Soft Costs	40.3%	28%		$61,935,650

Legend: [shaded cell] Adjusted percentage over HDR percentage

Note:

1. Capital costs are from Appendix B.