**Water Supply Advisory Committee Portfolio Building Block Information**

# 5. Purified Recycled Water for Seawater Intrusion Barriers - IPR

***working draft*** of 20 July 2015

## 1. Objectives

The technical team prepared this document as part of a series to provide our latest assessment of the anticipated costs, supply production, yields, timelines, and other relevant information for the various water supply enhancement alternatives that may serve as key components ("building blocks") in a future portfolio. Each of the major potential water supply components is now being considered individually so that each of these "building blocks" can be more carefully compared side by side. The objective is to provide WSAC with our best current assessment for each building block, so that the Committee can better evaluate its potential choices as they build portfolios for future consideration.

*Disclaimer/Context*

The information provided herein reflects the technical team's best assessment given currently available information. At this stage, all estimates are preliminary and suitable only for high level planning: cost estimates are prepared to a planning level, we have included a 50-percent contingency to address "known and 'unknown' unknowns," and the estimated capital and operating costs are intended to be used for comparison purposes, as Class 5 estimates with an accuracy range of -30% to +50%.[1]

As we continue to review and refine underlying assumptions and data, and as new information becomes available, our estimates will likely evolve. More extensive analysis ultimately will need to be conducted to develop more precise estimates – including site-specific field evaluations beyond the scope and timeline for WSAC activities.

Also, please note that the total portfolio yield is not equal to the sum of the individual building block yields. This is because the components operate interactively at a system level (as captured in *Confluence* modeling).

## 2. IPR for Seawater Intrusion Barrier Wells -- Overview

In this document, an approach of using purified recycled water for seawater intrusion barrier wells (a form of indirect potable reuse, or IPR) is envisioned generally as:

1. The City applying "Complete Advanced Treatment" (CAT) to produce purified recycled water of potable quality.

2. The City (in conjunction with SqCWD) developing seawater barrier injection wells at strategic locations along the coast in the Soquel area, and building a pipe and pumping system to convey the

[1] Per the Association for the Advancement of Cost Engineering (AACE), *Standard Cost Estimating Guidelines*. Note too that these are considered "Class 5" planning-level estimates, which include a 50 percent contingency factor, and should also be accompanied by an accuracy range of -30% to +50%. For example, a project presented with a $100M cost including contingency allowance ($66.7 million plus $33.3 million = $100 million) likely would have a final cost between $70 million and $150 million.

CAT-produced water to supply the seawater intrusion barrier wells. These wells would help protect the coastal freshwater aquifers from seawater intrusion while also enhancing groundwater recharge.

3. It is anticipated that the groundwater quality protection afforded by the seawater intrusion barrier wells, coupled with the aquifer recharge provided by the injected water, would facilitate some unspecified/un-estimated amount of additional groundwater withdrawals. To the extent additional groundwater withdrawals are enabled, there may be additional supply for Santa Cruz Water Department (SCWD) from Beltz wells, and/or for SqCWD from its wells.

There are numerous specific details and variations on how this IPR-seawater barrier approach might be structured and implemented. These include, for example, the forms of the institutional arrangements negotiated between the City and SqCWD regarding an equitable sharing of water, costs, and risks.

In this paper, we aim to be as explicit as possible about the underlying assumptions and constraints that are included in our analysis and findings. Where feasible, we provide preliminary indications of the impact of some of the possible variations. If the City pursues this building block further, the information provided in this document will need to be vetted and developed in more detail to confirm assumptions and refine cost estimates.

## 3. Base Case Configuration and Assumptions

1. CAT-produced potable quality water would be at provided at a scale of 4.7 MGD, for a total annual supply of 1,715 MG per year. This is based on the volume of City-owned wastewater effluent entering the City's wastewater treatment plant of 5.5 MGD, with little seasonal variation (driven by indoor water use).[2]

2. It is envisioned that the membrane process would operate continuously. Membrane processes work best when the flow is relatively steady; large diurnal variations are particularly undesirable. An equalization basin is included upstream of the treatment train to help moderate changes in flow rate. If you need to operate a facility with membrane systems such as RO at a reduced output, one approach, besides going through a shutdown and preservation process, is to rotate operation among modules. For example, you have four sets/banks of membranes and you operate each set one week in four. Thus, no set of modules sits idle for an extended period.

3. No explicit assumptions or quantified estimates are made regarding whether or the extent to which water supply benefits (e.g., extractable yields) may be improved by this approach.

4. Significant piping infrastructure would need to be constructed through the City of Santa Cruz and along the shoreline in the City's Soquel Creek's service area.

5. The barrier well coastal pipeline gets progressively smaller (in diameter) as the flow drops, moving from well-to-well.

[2] The 5.5 MGD flow does not include any effluent flow from the City of Scotts Valley.

## 4. Necessary Capital Improvements and Related Costs[3]

Table 5.1 provides an overview of the major capital investments and other upfront costs associated with developing and operationalizing the IPR for seawater barrier program.

**Table 5.1 IPR with seawater barriers capital improvement needs and costs (millions of 2015$)**

| Capital improvement item | Hard capital cost | Soft capital cost* | Total capital cost |
|---|---|---|---|
| **IPR with seawater barriers** | | | |
| a. Nitrification (6.1 MGD) | 2.25 | 0.70 | 2.95 |
| b. Equalization Basin (0.5 MG) | 0.75 | 0.24 | 0.99 |
| c. Ozone/BAC Filters (6.1 MGD) | 13.50 | 4.19 | 17.69 |
| d. Microfiltration (6.1 MGD) | 21.00 | 6.51 | 27.51 |
| e. Reverse Osmosis (5.5 MGD) | 30.00 | 9.30 | 39.30 |
| f. Advanced Oxidation (Peroxide + UV) (4.7 MGD) | 4.88 | 1.52 | 6.39 |
| g. Conditioning Facilities (4.7 MGD) | 2.15 | 0.67 | 2.82 |
| h. Effluent Diffuser Modification | 1.50 | 0.47 | 1.97 |
| i. Pumping System (WWTP to CAT) | 2.58 | 0.80 | 3.38 |
| J. Pipeline Installation (WWTP to CAT) | 0.18 | 0.06 | 0.24 |
| k. Pumping System (WWTP to Soquel Creek Coast) | 2.88 | 0.90 | 3.78 |
| l. Piping to SW Barrier Wells | 11.94 | 3.70 | 15.63 |
| m. Under San Lorenzo Riverway | 1.04 | 0.33 | 1.37 |
| n. Under Woods Lagoon | 1.33 | 0.41 | 1.74 |
| o. Pipeline Installation (WWTP to wells 1-5, 18") | 3.93 | 1.22 | 5.14 |
| p. Pipeline Installation (WWTP to wells 6 and 7, 14”) | 1.22 | 0.38 | 1.60 |
| q. Pipeline Installation (WWTP to wells 8-11, 12”) | 2.10 | 0.65 | 2.74 |
| r. Pipeline Installation (WWTP to well 12, 8”) | 0.35 | 0.11 | 0.46 |
| s. Injection Wells (SqCWD coastline) | 9.00 | 2.79 | 11.79 |
| t. Line Maintenance Facility Relocation | N/A | N/A | 5.20 |
| **Totals** | **112.58** | **34.95** | **152.69** |

<u>NOTES</u>:

* Soft costs include engineering, construction management, permitting, City contract administration and legal.

a. Modify existing wastewater treatment (WWTP) plant processes to achieve full nitrification.

b. Part of the Complete Advanced Treatment (CAT) water purification process: a 0.5-MG basin at the beginning of the CAT process to keep the flow rate relatively stable over time.

c. Part of the CAT water purification process: install ozonation with biologically active filtration to provide microbial and organic contaminant destruction.

[3] Note that at this stage of the evaluation process, all cost estimates are highly preliminary, “Planning Level” estimates reflecting a range of –30% to + 50% (per AACE Guidelines), and subject to modification as additional information emerges.

**Table 5.1 IPR with seawater barriers capital improvement needs and costs (millions of 2015$)**

| Capital improvement item | Hard capital cost | Soft capital cost* | Total capital cost |
|---|---|---|---|
| d. Part of the CAT water purification process: install low-pressure membrane filtration to remove solids and some microorganisms; pretreatment for the reverse osmosis (RO) process. The concentrate (10% of the flow) is recycled back to the head of the plant. | | | |
| e. Part of the CAT water purification process: add high-pressure membrane filtration to further purify the microfiltration product stream. | | | |
| f. Part of the CAT water purification process: install advanced oxidation with high-dose UV light plus peroxide to oxidize any remaining organic contaminants and provide an additional disinfection barrier. | | | |
| g. Construct de-carbonation and lime addition systems to modify the pH and add alkalinity to stabilize the highly purified RO effluent for corrosion control in the distribution system. | | | |
| h. Modify the Santa Cruz wastewater outfall to properly diffuse the RO concentrate stream into the ocean. | | | |
| i. Install a 4,300-gpm pumping system to move WWTP effluent to the CAT process train. | | | |
| j. Build a 200-foot, 20-inch diameter pipeline to convey an average of 6.1 MGD of WWTP effluent to the CAT process train. Costs use 6.1 MGD, not 5.5 MGD, because of the ability to capture recycle streams within the WWTP-CAT system. | | | |
| k. Install a 3,200-gpm pumping system to move CAT-purified water to the Soquel Creek coast. | | | |
| l. Build a 3.8-mile, 20-inch diameter pipeline to convey CAT-purified water to the Soquel Creek coast. | | | |
| m. Build a 350-foot, 20-inch diameter pipeline (see Note “l”) under the San Lorenzo Riverway. | | | |
| n. Build a 445-foot, 20-inch diameter pipeline section (see Note “l”) under Woods Lagoon. | | | |
| o. Build a 1.3-mile, 18-inch diameter pipeline at coast to connect conveyance main to first five barrier wells. | | | |
| p. Build a 0.5-mile, 14-inch diameter pipeline to connect to barrier wells 6 and 7. | | | |
| q. Build a 1.0-mile, 12-inch diameter pipeline to connect to barrier wells 8–11. | | | |
| r. Build a 0.3-mile, 8-inch diameter pipeline to connect to barrier well 12. | | | |
| s. Construct 12 new 250-gpd injection wells to inject seawater barrier water into the Soquel Creek coastline. | | | |
| t. Relocate the existing line maintenance facility to make room for addition of the Complete Advanced Treatment process train; includes purchase of property for new facilities on the west side of the City. | | | |

## 5. Annual Operation and Maintenance (O&M) Costs and Energy Requirements

Table 5.2 provides additional cost and energy use information, including annual O&M costs, annualized capital costs, total annualized and present value costs, and energy requirements for the IPR for seawater barrier approach. Note that water quality testing would be performed at the CAT plant and there is a cost component for water quality testing contained in the O&M. There are a few direct reuse plants operating in the United States, including several implemented by small utilities in Texas, that are researching and documenting performance. In addition, CAT-based IPR projects are running in Orange County, San Jose, West Basin and elsewhere that are benchmarking reliable performance. Verifying performance, and using existing information, will be a central part of the regulations and guidance that are being developed in the state and will come out in 2016.

| Table 5.2 IPR for Barrier Wells | |
|---|---|
| **Estimates** | **Seawater Intrusion/IPR** |
| Annual O&M costs ($M/yr) | $5.5 M |
| Total Annualized Cost ($M/Yr) | $17.7 M |
| PV Costs (30 years) ($M)[1] | $401 M |
| Energy Use (MWH/MG)[1] | 7.8 |

NOTES:

1. Discount rate = 2.5%; bond interest rate = 5.5%; interest on reserve = 3%; bond issuance cost = 3%.
2. Existing SCWD water production requires 1.6 MWH/MG.

## 6. Water Supply and Yield Implications

No explicit assumptions or quantified estimates are made regarding whether or the extent to which water supply benefits (e.g., extractable yields) may be improved by this approach.

## 7. Timeline for Implementation and Realizing Water Supply Benefits

The timeline for the seawater barrier well approach could take about 8 years, consisting of the following key elements:

- Permitting, right of way acquisition, and construction of seawater barrier injection wells and the CAT facilities and pipelines and pump stations required to develop the purified recycled water and deliver it to injection well locations. This could require 8 years.
- Regulatory approval for seawater intrusion barrier wells using IPR-quality recycled water would likely occur prior to facility construction, but could occur concurrently with treatment facility, pipeline, and injection well right of way and permitting activities.

## 8. Key Institutional Issues to Resolve

The City (and SqCWD) would need to resolve several critical institutional issues in order for an IPR seawater barrier program to proceed as envisioned here. Among these are the following:

- Regulatory approval from the State Water Resources Control Board, Division of Drinking Water (DDW), for IPR via seawater intrusion barrier wells.
- Public and political acceptability of purified recycled water as a potentially blended indirect part of the City's and SqCWD's source waters.
- Institutional issues associated with the need to forge clear and effective agreements between the City and SqCWD on water-, risk- and cost-sharing.

- If IPR were pursued, the City and SqCWD would need a public information campaign to educate the public on the safety and benefits of potable reuse similar to those being conducted in San Diego, San José, and elsewhere.

**9. Other Key Questions, Issues, and Observations**

- The degree to which the injection of CAT-generated waters would facilitate additional extraction of local groundwaters, and whether the City would benefit from the associated aquifer replenishment, requires further investigation.

- Potentially stranded assets -- pipe, pump and barrier wells – if the seawater intrusion barrier well approach is abandoned (e.g., to convert the program to another form of IPR or DPR approach). The City and SqCWD might find value to abandoned pipelines as part of their respective water distribution systems, eliminating the need for other improvements or water main replacement.

- The ability to establish coastal wells with the proper capacities in the appropriate locations would be a key determinant of the ultimate success of the project and would need early study.

- The need for rights-of-way and beach real estate on which to develop the injection wells could pose significant logistical challenges and would benefit from early and proactive attention from the City and SqCWD.