**TO:** WATER SUPPLY ADVISORY COMMITTEE (WSAC)

**FROM:** WSAC TECHNICAL TEAM

**SUBJECT:** UPDATED INFORMATION ON PORTFOLIO BUILDING BLOCKS

**DATE:** JULY 17, 2015

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At previous meetings the Water Supply Advisory Committee considered staff-developed portfolios that contained various water supply enhancement alternatives. The technical team has now prepared a series of documents that provide an updated assessment of the anticipated costs, supply production, yields, timelines, and other relevant information for the various water supply enhancement alternatives contained in those earlier portfolios. These documents, listed below, provide additional detail for each alternative and will facilitate a side by side comparison as Committee members build their own portfolios.

- Building Block 1 In-lieu Recharge of Regional Aquifers
- Building Block 2 Aquifer Storage and Recovery (ASR)
- Building Block 3 Purified Recycled Water for Direct Potable Reuse (DPR)
- Building Block 4 Purified Recycled Water to Loch Lomond – Indirect Potable Reuse (IPR)
- Building Block 5 Purified Recycled Water for Seawater Intrusion Barrier - IPR
- Building Block 6 Purified Recycled Water, Converting IPR to DPR
- Building Block 7 DeepWater Desalination
- Building Block 8 Local Desalination (scwd2 Desal)

These documents continue to be works in progress that may evolve as additional information is requested and/or revealed for each alternative. **Building Blocks 1 and 2 will accompany the July 17, 2015 packet; Building Blocks 3-8 will be delivered prior to the July WSAC meeting. Building Block 1 and 2 documents are attached to this memo.**

Another document is being develop, Item 15d Updated Information about Additional Infrastructure or Operating Rule Changes. This document will begin to elaborate on several tangential themes associated with one or more of the above such as adding a second pipe to Loch Lomond Reservoir, raising Newell Creek Dam. This document will also be delivered prior to the Committee's July meeting.

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

# 1. In-lieu Recharge of Regional Aquifers

***working draft*** of 17 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 builds 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. In-Lieu Recharge -- Overview

An in-lieu ("passive") recharge approach for Santa Cruz is envisioned as:

1. The City capturing and treating available winter flows and providing those waters to meet winter demands in neighboring communities served by the Scotts Valley Water District (SVWD) and Soquel Creek Water District (SqCWD). Based on the most recent reporting data provided by SVWD and SqCWD, their respective wintertime demands (2014-2015) are 0.9 MGD and 2.6 MGD. These demands are currently met 100% by groundwater pumping.

[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.

2. SVWD and SqCWD would be able to rest their wells in the winter season, providing for in-lieu recharge of their respective aquifer systems. I.e., the aquifers would recharge at a natural rate in the months that groundwater withdrawals stopped. [2]

3. In return, SVWD and SqCWD would provide groundwater to the City in dry summer periods, to reduce (or eliminate) the periodic peak season water supply shortfalls otherwise anticipated for Santa Cruz Water Department (SCWD) customers.

In-lieu recharge might be structured and implemented in many different ways. These possible variations include, for example, whether the operational rules governing Loch Lomond reserves might be altered (and if so, by how much and under what conditions); whether the Newell Creek Dam might be raised; where and how winter flows are treated to potable quality; the scale and location of any new infrastructure (e.g., interties, pumps, wells) necessary to implement the approach; changes to the City's existing water rights; and the forms of the institutional arrangements negotiated between the City and SVWD and SqCWD regarding how they share water, costs, and risks.

These (and other) details influence how much water may be transferred in each direction (and when), the associated improvements in yields and system reliability, how long it would take to implement and receive water back, how much the approach would cost, and what an equitable allocation of costs might look like. 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. If a building block is pursued further, the information will need to be vetted and developed in more detail to confirm assumptions, conduct sensitivity analyses related to key assumptions, and refine cost and yield estimates.

### 3. Base Case Configuration and Assumptions

1. Winter flow availability is based on DFG-5 and climate change projections, and existing City water rights.

2. Newell Creek Dam height and Loch Lomond operational rules remain as they currently exist.

3. The Loch Lomond operating rule for draw down reserve *may* be reduced from 1,000 MG to 500 MG if and when return water of at least 500 MG over the 180-day peak season can be assured, and the resource management agencies accept potentially warmer water releases for fisheries (lower lake levels resulting from changes in operating rules very likely would mean warmer released water).[3]

4. Winter flows are treated to potable standards at the Graham Hill Water Treatment Plant (GHWTP) prior to distribution to SVWD and SqCWD.

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[2] On a mass balance basis with previous aquifer levels (pre "in lieu" operations), what is not withdrawn should recharge. The success/applicability for in lieu (i.e., the levels of recharge attained) would need to be tested. In-lieu recharge has worked well at some locations but not as well or at all in others. The water sector typically measures groundwater levels and test pumping to determine success for in lieu recharge.

[3] Essentially, the City may consider transferring 500 MG of its water "insurance policy" from Loch Lomond to the in-lieu program, once the in-lieu program can guarantee at least 500 MG of peak season return flow.

5. Return flows to SCWD of up to 4 MGD[4] are used as the basis for the scale of infrastructure requirements, about 2 MGD each from SVWD and SqCWD. The City, working in conjunction with SVWD and SqCWD, would put in new wells in each District to increase capacity to extract enough stored water to meet transfer needs to SCWD.

6. The volume of water that may be returned to SCWD is capped at 60% of the water provided to SVWD and SqCWD, to reflect hydraulic loss in the aquifer systems (20%), and the assumed desire or need for the Districts to keep a portion of the in-lieu water (20%) to meet their own obligations. [5,6]

7. Tait Street Diversion facility modifications include improvements and expansion to 14 MGD to handle the higher flow rates (*source:* Table 15, *Reconnaissance-Level Evaluation of ASR and IPR DRAFT,* Pueblo Water Resources, Inc., 2015; costs not escalated).

8. Graham Hill Water Treatment Plant improvements and expansion to 14 MGD include modifications to handle higher flow rates—addition of pre-treatment, disinfection and oxidation, and solids handling (*source:* Table 15, *Reconnaissance-Level Evaluation of ASR and IPR DRAFT,* Pueblo Water Resources, Inc., 2015; costs not escalated). Ranney Collectors at Felton offer a potentially lower-cost alternative to the pretreatment proposed here; its feasibility as an alternative should be considered should this Building Block be carried forward.

9. It is anticipated that groundwater extracted from SVWD will require treatment for iron and manganese removal prior to being pumped back to the City to meet SCWD demands. This need would be verified during design. (Returned water would not pass through GHWTP for additional treatment.)

10. Yield estimates for in-lieu reflect the assumption that SCWD realizes water savings from Program C Rec (i.e., that C Rec is anticipated to be part of the portfolio along with in-lieu recharge). For purposes of this building block, the assumed peak season demand reduction attained is 150 MG. If additional changes in peak season demands are agreed upon by WSAC, then associated modifications to the yields in this portfolio will be derived.

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[4] A 4 mgd return rate is also applied to potential ASR groundwater recovery and transfer back to SCWD (see Building Block 2)

[5] Note that the ASR analyses presented for Building Block 2 applies 80% rather than 60%. Using a higher assumed return percentage for ASR reflects the much more active control ASR recharge provides the City. The total volume recharged under the in lieu strategy is limited by the winter demands of the receiving entities. These demands, as noted above, would not fully use the available water: 2.6 MGD + 0.9 MGD = 3.5 MGD, and over 90 days this amounts to 315 MG (if the season extended for 120 days, then the total delivered increases to 420 MG). ASR allows SCWD to potentially fill the available storage much more quickly and thereby create more flexibility for SCWD on water available for dry year withdrawal. The different percentage also can also serve as the basis for a sensitivity test for the potential water supply improvement with water stored in local aquifers.

[6] The amount of water SCWD can get back and when is an administrative agreement issue and not completely a technical issue. For example, in the October 2011 letter sent to the Board of Supervisors by the SqCWD Board, the SqCWD says “Once the City is able to validate the yield estimates from a transfer project, SqCWD will evaluate how much groundwater we could supply to the City during drought periods to supplement their other sources."

**4. Necessary Capital Improvements and Related Costs**[7]

Table 1.1 provides an overview of the major capital investments and other upfront costs associated with operationalizing the in-lieu program.

**Table 1.1 In-lieu supplied by winter flows capital improvement needs and costs (millions of 2015$)**

| Capital improvement item | Hard capital cost | Soft capital cost** | Total capital cost |
|---|---|---|---|
| **In-lieu supplied by winter flows** | | | |
| a. Pipeline 1 (Felton Pump Station to Loch Lomond)* | 19.80 | 6.14 | 25.94 |
| b. Intertie No. 1 Pipeline (City to Scotts Valley) | 3.25 | 1.01 | 4.26 |
| c. Pump Station (City to Scotts Valley) Intertie No. 1 | 1.20 | 0.38 | 1.58 |
| d. Intertie Pipeline (City to Soquel Creek) | 9.84 | 3.06 | 12.89 |
| e. Tait Street Diversion Improvements | 10.29 | 3.19 | 13.48 |
| f. Graham Hill WTP Improvements* | 47.31 | 14.67 | 61.98 |
| g. Extraction Wells in Scott's Valley (6 wells) | 4.50 | 1.40 | 5.90 |
| h. Extraction Wells in Soquel Creek (6 wells) | 4.50 | 1.40 | 5.90 |
| i. Iron & Manganese Treatment (Scott's Valley) | 1.80 | 0.56 | 2.36 |
| **Totals** | **102.49** | **31.81** | **134.29** |

[7] 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.

*  Denotes an item with costs partially or completely envisioned within the City's CIP. The 2013 CIP estimate for Pipeline 1 is $12.7M. The Graham Hill Water Treatment Plant improvements included in the CIP (not all-inclusive of those proposed here) total $14.2M.

** Soft cost includes engineering, site investigations, construction management, permitting, City contract administration and legal.

a. Replace existing 4-mile pipeline with new 30-inch diameter pipeline from Felton Booster pump station to Loch Lomond reservoir. New pipeline will follow public streets.
b. Build a 1.5-mile, 12-inch diameter pipeline as sufficient to convey 2 MGD of potable water to the Scotts Valley Water District distribution system.
c. Construct a 1,800 GPM pump station to move water from Santa Cruz to SVWD through Intertie No. 1.
d. Build a 4.7–mile, 16-inch diameter pipeline to convey about 2.6 MGD of potable water from Santa Cruz to the SqCWD distribution system (SqCWD's average winter demand) and return about 2.0 MGD back to SCWD. Reduced return flow recognizes potential for lost water as well as use of some stored water by SqCWD.
e. Improve and expand Tait Street Diversion facility to add capacity for increased flow.
f. Improve and expand capacity at Graham Hill Water Treatment Plant to treat added flow. GHWTP would require improvements to produce more winter flow consistency especially because winter water is more challenging to treat.
g. Construct six new 250-GPM wells to withdraw stored water to send to SCWD.
h. Construct six new 250-GPM wells to withdraw water to send to SCWD.
i. Include iron and manganese treatment in SVWD extraction wells for parity with existing groundwater treatment needs. Necessity at these new wells will be verified during project development.

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

Table 1.2 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 in-lieu approach.

| Table 1.2 In-Lieu Recharge Using Winter Flows in millions 2015 $s | |
|---|---|
| **Estimates** | **In-lieu Recharge** |
| Annual O&M costs ($M/yr) | $3.2 |
| Total Annualized Cost ($M/yr) | $14.0 |
| PV Costs (30 years) ($M)[1] | $317 |
| Energy Use (MWH/MG)[2] | 6.3 |
| NOTES:<br>1. Discount rate = 2.5%; bond interest rate = 5.5%; interest on reserve = 3%, bond issuance cost = 3%.<br>2. Existing SCWD water production requires 1.6 MWH/MG | |

NOTES:

1. Based on the revised yield numbers, a second pipeline between the Felton Booster Pump Station and Loch Lomond Reservoir was deemed unnecessary.
2. Modifications to the Loch Lomond intake were deemed unnecessary to the current in lieu scenario.
3. Interties to SVWD and SqCWD have been added.
4. It is assumed that hydraulic conditions will allow water to flow to SqCWD without addition of a pump station.
5. Extraction wells were added in SVWD and in SqCWD to allow a total withdrawal of up to 4 mgd of water for transfer back to Santa Cruz. This assumption is conservative; it will need to be verified during project development.
6. Updated O&M costs include the cost of treating the additional water produced.

## 6. Water Supply and Yield Implications

Table 1.3 provides the water supply production and yield estimates for the in-lieu option, including water provided to meet SVWD and SqCWD demands, as well as water returns to SCWD.

**Table 1.3. In-lieu: Yields, peak season shortages, and demands met for SVWD & SqCWD (MG)**

| | Santa Cruz yields | | Remaining peak-season shortages (% shortfall) | | Average annual combined SV and SqC demand served in-lieu of groundwater draw (% met) | Average annual separate SV and SqC demand served in-lieu of groundwater draw |
|---|---|---|---|---|---|---|
| | **Worst-year yield** | **Average-year yield** | **Worst-year** | **Average-year** | | |
| In-lieu recharge | 780 | 290 | 330 (17%) | 50 (<3%) | 360 (24%) | 160 to SV; 200 to SqC |

Note that the yield estimates for in-lieu reflect an assumption that Program C Rec is part of the Portfolio with In-lieu recharge, such that in-lieu yields include the impact of water savings associated with the conservation component.[8]

Return water from SVWD and SqCWD under the in-lieu recharge approach are estimated to be as follows:

- The amount of water returned to SCWD varies by year and level of need; returns of some volume are projected to occur in about 28% of future years.
- The returns to Santa Cruz range up to 820 MG in the driest year (though the assumed infrastructure sizing may constrain that return flow to about 720 MG). Sensitivity analyses can be developed in the future to explore the tradeoff between added costs for larger (or smaller) infrastructure and the associated changes in yields.
- The return flows to Santa Cruz average 331 MG in 28% of years with return water. The average return to Santa Cruz across all years (including the 72% of years with no estimated returns) is about 90 MG.
- Given a 90 MG average annual water return to SCWD and an estimated total annualized cost of $14.0 million, the annualized cost per MG returned to the City is approximately $155,500 per MG.[9]

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

A preliminary estimate of the timeline for an in-lieu program includes the following elements:

- Establish conveyance facilities to transfer treated winter flows to SVWD and SqCWD and extraction wells in Scotts Valley and Soquel Creek to enhance system capacity and allow future return delivery to SCWD during peak seasons.
- Provide in-lieu water to SVWD and SqCWD at levels averaging 160 MG and 200 MG, respectively (totaling 360 MG per year on average).
- Possibly 3 or more years until sufficient in-lieu volumes accumulate for a guarantee of 500 MG being available for return delivery to SCWD within the 180-day peak season.

Given the above three time components, the overall anticipated timeline between initiation and the plausible return of significant volumes of water to the City amounts to 8 years. This assumes the relevant institutional issues can also be resolved successfully within this time frame.

[8] Please recall that "yields" refer to the ability of a portfolio to meet peak season gaps between supply and demand. Based on *Confluence* model runs reflecting climate change and DFG-5 fish flow requirements, the worst-year peak season shortage amounts to 1,110 MG, given the existing SCWD system portfolio. The average-year peak season shortage is 340 MG. Thus, the maximum yields of a portfolio are 1,110 MG and 340 MG for worst and average years, respectively.

[9] If instead annualized production costs are measured according to the volume of water delivered to SVWD and SqCWD combined each year (360 MG on average), then the in-lieu approach has a cost of nearly $38,900/MG.

**8. Key Institutional Issues to Resolve**

The City needs to resolve several critical institutional issues in order for an in-lieu program to proceed as envisioned here. Among these are the following:

- Agreements between the City and SVWD and SqCWD regarding the terms and conditions of any transfers of water in either direction. Elements of the agreement would need to include:
    - Quantities of water to be assured for transfer in each direction, and the conditions under which those quantities may be flexible or firm.
    - Mechanisms for cost sharing and terms of pricing, etc. (e.g., will water be bought and sold on a volumetric basis, and/or will there be cost sharing that embodies capital and other related upfront costs, O&M costs, etc.?).
    - Remedies for failure of any party to deliver on its obligations.
- Regulatory and other permit-related requirements to establish and operate interties and other necessary project components.
- Change in City water rights to accommodate/allow change in place of use.
- Possible implications of new State groundwater management rules and regulations (e.g., which may limit or otherwise complicate the withdrawal of groundwater for transfer back to SCWD).
- If the City plans to operate Loch Lomond with a lower reserve (500 mg), SCWD needs to confirm that operational modifications will not adversely affect its required fisheries release (e.g., released water is too warm because the reservoir water level is lower).
- The City and neighboring Districts will need to address land acquisition needs associated with developing the new extraction wells.
- Examine if there are opportunities to include an “overdraft provision” in the agreements.

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

- Will winter precipitation and flows be sufficient to meet the targeted levels of demands at SVWD and SqCWD within a reasonable time period?
- How soon will an appreciable volume of water be available for transfer back to SCWD?
- SVWD and SqCWD (with likely City participation) will need to locate new sites for the extraction wells.
- Will in lieu recharge work successfully in the Lompico, Butano, and Purisima aquifers? Some agencies have tried in lieu recharge but have been unsuccessful in storing water that they could

recover later.

- How have the target aquifers behaved during recent dry-period curtailments? What can we learn from that about potential aquifer responses to systematic well-resting, as contemplated here?
    - Note that groundwater modeling for the Santa Margarita/Lompico/Butano aquifers and for the Purisima aquifer presents an opportunity to anticipate and “test” potential benefits ahead of field testing
    - An enrichment session on these models and related insights on aquifer recovery issues would be beneficial).

**Water Supply Portfolio Building Block Information**

# 2. Aquifer Storage and Recovery (ASR)

***working draft*** of 17 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 builds portfolios for future consideration.

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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. For example, 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. Aquifer Storage and Recovery -- Overview

In this document, an aquifer storage and recovery (ASR) recharge approach for Santa Cruz is envisioned generally as:

1. The City capturing available winter flows from the San Lorenzo River, treating the water to potable quality, and providing those waters for well injection into the Santa Margarita and Purisima aquifers that generally underlie the areas served by the Scotts Valley Water District (SVWD) and Soquel Creek Water District (SqCWD), respectively. This injection is intended to help restore groundwater levels in the depleted regional aquifers, reduce seawater intrusion into the Purisima formation, and

[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.

provide stored waters that could be tapped in dry periods by the City, SVWD, and SqCWD.

2. The City would extract the stored water from those ASR wells in times of need. This recharge project presumably would also enable SVWD and SqCWD to extract more groundwater from their wells in times of need.

3. In return for the City providing treated winter flows for regional aquifer recharge and storage, SVWD and SqCWD would provide groundwater to the City in dry summer periods to reduce (or eliminate) the periodic peak season water supply shortfalls anticipated for the City Water Department customers.

There are numerous specific details and variations on how an ASR approach might be structured and implemented. These include, for example, where and how winter flows are treated to potable quality, the scale and location of any new infrastructure (e.g., interties, pumps, wells) necessary to implement the approach, the need for and potential outcomes from groundwater modeling and pilot testing to evaluate the likelihood and degree of success of the ASR approach (e.g., to assess changes in aquifer levels and water quality, hydraulic losses, ability to extract the stored water), changes to the City's existing water rights, and the forms of the institutional arrangements negotiated between the City and SVWD and SqCWD regarding sharing water, costs, and risks.

Each of these (and other) details influence how much water may be transferred in each direction (and when), the associated improvements in yields and system reliability, how long it would take to implement and receive water back, how much the approach would cost, and what an equitable allocation of costs might look like. 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 this building block is pursued 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. Winter flow availability is based on DFG-5 and climate change projections, and existing City water rights.

2. Newell Creek Dam and Loch Lomond operational rules remain as they currently exist.

3. The Loch Lomond operating rule for draw down reserve *may* be reduced from 1,000 MG to 500 MG if and when return water of at least 500 MG over the 180-day peak season can be assured and the resource management agencies accept potentially warmer water (lower lake levels resulting from changes in operating rules very likely would mean warmer released water).[2]

4. Winter flows are treated to potable standards at Graham Hill Water Treatment Plant (GHWTP) prior to distribution to ASR wells for recharge/injection.

[2] Essentially, the City may consider transferring 500 MG of its water "insurance policy" from Loch Lomond to the ASR program, once the ASR program can guarantee at least 500 MG of peak season return flow.

5. Treated winter flow for injection of up to 5 MGD, and return flows to SCWD of up to 4 MGD, are used as the basis for the scale of infrastructure requirements, the potential timeframe for aquifer storage attained via recharge, and the yield projections.[3]

6. The City may work in conjunction with SVWD and SqCWD to place new ASR wells in each District to increase capacity to inject and extract the stored water.

7. The volume of water that may be returned to SCWD is capped at 80% of the water provided for recharge, to reflect hydraulic loss in the aquifer systems (20%) and possible use of some stored water by the other Districts.[4]

8. Tait Street Diversion facility modifications include improvements and expansion to 14 MGD to handle higher flow rate (*source:* Table 15, *Reconnaissance-Level Evaluation of ASR and IPR DRAFT,* Pueblo Water Resources, Inc., 2015; costs not escalated).

9. Graham Hill Water Treatment Plant improvements and expansion to 14 MGD include modifications to handle higher flow rates—includes addition of pre-treatment, disinfection and oxidation, and solids handling (*source:* Table 15, *Reconnaissance-Level Evaluation of ASR and IPR DRAFT,* Pueblo Water Resources, Inc., 2015; costs not escalated). Ranney Collectors at Felton offer a potentially lower-cost alternative to the pretreatment proposed here; its feasibility as an alternative should be considered should this Building Block be carried forward.[5]

10. It is anticipated that groundwater extracted from SVWD will require treatment for iron and manganese removal prior to being pumped back to the City to meet SCWD demands. This need would be verified during design. This assumption is conservative since it currently is unknown whether injected water would mobilize minerals from the existing aquifer. Sometimes injected water forms a ”bubble” around the injection site and additional treatment such as iron and manganese removal would be unnecessary.[6]

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[3] The flow volume levels applied here are based on preliminary assessments of the volume needed to meet most projected SCWD shortfalls (4 mgd of return flows), and an assumed intent to add sufficient recharge water to accommodate 20% hydraulic loss (hence 5 mgd outflow). These flow volume levels may be modified in future sensitivity analyses to examine the impact of projected costs and yields of different potential scales of ASR investment and operation.

[4] The in lieu recharge analyses presented for Building Block 1 used 60% rather than 80%. Using a different number reflects the higher degree of active control ASR recharge provides. The total volume recharged under the in lieu strategy is limited by the winter demands of the receiving entities. ASR allows SCWD to potentially fill the available storage much more quickly and thereby create more flexibility for SCWD on water available for dry year withdrawal. The different percentages can also be examined in sensitivity analyses to assess the impact of alternative assumptions regarding hydraulic loss and other factors that influence return flows.

[5] GHWTP enhancements are scaled for 8 mgd. The average production for ASR recharge is assumed to be 5 mgd, and the larger scaling of the facilities is intended to enable peaking capacity.

[6] Note that the new conceptual systems would have treatment at the well since recovery water would transfer directly into the SVWD or SqCWD distribution systems.

11. Yield estimates for ASR reflect the assumption that SCWD realizes water savings from Program C Rec (i.e., that C Rec is anticipated to be part of the portfolio along with ASR). For purposes of this building block, the assumed peak season demand reduction attained is 150 MG. If additional changes in peak season demands are agreed upon by WSAC, then associated modifications to the yields in this portfolio will be derived.

12. Pilot testing, groundwater modeling, and other activities required to properly assess the viability of ASR and to best locate required wells and other infrastructure will require 7 to 11 years to complete (based on information provided by Pueblo Water Resources. 2015. *Reconnaissance-Level Evaluation of ASR and IPR DRAFT).*

## 4. Necessary Capital Improvements and Related Costs[7]

Table 2.1 provides an overview of the major capital investments and other upfront costs associated with developing and operationalizing the ASR program.

**Table 2.1 ASR capital improvement needs and costs (millions of 2015$)**

| Capital improvement item | Hard capital cost | Soft capital cost** | Total capital cost |
|---|---|---|---|
| **ASR** | | | |
| a. Intertie pipeline (City to/from SqCWD) | 13.20 | 4.10 | 17.30 |
| b. Pump Station (SqCWD to Aquifer) | 1.08 | 0.34 | 1.42 |
| c. Intertie No. 1 Pipeline (City to Scotts Valley) | 4.33 | 1.35 | 5.68 |
| d. Pump Station (City to Scotts Valley) Intertie No. 1 | 1.08 | 0.34 | 1.42 |
| e. Tait Street Diversion Improvements | 10.29 | 3.19 | 13.48 |
| f. Graham Hill WTP Improvements* | 47.31 | 14.67 | 61.98 |
| g. ASR Wells in SVWD (10 wells) | 7.50 | 2.33 | 9.83 |
| h. ASR Wells in SqCWD (10 wells) | 7.50 | 2.33 | 9.83 |
| i. Iron & Manganese Treatment (SVWD) | 3.00 | 0.93 | 3.93 |
| **Totals** | **94.66** | **29.38** | **124.04** |

<u>Note</u>: Land acquisition costs (for well sites and other needs) are not included here.

* Denotes an item with costs partially or completely envisioned within the City's CIP. The Graham Hill Water Treatment Plant improvements included in the CIP (not all-inclusive of those proposed here) total $14.2M.

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

a. Build a ~4.7-mile, 16-inch diameter pipeline to convey water from the Santa Cruz distribution system to the SqCWD distribution system.

b. Construct a 1,800-GPM pump station to move treated water within the SqCWD distribution system into their new aquifer storage and recovery well field (2.5-MGD).

c. Build a 1.5-mile, 16-inch diameter pipeline to connect the Santa Cruz distribution system to the

[7] 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 2.1 ASR capital improvement needs and costs (millions of 2015$)**

| Capital improvement item | Hard capital cost | Soft capital cost** | Total capital cost |
|---|---|---|---|
| SVWD distribution system through intertie No. 1 (2.5-MGD). | | | |
| d. Construct a 1,800-GPM pump station to move water from Santa Cruz to SVWD through Intertie No. 1. | | | |
| e. Improve and expand Tait Street Diversion facility to add capacity for increased flow (to 14 MGD). | | | |
| f. Improve and expand the Graham Hill Water Treatment Plant to handle increased flow (to 14 MGD). GHWTP would require improvements to produce more winter flow consistency especially because winter water is more challenging to treat. | | | |
| g. Construct new 250-GPM aquifer storage and recovery wells to store some of the additional captured water in Scotts Valley and later withdraw it. | | | |
| h. Construct new 250-GPM aquifer storage and recovery wells to store some of the additional captured water in SqCWD Creek and later withdraw it. | | | |
| i. Include iron and manganese treatment in the SVWD ASR wells for parity with existing groundwater treatment needs. Necessity of treatment at these new wells will be verified during project development. | | | |

<u>NOTE</u>:

1. An intertie to SVWD has been added to move water to the new ASR wells in SVWD.
2. Based on the revised yield numbers, a second pipeline between the Felton Booster Pump Station was deemed unnecessary and removed.
3. Based on the revised yield numbers (sizing for 5-MGD injection capacity), the pipeline to SVWD was upsized from 12 inches to 16 inches in diameter. The pipeline size increased over that for Building Block 1 because the transfer rate into SVWD increased.
4. The maximum yield for recharge was revised to 5 MGD, thus the number of wells had to be increased to ten wells each in Soquel Creek and in Scotts Valley. It is anticipated that the maximum rated flow rate may not be achievable during injection (as described in the *Pueblo Reconnaissance-Level Evaluation of ASR and IPR* report), hence *up to* ten wells may be needed.
5. The design capacities of the new ASR wells are 250 GPM. These are smaller than those used in *the Pueblo* report, where 350-GPM wells were used; the size difference is due to a difference in expected operating scenarios. The *per-well* cost for this project is substantially lower because: 1) The wells are significantly smaller, and 2) pumping is done from a centralized location, providing economy of scale over a one-pump-per-well approach.
6. The cost of treating the additional water produced has been added to the O&M cost.

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

Table 2.2 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 ASR approach.

| Table 2.2 ASR Using SLR Winter Flows | |
|---|---|
| **Estimates** | **ASR Using SLR winter flows** |
| Annual O&M costs ($M/yr) | $3.8 M |
| Total Annualized Cost ($M/Yr) | $13.9 M |
| PV Costs (30 years) ($M)[1] | $314 M |
| Energy Use (MWH/MG)[2] | 6.3 |
| NOTES:<br>1. Discount rate = 2.5%; bond interest rate = 5.5%; interest on reserve = 3%, bond issuance cost = 3%.<br>2. Existing SCWD water production requires 1.6 MWH/MG. | |

Based on the total annualized cost of $13.9 M, and the production of 350 MG of recharge water provided per year,[8] the total annualized cost per MG produced annually is approximately $37,140.

### 6. Water Supply and Yield Implications

Table 2.3 provides the water supply production and yield estimates and for the ASR option, including projected water returns to SCWD.

**Table 2.3. Estimated yields, peak season shortages, and returns for SCWD from ASR (MG)**

| | Santa Cruz yields | | Remaining peak-season shortages (% shortfall) | | Average annual steady state water added to storage (aquifer recharge) | Average annual groundwater withdrawal and return flows to SCWD |
|---|---|---|---|---|---|---|
| | **Worst-year yield** | **Average-year yield** | **Worst-year** | **Average-year** | | |
| ASR | 800 | 310 | 310<br>(17%) | 30<br>(<2%) | 420 | 180 |

Note that the yield estimates for ASR reflect an assumption that Program C Rec is also part of the Portfolio with ASR, such that the ASR portfolio yields reflect water savings associated with the conservation component.[9]

[8] Applying an average of the equivalent of 70 days of recharge per year (per Pueblo Water Resources, 2015) at 5 MGD, produces 350 MG of recharge per year on average.

[9] Please recall that "yields" refer to the ability of a portfolio to meet peak season gaps between supply and demand. Based on *Confluence* model runs reflecting climate change and DFG-5 fish flow requirements, the worst-year peak season shortage amounts to 1,110 mg, given the existing SCWD system portfolio. The average-year peak

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

The timeline for full-scale implementation of an ASR approach that reliably provides sufficient water back to SCWD may amount to 15 to 20 years, or longer, consisting of the following components:

- Pilot testing, groundwater modeling, and other activities required to properly assess the viability of ASR and to identify best locations for required wells and other infrastructure.

- Completion of additional infrastructure requirements for full ASR implementation – including siting and developing any necessary new wells, pipelines, treatment facilities. When combined with the above tasks, this may require 7 to 11 years for completion.

- Eight to nine years for anticipated typical recharge levels to restore regional aquifers (add at least 3 BG of stored water)[10], assuming sufficient winter rainfall to provide needed winter flows, and recharge facilities operate as hoped. This portion of the timeline could be longer, depending on precipitation patterns and other factors.

- Some ASR-based recharge and recovery may be realized during this 15 to 20 year period, as the program makes progress and (hopefully) some wells are successfully established and operated relatively early in the process. The potential time path for potential interim progress can be further explored.

**8. Key Institutional Issues to Resolve**

The City needs to resolve several critical institutional issues that need to be resolved in order for an in-lieu program to proceed as envisioned here. Among these are the following:

- Agreements between the City and SVWD and SqCWD regarding the terms and conditions of any transfers of water in either direction. Elements of the agreement would need to include:
    - Quantities of water to be assured for transfer in each direction, and the conditions under which those quantities may be flexible or firm.
    - Mechanisms for cost sharing and terms of pricing, etc. (e.g., will water be bought and sold on a volumetric basis, and/or will there be cost sharing that embodies capital and other related upfront costs, O&M costs, etc.).
    - Remedies for failure of any party to deliver on its obligations.

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season shortage is 340 mg. Thus, the maximum yields of a portfolio are 1110 mg and 340 mg for worst and average years, respectively.

[10] Applying an average of the equivalent of 70 days of recharge per year (per Pueblo Water Resources, 2015) at 5 MGD, produces 350 MG of recharge per year on average. Therefore, 8 to 9 years of recharge would be required, under average conditions, to attain 3 BG of total recharge volume added. This does not account for hydraulic loss during those years.

- Regulatory and other permit-related requirements to establish and operate interties, ASR wells, treatment facilities, and other necessary project components.

- Change in City water rights to accommodate/allow change in place of use.

- Possible implications of new State groundwater management rules and regulations (e.g., which may limit or otherwise complicate the withdrawal of groundwater for transfer back to SCWD).

- The City will need to address land acquisition needs associated with developing the new ASR wells.

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

- Will winter precipitation and flows be sufficient to meet the targeted levels of recharge?

- How soon will an appreciable volume of water be available for return back to SCWD?

- How likely is it that pilot testing, etc., would indicate limitations of the approach that would cause the ASR approach to be set aside or significantly scaled back in scope? If so, how much might be invested in studies and assets that become stranded, and how many years may have been used in the process?

- The City and the SVWD and SqCWD will need to locate new sites for the ASR wells.

- Will ASR recharge work successfully in the Lompico, Butano, and Purisima aquifers? Some agencies have tried ASR recharge but have been unsuccessful in storing water that they could recover later. Will there be any opportunities to explore “overdraft” provisions with SVWD and SqCWD, and state regulatory agencies, that may enable the City to take water back ahead of the volumes recharged?

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

# 3. Purified Recycled Water for Direct Potable Reuse (DPR)

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

## 1. Objectives

The technical team prepared this document as part of a series that provides 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 material 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. Purified Recycled Water for Direct Potable Reuse -- Overview

In this document, a direct potable reuse (DPR) approach is envisioned generally as:

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

2. Building a pipe and pumping system to blend the CAT-produced water into the North Coast water main near the Bay Street Tank site, and blending further with San Lorenzo River (SLR) water at 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.

SLR pump station.

3. Treating the blended source waters for potable supply at the Graham Hill Water Treatment Plant (GHWTP).

4. The additional supply provided would help meet water demands for Santa Cruz Water Department (SCWD).

5. Once SCWD needs are met, and Loch Lomond storage targets are achieved, any additional available supply could be made available to help meet demands in areas served by the Scotts Valley Water District (SVWD) and Soquel Creek Water District (SqCWD). Such transfers would help restore groundwater levels in the depleted regional aquifers (by enabling passive [in-lieu] recharge), reduce seawater intrusion potential into the Purisima formation, and provide stored waters that could be tapped in dry periods (including the possible return of some waters from neighboring Districts to the City).

There are numerous specific details and variations on how this DPR approach might be structured and implemented. These include, for example, whether any excess water might be made available to SVWD and SqCWD for in-lieu recharge. If these transfers are included, issues arise regarding the scale and location of any new infrastructure (e.g., interties, pumps, wells) that may be necessary to implement the approach, and the forms of the institutional arrangements negotiated between the City and SVWD and SqCWD regarding sharing water, costs, and risks. The latter issue impacts when and how much water may be transferred to and from SVWD and SqCWD, the associated improvements in yields and system reliability, how much the approach would cost, and what an equitable allocation of costs might look like.

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 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.

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

3. Newell Creek Dam height and Loch Lomond operational rules remain as they currently exist.

4. Purified recycled water is blended first into the North Coast raw water main near the Bay Street Tank site, then with other source waters entering the Graham Hill Water Treatment Plant (GHWTP) for additional treatment before distribution to SCWD customers.

5. If in-lieu recharge is considered part of this building block, then the costs, yields, and issues associated with the in-lieu component will depend on several factors, as described in the summary paper for Building Block #1.

6. Yield estimates for DPR reflect the assumption that SCWD realizes water savings from Program C Rec (i.e., that C Rec is anticipated to be part of the portfolio along with DPR). For purposes of this building block, the assumed peak season demand reduction attained is 150 MG. If additional changes in peak season demands are agreed upon by WSAC, then associated modifications to the yields in this portfolio will be derived.

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

Table 3.1 provides an overview of the major capital investments and other upfront costs associated with developing and operationalizing the DPR program.

**Table 3.1 DPR capital improvement needs and costs (millions of 2015$)**

| Capital improvement item | Hard capital cost | Soft capital cost* | Total capital cost |
|---|---|---|---|
| **DPR** | | | |
| 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 (UV + Peroxide) (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 (CAT to Bay St. Tank Site) | 1.92 | 0.60 | 2.52 |
| l. Pipeline installation (CAT to Bay St. Tank Site) | 3.96 | 1.23 | 5.19 |
| m. Line maintenance facility relocation | N/A | N/A | 5.20 |
| **Totals** | **84.67** | **26.29** | **116.15** |

[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 3.1 DPR capital improvement needs and costs (millions of 2015$)**

| Capital improvement item | Hard capital cost | Soft capital cost* | Total capital cost |
|---|---|---|---|

NOTES:

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

a. Modify existing wastewater treatment plant (WWTP) 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.
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.
k. Install a 3,200-gpm pumping system to move WWTP effluent to North Coast raw water main at the Bay Street Tank site.
l. Build a 1.1-mile, 20-inch diameter pipeline to convey an average of 4.7 MGD of CAT-purified water to the Bay Street Tank site for blending into the North Coast raw water main.
m. Relocate the existing line maintenance facility to make room for addition of the CAT process train. Includes purchase of property for new facilities on the west side of the City.



If an in-lieu component is linked to the DPR approach, additional capital costs would be incurred, as outlined in Building Block summary paper #1.

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

Table 3.2 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 DPR 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 3.2 DPR for Regional Demands**

| Estimates | DPR for City and Regional Use |
|---|---|
| Annual O&M costs ($M/yr) | $4.7 M |
| Total Annualized Cost ($M/Yr) | $14.0 M |
| PV Costs (30 years) ($M)[1] | $317M |
| Power Consumption (MWh/MG)[2] | 6.3 |

<u>NOTES</u>:
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.

If an in-lieu component is linked to the DPR approach, then additional O&M and other costs and energy requirements would be incurred, as outlined in Building Block #1.

### 6. Water Supply and Yield Implications

Table 3.3 provides the water supply production and yield estimates for the DPR option. The availability of this supply of 1,715 MGY (in combination with conservation Program C Rec ) addresses all anticipated future demands (no shortfalls) for SCWD, and also offers an opportunity to provide in-lieu recharge for SVWD and SqCWD as well (at levels of more than half of their combined winter demands).

**Table 3.3. DPR: Estimated yields, peak season shortages, and in-lieu demands met for SVWD and SqCWD (MG)**

| | Santa Cruz yields | | Remaining peak-season shortages (% shortfall) | | Average annual combined SV and SqC demand served in-lieu of groundwater draw (% met) | Average annual separate SV and SqC demand served in-lieu of groundwater draw |
|---|---|---|---|---|---|---|
| | **Worst-year yield** | **Average-year yield** | **Worst-year** | **Average-year** | | |
| DPR | 1,110 | 340 | 0<br>(0%) | 0<br>(0%) | 870<br>(57%) | 250 to SV<br>620 to SqC |

The total annual supply produced by the DPR approach is 1715 MG, and given the total annualized cost of $14.0 million, the average annualized cost per unit of production is approximately $8,160 per MG.

Note that the yield estimates shown in Table 3.3 for DPR reflect an assumption that Program C Rec is part of the Portfolio with DPR, such that some yield also is attributed to the water savings associated with conservation component.[4]

If an in-lieu component is linked to the DPR approach, additional water supply production and yields would be realized, as outlined in Building Block summary paper #1.

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

The timeline for the DPR approach could be 9 or 13 years, consisting of the following key elements:

- Permitting, right of way acquisition, and construction of CAT facilities and pipelines and pump stations to develop the purified recycled water and deliver it to GHWTP. (2-3 years). Similar requirements for in-lieu-related interties and any additional well development in SVWD and SqCWD could occur concurrently, if in-lieu is part of the DPR approach.

- Regulatory approval for DPR would likely occur prior to facility construction, but may occur concurrently with facility and pipeline right of way and permitting activities. State development of final DPR-specific regulations, and (or) approval of SCWD's DPR program (7-10 years but might be accelerated given current State-level priorities and initiatives to facilitate potable reuse).

## 8. Key Institutional Issues to Resolve

The City needs to resolve several critical institutional issues in order for a DPR 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 DPR.

- Public and political acceptability of purified recycled water as a blended part of the City's potable source waters.

- Agreements with SVWD, and perhaps the County, regarding the volume of effluent delivered to SCWD's wastewater treatment plant (as opposed to being extracted by SVWD for recycling elsewhere). The 5.5 MGD flow referred to above does <u>not</u> include any raw sewage or effluent flow from the City of Scotts Valley.

- If an in-lieu component is linked to the DPR approach, then all the institutional issues associated with that approach (including the need for clear agreements between the City and SVWD and

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[4] Please recall that "yields" refer to the ability of a portfolio to meet peak season gaps between supply and demand. Based on *Confluence* model runs reflecting climate change and DFG-5 fish flow requirements, the worst-year peak season shortage amounts to 1,110 MG, given the existing SCWD system portfolio. The average-year peak season shortage is 340 MG. Thus, the maximum yields of a portfolio are 1110 MG and 340 MG for worst and average years, respectively.

SqCWD on water-, risk- and cost-sharing) would need to be realized, as outlined in Building Block summary paper #1.

- If DPR were pursued, a public information campaign would be strongly recommended 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**

- Given the ability of the DPR option (when coupled with Program C Rec) to meet all of SCWD's anticipated supply needs, there is no apparent need for return flows from a potential in-lieu recharge component. Excess DPR water might thus be sold to SVWD and SqCWD (if the cost was competitive with other supply options the Districts are considering), without any obligation or agreement for return draws on their groundwater.

- The potential use of purified recycled water provides a production supply that is largely independent of rainfall.

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

# 4. Purified Recycled Water to Loch Lomond - Indirect Potable Reuse (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 to 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 via Loch Lomond -- Overview

In this document, an indirect potable reuse (IPR) approach to reservoir augmentation for Santa Cruz is envisioned generally as:

1. The City applying “Complete Advanced Treatment” (CAT) to produce purified recycled water of potable quality, and building a pipe and pumping system to convey the CAT-produced water up to Loch Lomond to supplement (and blend with) stream flow and runoff accumulated and stored in the reservoir.

[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.

2. The CAT-generated supply provided to Loch Lomond, as blended with other waters stored in the reservoir, is used as a source of potable supply (after treatment at the Graham Hill Water Treatment Plant (GHWTP)) and for instream flow enhancement (as water is released from the dam).

3. The additional supply provided would be used to help meet water demands for Santa Cruz Water Department (SCWD).

4. Once SCWD needs are met, and Loch Lomond storage targets are achieved, then any additional available supply *could* be made available to help meet demands in areas served by the Scotts Valley Water District (SVWD) and Soquel Creek Water District (SqCWD). Such transfers would enable passive (in-lieu) recharge and help restore groundwater levels in the depleted regional aquifers, reduce seawater intrusion into the Purisima formation, and provide stored waters that could be tapped in dry periods (including the possible return of some waters from neighboring Districts to the City).

There are numerous specific details and variations on how this IPR approach might be structured and implemented. These include, for example, whether any excess water might be made available to SVWD and SqCWD for in-lieu recharge. If these transfers are included, issues arise regarding the scale and location of any new infrastructure (e.g., interties, pumps, wells) as may be necessary to implement the approach, and the forms of the institutional arrangements negotiated between the City and SVWD and SqCWD regarding sharing water, costs, and risks.

There are also questions about how much dilution of the recycled water in Loch Lomond may be required by state regulators, and under what conditions (and how frequently) this dilution requirement may limit the ability to store recycled water in the reservoir. Dilution may be an issue that arises during dry periods, when less upstream water is available in the reservoir to provide target levels of dilution and blending with the purified recycled water, but when the recycled water would be most needed and valuable.

Each of these (and other) details influence how much purified recycled water may be added to Loch Lomond and, thus, how much water would be available to meet City needs and/or to offer opportunities for in-lieu recharge. The details of any agreements forged with neighboring water districts will influence when and how much water may be transferred to and from SVWD and SqCWD, the associated improvements in yields and system reliability, how much the approach would cost, and what an equitable allocation of costs might look like.

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. This is based on the volume of City-owned wastewater effluent entering the

City's wastewater treatment plant of about 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. Newell Creek Dam height and Loch Lomond operational rules remain as they currently exist.
4. Water extracted from the San Lorenzo River (SLR) is treated at the Graham Hill Water Treatment Plant (GHWTP) before distribution to SCWD customers.
5. If in-lieu recharge is considered part of this building block, then the costs, yields, and issues associated with the in-lieu component will depend on several factors, as described in the summary paper for Building Block #1.
6. Yield estimates for in-lieu reflect the assumption that SCWD realizes water savings from Program C Rec (i.e., that C Rec is anticipated to be part of the portfolio along with in-lieu recharge). For purposes of this building block, the assumed peak season demand reduction attained is 150 MG. If additional changes in peak season demands are agreed upon by WSAC, then associated modifications to the yields in this portfolio will be derived.

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

Table 4.1 provides an overview of the major capital investments and other upfront costs associated with developing and operationalizing the IPR via Loch Lomond program.[4]

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

[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.

[4] In-line monitoring needs and costs require additional investigation.

**Table 4.1 IPR to Loch Lomond, capital improvement needs and costs (millions of 2015 $)**

| Capital improvement item | Hard capital cost | Soft capital cost* | Total capital cost |
|---|---|---|---|
| **IPR** | | | |
| 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 (UV + Peroxide) (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 (CAT to Loch Lomond) | 1.92 | 0.60 | 2.52 |
| l. Pipeline installation (CAT to Loch Lomond) | 44.88 | 13.92 | 58.80 |
| m. Line maintenance facility relocation | N/A | N/A | 5.20 |
| **Totals** | **125.59** | **38.98** | **169.76** |

<u>NOTES</u>:

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

a. Modify existing wastewater treatment plant (WWTP) 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.
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: install 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 Loch Lomond Reservoir.
l. Build a 13-mile, 20-inch diameter pipeline to convey an average of 4.7 MGD of CAT-purified water

| | |
|---|---|
| | to the Loch Lomond Reservoir. |
| m. | Relocate the existing line maintenance facility to make room for addition of the CAT process train. Includes purchase of property for new facilities on the west side of the City. |

If an in-lieu component is linked to the IPR via Loch Lomond approach, additional capital costs would be incurred, as outlined in Building Block summary paper #1.

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

Table 4.2 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 via Loch Lomond 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 4.2 IPR for Reservoir Augmentation**

| Estimates | IPR for Reservoir Augmentation |
|---|---|
| Annual O&M costs ($M/yr) | $7.2 M |
| Total Annualized Cost ($M/Yr) | $20.9 M |
| PV Costs (30 years) ($M)[1] | $471 M |
| Energy Use (MWH/MG)[2] | 9.6 |

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.

If an in-lieu component is linked to the IPR via Loch Lomond approach, additional O&M and other costs and energy requirements would be incurred, as outlined in Building Block summary paper #1.

**6. Water Supply and Yield Implications**

Table 4.3 provides the water supply production and yield estimates and for the IPR via Loch Lomond option. The availability of this supply of 1,715 MG annually (in combination with conservation Program C Rec) addresses nearly all anticipated future demands for SCWD (no shortfalls > 3%), and also offers an opportunity to provide in-lieu recharge for SVWD and SqCWD as well (at levels of more than three-quarters of their combined winter demands).

The total annual supply produced by the IPR approach is 1715 MG, and given the total annualized cost of $20.8 million, the average annualized cost per unit of production is approximately $12,130 per MG.

**Table 4.3. IPR via Loch Lomond: Estimated yields, peak season shortages, and in-lieu demands met for SVWD and SqCWD (MG)**

| | Santa Cruz yields | | Remaining peak-season shortages (% shortfall) | | Average annual combined SV and SqC demand served in-lieu of groundwater draw (% met) | Average annual separate SV and SqC demand served in-lieu of groundwater draw |
|---|---|---|---|---|---|---|
| | Worst-year yield | Average-year yield | Worst-year | Average-year | | |
| IPR via Loch Lomond | 1,050 | 330 | 60 (3%) | 0 (0%) | 1,170 (76%) | 340 to SV<br>830 to SqC |

Note that the yield estimates for IPR via Loch Lomond reflect an assumption that Program C Rec peak-season demand reductions are also part of the Portfolio with IPR, such that some yield is also attributed to the water savings associated with conservation component.[5]

If an in-lieu component is linked to the IPR via Loch Lomond approach, additional water supply production and yields would be realized, as outlined in Building Block summary paper #1.

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

The timeline for the IPR via Loch Lomond approach may be about 8 years, consisting of the following key elements:

- Permitting, right of way acquisition, and construction of CAT facilities and pipelines and pump stations to develop the purified recycled water and deliver it to Loch Lomond, which may amount to 8 years. Similar requirements for in-lieu-related interties and any additional well development in SVWD and SqCWD could occur concurrently.

- Regulatory approval for IPR via reservoir augmentation would likely occur prior to facility construction, but may occur concurrently with facility and pipeline right of way and permitting activities.

## 8. Key Institutional Issues to Resolve

The City needs to resolve several critical institutional issues in order for a Reservoir Augmentation via IPR program to proceed as envisioned here. Among these are the following:

[5] Please recall that "yields" refer to the ability of a portfolio to meet peak season gaps between supply and demand. Based on *Confluence* model runs reflecting climate change and DFG-5 fish flow requirements, the worst-year peak season shortage amounts to 1,110 MG, given the existing SCWD system portfolio. The average-year peak season shortage is 340 MG. Thus, the maximum yields of a portfolio are 1110 MG and 340 MG for worst and average years, respectively.

- Regulatory approval from the State Water Resources Control Board, Division of Drinking Water (DDW) for IPR via reservoir augmentation.

- Public and political acceptability of purified recycled water as a blended part of the City's source waters.

- If an in-lieu component is linked to the IPR via Loch Lomond approach, then all the institutional issues associated with that approach (including the need for clear agreements between the City and SVWD and SqCWD on water-, risk- and cost-sharing) would need to be realized, as outlined in Building Block summary paper #1.

- If IPR were pursued, the City would want to consider 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 Jose, and elsewhere.

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

- The degree to which reservoir dilution/blending regulatory requirements for IPR might limit either the volume of purified recycled water allowed in Loch Lomond in dry years, alter the Loch Lomond operating procedures to retain sufficient dilution/blend waters, or both. (This may be something the technical team can model via *Confluence* for assumed regulatory dilution requirements).

- The potential use of purified recycled water provides a production supply that is largely independent of rainfall.

**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:<br>1. Discount rate = 2.5%; bond interest rate = 5.5%; interest on reserve = 3%; bond issuance cost = 3%.<br>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.

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

# 6. Purified Recycled Water: Converting IPR for Seawater Barrier (Building Block #5) to Direct Potable Reuse (DPR)

***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 material 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. Converting Purified Recycled Water from IPR (Seawater Barrier) to Direct Potable Reuse -- Overview

In this document, the conversion of an indirect potable reuse (IPR)-based seawater intrusion barrier wells application (as described in the summary report on Building Block #5) to create a new direct potable reuse (DPR)-based water supply is envisioned generally as:

1. The City continuing to operate a "Complete Advanced Treatment" (CAT) facility it has built for IPR to produce purified recycled water of potable quality.

[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.

2. Building a pipe and pumping system to blend the CAT-produced water into the North Coast water main near the Bay Street Tank site, and blending further with San Lorenzo River (SLR) water at the SLR/Coast pump station.

3. Treating the blended source waters for potable supply at the Graham Hill Water Treatment Plant (GHWTP).

4. The additional supply provided would help meet water demands for Santa Cruz Water Department (SCWD).

5. Once SCWD needs are met, then any additional available supply could be made available to help meet demands in areas served by the Scotts Valley Water District (SVWD) and Soquel Creek Water District (SqCWD). This water transfer is intended to help restore groundwater levels in the depleted regional aquifers (by enabling passive (in-lieu) recharge, reduce seawater intrusion into the Purisima formation, and provide stored waters that could be tapped in dry periods (including the possible return of some waters from neighboring Districts to the City).

There are numerous specific details and variations on how this IPR-to-DPR conversion might be structured and implemented. These include, for example, whether any excess water might be made available to SVWD and SqCWD for in-lieu recharge. If these transfers are included, issues arise regarding the scale and location of any new infrastructure (e.g., interties, pumps, wells) that may be necessary to implement the approach, and the forms of the institutional arrangements negotiated between the City and SVWD and SqCWD regarding sharing water, costs, and risks. The latter issue impacts when and how much water may be transferred to and from SVWD and SqCWD, the associated improvements in yields and system reliability, how much the approach would cost, and what an equitable allocation of costs might look like.

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

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

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. Newell Creek Dam height and Loch Lomond operational rules remain as they currently exist.

4. Purified recycled water – previously used for IPR –is instead blended first with North Coast source waters near the Bay Street Tanks site, then with other source waters entering the Graham Hill Water Treatment Plant (GHWTP) for additional treatment before distribution to SCWD customers.

5. If in-lieu recharge is considered part of this building block, then the costs, yields, and issues associated with the in-lieu component will depend on several factors, as described in the summary paper for Building Block #1.

6. Yield estimates for in-lieu reflect the assumption that SCWD realizes water savings from Program C Rec (i.e., that C Rec is anticipated to be part of the portfolio along with in-lieu recharge). For purposes of this building block, the assumed peak season demand reduction attained is 150 MG. If additional changes in peak season demands are agreed upon by WSAC, then associated modifications to the yields in this portfolio will be derived.

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

Table 6.1 provides an overview of the major capital investments and other upfront costs associated with developing and operationalizing the DPR program, assuming that the CAT facility is already constructed and operational (as part of a prior IPR program), and that the major infrastructure requirements entail the piping and pumping modifications and additions required to implement the transition from IPR to DPR. Additional infrastructure requirements may be imposed by the State for DPR (vs. an IPR approach) once potable reuse regulations are more developed.

**Table 6.1 DPR capital improvement needs and costs (millions of 2015$)**

| Capital improvement item | Hard capital cost* | Soft capital cost** | Total capital cost |
|---|---|---|---|
| **DPR** | | | |
| a. Pumping system (CAT to Bay St. Tanks site) | 2.31 | 0.72 | 3.02 |
| b. Pipeline installation (CAT to Bay St. Tanks site) | 4.76 | 1.48 | 6.23 |
| **Totals** | **7.07** | **2.20** | **9.25** |

[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 6.1 DPR capital improvement needs and costs (millions of 2015$)**

| Capital improvement item | Hard capital cost* | Soft capital cost** | Total capital cost |
|---|---|---|---|

NOTES:
*An additional 20% contingency mark-up added to account for needed on-site modifications. Decommissioning of the IPR pipeline and well field is not included.
** Soft costs include engineering, construction management, permitting, City contract administration and legal.
a. Install pumps to pump Complete Advanced Treatment (CAT)-purified water to the Bay Street Tanks site.
b. Build pipeline to convey CAT-purified water to the Bay Street Tanks site.

If an in-lieu component is linked to the DPR approach, additional capital costs would be incurred, as outlined in Building Block summary paper #1.

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

Table 6.2 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 transition from an IPR to a DPR approach. The O&M costs reflect the full annual costs of operating the DPR system. The total annualized costs include only the annualized value of capital cost to convert the existing recycled water program to DPR (plus the full O&M cost of continuing to operate the system for DPR; we assume that the seawater barrier approach would be decommissioned). The full cost of the Building Block would include the capital costs from Building Block #5. Additional operational requirements may be imposed by the State for DPR (vs. an IPR approach) once potable reuse regulations are more developed, which could add costs.

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 6.2. DPR Converted from Seawater IPR | |
|---|---|
| **Estimates** | **Conversion of CAT to DPR for City and Regional Use[1]** |
| Annual O&M costs ($M/yr) | $4.8 M |
| Total Annualized Cost ($M/Yr) | $5.6 M |
| PV Costs (30 years) ($M)[2] | $119M |
| Energy Use (MWH/MG)[3] | 6.3 |

NOTES:
1. For consistency, this option only includes incremental costs associated with the added infrastructure to repurpose the CAT system to DPR, rather than IPR use for seawater intrusion barriers. O&M costs reflect incremental operational expense for DPR configuration.
2. Discount rate = 2.5%; bond interest rate = 5.5%; interest on reserve = 3%, bond issuance cost = 3%.
3. Existing SCWD water production requires 1.6 MWH/MG.

If an in-lieu component is linked to the DPR, additional O&M and other costs and energy requirements would be incurred, as outlined in the summary paper for Building Block #1.

## 6. Water Supply and Yield Implications

Table 6.3 provides the water supply production and yield estimates for the DPR option. This indicates that the availability of the DPR supply of 1,715 MG annually (in combination with conservation Program C Rec) addresses all anticipated future demands for SCWD (no shortfalls), and also offers an opportunity to provide in-lieu recharge for SVWD and SqCWD as well (for more than half of their combined winter demands).

The total annual supply produced by the IPR conversion to DPR approach is 1,715 MG, and given the total annualized cost of $5.6 million (assuming the initial CAT investment cost for the IPR approach is considered a sunk cost), the average annualized cost per unit of production is approximately $3,270 per MG. If the full cost of the CAT facility is included, then the average annual production cost is approximately $8,690 per MG.

**Table 6.3. DPR: Estimated yields, peak season shortages, and in-lieu demands met for SVWD and SqCWD (MG)**

| | Santa Cruz yields | | Remaining peak-season shortages (% shortfall) | | Average annual combined SV and SqC demand served in-lieu of groundwater draw (% met) | Average annual separate SV and SqC demand served in-lieu of groundwater draw |
|---|---|---|---|---|---|---|
| | Worst-year yield | Average-year yield | Worst-year | Average-year | | |
| DPR<br>(converted from IPR) | 1,110 | 340 | 0<br>(0%) | 0<br>(0%) | 870<br>(57%) | 250 to SV<br>620 to SqC |

Note that the yield estimates for DPR reflect an assumption that Program C Rec is also part of the Portfolio with DPR, such that some yield is also attributed to the water savings associated with conservation component.[4]

If an in-lieu component is linked to the DPR approach, then additional water supply production and yields would be realized, as outlined in Building Block summary paper #1.

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

If permitting is not onerous, the timeline for converting from IPR to DPR could be quite short (2 years), reflecting the fact that only a modest amount of new infrastructure needs to be developed (and the CAT facility is already in place and operational, with regulatory approvals for IPR). The timing for such a conversion would be well into the future so it is likely that IPR and DPR regulations will be much better established, making the permitting process less uncertain.

There may be some delays associated with obtaining additional regulatory clearance and public acceptance of the transition to a DPR approach.

## 8. Key Institutional Issues to Resolve

The City needs to resolve several critical institutional issues in order for a DPR 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 DPR.
- Public and political acceptability of purified recycled water as a blended part of the City's direct potable supply.
- Agreements with SVWD, and perhaps the County, regarding the volume of effluent delivered to SCWD's wastewater treatment plant (as opposed to being extracted by SVWD for recycling elsewhere). The 5.5 –MGD flow referred to above does not include any raw sewage or effluent flow from the City of Scotts Valley.
- If an in-lieu component is linked to the DPR approach, then all the institutional issues associated with that approach (including the need for clear agreements between the City and SVWD and SqCWD on water-, risk- and cost-sharing) would need to be realized, as outlined in Building Block summary paper #1.

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[4] Please recall that "yields" refer to the ability of a portfolio to meet peak season gaps between supply and demand. Based on *Confluence* model runs reflecting climate change and DFG-5 fish flow requirements, the worst-year peak season shortage amounts to 1,110 MG, given the existing SCWD system portfolio. The average-year peak season shortage is 340 MG. Thus, the maximum yields of a portfolio are 1,110 MG and 340 MG for worst and average years, respectively.

- If DPR were pursued, the City should consider 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

- Given the ability of the DPR option (when coupled with Program C Rec to meet all of SCWD's anticipated supply needs, there is no apparent need for return flows from a potential in-lieu recharge component. Excess DPR water might thus be sold to SVWD and SqCWD (if the cost was competitive with other supply options the Districts are considering), without any obligation or agreement for return draws on their groundwater.

- Potentially stranded assets -- pipe, pump and barrier wells – if the seawater intrusion barrier well approach is abandoned (e.g., to convert the program to a 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 potential use of purified recycled water provides a production supply that is largely independent of rainfall.

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

# 7. Deep Water Desalination (DW Desal)

***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 material 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. Deep Water Desalination -- Overview

In this document, the seawater desalination-based "DW Desal" is envisioned generally as:

1. The City acquiring rights to a share of the Deep Water Desalination facility's anticipated production, with the City share amounting to 3 MGD (about 1,100 MG per year).

2. The City contributing a share of the costs for building a pipe and pumping system to deliver water within the service area of Soquel Creek Water District (with two-thirds of the costs paid by the City and the rest shared proportionally with other North County water agencies investing in DW Desal),

[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.

and then paying for additional piping and pumping up to an intertie with Santa Cruz Water Department's (SCWD's) existing system at the 41st Street and Soquel Drive intersection.

3. The City distributing the DW Desal water to customers, along with its other finished potable supplies as produced at the Graham Hill Water Treatment Plant (GHWTP).

4. The additional supply provided would help meet water demands for SCWD.

5. Once SCWD needs are met, then any additional available supply could be made available to help meet demands in areas served by the Scotts Valley Water District (SVWD) and Soquel Creek Water District (SqCWD). Such transfers would help restore groundwater levels in the depleted regional aquifers (by enabling passive (in-lieu) recharge), reduce seawater intrusion into the Purisima formation, and provide stored waters that could be tapped in dry periods (including the possible return of some waters from neighboring Districts to the City).

There are numerous specific details and variations on how this DW Desal approach might be structured and implemented. These include, for example, how large a share of the project the City acquires, how the size and cost of pipe and pumping facilities may be influenced by whether other regional entities also buy into DW Desal, and what institutional agreements may be forged with them for cost- and risk-sharing.

As itemized above, another factor is whether any excess SCWD water might be made available to SVWD and SqCWD for in-lieu recharge. If this is included, issues arise regarding the scale and location of any new infrastructure (e.g., interties, pumps, wells) as may be necessary to implement the approach, and the institutional arrangements negotiated between the City and SVWD and SqCWD regarding sharing water, costs, and risks. The latter issue impacts when and how much water may be transferred to and from SVWD and SqCWD (and when), the associated improvements in yields and system reliability, how much the approach would cost, and what an equitable allocation of costs might look like.

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. DW Desal water is purchased (i.e., a one-third share buy-in of a 9-MGD facility) based on a desired acquisition of a 3-MGD supply, providing nearly 1,100 MG per year.

2. The costs and timetable for DW Desal water are informed by the developer's projections; however, the Technical Team has modified these estimates to reflect its professional judgment (increasing the costs and lengthening the schedule, as detailed below). Pipeline and pumping costs to move the water (4.5MGD) from the production facility across Aptos are shared with other regional water agencies (because the other entities are expected to also use a portion of the pipeline capacity); the in-City pipeline cost is borne by the City alone to deliver 3MGD to the City.

3. Newell Creek Dam height and Loch Lomond operational rules remain as they currently exist.

4. If in-lieu recharge is considered part of this building block, then the costs, yields, and issues associated with the in-lieu component will depend on several factors, as described in the summary paper for Building Block #1.

5. Yield estimates for in-lieu reflect the assumption that SCWD realizes water savings from Program C Rec (i.e., that C Rec is anticipated to be part of the portfolio along with in-lieu recharge). For purposes of this building block, the assumed peak season demand reduction attained is 150 MG. If additional changes in peak season demands are agreed upon by WSAC, then associated modifications to the yields in this portfolio will be derived.

## 4. Necessary Capital Improvements and Related Costs[2]

Table 7.1 provides an overview of the major capital investments and other upfront costs associated with developing and operationalizing the DW Desal program.



[2] 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 7.1 DW Desal capital improvement needs and costs (millions of 2015$)**

| Capital improvement item | Hard capital cost | Soft capital cost | Total capital cost |
|---|---|---|---|
| **DW Desal** | | | |
| a. Intake (18 mgd) & Outfall (9 mgd) | 20.00 | 6.20 | 26.20 |
| b. DAF (18 mgd) | 2.59 | 0.80 | 3.39 |
| c. Solids handling | 2.75 | 0.85 | 3.61 |
| d. Microfiltration (18 mgd) | 10.00 | 3.10 | 13.10 |
| e. Seawater Reverse Osmosis (16.2 mgd) | 15.00 | 4.65 | 19.65 |
| f. Conditioning facilities (9.0 mgd) | 1.51 | 0.47 | 1.98 |
| g. Pumping system (Desalination plant to SCWD) | 1.88 | 0.58 | 2.46 |
| h. Pipeline installation (From Desalination Plant across Aptos) | 41.80 | 12.96 | 54.76 |
| i. Pipeline installation (Across Santa Cruz) | 19.39 | 6.01 | 25.40 |
| **Totals** | **114.92** | **35.62** | **150.55** |

NOTE:

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

** The facility is designed to produce 9 MGD of potable water to allow both SCWD and its neighbors to purchase water. It is assumed that SCWD will purchase one-third of this volume. The facility was sized for the full flow and the facility cost represented here is one-third of the total. The pipeline cost breakouts are itemized below.

a. Build an 18-MGD seawater intake and a 9-MGD outfall extending out into the ocean from Moss Landing. The intake and outfall construction costs for the alignment in the *Initial Evaluation of the Deep Water Desalination Project Costs* (Kennedy Jenks 2014) were deemed overly optimistic given the challenging alignment requirements through coastline navigation channels and environmentally sensitive areas. These costs have been substantially increased based on comparison of costs with other sweater desalination projects and engineering judgment.

b. Part of the Seawater Desalination Treatment Process: Install a dissolved air filtration (DAF) pretreatment for algae removal (pre-treatment for the microfiltration [MF] process).

c. Part of the Seawater Desalination Treatment Process: Construct a solids handling system (for waste from DAF process).

d. Part of the Seawater Desalination Treatment Process: Install MF pretreatment to remove solids (for the seawater reverse osmosis [SWRO] process).

e. Part of the Seawater Desalination Treatment Process: Install seawater reverse osmosis (RO) treatment.

f. Modify the pH and add alkalinity to stabilize the highly purified RO effluent for corrosion control in the distribution system.

g. Install a 6,250-gpm pumping system to move the desalinated water from the plant to Santa Cruz; 1/3 cost paid by SCWD.

h. Build a 15-mile, 20-inch pipeline section to convey 4.5-mgd of desalinated water across Aptos to the Santa Cruz area. SCWD and SqCWD share the pipeline; SCWD pays 2/3 of the cost for this pipeline. City pays 2/3 the cost to move the water.

| | |
|---|---|
| **i.** | Build a 16-inch pipeline section to convey 3-mgd of the desalinated water to connect the 20-inch pipeline to the SCWD distribution system at the 41st Street and Soquel Drive intersection. Full cost paid by SCWD. (Pipe sizes and volumes would be revisited during future design.) |

If an in-lieu component is linked to the DW Desal approach, additional capital costs would be incurred, as outlined in Building Block summary paper #1.

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

Table 7.2 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 DW Desal approach.

| **Table 7.2 Deep Water Desalination Used for Santa Cruz and Regional Demands** | |
|---|---|
| **Estimates** | **DW Desal for Regional Use** |
| Annual O&M costs ($M/yr) | $6.3 M |
| Total Annualized Cost ($M/Yr) | $18.4 M |
| PV Costs (30 years) ($M)[1] | $413 M |
| Energy Use (MWH/MG)[2] | 12.4 |

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.

If an in-lieu component is linked to the DW Desal approach, then additional O&M and other costs and energy requirements would be incurred, as outlined in Building Block summary paper #1.

**6. Water Supply and Yield Implications**

Table 7.3 provides the water supply production and yield estimates and for the DW Desal option, indicating that the availability of this supply of 3 MGD (~1,100 MG annually), in combination with conservation Program C addresses most anticipated future demands for SCWD (resulting in limited shortfalls). The acquisition of DW Desal waters also offers an opportunity to provide in-lieu recharge for up to half of SVWD and SqCWD winter demands.

Given that the total annualized cost of the DW Desal option of $18.3 Million, and an annual supply production of approximately 1,100 MG, the annualized unit cost of production amounts to approximately $16,640 per MG.

**Table 7.3. DW Desal: Estimated yields, peak season shortages, and in-lieu demands met for SVWD and SqCWD (MG)**

| | Santa Cruz yields | | Remaining peak-season shortages (% shortfall) | | Average annual combined SV and SqC demand served in-lieu of groundwater draw (% met) | Average annual separate SV and SqC demand served in-lieu of groundwater draw |
|---|---|---|---|---|---|---|
| | Worst-year yield | Average-year yield | Worst-year | Average-year | | |
| DW Desal | 710 | 330 | 400 (21%) | 10 (<1%) | 770 (50%) | 230 to SV<br>540 to SqC |

Note that the yield estimates for DW Desal reflect an assumption that Program C Rec is also part of the Portfolio with DW Desal, such that DW some yield is also attributed to the water savings associated with conservation component.[3]

If an in-lieu component is linked to the DW Desal approach, then additional water supply production and yields would be realized, as outlined in Building Block summary paper #1.

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

The timeline for the DW Desal approach may be up to 7 years (although the developer states that delivery could begin by 2016). Timeline elements consist of the following:

- Permitting, other regulatory approvals, and construction of DW desalination facilities (intake, outfall, treatment process, and all related facilities) to develop the desalinated water for distribution to its investor/customers.

- Permitting, right of way acquisition, and construction of pipelines and pumping facilities to convey DW Desal water from Monterey to Santa Cruz (including the possibility of jointly-developed and shared pipeline facilities to the region).

## 8. Key Institutional Issues to Resolve

The City, and/or project developers, need to resolve several critical institutional issues in order for a DW Desal program to proceed as envisioned here. Among these are the following:

[3] Please recall that "yields" refer to the ability of a portfolio to meet peak season gaps between supply and demand. Based on *Confluence* model runs reflecting climate change and DFG-5 fish flow requirements, the worst-year peak season shortage amounts to 1,110 MG, given the existing SCWD system portfolio. The average-year peak season shortage is 340 MG. Thus, the maximum yields of a portfolio are 1110 MG and 340 MG for worst and average years, respectively. Program C Rec provides yields of 130 MG and 100 MG in the worst year and average years, respectively.

- Regulatory approval and permits, from the California Coastal Commission and other federal, state and local entities for development of the seawater desalination facilities and all necessary pipelines, and for any mandated or desired environmental and carbon footprint mitigation or restoration/offsets.

- Public and political acceptability of desalinated water as a part of the City's water supply portfolio.

- Agreements with SqCWD, other potential regional DW Desal investors, and perhaps the County, regarding the sharing of major portions of the overall conveyance facilities, including cost and risk sharing and other facets.

- If an in-lieu component is linked to the DW Desal approach, then all the institutional issues associated with that approach (including the need for clear agreements between the City and SVWD and SqCWD on water-, risk- and cost-sharing) would need to be realized, as outlined in Building Block summary paper #1.

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

- Given the ability of the DW Desal option (when coupled with Program C Rec) to meet most of SCWD's anticipated supply needs, there is limited need for return flows from a potential in-lieu recharge component. Excess DW Desal water might thus be sold to SVWD and SqCWD, though the viability of water sales may be limited by whether the price set by the City is competitive with other supply options the Districts are considering.

- If and when desal water is no longer needed, or needed in lesser quantities, it may be relatively easy to sell off shares and thus reduce the potential level of stranded assets.

- The potential use of desalinated seawater provides a production supply that is largely independent of rainfall.

## Water Supply Advisory Committee Portfolio Building Block Information
# 8. Local Desalination (scwd$^2$ Desal)

***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 builds portfolios for future consideration.

*Disclaimer/Context*

The material 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] However, for this option, given that we are building on fairly detailed prior planning work by the City, the cost estimates are likely to be less uncertain than those of the other options being examined.

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. Local (scwd$^2$) Desal -- Overview

In this document, the seawater desalination-based "Local Desal" approach is envisioned generally as:

1. The City developing a seawater desalination facility largely based on the original plans for the scwd$^2$ facility, though scaled up to 3 MGD (rather than 2.5 MGD) to better meet anticipated SCWD needs under DFG-5 and climate change. (The 3-MGD scale also provides a more suitable basis of

[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.

comparison with the Deep Water Desalination facility option described in Building Block #7.)

2. The City distributing the Local Desal water to its customers, along with its other finished potable supplies as produced at the Graham Hill Water Treatment Plant (GHWTP), with the additional supply used to help meet water demands for Santa Cruz Water Department (SCWD).

3. Once SCWD needs are met, then any additional available supply could be made available to help meet demands in areas served by the Scotts Valley Water District (SVWD) and/or the Soquel Creek Water District (SqCWD). Such transfers help restore groundwater levels in the depleted regional aquifers (by enabling passive (in-lieu) recharge, reduce seawater intrusion into the Purisima formation, and provide stored waters that could be tapped in dry periods (including the possible return of some waters from neighboring Districts to the City).

There are numerous specific details and variations on how the Local Desal approach might be structured and implemented. These include, for example, whether technology advancements (such as forward osmosis) may become commercially viable at the municipal desalination scale and thus enable cost and/or energy use savings.

Another factor is whether any excess SCWD water might be made available to SVWD and/or SqCWD for in-lieu recharge. If this is included, issues arise regarding the scale and location of any new infrastructure (e.g., interties, pumps, wells) as may be necessary to implement the approach, and the forms of the institutional arrangements negotiated between the City and SVWD and SqCWD regarding sharing water, costs, and risks. The latter issue impacts when and how much water may be transferred to and from SVWD and SqCWD (and when), the associated improvements in yields and system reliability, how much the approach would cost, and what an equitable allocation of costs might look like.

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. Local Desal facilities are developed at a production scale of 3 MGD supply, providing nearly 1,100 MG per year.

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. The timetable for Local Desal reflects the project planning work already accomplished.

4. The costs of the Local Desal approach are increased from the original estimates to account for both general price escalation as well as generally higher bid prices in the current economy compared to the original cost basis period. Costs are also increased to reflect the increased scale of the facility and its operation (3.0 MGD rather than 2.5 MGD).

5. The City of Santa Cruz develops the Local Desal project on its own, rather than negotiating a new agreement for a shared desal facility (such as was the case for the original scwd$^2$ plan).

6. Newell Creek Dam height and Loch Lomond operational rules remain as they currently exist.

7. If in-lieu recharge is considered part of this building block, then the costs, yields, and issues associated with the in-lieu component will depend on several factors, as described in the summary paper for Building Block #1.

8. Yield estimates for in-lieu reflect the assumption that SCWD realizes water savings from Program C Rec (i.e., that C Rec is anticipated to be part of the portfolio along with in-lieu recharge). For purposes of this building block, the assumed peak season demand reduction attained is 150 MG. If additional changes in peak season demands are agreed upon by WSAC, then associated modifications to the yields in this portfolio will be derived.

## 4. Necessary Capital Improvements and Related Costs[2]

Table 8.1 provides an overview of the major capital investments and other upfront costs associated with developing and operationalizing the Local Desal program.

**Table 8.1 Local Desal capital improvement needs and costs (millions of 2015$)**

| Capital improvement item | Hard capital cost | Soft capital cost* | Total capital cost |
|---|---|---|---|
| **scwd$^2$ Desalination Plant** | | | |
| a. City SWRO plant capital cost (at 3-MGD scale) | N/A | N/A | 138.00 |
| b. Effluent outfall modifications | 1.50 | 0.47 | 1.97 |
| **Totals** | **1.50** | **0.47** | **139.97** |

NOTES:

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

a. Construction of 3-MGD seawater reverse osmosis (SWRO)-based treatment plant. *Source: 2012 scwd$^2$ report*; cost scaled to 3-mgd capacity and 2015 dollars. Estimate includes intake structure and pumping facility, SWRO plant, brine disposal, and solids handling.

b. Modify the existing wastewater treatment plant outfall to accommodate disposal of SWRO brine.

[2] 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.

If an in-lieu component is linked to the Local Desal approach, additional capital costs would be incurred, as outlined in Building Block summary paper #1 or Building Block summary paper #2, respectively.

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

Table 8.2 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 Local Desal approach.

| Table 8.2 scwd² Seawater Desalination Used for Santa Cruz and Regional Demands | |
|---|---|
| **Estimates** | **scwd² Seawater Desalination for Regional Use** |
| Annual O&M costs ($M/yr) | $3.9 M |
| Total Annualized Cost ($M/Yr) | $15.1 M |
| PV Costs (30 years) ($M)[1] | $343 M |
| Energy Use (MWH/MG)[2] | 11.0 |
| NOTES:<br>1. Discount rate = 2.5%; bond interest rate = 5.5%; interest on reserve = 3%; bond issuance cost = 3%.<br>2. Existing SCWD water production requires 1.6 MWH/MG. | |

If an in-lieu component is linked to the Local Desal approach, then additional O&M and other costs and energy requirements would be incurred, as outlined in Building Block summary paper #1.

## 6. Water Supply and Yield Implications

Table 8.3 provides the water supply production and yield estimates and for the Local Desal option, indicating that the availability of this climate-independent supply of 3 MGD (~1,100 MG annually), in combination with conservation Program C Rec addresses most anticipated future demands for SCWD (resulting in limited shortfalls). The production of local desalination waters also offers an opportunity to provide in-lieu recharge for up to half of SVWD and SqCWD winter demands.

Given that the total annualized cost of the Local Desal option of $15.0 Million, and an annual supply production of approximately 1,100 MG, the annualized unit cost of production amounts to approximately $13,740 per MG.

**Table 8.3. Local (SCWD²) Desalination: Estimated yields, peak season shortages, and in-lieu demands met for SVWD and SqCWD (MG)**

| | Santa Cruz yields | | Remaining peak-season shortages (% shortfall) | | Average annual combined SV and SqC demand served in-lieu of groundwater draw (% met) | Average annual separate SV and SqC demand served in-lieu of groundwater draw |
|---|---|---|---|---|---|---|
| | Worst-year yield | Average-year yield | Worst-year | Average-year | | |
| Local Desalination | 710 | 330 | 400 (21%) | 10 (<1%) | 770 (50%) | 230 to SV<br>540 to SqC |

Note that the yield estimates for the Local Desal option reflect an assumption that Program C Rec is also part of the Portfolio with Local Desal, such that some yield is also attributed to the water savings associated with conservation component.[3]

If an in-lieu component is linked to the Local Desal approach, then additional water supply production and yields may be realized, as outlined in Building Block summary paper #1.

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

The timeline for the Local Desal approach may be within 6 years if existing plans can be used. Timeline elements consist of the following:

- Permitting, other regulatory approvals, and construction of the seawater reverse osmosis (SWRO)-based facilities (intake, outfall, treatment process, and all related facilities) to develop the desalinated water.[4]
- Permitting, right of way acquisition, and construction of pipelines and pumping facilities to convey Local Desal water from the desalination plant to a suitable point in the City's existing distribution network.

## 8. Key Institutional Issues to Resolve

The City needs to resolve several critical institutional issues in order for a Local Desal program to proceed as envisioned here. Among these are the following:

[3] Please recall that "yields" refer to the ability of a portfolio to meet peak season gaps between supply and demand. Based on *Confluence* model runs reflecting climate change and DFG-5 fish flow requirements, the worst-year peak season shortage amounts to 1,110 MG, given the existing SCWD system portfolio. The average-year peak season shortage is 340 MG. Thus, the maximum yields of a portfolio are 1,110 MG and 340 MG for worst and average years, respectively. Program C Rec provides yields of 130 MG and 100 MG in the worst year and average years, respectively.

[4] If a new environmental document and/or other elements need to be redone for the slightly expanded Local Desal facility, the timeline could be extended. This is an issue requiring additional investigation.

- Regulatory approval and permits from the California Coastal Commission and other federal, state and local entities for development of the Local Desal facilities and all necessary pipelines, and for any mandated or desired environmental and carbon footprint mitigation or restoration/offsets.

- Public and political acceptability of Local Desal water as a part of the City's water supply portfolio, including a public vote on the question. A public outreach effort would likely be required to help inform the voting public.

- If an in-lieu component is linked to the Local Desal approach, then all the institutional issues associated with that approach (including the need for clear agreements between the City and SVWD and SqCWD on water-, risk- and cost-sharing) would need to be realized, as outlined in Building Block summary paper #1.

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

- Given the ability of the local seawater desalination option (when coupled with Program C Rec) to meet most of SCWD's anticipated supply needs, there is limited need for return flows from a potential in-lieu recharge component. Excess Local Desal water might thus be provided to SqCWD for purchase (unless the project is developed as a shared facility with agreed-upon cost- and water-sharing agreements), and/or SVWD. Water sales or other water- and cost-sharing arrangements may be limited by whether the price set by the City was competitive with other supply options the Districts are considering.

- Developing a local  seawater desalination plant enables the City to have more control over the design and operation of the facility compared to a buy-in of shares of the DW Desalination project. However, the local desalination facility is less fungible as a possible traded asset.

- The potential use of desalinated sea water provides a production supply that is largely independent of rainfall.