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: 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	

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.

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[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).