Portfolio Update for MCDS Exercise
25 June 2015

Based on discussions at the June 11/12 WSAC meetings, we have made several requested modifications to the four portfolios used in the Committee's SWOT exercise. This document provides a summary of how the portfolios have been modified. Also presented are summary tables containing updated portfolio-specific cost, yield, and related empirical information developed by the technical team. This information is provided for your use in the upcoming MCDS exercises.

Table 1 provides an overview of the portfolios and the modifications made to them, compared to the versions developed for the June 11/12 exercise. Some of the modifications reflect WSAC-requested changes in the content of the portfolios, and some reflect improvements and clarifications to the cost, yield, or other empirical estimates associated with each portfolio.

Additional changes and observations include:

- An important embellishment to this round of portfolio evaluations is the addition of return water from SVWD and SqCWD under the in-lieu recharge agreements, in Portfolios 1.1 and 1.2.
  - The amount of water returned to SCWD varies by year and level of need, and generally is projected to occur in about 30% of future years.
  - For Portfolio 1.1A, the returns to Santa Cruz range up to 820 mg in the driest year, and average 330 mg in the years with return water. The average return to Santa Cruz across all years is about 90 mg.
  - For Portfolio 1.2A, the returns to Santa Cruz range up to about 740 mg in the driest year, and average 400 mg in the years with return water. The average return to Santa Cruz across all years is about 100 mg.
  - Note that the production ability of Beltz cannot be increased by an additional 1 mgd. The city pumps 0.8 mgd in normal and 1.1 mgd in critically dry years, but not 2 mgd.
- Ranney collectors at Felton have been removed from the infrastructure requirements and cost estimates for all the portfolios. Our analyses indicate they provide very little additional value (in terms of adding to supplies and yields) to any of the portfolios, because turbidity-related constraints on the overall system are relatively small (turbidity issues generally arise in wet years when the added water is not needed, and not in dry years when there is little additional water available to extract).
- A second pipeline between Felton and Loch Lomond has been added for Portfolios 1.1 and 1.2, because it enhances the value of operational changes included for the latter portfolio (and, including it in the former portfolio enables a true apples-to-apples comparison between 1.1 and 1.2). Newell Creek Dam was raised for 1.1; not for 1.2.
- For all other portfolios, an improvement of the existing pipeline is included, as the pipeline improvement provides supply benefits. The modeling shows that the primary infrastructure-related constraint to diverting from Felton is the hydraulic limitations of the current pipe. This upgraded

pipeline provides much the same supply benefit as adding a second pipeline. Hence, there is no second pipeline included in the cost estimates for Portfolios 2, 3, 4.1, and 4.2.

Table 1. Overview of portfolios and modifications since June 11/12 (modifications to original portfolio in *italics*)

Portfolio	Comment/modification	Plan A	Plan B
1.1: Original Portfolio 1, with modifications to Plan A-1	Additional Plan A infrastructure specifically designed to expand Loch Lomond capacity in order to maximize potential to keep it full and provide for a longer season to benefit Santa Cruz and for in lieu recharge	In lieu recharge Second pipeline to Loch Lomond *Newell Creek Dam Raise* *Return water to SCWD* *12" intertie with SVWD*	IPR to Loch Lomond
1.2: Original Portfolio 1, using Plan A-2	Modifying the operating rule curve for Loch Lomond (taking reserve down to 500 mg) makes more water available for Santa Cruz and potentially for in lieu recharge	In lieu recharge Second pipeline to Loch Lomond Loch Lomond minimum storage reduced to 500 mg *Return water to SCWD* *12" intertie with SVWD*	IPR to Loch Lomond
2: Original Portfolio 2	No changes	ASR	DPR
3: Original Portfolio 3	No changes (clarify marginal cost)	ASR with IPR seawater barrier	DPR
4.1: Original Portfolio 4	Updating scale (3 mgd) and schedule for DW Desal	ASR with DW Desal	DW Desal
4.2: Modified Portfolio 4	Replacing source of desal water; otherwise identical to Portfolio 4.1	ASR with *$SCWD^2$ Desal*	*$SCWD^2$ Desal*

Tables 2 through 8 provide information on the capital improvements associated with each key portfolio element (e.g., ASR, DPR, in-lieu, desal, IPR), and also reveal the build-up of the capital cost estimates. All items that are likely to be addressed to some significant degree as part of the CIP are highlighted (marked by an alphabetical table note in Tables 2 through 8), so that they can be readily identified. However, several items mentioned in the CIP may not include the specific enhancements or levels of investment associated with operationalizing a portfolio, i.e., there may still be considerable additional cost for some portfolio-related investments, above and beyond what may be indicated in the CIP, in order to implement a portfolio.

Table 9 provides a summary comparison of the total capital costs across the major portfolio elements, netting out the impact of CIP-related components. Table 9 also lists the estimated annual operation and maintenance (O&M) costs of each element.

Table 2. Portfolio 1.1, Plan A
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)[a]	19,800,000	6,140,000	25,940,000
b.	Pipeline 2 (Felton Pump Station to Loch Lomond)	19,800,000	6,140,000	25,940,000
c.	Tait Street diversion improvements[a]	8,080,000	2,510,000	10,590,000
d.	Graham Hill WTP improvements[a]	29,180,000	9,050,000	38,230,000
e.	Intertie No. 1 Pipeline (City to Scotts Valley)	3,250,000	1,010,000	4,260,000
f.	Pump Station (City to Scotts Valley) Intertie No. 1[a]	1,200,000	380,000	1,580,000
g.	Loch Lomond Bypass Tunnel No. 1[a]	27,680,000	8,580,000	36,260,000
h.	Loch Lomond Outlet Tower[a]	15,000,000	4,650,000	19,650,000
i.	Loch Lomond 30-inch diameter reclaim tunnel pressure pipes for reservoir discharge storage	4,920,000	1,530,000	6,440,000
j.	Site mobilization	1,500,000	470,000	1,970,000
k.	Parking lot/boat launch demolition	380,000	120,000	490,000
l.	Clear trees from lake inundation perimeter	10,240,000	3,180,000	13,410,000
m.	Raise Loch Lomond 6 feet per Geotechnical Report Figure 1 with downstream MSE wall	7,880,000	2,450,000	10,320,000
n.	Groin trench drain and piezometer modifications	2,250,000	700,000	2,950,000
o.	Spillway and bridge modification	3,750,000	1,170,000	4,920,000
p.	Rehabilitate and extend aeration system	290,000	90,000	370,000
q.	Raise and reinstall boat ramp and recreation area	4,130,000	1,280,000	5,410,000
	Totals	**159,330,000**	**49,450,000**	**208,730,000**

a. Denotes an item with costs largely envisioned within CIP.

Table 3. Portfolio 1.2 Plan A
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)[a]	19,800,000	6,140,000	25,940,000
b. Pipeline 2 (Felton Pump Station to Loch Lomond)	19,800,000	6,140,000	25,940,000
c. Tait Street diversion improvements[a]	8,080,000	2,510,000	10,590,000
d. Graham Hill WTP improvements[a]	29,180,000	9,050,000	38,230,000
e. Intertie No. 1 Pipeline (City to Scotts Valley)	3,250,000	1,010,000	4,260,000
f. Pump Station (City to Scotts Valley) Intertie No. 1[a]	1,200,000	380,000	1,580,000
g. Loch Lomond Bypass Tunnel No. 1[a]	27,680,000	8,580,000	36,260,000
h. Loch Lomond Outlet Tower[a]	15,000,000	4,650,000	19,650,000
i. Loch Lomond 30-inch diameter reclaim tunnel pressure pipes for reservoir discharge storage	4,920,000	1,530,000	6,440,000
Totals	**128,910,000**	**39,990,000**	**168,890,000**

a. Denotes an item with costs largely envisioned within CIP.
Note: does not include raising Newell Creek Dam

Table 4. Portfolios 1.1 and 1.2, Plan B
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)	2,250,000	700,000	2,950,000
b. Ozone/BAC filters (6.1 mgd)	13,500,000	4,190,000	17,690,000
c. Microfiltration (6.1 mgd)	21,000,000	6,510,000	27,510,000
d. Reverse osmosis (5.5 mgd)	30,000,000	9,300,000	39,300,000
e. Advanced oxidation (Peroxide + UV) (4.7 mgd)	4,880,000	1,520,000	6,390,000
f. Conditioning facilities (4.7 mgd)	2,150,000	670,000	2,820,000
g. Effluent diffuser modification	1,500,000	470,000	1,970,000
h. Pumping system (WWTP to CAT)	2,580,000	800,000	3,380,000
i. Pipeline installation (WWTP to CAT)	150,000	50,000	190,000
j. Pumping system (CAT to Loch Lomond)	2,880,000	900,000	3,780,000
k. Pipeline installation (CAT to Loch Lomond)	35,910,000	11,140,000	47,040,000
l. Equalization basin	750,000	240,000	990,000
m. Line maintenance facility relocation	N/A	N/A	5,200,000
Totals	**117,550,000**	**36,490,000**	**159,210,000**

Table 5. Portfolios 2, 3, and 4.1 and 4.2, Plan A
ASR capital improvement needs and costs (millions of 2015$)

Capital improvement item	Hard capital cost	Soft capital cost	Total capital cost
ASR			
a. Conveyance pipeline (City to/from SqCWD)	10,560,000	3,280,000	13,840,000
b. Pump Station (Raw Water)	2,250,000	700,000	2,950,000
c. Pump Station (SqCWD to Aquifer)	3,750,000	1,170,000	4,920,000
d. Intertie No. 1 Pipeline (City to Scotts Valley)	3,250,000	1,010,000	4,260,000
e. Tait Street diversion improvements[a]	8,080,000	2,510,000	10,590,000
f. Pump Station (City to Scotts Valley) Intertie No. 1[a]	1,200,000	380,000	1,580,000
g. Graham Hill WTP improvements[a]	29,180,000	9,050,000	38,230,000
h. ASR Wells (SqCWD)	3,000,000	930,000	3,930,000
i. ASR Wells (Scott's Valley)	3,000,000	930,000	3,930,000
Totals	**64,270,000**	**19,960,000**	**84,230,000**

a. Denotes an item with costs largely envisioned within CIP.
Note: Land acquisition costs (for well sites and other needs) and water treatment costs are not yet included here.

Table 6. Porfolio 3, Plan A
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)	2,250,000	700,000	2,950,000
b.	Ozone/BAC filters (6.1 mgd)	13,500,000	4,190,000	17,690,000
c.	Microfiltration (6.1 mgd)	21,000,000	6,510,000	27,510,000
d.	Reverse osmosis (5.5 mgd)	30,000,000	9,300,000	39,300,000
e.	Advanced oxidation (Peroxide + UV) (4.7 mgd)	4,880,000	1,520,000	6,390,000
f.	Conditioning facilities (4.7 mgd)	2,150,000	670,000	2,820,000
g.	Effluent diffuser modification	1,500,000	470,000	1,970,000
h.	Pumping system (WWTP to CAT)	2,580,000	800,000	3,380,000
i.	Pipeline installation (WWTP to CAT)	150,000	50,000	190,000
j.	Equalization basin	750,000	240,000	990,000
k.	Pumping system (WWTP to Soquel Creek Coast)	2,880,000	900,000	3,780,000
l.	Above-ground piping to SW barrier wells	10,610,000	3,290,000	13,900,000
m.	Under San Lorenzo Riverway	930,000	290,000	1,220,000
n.	Under Woods Lagoon	1,180,000	370,000	1,540,000
o.	Pipeline installation (WWTP to wells 1–5, 18”)	3,930,000	1,220,000	5,140,000
p.	Pipeline installation (WWTP to wells 6 and 7, 14”)	1,220,000	380,000	1,600,000
q.	Pipeline installation (WWTP to wells 8–11, 14”)	2,100,000	650,000	2,740,000
r.	Pipeline installation (WWTP to wells 12, 14”)	350,000	110,000	460,000
s.	Injection wells (SqCWD coastline)	4,590,000	1,430,000	6,020,000
t.	Line maintenance facility relocation	N/A	N/A	5,200,000
	Totals	**106,550,000**	**33,090,000**	**144,790,000**

Table 7. Portfolios 2 and 3, Plan B
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)	2,250,000	700,000	2,950,000
b. Ozone/BAC filters (6.1 mgd)	13,500,000	4,190,000	17,690,000
c. Microfiltration (6.1 mgd)	21,000,000	6,510,000	27,510,000
d. Reverse osmosis (5.5 mgd)	30,000,000	9,300,000	39,300,000
e. Advanced oxidation (Peroxide + UV) (4.7 mgd)	4,880,000	1,520,000	6,390,000
f. Conditioning facilities (4.7 mgd)	2,150,000	670,000	2,820,000
g. Effluent diffuser modification	1,500,000	470,000	1,970,000
h. Pumping system (WWTP to CAT)	2,580,000	800,000	3,380,000
i. Pipeline installation (WWTP to CAT)	150,000	50,000	190,000
j. Pumping system (CAT to Bay St. Reservoir)	1,920,000	600,000	2,520,000
k. Pipeline installation (CAT to Bay St. Reservoir)	3,170,000	990,000	4,160,000
l. Equalization basin	750,000	240,000	990,000
m. Line maintenance facility relocation	N/A	N/A	5,200,000
Totals	**83,850,000**	**26,040,000**	**115,070,000**

Table 8. Portfolio 4.1, Plan B
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)	20,000,000	6,200,000	26,200,000
b. Microfiltration (18 mgd)	10,000,000	3,100,000	13,100,000
c. Reverse osmosis (16.2 mgd)	15,000,000	4,650,000	19,650,000
d. UV disinfection (9.0 mgd)	1,500,000	470,000	1,970,000
e. Conditioning facilities (9.0 mgd)	1,400,000	440,000	1,830,000
g. Pipeline installation (Desalination Plant to Aptos)	41,800,000	12,960,000	54,760,000
h. Pipeline installation (Aptos to Aquifer)	7,400,000	2,300,000	9,690,000
Totals	**97,100,000**	**30,120,000**	**127,200,000**

Table 9. Portfolio 4.2, Plan B
scwd² Desal capital improvement needs and costs (millions of 2015$)

Capital improvement item	Hard capital cost	Soft capital cost	Total capital cost
SCWD² Desal			
a. City desalination plant capital cost (at 3 mgd scale)	N/A	N/A	138,000,000
b. Effluent outfall modifications	1,500,000	470,000	1,970,000
Totals	**1,500,000**	**470,000**	**139,970,000**

Table 10. Total capital costs and annual O&M costs of portfolio components (millions of 2015%)

	Total	CIP	Not in CIP	Annual O&M
In-lieu	208.7	132.3	76.4	2.8
ASR	84.2	50.4	33.8	1.8
DPR	115.1	0.0	115.1	13.8
IPR to Loch Lomond	159.2	0.0	159.2	7.0
IPR to seawater barrier	122.1	0.0	122.1	5.5
DW Desal	127.2	0.0	127.2	5.2
scwd² Desal	140.0	0.0	140.0	2.8

Tables 10 through 21 provide additional information regarding costs, yields, supply production, and energy requirements for each portfolio.[1] These are updated versions of the tables provided in the portfolio materials circulated in the packet for the June 11/12 WSAC meetings.

Table 22 provides a summary of the yield, shortage, and in-lieu demands met by Plans A and B under each portfolio. This also shows the in-lieu demands met separately for SVWD and SqCWD.

Table 23 shows the shortage and curtailment levels associated with different levels of water supply shortfall relative to peak season demands. This table reflects base case (no action) shortage frequencies under climate change and DFG-5 fish flow requirements. Under any scenario and portfolio, each 90 to 100 mg of peak season shortfall is roughly equivalent to 5% of shortage (e.g., a shortfall of 290 mg results in the need for curtailments of about 15%).

Table 24 provides a summary of the estimated timelines required to attain full implementation and related water supply production benefits.

1. In reviewing the results conveyed in these tables, 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.

Results for Portfolio 1.1: In-Lieu Recharge, with IPR to Loch Lomond as Plan B

Table 10. Portfolio 1.1/Plan A: In-Lieu Recharge Using Winter Flows (w/ Current Loch Operating Rule – Reserve of 1000 MG), Return From SVWD and SqCWD, Coupled with Program C Rec				
	Estimates	**Component 1: Program C Rec**	**Component 2: In-lieu Recharge**	**Totals [weighted average]**
A	Capital (upfront) costs ($M)	n/a	$209 M	$209 M +
B	Annual O&M costs ($M/yr)	n/a	$2.8	$2.8 M +
C	Total Annualized Cost ($M/Yr)	$1.1 M[2]	$22.8 M	$23.9 M
D	PV Costs (30 years) ($M)	$23 M	$446 M	$469 M
E	Production Supply (mgy)	173 mgy[3]	500 mgy[4]	673 mgy
F	Average Year peak season Yield (mg)	100 mg	90 mg	290 mg
G	Worst Year peak season Yield (mg)	130 mg	450 mg	580 mg
H	Energy Use (MW/MG)	(1.6)	4.9	[$3.2]
I	Annualized Unit Cost (C/E; $/mg)	$6,532	$44,618	[$34,828]
J	Average SV & SqCWD demand served (mg and %)	n/a	360 mg (24%)	360 mg (24%)

Table 11. Portfolio 1.1/Plan B: In-lieu using Winter Flows, Return from SVWD and SqCWD, coupled with IPR for Reservoir Augmentation, plus Program C Rec					
	Estimates	**Component 1: Program C Rec**	**Component 2: In-lieu recharge using SLR winter flows**	**Component 3: IPR for Reservoir Augmentation**	**Totals [weighted average]**
A	Capital (upfront) costs ($M)	n/a	$209 M	$158 M	$367 M +
B	Annual O&M costs ($M/yr)	n/a	$2.8	$7.0 M	$9.8 M +
C	Total Annualized Cost ($M/Yr)	$1.1 M[2]	$22.8 M	$27.0 M	$50.9 M
D	PV Costs (30 years) ($M)	$23 M	$446 M	$446 M	$915 M
E	Production Supply (mgy)	173 mg[3]	500 mgy	1,715 mgy	2,388 mgy
F	Average Year peak season Yield (mg)	100 mg	90 mg	140 mg	330 mg
G	Worst Year peak season Yield (mg)	130 mg	450 mg	470 mg	1,050 mg
H	Energy Use (MW/MG)	(1.6)	4.6	10.2	[8.2]
I	Annualized Unit Cost (C/E; $/mg)	$6,532	$44,618	$15,743	[$21,122]
J	Average SV & SqCWD demand served (mg and %)	n/a	360 mg (24%)	1,170 mg (76%)	1,530 mg (100%)

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2. Twenty-five year average annual cost to utility and customers, omitting administrative costs borne by the Water Department.
3. Average annual water savings over 25 years; maximum savings of 220 mg attained in 2030.
4. Amount of water provided by SCWD for in-lieu recharge (not the amount returned back to SCWD). Returns to Santa Cruz are projected for about 30% of years, at levels averaging between 330 mg and 400 mg per year with returns.

Results for Portfolio 1.2: In-Lieu Recharge with Modified Loch Lomond Reserve, with IPR to Loch Lomond as Plan B

Table 12. Portfolio 1.2/Plan A: In-Lieu Recharge Using Winter Flows (w/ Modified Loch Operating Rule – Reserve of 500 MG), Return from SVWD and SqCWD, Plus Program C Rec				
	Estimates	**Component 1: Program C Rec**	**Component 2: In-lieu Recharge**	**Totals [weighted average]**
A	Capital (upfront) costs ($M)	n/a	$169 M	$169 M +
B	Annual O&M costs ($M/yr)	n/a	$3.3	$3.3 M +
C	Total Annualized Cost ($M/Yr)	$1.1 M[2]	$16.8 M	$17.9 M
D	PV Costs (30 years) ($M)	$23 M	$383 M	$406 M
E	Production Supply (mgy)	173 mgy[3]	500 mgy[4]	673 mgy
F	Average Year peak season Yield (mg)	100 mg	210 mg	310 mg
G	Worst year peak season yield (mg)	130 mg	590 mg	720 mg
H	Energy Use (MWH/MG)	(1.6)	5.7	~[3.2]
I	Annualized Unit Cost (C/E; $/mg)	$6,532	$44,618	[$34,828]
J	Average SV & SqCWD demand served (mg and %)	n/a	~570 mg (37%)	570 mg (37%)

Table 13. Portfolio 1.2/Plan B: In-lieu Using Winter Flows (w/ Modified Loch Operating Rule – Reserve of 500 MG), Return from SVWD and SqCWD, with IPR for Reservoir Augmentation, plus Program C Rec					
	Estimates	**Component 1: Program C Rec**	**Component 2: In-lieu recharge using SLR winter flows**	**Component 3: IPR for Reservoir Augmentation**	**Totals [weighted average]**
A	Capital (upfront) costs ($M)	n/a	$169 M	$158 M	$327 M +
B	Annual O&M costs ($M/yr)	n/a	$3.3	$7.0 M	$10.3 M +
C	Total Annualized Cost ($M/Yr)	$1.1 M[2]	$16.8M	$27.0 M	$44.9 M
D	PV Costs (30 years) ($M)	$23 M	$383 M	$446 M	$852 M
E	Production Supply (mgy)	173 mg[3]	500 mgy	1,715 mgy	2,388 mgy
F	Average Year peak season Yield (mg)	100 mg	210 mg	10 mg	320 mg
G	Worst Year peak season Yield (mg)	130 mg	590 mg	260 mg	980 mg
H	Energy Use (MWH/MG)	(1.6)	5.7	10.2	~[8.2]
I	Annualized Unit Cost (C/E; $/mg)	$6,532	$44,618	$15,743	[$21,122]
J	Average SV & SqCWD demand served (mg and %)	n/a	570 mg (37%)	960 mg (63%)	1,530 mg (100%)

Results for Portfolio 2: ASR, with DPR as Plan B

Table 14. Portfolio 2/Plan A: ASR using Winter Flows, Coupled with Program C Rec (assuming ASR performs as required and delivers required supply)

	Estimates	Component 1: Program C Rec	Component 2: ASR using SLR winter flows	Totals [weighted average]
A	Capital (upfront) costs ($M)	n/a	$84 M	$84 M +
B	Annual O&M costs ($M/yr)	n/a	$ 1.8 M	$1.8 M +
C	Total Annualized Cost ($M/Yr)	$1.1 M[2]	$8.5 M	$9.6 M
D	PV Costs (30 years) ($M)	$23 M	$193 M	$216 M
E	Production Supply (mgy)	173 mgy[3]	560 mgy	733 mgy
F	Average Year peak season Yield (mg)	100 mg	240 mg	340 mg
G	Worst year peak season Yield (mg)	130 mg	980 mg	1,110 mg
H	Energy Use (MWH/MG)	(1.6)	3.9	[2.6]
I	Annualized Unit Cost (C/E; $/mg)	$6,532	$15,179	[$13,138]
J	Average SV & SqCWD demand served (mg and %)	n/a	n/a	0 mg

Table 15. Portfolio 2/Plan B: DPR for Regional demands and In-Lieu Recharge, plus Program C Rec

	Estimates	Component 1: Program C Rec	Component 2: DPR for City and Regional Use	Totals [weighted average]
A	Capital (upfront) costs ($M)	n/a	$115 M	$115 M +
B	Annual O&M costs ($M/yr)	n/a	$4.5 M	$4.5M +
C	Total Annualized Cost ($M/Yr)	$1.1 M[2]	$13.8 M	$14.9 M
D	PV Costs (30 years) ($M)	$23 M	$311 M	$334 M
E	Production Supply (mgy)	173 mgy[3]	1,715 mgy	1,888 mgy
F	Average Year peak season Yield (mg)	100 mg	240 mg	340 mg
G	Worst year peak season yield (mg)	130 mg	980 mg	1,110 mg
H	Energy Use (MWH/MG)	(1.6)	6.4	[5.7]
I	Annualized Unit Cost (C/E; $/mg)	$6,532	$8,047	[$7,917]
J	Average SV & SqCWD demand served (mg and %)	n/a	870 mg (57%)	870 mg (57%)

Results for Portfolio 3: ASR plus Seawater Barrier, with DPR as Plan B

Table 16. Portfolio 3/Plan A: ASR using Winter Flows, Coupled with IPR for Barrier Wells, plus Program C Rec

	Estimates	Component 1: Program C Rec	Component 2: ASR using SLR winter flows	Component 3: Seawater Intrusion/IRP[5]	Totals [weighted average]
A	Capital (upfront) costs ($M)	n/a	$84 M	$122 M	$206 M +
B	Annual O&M costs ($M/yr)	n/a	$ 1.8 M	$5.5 M	$7.3 M +
C	Total Annualized Cost ($M/Yr)	$1.1 M[2]	$8.5 M	$16.5 M	$26.1 M
D	PV Costs (30 years) ($M)	$23 M	$193 M	$373 M	$589 M
E	Production Supply (mgy)	173 mg[3]	560 mgy	n/a[5]	733 mg
F	Average Year peak season Yield (mg)	100 mg	240 mg	n/a	340 mg
G	Worst year peak season Yield (mg)	130 mg	980 mg	n/a	1,110 mg
H	Energy Use (MWH/MG)	(1.6)	3.9	n/a	[13.1]
I	Annualized Unit Cost (C/E; $/mg)	$6,532	$15,179	n/a	[$35,648]
J	Average SV & SqCWD demand served (mg and %)	n/a	n/a	n/a	n/a

Table 17. Portfolio 3/Plan B: DPR for Regional demands and In-Lieu Recharge + Program C Rec

	Estimates	Component 1: Program C Rec	Component 2: Conversion of CAT to DPR for City and Regional Use[6]	Totals [weighted average]
A	Capital (upfront) costs ($M)	n/a	$4.2 M	$4.2 M +
B	Annual O&M costs ($M/yr)	n/a	$0.1 M	$0.1 M +
C	Total Annualized Cost ($M/Yr)	$1.1 M[2]	$0.5 M	$1.6 M
D	PV Costs (30 years) ($M)	$23 M	$11 M	$34 M
E	Production Supply (mgy)	173 mg[3]	1,715 mgy	1,888 mg
F	Average Year peak season Yield (mg)	100 mg	240 mg	340 mg
G	Worst year peak season Yield (mg)	130 mg	980 mg	1,110 mg
H	Energy Use (MWH/MG)	(1.6)	6.4	[5.7]
I	Annualized Unit Cost (C/E; $/mg)	$6,532	n/a	[$7,917]
J	Average SV & SqCWD demand served (mg and %)	n/a	870 mg (57%)	870 mg (57%)

5. Protects coastal aquifer from sweater intrusion, enhances recharge, and may contribute to groundwater extraction volumes
6. 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.

Results for Portfolio 4.1: ASR plus Deep Water Desal

Table 18. Portfolio 4.1/Plan A: ASR using Winter Flows, Coupled with DW Desal, plus Program C Rec					
	Estimates	**Component 1: Program C Rec**	**Component 2: ASR using SLR winter flows**	**Component 3: Deepwater Desal**	**Totals [weighted average]**
A	Capital (upfront) costs ($M)	n/a	$84 M	$127 M	$211 M +
B	Annual O&M costs ($M/yr)	n/a	$ 1.8 M	$5.2 M	$7.0 M +
C	Total Annualized Cost ($M/Yr)	$1.1 M	$8.5 M	$15.4 M	$25.0 M
D	PV Costs (30 years) ($M)	$23 M	$193 M	$348 M	$559 M
E	Production Supply (mgy)	173 mgy	560 mgy	1,095 mgy	1,828 mgy
F	Average Year peak season Yield (mg)	100 mg	240 mg	n/a[7]	340 mg
G	Worst yr. peak season Yield (mg)	130 mg	980 mg	n/a[7]	1,110 mg
H	Energy Use (MWH/MG)	(1.6)	2.1	5.2	[26.2]
I	Annualized Unit Cost (C/E; $/mg)	$6,532	$15,179	$14,064	[$13,693]
J	Average SV & SqCWD demand served (mg and %)	n/a	n/a	1,530 mg (100%)	1,530 mg (100%)

Table 19. Portfolio 4.1/Plan B: ASR abandoned; and DW Desal Used for Santa Cruz and Regional Demands and In-Lieu Recharge, plus Program C Rec				
	Estimates	**Component 1: Program C Rec**	**Component 2: Deepwater Desal for Regional Use**	**Totals [weighted average]**
A	Capital (upfront) costs ($M)	n/a	$127 M	$127 M +
B	Annual O&M costs ($M/yr)	n/a	$5.2 M	$5.2 M +
C	Total Annualized Cost ($M/Yr)	$1.1 M	$15.4 M	$16.5 M
D	PV Costs (30 years) ($M)	$23 M	$348 M	$371 M
E	Production Supply (mgy)	173 mgy	1,095 mgy	1,268 mgy
F	Average Year peak season Yield (mg)	100 mg	230 mg	330 mg
G	Worst year peak season yield (mg)	130 mg	580 mg	710 mg
H	Energy Use (MWH/MG)	(1.6)	5.2	[36.1]
I	Annualized Unit Cost (C/E; $/mg)	$6,532	$14,064	[$13,036]
J	Average SV & SqCWD demand served (mg and %)	n/a	770 mg (50%)	770 mg (50%)

7. If ASR works as required, then all demands are met and DW Desal does not contribute to "yields" as defined here. However, absent ASR, DW Desal (scaled at 3 mgd) meets most SCWD demands and provides yields of 230 mg and 580 mg in average- and worst-year peak seasons, respectively (resulting in a worst-year shortage of about 20%).

Results for Portfolio 4.2: ASR plus SCWD^2 Desal

Table 20. Portfolio 4.2/Plan A: ASR using Winter Flows, Coupled with SCWD^2 Desal, plus Program C Rec					
	Estimates	**Component 1: Program C Rec**	**Component 2: ASR using SLR winter flows**	**Component 3: SCWD^2 Desal**	**Totals [weighted average]**
A	Capital (upfront) costs ($M)	n/a	$84 M	$139 M	$221 M +
B	Annual O&M costs ($M/yr)	n/a	$ 1.8 M	$2.8 M	$4.6 M +
C	Total Annualized Cost ($M/Yr)	$1.1 M	$8.5 M	$13.9 M	$23.5 M
D	PV Costs (30 years) ($M)	$23 M	$193M	$317 M	$533 M
E	Production Supply (mgy)	173 mgy	560 mgy	1,095 mgy	1,828 mgy
F	Average Year peak season Yield (mg)	100 mg	240 mg	n/a[8]	340 mg
G	Worst yr. peak season Yield (mg)	130 mg	980 mg	n/a[8]	1,110 mg
H	Energy Use (MWH/MG)	(1.6)	3.9	5.7	[4.5]
I	Annualized Unit Cost (C/E; $/mg)	$6,532	$15,179	$12,694	[$12,872]
J	Average SV & SqCWD demand served (mg and %)	n/a	n/a	1,530 mg (100%)	1,530 mg (100%)

Table 21. Portfolio 4.2/Plan B: ASR abandoned; and SCWD^2 Desal Used for Santa Cruz and Regional Demands and In-Lieu Recharge, plus Program C Rec				
	Estimates	**Component 1: Program C Rec**	**Component 2: SCWD^2 Desal for Regional Use**	**Totals [weighted average]**
A	Capital (upfront) costs ($M)	n/a	$139 M	$139 M +
B	Annual O&M costs ($M/yr)	n/a	$2.8 M	$2.8 M +
C	Total Annualized Cost ($M/Yr)	$1.1 M[2]	$13.9 M	$15.0 M
D	PV Costs (30 years) ($M)	$23 M	$317 M	$340 M
E	Production Supply (mgy)	173 mgy[3]	1,095 mgy	1,268 mgy
F	Average Year peak season Yield (mg)	100 mg	230 mg	330 mg
G	Worst year peak season yield (mg)	130 mg	580 mg	710 mg
H	Energy Use (MWH/MG)	(1.6)	5.7	[4.7]
I	Annualized Unit Cost (C/E; $/mg)	$6,532	$12,694	[$11,853]
J	Average SV & SqCWD demand served (mg and %)	n/a	770 mg (50%)	770 mg (50%)

8. If ASR works as required, then all demands are met and SCWD^2 Desal does not contribute to "yields" as defined here. However, absent ASR, SCWD^2 Desal (scaled at 3 mgd) meets most demands and provides yields of at least 230 mg and 580 mg in average- and worst-year peak seasons, respectively (resulting in a worst-year shortfall of about 20%).

Table 22. Revised estimated yields, peak season shortages, and demands met for SVWD and SqCWD

	Santa Cruz yields (mg)		Remaining peak-season shortages (mg)		Average annual combined SV and SqC demand served in-lieu of groundwater draw (mg)	Average annual separate SV and SqC demand served in-lieu of groundwater draw (mg)
	Worst-year yield	Average-year yield	Worst-year	Average-year		
Portfolio 1.1						
Plan A: CRec + In-Lieu Recharge + GW Return	580	290	530	50	360 (24%)	160 to SV; 200 to SqC
Plan B: IPR to Lake	1,050	330	60	10	1,530 (100%)	400 to SV; 1130 to SqC
Portfolio 1.2						
Plan A: CRec + Reduced Lake Minimum by 500 mg + In-Lieu Recharge + GW Return	820	330	290	10	570 (37%)	–
Plan B: IPR to Lake	980	320	30	0	1,530 (100%)	400 to SV; 1,130 to SqC
Portfolio 2						
Plan A: CRec + ASR	1,110	340	0	0	–	–
Plan B: CRec + DPR	1,110	340	0	0	870 (57%)	250 to SV; 620 to SqC
Portfolio 3						
Plan A: CRec + ASR + Recycled to Seawater Barrier	1,110	340	0	0	–	–
Plan B: CRec + DPR	1,110	340	0	0	870 (57%)	250 to SV; 620 to SqC
Portfolio 4.1						
Plan A: CRec + ASR + DW Desal (3 mgd)	1,110	340	0	0	1,530 (100%)	400 to SV; 1,130 to SqC
Plan B: CRec + DW Desal (3 mgd)	710	330	400	10	770 (50%)	230 to SV; 540 to SqC
Portfolio 4.2						
Plan A: CRec + ASR + Local Desal (3 mgd)	1,110	340	0	0	1,530 (100%)	400 to SV; 1,130 to SqC
Plan B: CRec + Local Desal (3 mgd)	710	330	400	10	770 (50%)	230 to SV; 540 to SqC

Table 23. Probabilities and projected peak season supply shortfalls in any year: Climate change, DFG-5, and revised interim mid-range demand forecast, with baseline SCWD system and portfolio

Shortage	Shortage	Probability
> 950 mg	> 50%	6%
480–950 mg	25% to 50%	31%
290–480 mg	15% to 25%	12%
100–290 mg	5% to 15%	6%
0–100 mg	< 5%	45%

Table 24. Summary timelines for portfolio components

Portfolio component	Applicable portfolios	Approximate timeline
In-lieu recharge	1.1A and 1.2A	8 years to full implementation (and expected potential availability of return water).
IPR to Loch Lomond	1.1B and 1.2B	8 years to full implementation (if some or all of non-construction portions started concurrently with in-lieu efforts under portfolios 1.1A and 1.2A, implementation shortened to 2 years).
ASR using winter flows (aiming for 20 wells for full implementation) [a]	2A	7 to 11 years to full implementation, assuming all goes well and sufficient wet winters enable 3 BG water available to go to storage.[a]
ASR using winter flows (aiming for 20 wells for full implementation)	3A, 4.1A, 4.2A	7 to 11 years to full implementation, assuming all goes well and sufficient wet winters enable 3 BG water available to go to storage.
IPR seawater barrier	3A	8 years to implementation (could be developed concurrently with ASR portion of Portfolio 3A).
DPR	2B and 3B	Possibly 9 years, but portions could be pursued concurrently with Plan A activities, shortening Plan B implementation phase to 2 years.
DW Desal	4.1A and 4.1B	Up to 7 years, though developer believes availability by 2016.
$SCWD^2$ Desal	4.2A and 4.2B	Within 6 years, if able to use existing plans.

a. If ASR were to be phased in, instead of pursued as 1 block (i.e., 4 wells initially, and then possibly adding 16 more), then the implementation timeline might be 7 to 11 years to execute the initial phase, and then if no further wells added, add perhaps 25 years to attain 3 BG of recharge-based storage (resulting in perhaps 32 + years in total). If movement to expand to full-scale occurs after year 8, then perhaps 8 or more years to complete additional wells and attain 3BG storage, resulting in in a combined timeline of perhaps 16 + years in total (assuming sufficient winter water).