Agenda Item 5a

Draft
Santa Cruz Water Supply Advisory Committee
Agreements and Recommendations

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Article I. Executive Summary (Draft 9.24)

Appointed by City Council in 2014, the Water Supply Advisory Committee's (WSAC) charge was to *explore, through an iterative, fact-based process, the City's water profile, including supply demand and future risks; analyze potential solutions to deliver a safe, adequate, reliable, affordable and environmentally sustainable water supply and to develop recommendations for City Council consideration.* This document lays out the WSAC Process, Information Developed and Considered, Analysis, Agreements and Recommendations.

The WSAC brought together a diverse set of perspectives and viewpoints from a broad sector of the community. The Committee placed a high value on transparency, trust and consensus. With that in mind, developing the "how" – the Agreements – was as critical as the "what" – the Recommendations.

The Agreements lay out strategies for how the recommendations will be implemented, with particular emphasis on how to approach managing change. The Committee agreed to a S*taggered Implementation Approach*, which will allow work to begin on full scale implementation of the top-tier recommendations, with clearly defined decision points, thresholds and metrics; and also to begin some preliminary work on purified recycled water. The implementation strategy is discussed in detail and by example in section 3.20 of this document.

In addressing the issues of trust and transparency, the Agreements provide an in-depth *Change Management Strategy.* The strategy underscores the guidelines and principles that reflect the Committee's values and priorities, and establishes mechanisms for dealing with changes that will undoubtedly occur over time. The Change Management Strategy includes procedures for planning, doing, checking and acting; an Adaptive Pathway framework for implementing the three main supply recommendations; defined roles and responsibilities for Water Department staff and the Water Commission; and clear guidance for decision making. The Change Management Strategy is discussed in depth in section 3.22.

The Committee's overarching goal is to provide the community with a plan to provide major improvement to the sufficiency and reliability of the Santa Cruz water supply by 2025. The recommendations made in this report reflect consensus among WSAC members for how best to address an agreed-upon gap of 1.2 billion gallons annually between water supply and water demand~~,~~ during times of extended drought. The recommendations include: continued strong water conservation programs; storage of available San Lorenzo River flows during the rainy season in regional aquifers, through processes known as "In Lieu" water transfers, for passive recharge, and Aquifer Storage and Recovery (ASR) for active recharge; and a "rainfall-independent" plan to use purified recycled water, with desalination included as a back-up, should the use of purified recycled water not be feasible. This report provides detailed information on each of the recommended strategies. In brief:

Conservation – In addition to the existing conservation programs such as home and business evaluations, water saving rebates, water budgets for large landscapes and free water-saving devices, the WSAC is looking at new programs, increased rebates and better management of peak season demand. The goal of these additional programs would be to further reduce demand by 200 to 250 million gallons per year (mgy) by 2035, with a particular focus on producing savings during the peak season.

In Lieu Water Exchanges – In normal years the Santa Cruz Water Department (SCWD) receives more rainfall than is needed to meet customer demand or can be stored. Available winter flows would be delivered to Soquel Creek Water District (SqCWD) and/or Scotts Valley Water District (SVWD) customers, thus allowing reduced pumping from these regional aquifers and enabling the aquifer to rest and recharge. Some portion of the water delivered would be banked by the City to be used during future dry years.

Aquifer Storage and Recover (ASR) – Available winter flows would be injected into aquifers through new and existing wells owned by the SCWD, Scotts Valley Water District (SVWD) and/or SoqCrWD, accelerating aquifer recharge. In future dry years Santa Cruz Water Department would be able to retrieve said water and provide it to customers.

Purified Recycled Water – Purified recycled water would be developed as a supplemental or replacement supply in the event the groundwater storage strategies described above are not sufficient to meet the yield goal. If it is determined that recycled water cannot meet our needs, then desalinated seawater would be used.

With these recommendations, the Water Supply Advisory Committee has met its charge to reach consensus on how best to deliver a safe, adequate, reliable, affordable and environmentally sustainable water supply to our community by 2025. This body of this report provides the detailed information which supports the information in this Executive Summary.

Article II. Preamble

Section 2.01 Committee Charge

The Committee's purpose is to explore, through an iterative, fact-based process, the City's water profile, including supply, demand and future risks; analyze potential solutions to deliver a safe, adequate, reliable, affordable and environmentally sustainable water supply and develop recommendations for City Council consideration.

Section 2.02 Committee Membership

The following individuals were appointed to the Water Supply Advisory Committee to represent the interests listed:

Community Interest	**Representative**
Business Organization (Think Local First)	Peter Beckmann
City Resident	Doug Engfer
Santa Cruz Water Commission	David Green Baskin
Water Customer (Non-City Resident)	Suzanne Holt
City Resident	Dana Jacobson
City Resident	Charlie Keutmann
Santa Cruz Desalination Alternatives	Rick Longinotti
Environmental Organization (Surfrider Foundation)	Sarah Mansergh
Business Organization (Santa Cruz Chamber of Commerce)	Mark Mesiti-Miller
Environmental Organization (Coastal Watershed Council)	Greg Pepping
Santa Cruz Sustainable Water Coalition	Mike Rotkin
Business Organization (Santa Cruz County Business Council)	Sid Slatter
Sierra Club	Erica Stanojevic
Santa Cruz Water Commission	David Stearns
Santa Cruz Water Department (ex officio/non-voting member)	Rosemary Menard

Section 2.03 Committee Agreement about Decision-Making

The Committee's decision-making processes will differ from the Council or City Commissions in that it is intended to reach consensus through a collaborative process. Therefore, the Committee will use this hierarchy of decision tools:

i. The preferred decision tool is for the Committee to arrive at a "sense of the meeting."
ii. Consensus is highly desirable.
iii. Informal voting may only be used to explore the decision space.
iv. Formal voting may be used as a fallback when consensus fails as long as there is consensus that a vote should take place. The voting shall be by a supermajority of 10.

Section 2.04 General Context and Framing Issues

The most important element of a problem solving process is defining the problem. Yet one of the characteristics of long range planning for complex systems is that even the problem is difficult to define. This is true of Santa Cruz's water planning.

Like all long range planning, water supply planning must deal with the realities of an uncertain future. In a historical context, water supply planning uncertainties have included the normal sources of variability:

- weather and its impacts on supply;
- demand increases in the future due to growth and development;
- demand decreases resulting from changing plumbing codes, technologies, demographics, or consumer behaviors (conservation); and
- potential supply decreases due to regulatory requirements to release water to support threatened or endangered fish species.

Today, uncertainties related to impacts of climate change must be added to this list.

During the first phase of the WSAC's work, the Committee was presented information about a variety of decision tools that the technical and facilitation teams believed could be useful in the Committee's work. The Committee considered and applied a variety of tools:

1. Scenario planning, including portfolio development,
2. Risk analysis and risk management, and
3. Criteria based evaluation of alternatives and portfolios using a Multi-Criteria Decision Support tool (MCDS).

The Committee explored or applied all of these tools as it did its work. The Adaptation Strategy described in more detail in Section 3.20 later in this document exists largely as a result of the Committee's efforts to create a plan that would be able to respond to the new information that will emerge and the potential changes in our understanding of circumstances that will occur over time.

Section 2.05 Overview of Committee Process

The Committee's process was divided into three phases:

- a reconnaissance phase where the Committee learned about the water system and its issues and identified a broad range of alternatives approaches for addressing the system reliability issues;
- an analysis phase where more detailed information about supply, demand, the supply shortfall, and the alternative approaches to solving the problem were explored in some detail; and
- an agreements phase where the Committee developed the agreements and recommendations that they conveyed to the City Council. The process has been iterative without stark boundaries between the phases but with a steadily increasing level of understanding of the issues, drivers, opportunities and constraints that the Committee was dealing with.

The Committee's process has been supported by a technical team that brought a diverse range of skills, experience and expertise to the tasks the Committee defined. The Committee also selected a group of four independent individuals to serve as an Independent Review Panel and provide perspective about technical issues that the Committee dealt with. Finally, the Committee was professionally facilitated by a team of individuals experienced in collaborative problem solving and multi-party negotiations.

All Committee meetings were open to the public and opportunities for public comment were regularly provided including, specifically, in advance of the Committee's taking action on any important decisions. The Committee had its own website and received and responded to all website communications received from the public. All public communications received via the website were shared with all Committee members, and with City staff and the technical team.

Section 2.06 WSAC Process and Support Team

To be added – a brief description of the tech team, facilitation team IRP etc.

Article III. Agreements

Section 3.01 Introduction

This Article summarizes the work the Committee did in several major topic areas that were key to developing their understanding of the issues and their recommendations to the Council. In each of the sections that follow, the issue is described, the work the Committee did on that issue is summarized, any agreement that the Committee reached about that topic is presented and the key assumptions are articulated.

The analysis, assumptions and agreements presented in this section create the foundation for the Committee's recommendations to the City Council presented in Article IV.

0 begins with a brief statement about the nature of Santa Cruz's water supply problem that was based on conventional wisdom and past studies and analysis. The analysis described in Section 3.04 through Section 3.07 deconstructs and then reconstructs that conventional wisdom to quantify the supply-demand gap and to include the potential impacts of fish flow releases and climate change on the size and characteristics of Santa Cruz's water supply reliability issues.

Section 3.02 Background

The Water Supply Advisory Committee's Analysis Phase work program was designed around the use of scenario planning to explore and evaluate a range of alternatives. This section summarizes the basic work to date and provides an overview of the products developed to support the Committee's work. Several additional documents are attached to this document as appendices; they provide more detailed information where such information was thought to be relevant and potentially of interest.

The key ingredients of the Committee's scenario planning include:

- Problem definition
    - Forecasts of current and future water demand;
    - Analyses of supply available to meet current and future water demand; and
    - Identification of probable and plausible challenges that will need to be addressed in the future; in this case these include a probable requirement for releasing water for fish flows and plausible impacts of climate change.
- Solution development
    - A range of demand management (water conservation) and supply augmentation alternatives that can be combined in various portfolios to meet the supply demand gap; and
    - Evaluation criteria to use in considering the portfolios created.

The following sections provide a high level summary of the Committee's progress in their work related to scenario planning and, where relevant, links are provided to more detailed information, typically found in materials developed for committee meetings. In addition, comprehensive information about the Committee's work is available through its website: www.santacruzwatersupply.com.

Section 3.03 Preliminary Problem Definition

Over the many years that Santa Cruz has been studying ways to improve the reliability of its water supply, the problem has been defined in a variety of ways that were relevant at the time. Today, it is fair to say that the fundamental cause of the Santa Cruz water system's reliability problem is the inability to store sufficient volumes of available winter flows for use in the driest years and/or the lack of a supply that does not depend on those flows. At least one of these is needed to ensure an adequate and dependable supply during water years classified as critically dry and, to some degree, dry.

Section 3.04 Historical Context – The Challenge of Variability

Figures 1 and 2 show two versions of local, historical information for water years (October 1 to September 30) classified into water-year types. These are familiar figures to many, but the purpose of including them up front is to emphasize two issues:

- Figure 1 shows the data sorted chronologically. This view underlines the significant variability of the data including underlining the fact that the City has no certainty about what the following year will bring, nor any certainty about how long any pattern may last. .
- Figure 2 sorts the data into year types, showing the number of years that have historically fallen into each year type. As will be discussed later in this section, a plausible impact of climate change on Santa Cruz's water supply would be an increase, perhaps even a significant increase, in the fraction of dry and critically dry years that Santa Cruz will experience, thereby exacerbating the reliability issues the system currently faces.

Figure 1 – Water Year Classification System

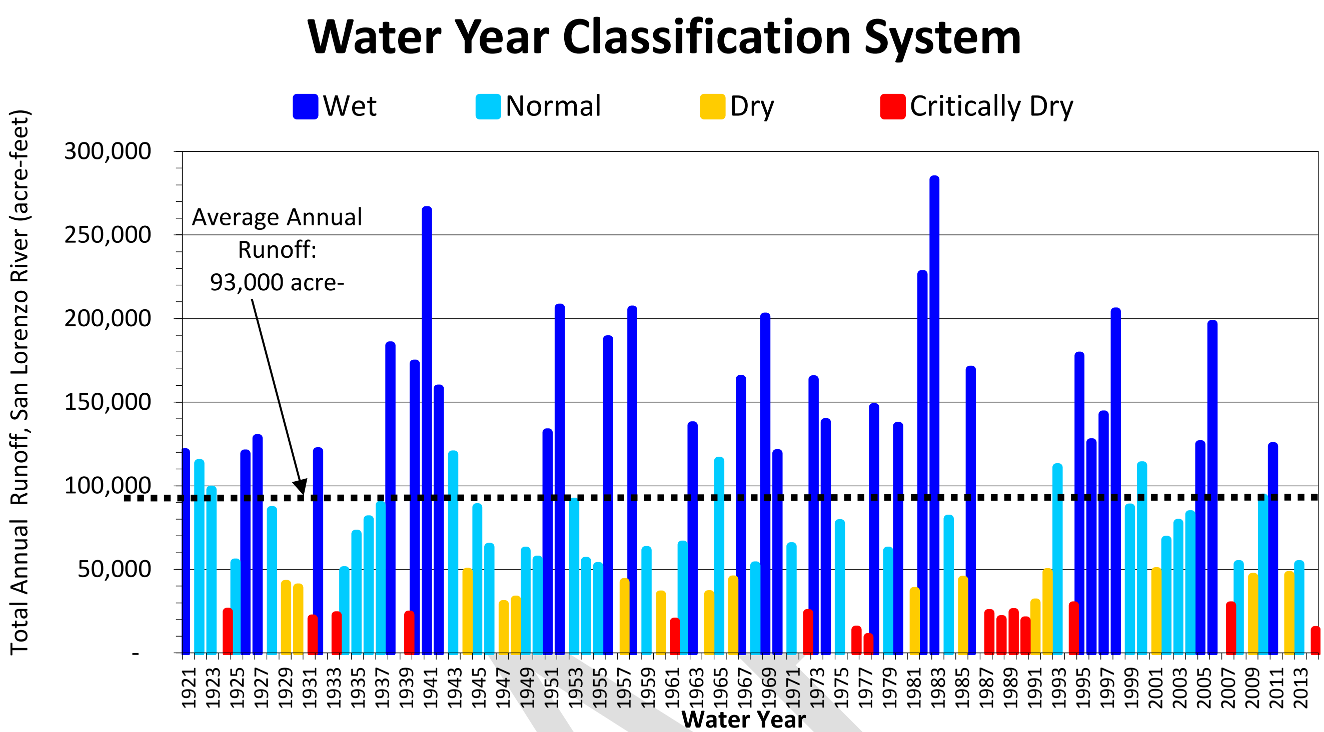
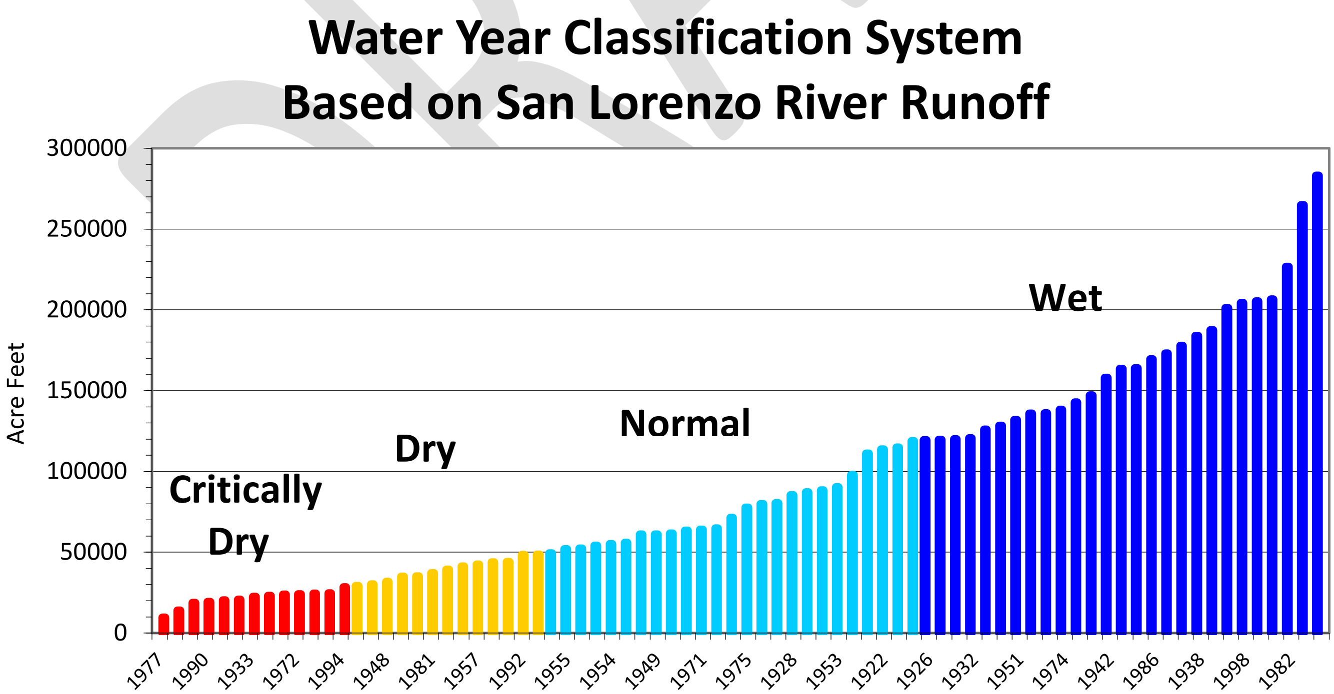


Figure 2 – Water Year Classification System Based on San Lorenzo River Runoff



Section 3.05 Forecast of Current and Future Water Demand

(a) Water Demand and Growth – the City General Plan

At its August 1, 2014 meeting, the Water Supply Advisory Committee agreed that using water scarcity to change the assumptions about the City's future growth and development, as laid out in the 2010 Council adopted General Plan, was not part of the Committee's decision space. In making this agreement, the Committee recognized that there are several growth issues that are within the Committee's purview including, for example, the potential impacts of growth on water demand for the period after that covered by the General Plan.

The Committee also acknowledged the requirements in the California Urban Water Management Planning Act (Water Code Section 10631) requiring that "… The projected population estimates shall be based upon data from the state, regional, or local service agency population projections within the service area of the urban water supplier and shall be in five-year increments to 20 years or as far as data is available."

(b) Water Demand and Growth – UCSC Future Demands

Significant work has been done to update the water demand forecast used in the 2010 Urban Water Management Plan. This demand forecast incorporates the changes in population and development that were part of the City's General Plan update as well as whatever up to date information was available at the time for the Water Department's outside-city service area.

The University's estimated build-out demand is 349 mgy. The WSAC did not generate an independent estimate of UCSC demand. The 349 figure for the University's buildout demand is based in part on its 2005 - 2020 Long Range Development Plan with added demand for the University's Marine Science and Delaware Street facilities. he only change made by City staff to the University water demand was to extend the previous forecast of 349 mgy in 2030 further out into the future to reflect a lower, more realistic, rate of growth, with two potential endpoints: 2035 and 2050. In the lower bound forecast, buildout occurs in 2050. In the upper bound forecast it occurs in 2035. The primary forecast is the midpoint between the lower and upper bound forecasts. The forecast of UCSC demand is given in Table 1. The primary forecast almost exactly replicates a forecast based on projected enrollment and average rates of water use per student.[1]

Table 1 – Primary, High and Low Projections for University Growth

	2013*	2020	2025	2030	2035
Low	182	186	213	240	268
Primary	182	196	234	271	308
High	182	207	254	302	349

Notes
*Actual per Water Department billing records.

[1] The enrollment-based approach yields a 2035 demand of 304 MG, which differs from the primary forecast by less than 2%.

(c) Interim Demand Forecast – February to April 2015

An interim demand forecast was developed by working from the demand forecast used in the 2010 Urban Water Management Plan. The 2010 Urban Water Management Plan demand forecast incorporates the changes in population and development that were part of the City's General Plan update as well as whatever up-to-date information was available at the time for the Water Department's outside-city service area at the time. This interim forecast was intended to be used by the Committee in developing its supply-demand gap until the econometric model was completed.

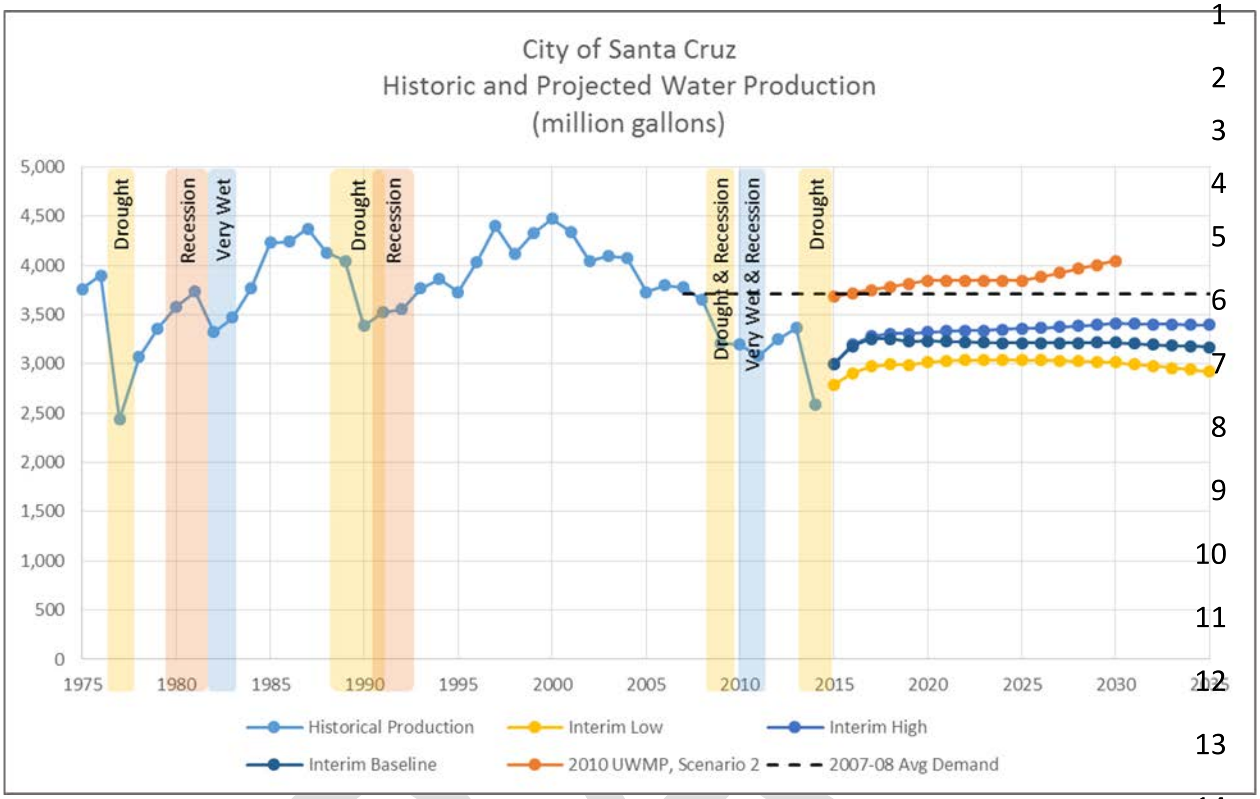
Working from the 2010 forecast, the interim forecast incorporated a number of key changes including:

- incorporating effects of existing, ongoing water conservation programs,
- integrating the expected impacts of changes in the State's building and plumbing codes that will affect future water use in both existing and new construction,
- adding into the forecast the effects of income changes and price increases on water use,
- revising the projected growth of commercial services, and
- using the University's projection of its ultimate build-out demand but extending its time for completion as described above.

The result was a forecast for current and future demand that looks substantially different from the 2010 Urban Water Management Plan forecast. Most notably, the revised forecast no longer shows an increase in water demand during the coming 20 years.

Figure 3 below portrays the interim demand forecast and incorporates the changes described above as well as the revisions to the University's growth projections described above.

Figure 3– April 2015 Interim Demand Forecast with High and Low Forecasts[1]



At the Committee's April 30 – May 1, 2015 meeting they agreed that this interim forecast would be used as the basis for the Committee's work until the results of the econometric forecast became available.

(d) Econometric Demand Forecast – July to September 2015

The forecast of future water demand is a foundational component to any water utility of its future needs for water supply. In recent years the historical patterns of water demand have been upended by a variety of factors, including the cumulative effects of tighter efficiency standards for appliances and plumbing fixtures, greater investment in conservation, a significant uptick in water rates, an equally significant downturn in economic activity during the Great Recession, and on-going drought. These events have resulted in even more uncertainty than usual regarding future water demand and have placed even greater importance on sorting out the effect each has had on demand in recent years as well as how they are likely to affect demand going forward.

One of the first requests made by the WSAC was for the Water Department to update the demand forecast to reflect current information on water usage and to account for effects of conservation, water rates, and other factors expected to impact the future demand for water.

i) Statistical Models of Average Demand

Econometric demand forecasting develops statistically-based models of average water use per service by customer class. A demand forecast was developed based on these models covering the period 2020-2035 and incorporating empirical relationships between water use and key explanatory variables, including season, weather, water rates, household income, employment, conservation, and drought restrictions. The approach builds on similar models of water demand developed for the California Urban Water Conservation Council (Western Policy Research, 2011), Bay Area Water Supply and Conservation Agency (Western Policy Research, 2014), California Water Services Company (A&N Technical Services, 2014, M.Cubed 2015), and Contra Costa Water District (M.Cubed 2014).

The statistical models of demand were estimated using historical data on customer class water use, weather, water price, household income, conservation, and other economic variables driving water demand. The monthly models of water demand were combined with service and housing growth forecasts to predict future water demands. The demand models explain 90 to 99% of the observed variation in historical average use over the 14 year estimation period.

The forecasts of average demand by customer class are summarized in Table 2. The forecasts include adjustments for future effects of water rates, plumbing codes and the City's baseline conservation program[2] and are predicated on average weather and normal (predicted) income and growth.

Table 2 – Forecasted Average Demand by Customer Class (CCF/Year)

YEAR		2013	2020		2025		2030		2035	
	Per	Actual 1/	Forecast	CI	Forecast	CI	Forecast	CI	Forecast	CI
Single Family	Housing Unit	87	86	± 3	83	± 3	80	± 4	78	± 4
Multi Family	Housing Unit	53	56	± 2	52	± 2	50	± 2	49	± 3
Business	Service	405	400	± 12	389	± 12	382	± 13	377	± 13
Municipal	Service	388	296	± 26	290	± 27	283	± 29	277	± 30
Irrigation	Service	365	286	± 28	271	± 28	257	± 28	244	± 28
Golf	Acre	990	671	± 130	641	± 134	606	± 137	593	± 144

1/ Actual use, unadjusted for weather or economy. Stage 1 drought water use restrictions in effect May - Dec.

CI = 95% confidence interval.

ii) Industrial Demand

Because of its unique characteristics, industrial demand was forecasted separately from the other customer categories. In the case of industrial demand, there is a strong relationship between Santa Cruz County manufacturing employment and aggregate industrial water use. This relationship is used to generate the industrial demand forecast shown in Table 3 below.

[2] The baseline conservation program level is Program A in the City's forthcoming water conservation master plan.

Table 3 – Industrial Demand Forecast

	2013 1/	2020	2025	2030	2035
Mfg Employment Forecast 2/		5,900	6,200	6,400	6,500
Industrial Water Demand (MG)					
Low	56	56	58	59	60
Primary	56	57	59	61	62
High	56	57	60	63	64

Notes
1/ Actual per Water Department billing records.
2/ Caltrans Economic Forecast for Santa Cruz County.

iii) Population, Housing, and Non-Residential Connection Forecasts

Forecasts of population, housing units, and non-residential connections are anchored to AMBAG's 2014 Regional Growth Forecast (AMBAG 2014). Projected growth in single- and multi-family housing units are shown in Table 4 and projected growth in non-residential services (excluding industrial and UCSC) are summarized in Table 5.[3]

Table 4 – Forecast of Occupied Housing Units

	2014 1/	2020	2025	2030	2035
Inside-City					
Single Family	12,246	12,534	12,780	13,030	13,246
Multi Family	9,583	10,958	11,398	12,106	12,679
Subtotal	21,829	23,492	24,177	25,136	25,925
Outside-City					
Single Family	6,743	6,922	7,074	7,230	7,390
Multi Family	7,901	7,910	8,033	8,310	8,495
Subtotal	14,644	14,832	15,107	15,540	15,884
Service Area					
Single Family	18,989	19,456	19,854	20,260	20,636
Multi Family	17,484	18,868	19,431	20,416	21,174
Total	36,473	38,324	39,284	40,676	41,809

Notes
1/ Actual per Water Department billing records.

[3] The decrease in forecasted golf acreage is due to the intention of Pasatiempo golf course to shift to non-City sources of irrigation water.

Table 5 – Forecast of Non-Residential Services and City-Irrigated Golf Acreage

	2013 [1/]	2020	2025	2030	2035
Business [2/]	1,889	1,948	1,971	2,008	2,055
Municipal [3/]	218	218	218	218	218
Irrigation [4/]	452	651	723	845	951
Golf					
DeLaveaga	79	79	79	79	79
Pasatiempo	68	40	30	20	20
Total Golf	146	119	109	99	99

Notes
1/ Actual per Water Department billing records.
2/ Based on ratio of business to residential demand.
3/ No expected growth in number of municipal services.
4/ Based on historical rate of gain in irrigation services per gain in multi-family and business services.

iv) Demand Forecasts

The primary forecast of system demand is provided in Table 6 . Under the primary forecast, total system demand is expected to remain stable at about 3,400 MGY over the forecast period, despite a 13 percent increase in population over the same period. Per capita water use is projected to go from 93 gallons per day in 2020 to 84 gallons per day in 2035, a decrease of approximately 10 percent.

Table 6 -- Primary Forecast of Class Demands and System Production

YEAR		2020	2025	2030	2035
		Forecast	Forecast	Forecast	Forecast
Service Units	**Units**				
SFR	Housing Units	19,456	19,854	20,260	20,636
MFR	Housing Units	18,867	19,430	20,416	21,174
BUS	Services	1,948	1,971	2,008	2,055
IND	NA	NA	NA	NA	NA
MUN	Services	218	218	218	218
IRR	Services	651	723	845	951
GOLF	Acres	119	109	99	99
UC	NA	NA	NA	NA	NA
Avg Demand	**Units**				
SFR	CCF	86	83	80	78
MFR	CCF	56	52	50	49

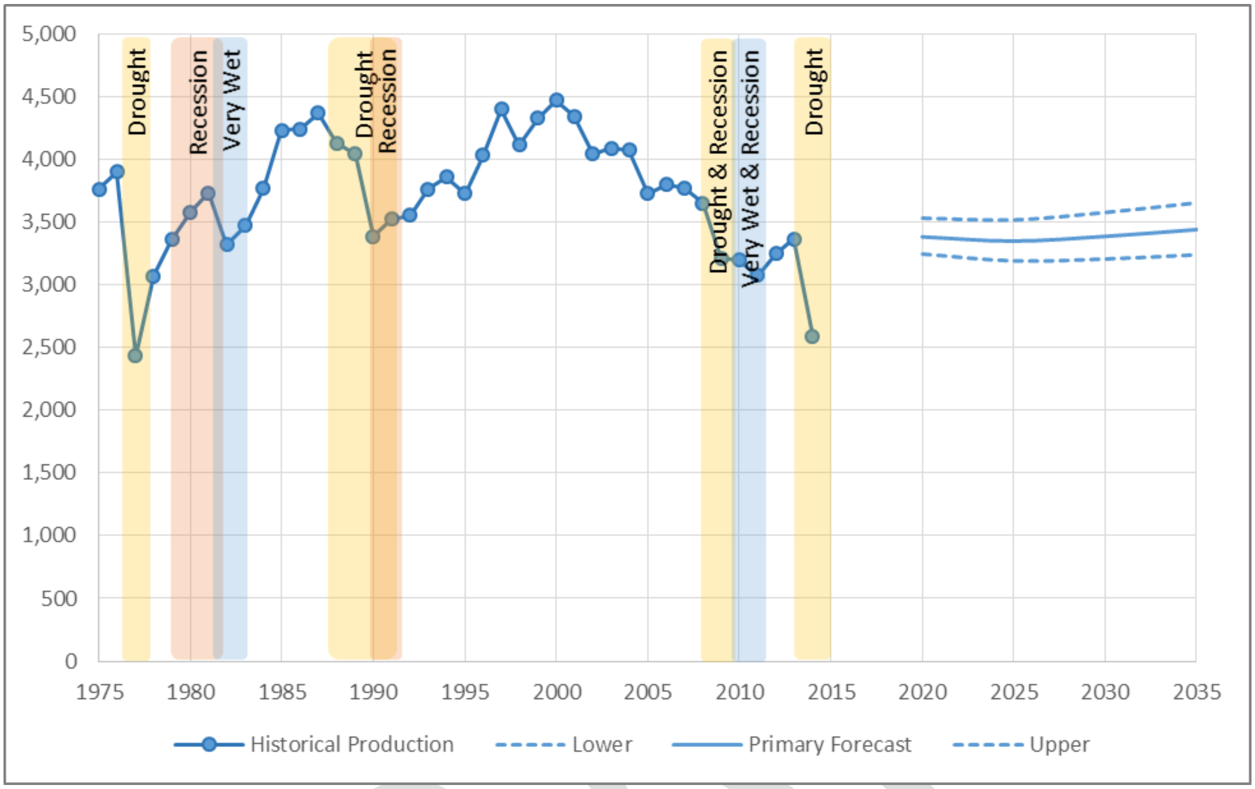
BUS	CCF	400	389	382	377
IND	NA	NA	NA	NA	NA
MUN	CCF	296	290	283	277
IRR	CCF	286	271	257	244
GOLF	CCF	671	641	606	593
UC	NA	NA	NA	NA	NA
Annual Demand	**Units**				
SFR	MG	1,256	1,228	1,208	1,196
MFR	MG	792	759	766	775
BUS	MG	583	573	575	580
IND	MG	57	59	61	62
MUN	MG	48	47	46	45
IRR	MG	139	147	163	174
GOLF	MG	60	52	45	44
UC	MG	196	234	271	308
Total Demand	**MG**	**3,131**	**3,099**	**3,134**	**3,184**
MISC/LOSS	MG	254	251	254	258
Total Production	**MG**	**3,385**	**3,351**	**3,388**	**3,442**
Rounded	**MG**	**3,400**	**3,400**	**3,400**	**3,400**

Forecasted demands are significantly lower than the 2010 UWMP forecast. The primary reasons for this are that the 2010 UWMP forecast (1) did not include adjustments for the future effects of passive and active conservation and higher water rates on future water use and (2) assumed higher UCSC demand.

Figure 4 shows a comparison of historical production and the primary, lower, and upper bound[4] forecasts from the econometric models. It is interesting to see how historical production has been influenced by weather and economic events. The forecast does not exhibit a similar degree of variability because it is based on average weather and normal economic conditions. In other words, it is a forecast of *expected future demand*. Realized future demand will certainly not be smooth like the forecast. It will vary about the expected value depending on year-to-year variation in future weather and economic conditions. The forecast, however, provides the baseline around which this variability is likely to occur.

[4] Add explanatory footnote explaining how the upper and lower bound were calculated

Figure 4 – Historical and Forecast Production in Millions of Gallons



Appendices: February 2015 Tech Memo; April 2015 Tech Memo; July 2015 Tech Memo and/or Final Report

(e) Committee Agreement(s)

At the Committee's April 30 – May 1, 2015 meeting they agreed that the interim forecast would be used as the basis for the Committee's work until the results of the econometric forecast became available.

At its July 23, 2015 meeting, the Water Supply Advisory Committee Agreed to use the econometric demand forecast as presented by David Mitchell of M Cubed Consulting at this meeting.

On September 10, 2015, the Committee accepted a revised forecast that corrected an error in the way that future plumbing and building code changes were incorporated into the forecast. Figure 4 above, reflects the revised, corrected forecast.

(f) List of Key Assumptions for Econometric Demand Forecast

- Future growth rates for service area population, housing units, and service connections are based on AMBAG's 2014 Regional Growth Projections and the City's General Plan.

- UC demand at buildout is assumed to be 349 MGY. Upper- and lower-bound demand forecasts assume UC buildout occurs in 2035 and 2050, respectively. The primary forecast uses the midpoint of the upper- and lower-bound forecasts.
- Future demand is progressively adjusted for expected water savings from national appliance standards (clothes and dish washers), California plumbing codes (showerheads, faucets, toilets, and urinals), and continuation of the City's basic conservation programs. These adjustments total approximately 370 MGY by 2035.
- The Pasatiempo Golf Course is assumed to shift off of City water so that by 2030 no more than 20 acres of the course (29%) are irrigated with City water.
- Water rates are assumed to increase by an average of 10% per year for the next five years and by an average of 4.4% per year thereafter.
- Median household income is assumed to grow at its long-term historical rate of growth (based on CalTrans data and projections).
- Regional unemployment and housing vacancy rates are assumed to equal their long-term average rates.
- Monthly rainfall and average maximum daily air temperature are assumed to equal their 30-year normal values.
- No restrictions on water use due to drought or other reason are assumed to be in place. The forecast assumes unrestricted customer water demands.

Section 3.06 Analysis of Supply Available to Meet Current and Projected Future Water Demand

The projected change in demand has had an immediate and important impact on the analysis of the adequacy of current supply to meet demand. Essentially the projected stabilization and longer term reduction in demand would allow the water system to fully meet customer demand, under natural (unconstrained) flow conditions, even in historically worst case conditions such as the 1976-1977drought.

City staff and members of the technical team have discussed this result and recognize that modeled results based on historic hydrological information underestimates the real-world likelihood of curtailments being implemented. This is because water managers making decisions in the late winter and spring of one water year may act more conservatively than the model to conserve storage in light of the uncertainty about the coming months and the next water year will bring. In fact, this reality was behind City staff's recommendation for implementing Stage 3 water restrictions in the spring of 2015.

The key assumption of using natural (unconstrained) flow conditions is also an important one. Natural flows mean no externally driven constraints on the City's ability to withdraw water from its existing sources, except for those associated with the City's water rights. The likelihood of this condition being the case in the future is low. The more likely case is that the City's ability to withdraw water from its supply sources will be affected by both the need to release water for fish flows (to meet the federal and state requirements for the protection of threatened and endangered coho salmon and steelhead trout,) and the impact climate change will have on available resources resulting in changed hydrology and increased likelihood of extended droughts. The implications of both of these factors on the City's future supply are discussed in more detail in the next sections.

(a) Future Challenges – Fish Flow Releases

The City has not yet finalized a flow agreement with state and federal fishery agencies. Two flow regimes have been identified and are being used by the WSAC to assess water supply reliability implications. The lower bound flow regime is called "City Proposal" and the upper bound flow regime is called "DFG-5." Both result in less water available for diversion than the natural flows discussed above and both have different impacts on the long-term availability of water to meet City needs.

i) Potential implications of Fish Flow Releases on the Frequency and Severity of Water Shortages

Table 7and Table 8 respectively show the forecasted peak-season shortage profiles in 2020 and 2035.

Table 7 – 2020 Shortage Profiles

2020 Shortage Profiles						Worst-Year Peak-Season Shortage
FLOWS	Likelihood of Peak-Season Shortages					
	0%	<15%	15%-25%	25%-50%	>50%	
	0	<300 mg	300-500 mg	500-1000 mg	>1000 mg	
Natural	100%	0%	0%	0%	0%	0%
City Prop	86%	12%	0%	1%	0%	34%
DFG-5	81%	10%	7%	1%	1%	68%

Table 8 – 2035 Shortage Profiles

2035 Shortage Profiles						Worst-Year Peak-Season Shortage
FLOWS	Likelihood of Peak-Season Shortages					
	0%	<15%	15%-25%	25%-50%	>50%	
	0	<305 mg	305-515 mg	515-1025 mg	>1025 mg	
Natural	100%	0%	0%	0%	0%	0%
City Prop	86%	12%	0%	1%	0%	34%
DFG-5	81%	10%	4%	4%	1%	69%

ii) Committee Conclusions on Fish Flow Releases

The Committee discussed this information and agreed that the following conclusions can be drawn from these profiles:

- With unconstrained natural flows, there are no shortages of any magnitude under any hydrologic condition. Since we saw above that there are no expected shortages under worst-year conditions, this is not surprising.

- As expected, the DFG-5 profile is worse (i.e., results in a higher likelihood of larger shortages) than the profile for City Proposed flows. For example, in both forecast years, there is about a 10% likelihood (7 out of 73 years) of a peak-season shortage larger than 15% under DFG-5. This compares to around 1% (1 out of 73 years) under the City Proposal.

- Even under the most stringent flow regime (DFG-5), there are no expected shortages in 80% of historic hydrologic conditions. Without taking into account the possible impacts of climate change, the City's supply reliability challenges have been and will continue to be in the driest years.

- The 2020 and 2035 profiles are similar since the forecast demands for those two years are similar.

- The key conclusion is that under baseline conditions, and assuming that future hydrology looks like the historic record, the City would have sufficient supply to serve its demands in the absence of any HCP flow restrictions. Under either of the habitat conservation plan flow proposals, the City faces peak-season shortages in the driest hydrologic conditions. In those driest years, those shortages can be significant, around 700 million gallons under City-Proposed flows and 1.2 billion gallons under DFG-5 flows.

iii) Key Assumptions about Fish Flow Releases

Fish flow assumptions used in the WSAC process are based on two key data sets:

- The City's July 2012 flow proposal to state and federal agencies for flow releases for the San Lorenzo River and Laguna and Majors creeks and Liddell Springs (City Proposal); and
- The September 2012 response received from the (then) California Department of Fish and Game suggesting modifications to the City Proposal (DFG-5).

Both fish flow regimes are designed to address flow requirements needed to maintain habitat for endangered coho salmon and threatened steelhead trout during their various fresh water life-stages. Both flow regimes are indexed to the amount of water available using a modified version of the year class type shown in Figures 1 and 2, which divides years into five rather than four categories and specifically links flow releases for a coming month to the year class type for the amount of water in the system in the previous month.

The ultimate resolution of fish flow requirements for the City's sources of supply will be the result of the City's negotiations with state and federal fishery agencies. Negotiated flows will be the foundation of a habitat conservation plan for the City's water system. At the completion of the environmental review of the habitat conservation plan, the City will receive a long term permit, called an Incidental

Take Permit (and a state version), that will give the City an ability to plan for and operate its water system with long term certainty.

iv) Committee Agreements on Fish Flow Releases

On April 30, 2015, the WSAC agreed that, for planning purposes, using the DFG-5 flows as an upper bound to of the potential impacts of fish flow releases on Santa Cruz's water system made the most sense. If the ultimate negotiated flow releases are lower, then the supply demand gap will be smaller and those results can be incorporated into future planning for supply augmentation.

(b) Potential Impacts of Climate Change

The second potentially significant factor to impact the City's current water system is climate change. With California in the throes of a deep multi-year drought, the City's water system may already been experiencing the impacts of climate change. For example, with the exception of the summer of 2011, the City has imposed some form of water restrictions on its customers every year since 2009. And this year's second consecutive year of rationing is entirely unprecedented.

The Water Supply Advisory Committee explored the impacts on future water supply reliability of two potential manifestations of climate change:

- Longer and more severe extended droughts; and
- Changes in ongoing hydrologic patterns.

i) Extended Droughts

As the Committee began to delve into the issue of climate change, the Technical Team conducted a brief literature search to frame the discussion. A summary of information related to drought is provided here to help frame the issue.

Recent evaluations of paleoclimate records and future climate model projections indicate that longer droughts have occurred in the past and are likely to occur again within the next century. In this section we review paleoclimate and climate change projection studies relevant to drought planning in California and the Santa Cruz region. Several publications, including some very recent ones, compare modern climate observations to historical records and to future climate projections.

Fritts (1991) shows that droughts in the Santa Cruz region were frequently much longer than three to eight years. Paleoclimate reconstruction for the California valleys show that precipitation from the 17th century until the 20th century was consistently below average 20th-century values, with long periods of relative drought and short periods of high rainfall. These data show that cycles of below-average precipitation have commonly lasted from 30 to 75 years (Fritts, 1991)[5].

[5] Fritts, H.C. 1991. *Reconstructing Large-Scale Climatic Patterns from Tree-Ring Data: A Diagnostic Analysis*. University of Arizona Press, Tucson, AZ.

Other paleoclimate analyses, summarized in Fritts (1991), have concluded:

- "The variability of precipitation was reconstructed to have been higher in the past three centuries than in the present" (p. 7).
- "Lower variability occurred in twentieth-century precipitation. Reconstructions of this kind should be used to extend the baseline information on past climatic variations so that projections for the future include a more realistic estimate of natural climatic variability than is available from the short instrumental record" (p. 8).

A recent publication by Cook et al. (2015)[6] compares paleoclimate drought records with future predicted conditions based on climate change models. Using tree ring data and current climate models, the authors found that drought conditions in the coming century are likely to be as bad as or worse than the most severe historical droughts in the region, with severe dry periods lasting several decades (20–30 years). In some cases, winter precipitation may increase, but gains in water during that period will most likely be lost due to hotter, drier summers and greater evaporation.

Other recent studies linking climate change, precipitation changes, and drought conditions have found that warming temperatures greatly increase drought risks in California (Diffenbaugh et al., 2015)[7].

The historic hydrologic record on which all of the prior analyses of Santa Cruz water supplies are based only goes back to 1937. This record therefore cannot adequately capture the kind of historic variability found in these paleoclimate studies and by extension the conditions the City might face under future conditions of climate change. The WSAC technical team created an extended-drought planning scenario that represents a discrete plausible future event that can help guide water resource planning in Santa Cruz. Building on examples from utilities around the state, the Santa Cruz extended drought planning sequence combines and places back to back the City's two worst drought sequences: 76-77 and 87-92. This eight year drought sequence is worse than anything in the historic hydrologic record, but is intended to represent what might be experienced under climate change. It was combined with each of the fish flow proposals discussed above and evaluated for the frequency and severity of the shortages that would be produced. Table 9 summarizes these results.

[6] Cook, B.I., T.R. Ault, and J.E. Smerdon. 2015. Unprecedented 21st century drought risk in the American southwest and central plains. *Science Advances* 1(1):e1400082. doi: 10.1126/sciadv.1400082

[7] Diffenbaugh, N.S., D.L. Swain, and D. Touma. 2015. Anthropogenic warming has increased drought risk in California. *PNAS.* doi: 10.1073/pnas.1422385112.

Table 9 – Extended drought peak-season shortage statistics (mg)

Table 9.

	City Proposal	DFG-5
Total 8-year (mg)	875	5,300
Average	5%	33%
Maximum	34%	69%
Minimum	0%	0%
Years > 20%	1	7

The key take-away message from Table 9 is that combining a multi-year drought with a significant commitment to fish flow releases would result in serious water shortages for Santa Cruz's water service customers. In the eight years modeled, customers would face curtailments of greater than 20% in seven out of the eight peak seasons. On average the shortage would be 33% and in the worst year the shortage would be nearly 70%.

To put these data in perspective, prior to the droughts occurring in water years 2014 and 2015 (October 1, 2013 through September 30, 2015) Santa Cruz's residential customer used about 60 gallons of water per person per day (gpcd). On average, during the extended drought modeled in this analysis, residential use would have to be reduced to 40 gpcd, and in the worst year, residential use would need to be reduced to 18 gpcd.

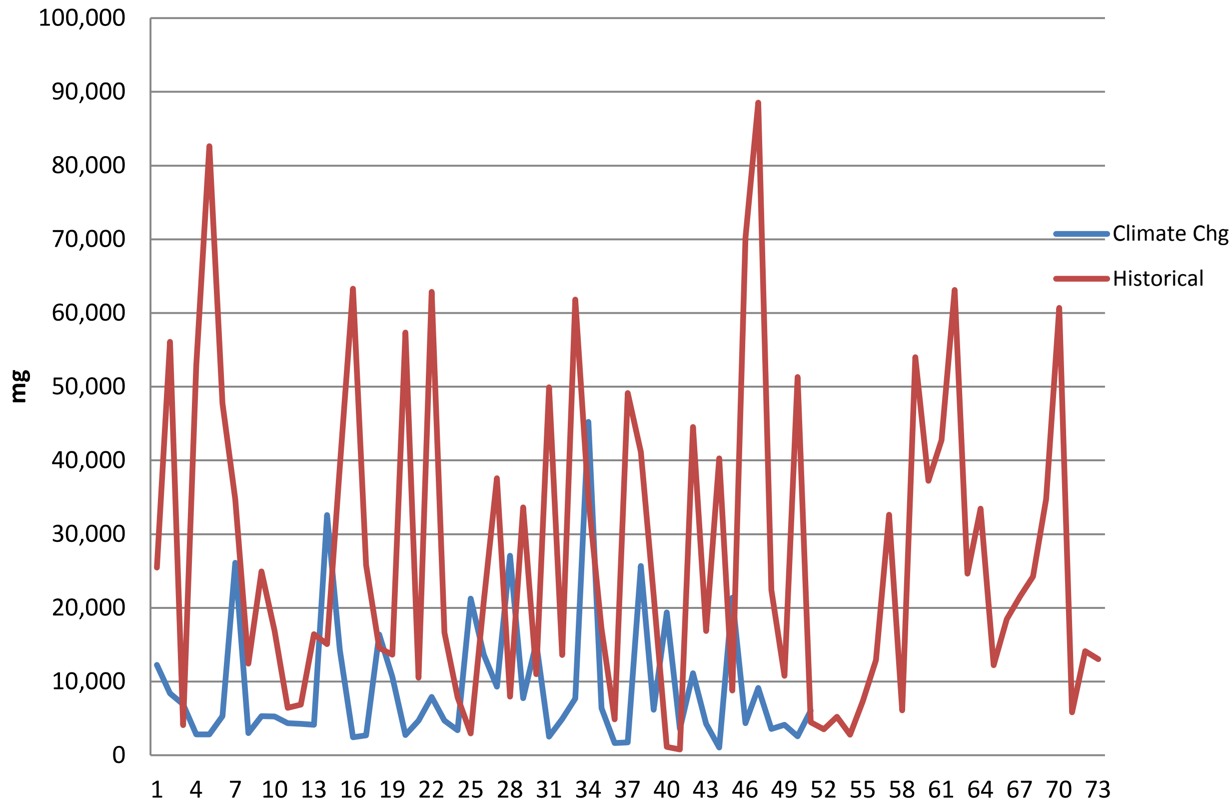
ii) Changes in Ongoing Hydrology

Across hundreds of modeling runs evaluating Santa Cruz water supplies, beginning with the 2003 Integrated Water Plan, the essential characteristics of the historic hydrologic flow record have remained constant. The worst drought event was 1976–1977. The 1987–1992 period represented another major drought. And it was clear which years in the record were very wet and which were exceptionally dry.

This historical foundation on which to plan and operate no longer applies when analyzing how the system will respond to potential changed hydrology driven by climate change. The essence of analyzing this type of climate change is the assumption that future weather and stream flows will not be the same as the past.

To analyze the plausible impact of climate change, a new 51 year flow record has been produced by working with hydrologic conditions that would occur in a selected global climate model and downscaling those conditions to Santa Cruz's sources and local conditions. In the resulting flow projection, there is no longer a 1976–1977 worst-case drought benchmark or a 1987–1992 sequence. As is illustrated in Figure 5 for City proposed HCP flows at Big Trees, a standard and long term flow gauging station on the San Lorenzo River, the distribution of flows is completely different from that of the historic record.

Figure 5 – Comparison of annual flows at Big Trees: City proposal.



While the worst years in the climate change scenario are no worse than the driest historic years, the overall pattern is a considerably drier one, which might be expected to result in a higher fraction of years in which there is insufficient water to meet the needs of both Santa Cruz water customers and fisheries.

iii) Committee Agreements on Climate Change

On April 30, 2015, the WSAC agreed that the Climate (hydrologic) Change and Extended Drought scenarios provide plausible parameters to use in its water system planning and that this analysis provides a useful point of depart for its scenario planning work.

iv) Key Assumptions about Climate Change

Content to be added

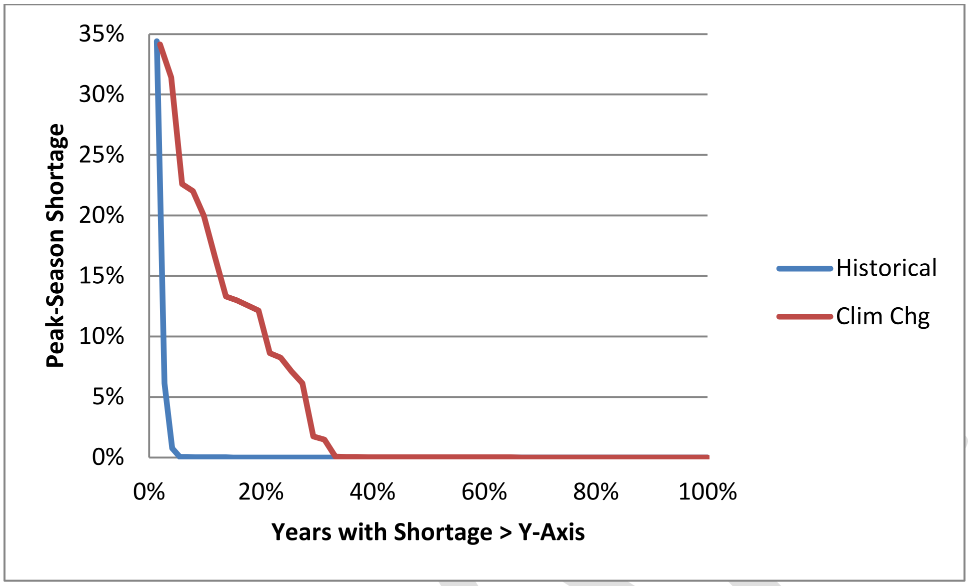
Section 3.07 How Climate Change Affects the System Modeling Results:

Combining potential fish flow releases and climate change impacts shows that climate change results in increasing both the frequency of and the size of shortages. The discussion below summarizes and explores these results.

(a) City Proposed Flows

Figure 6 compares the peak-season shortage duration curves for City Proposed flows with and without climate change.

Figure 6 – Peak-season shortage duration curves with and without climate change: City Proposed Flows

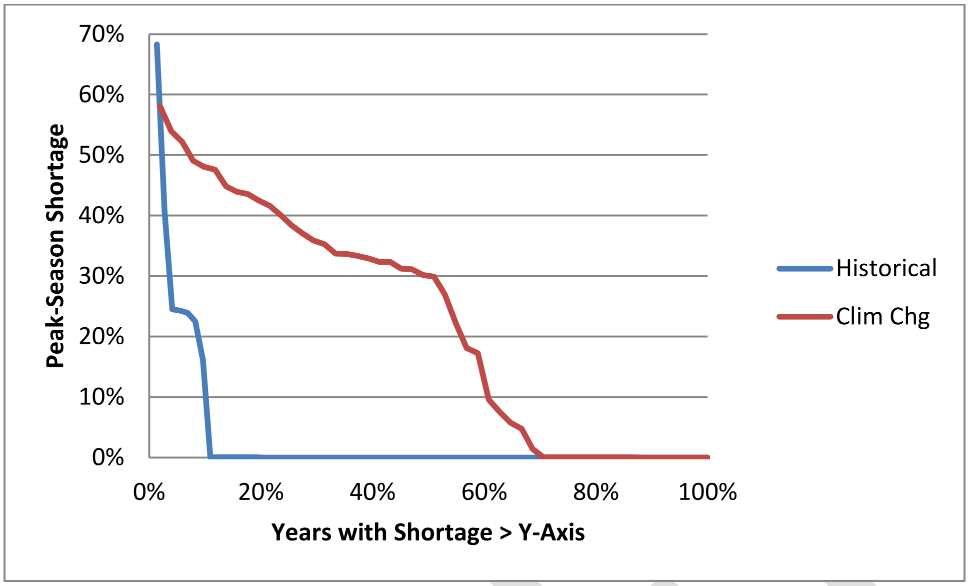


The differences between the two curves are immediately noticeable: Climate change shifts the curve upward and to the right, meaning there is an increased likelihood of larger shortages. Whereas with historic flows, there is a small chance (< 10%) of any shortage at all, this rises to more than 20% with climate change. The probability of a shortage greater than 20% increases from about 1% with historic flows to about 8% with climate change.

(b) DFG-5 Flows

Figure 7 shows the same system reliability comparisons for DFG-5 flows.

Figure 7 – Peak season shortage duration curves with and without climate change: DFG – 5 flows.



While the types of impacts are similar, their magnitudes with DFG-5 are much increased. For example, with DFG-5 flows and climate change there will be a peak-season shortage under nearly 70% of hydrologic conditions. In fact, a shortage exceeding 25% can be expected in just over half the years.

The foregoing results are consistent with the flow patterns of Figure 4, and highlight the importance of considering climate change as Santa Cruz plans for its water supply future. Even under the City's proposed HCP flows, which represent the potential lowest impact to Santa Cruz's water supply, water customers would have to contend with frequent shortages under this climate change scenario. If the outcome of the HCP negotiations are closer to the California Department of Fish and Wildlife's (CDFW's) DFG-5 proposal, the frequency and magnitude of shortages becomes much more onerous.

Thus with climate change, the City's water future will look qualitatively different. With historical flows, while there is a real possibility of large peak-season shortages, these are generally confined to the driest years with the large majority of conditions having no shortages. Clearly, that will not the case with the impact of climate change. Instead, significant shortages can be expected in many years. With DFG-5 flows, large shortages can be expected in the majority of years. The pattern of water availability to customers will be markedly altered and water rationing will be both more frequent and more severe.

Section 3.08 Problem Statement

Based on the preceding analysis, the WSAC recommendations are designed to address the following revised problem statement:

> *Santa Cruz's water supply reliability issue is the result of having only a marginally adequate amount of storage to serve demand during dry and critically dry years when the system's reservoir doesn't fill completely. Both expected requirements for fish flow releases and*

anticipated impacts of climate change will turn a marginally adequate situation into a seriously inadequate one in the coming years.

Santa Cruz's lack of storage makes it particularly vulnerable to multi-year droughts. The key management strategy currently available for dealing with this vulnerability is to very conservatively manage available storage. This strategy typically results in regular calls for annual curtailments of demand that may lead to modest, significant, or even critical requirements for reduction. In addition, the Santa Cruz supply lacks diversity, thereby further increasing the system's vulnerability to drought conditions and other risks.

The projected worst-year gap between peak-season available supply and demand in a worst drought year is about 1.2 billion gallons. While aggressive implementation of conservation programs will help reduce this gap, conservation alone cannot close this gap. The committee's goal was to establish a reasonable level of reliability for Santa Cruz water customers by substantially decreasing this worst-year gap while also reducing the frequency of shortages in less extreme years.

On September 11, 2015 meeting, the Committee adopted this formal problem statement. The basic understandings reflected in this problem statement underpin all the work the Committee did during Phase 2 of its process to identify, evaluate and select strategies for improving the reliability of Santa Cruz's water supply.

The Committee also noted that the Water Department is already taking steps to address the supply-demand gap, including incorporating into its Capital Improvement Plan funding for replacement of the pipeline between Felton and Loch Lomond.

Section 3.09 Data Driven Decision Making

Section 2.01 asked the Committee to "… to explore, through an iterative, fact-based process, the City's water profile, including supply, demand and future risks; analyze potential solutions to deliver a safe, adequate, reliable, affordable and environmentally sustainable water supply and develop recommendations for City Council consideration."

After defining the problem, the Committee worked hard to use a fact-based process in its works. Section 3.09 summarizes the work the Committee did to:

- identify and evaluate alternatives, to
- identify and apply Committee's evaluation criteria, and
- use scenario planning and portfolio building to explore risks and uncertainties.

Section 3.10 Evaluation Criteria

Criteria that enable one to distinguish among potential solutions are essential for effective problem solving. Understanding how various alternatives or portfolios of alternatives rate against those criteria is at the heart of the Committee's problem solving process. The development of the multi-criteria decision support (MCDS) model provided a focal point for the definition of criteria, subcriteria, and rating scales. A key purpose of using this approach is to support data-driven decision making.

The Council's charge to the Committee emphasizes the importance of data-driven decision making. The goal of developing and using a MCDS tool is not to produce an outcome by "pouring in the ingredients, turning the crank and having the answer come out."

No analytical tool can (or should) completely replace the judgment and careful weighing and balancing of values, uncertainties, and risks in this kind of decision-making. Rather the goal of using such a tool is to help develop information in a form that decision-makers can effectively and efficiently use as they make their decisions.

An additional benefit is that the careful thought that goes in to the creation of the MCDS tool creates many opportunities to talk about values and interests that are important to address as the collaborative problem solving process proceeds. Creating the MCDS model required the WSAC to identify important criteria and subcriteria, define what is meant by those criteria, and create rating scales that appropriately measure what is important to Committee members related to the criteria identified.

Table 10 provides a list of the evaluation criteria used by the Committee in the MCDS evaluation it conducted in the spring of 2015. The questions articulated in the table reflect what was relevant at the time the Committee used these criteria in their work.

In addition to using these criteria in that formal evaluation, these criteria were used more informally through much of the Committee's work during the Spring and Summer of 2015 as they worked together to identify and evaluate portfolios of measures to improve the reliability of Santa Cruz's water supply.

Table 10 – WSAC Evaluation Criteria

Criterion	Questions
Technical Feasibility	How likely is each Plan to be technically successful? For Plan B, consider the technical feasibility at the time the plan would actually start
Time Required to Demonstrate Technical Feasibility	How much time is required to demonstrate whether a Plan is technically feasible? When rating Plan B, start from the time Plan B actually begins.
Time Required to Full Scale Production	What is the time required to full scale production? For all Plans, start the clock when the Plan is permitted, has all needed rights and property ownership issues resolved and is ready to proceed.

Criterion	Questions
Adaptive Flexibility (includes Scalability)	What benefits in terms of adaptive flexibility is each Plan likely to contribute in the face of external conditions such as climate change, demand levels or streamflow requirements?
Supply Reliability	How likely would each Plan be to improve the reliability of the Santa Cruz water system in the face of different operating conditions such as turbidity, low flows, etc.?
Supply Diversity (Portfolio Level Only)	How does the Portfolio affect the diversity of Santa Cruz water supply portfolio?
Energy Profile	How much energy does each Plan require? Units are megawatts of energy per million gallons produced, mw/mg expressed as weighted average by Plan.
Environmental Profile	What is the environmental profile of each Plan? Note: this criterion covers a range of issues and a diversity of Plans. This is a great place to provide details about your rating using the comment button.
Regulatory Feasibility	How easy or difficult would the regulatory approval process be for these Plans?
Legal Feasibility	How easily and within what time period are these Plans likely to obtain the necessary rights in the form needed? When considering a Plan B that would start after a trigger, start the clock at the point at which the trigger actually occurs.
Administrative Feasibility	To what degree do each of the Plans require cooperation, collaboration, financial participation, and/or intergovernmental agreements to succeed? How likely is it that these can be obtained?
Potential for Grants or Special Low Interest Loans for Engineering and/or Construction	What is the potential for these Plans to qualify for grants and/or special low interest loans?
Political Feasibility	What level of political support is each Plan approach likely to have? When rating Plan B, take into account the impacts of additional time and the (hypothetical) failure of Plan A would have on Santa Cruz's political landscape.
Cost Metrics	How much do each of these Plans cost? Metric is annualized unit cost in dollars per million gallons, $/mg.

1

Appendix XX provides the detailed criteria the Committee used in its MCDS modeling and portfolio building exercises conducted in the Spring and Summer of 2015.

(a) Identifying and Evaluating Solutions

The WSAC used an iterative process to identify and evaluate alternative approaches to improving the reliability of the Santa Cruz water supply. Their efforts began with their work in the summer and fall of 2014 to identify a full range of demand management and water supply options for consideration. Since then, the WSAC, City staff and the technical team supporting the WSAC have invested considerable resources in developing and fleshing out demand management and supplemental water supply and infrastructure addition and operating change options to develop more specific planning level information for use in evaluating alternatives.

In this section, describes the Committee's iterative process for identifying and evaluating alternatives to improve the reliability of the Santa Cruz water supply.

i) Alternatives Identification: Our Water, Our Future – The Santa Cruz Water Supply Convention

During the community discussions of the desalination Draft Environmental Impact Report (DEIR), a common criticism was that the City hadn't adequately evaluated other alternatives during the decades of water supply planning that preceded the selection of desalination in the Integrated Water Planning process in early 2000s. A key element of the Council's decision to convene the WSAC was to have a community based process to consider alternatives to solve the water supply problem. The goal was to look in more detail at alternatives to desalination while not excluding desalination from further consideration.

As the Committee got underway in the spring of 2014, it was clear that a handful of very engaged citizens had ideas they wanted to share with the Committee regarding how to improve the reliability of the Santa Cruz water system. The challenge was to make sure that all those who might have ideas to share would have the opportunity to do so.

In June, the WSAC decided to include in its Reconnaissance phase an event that would engage the broader public by inviting those with strategies, alternatives, or ideas for improving water supply reliability to submit their proposals. The goal was to ensure that citizen and community-based ideas, as well as those provided by the technical team and other outside experts, were considered as possible strategies to improve water supply reliability in the Santa Cruz water system.

By late July, the Committee was starting to receive submissions covering a wide range of topics including:

- enhancing conservation efforts
- landscaping improvements

- expanding rainwater catchments and grey water systems
- incentivizing conservation through pricing structures
- revisiting old strategies such as exchanging highly treated wastewater for irrigation water used for north coast agriculture
- developing recycled water facilities and systems
- more groundwater development
- aquifer storage and recovery
- on-stream and off-stream storage projects
- desalination using a variety of existing and new approaches and technologies for both the desalination process and the energy issues related to desalination.

In August those submitting ideas in the first round were invited to further develop their proposals for submission to the WSAC and for public review at an event called "*Our Water, Our Future – the Santa Cruz Water Supply Convention*."

The *Convention* was held from 11:00 a.m. to 9:00 p.m. on Thursday, October 16 at the Civic Auditorium. More than 40 ideas were presented in poster session presentations set up around the hall. Brief oral presentations by the submitters were provided at noon and at 6:00 p.m. and attendees were invited and encouraged to visit the poster presentations of strategies, ideas, and alternatives and to interact with the submitters.

Approximately 350 people attended the convention. Attendees included most of the members of the WSAC, members of the City Council, and many staff members of the Water Department. WSAC members practiced rating and ranking the proposals using four criteria: effectiveness, environmental impact, community impact, and practicability.

Following the conclusion of the *Convention*, the WSAC continued to accept ideas and alternatives for addressing the issues that have been identified. The most recent proposal, a project for storing water in Hanson Quarry, was received in early January 2015. The Committee's purpose in keeping the door open for submission of new proposals was to ensure that the arbitrary exercise of a deadline did not keep a great idea from being considered.

ii) Selected Alternatives

Between the Committee's October and November meetings, WSAC members provided their technical consultant, Stratus Consulting, with their input on the alternatives identified in the *Convention* that they were most interested in considering further. Stratus' job was to select a dozen or so alternatives that were representative of a broad range of approaches that the Committee would use in testing the decision model. Alternatives not selected as part of this effort were not eliminated from further consideration, just not selected for further evaluation in the Recon phase of the Committee's work.

Twelve alternatives were selected by Stratus and approved by the Committee at their November meeting. The alternatives selected were:

- WaterSmart Software Implementation
- Landscaping Revisions, Rainwater Capture and Grey Water Reuse
- Water Neutral Development
- North Coast Off Stream Storage
- The Lochquifer Alternative
- Expanded Treatment Capacity on San Lorenzo River
- Ranney Collectors on San Lorenzo River
- Reuse for Agriculture
- Aquifer Restoration
- Potable Water Reuse
- Reverse Osmosis Desalination
- Forward Osmosis Desalination

The varied and often incomplete nature of the information provided by those proposing many of the alternatives submitted in the Water Supply Convention has proven to be a challenge for the Committee, City staff, and the technical team. Almost immediately following the November Committee meeting, information and assumptions about the selected alternatives were needed to support the Committee's use of the Recon MCDS model. To facilitate this timing, City staff made a variety of assumptions to fill in data gaps and used this information to provide default ratings for the alternatives and scenarios in the MCDS model. Still there is was a critical need to develop reasonably accurate technical details to support further analysis.

iii) Consolidated Alternatives

From the more than 80 initial suggestions and the 40 plus proposals presented by community interests, project proponents, and City staff during and after the October 16, 2014 Water Supply Convention, the technical team created 20 Consolidated Alternatives.

"Consolidated Alternatives" were alternative created from groups of Water Convention Alternatives with similar concepts and attributes. Consolidated Alternatives were created for a range of options and approaches such as additional demand management activities, approaches to improving storage for available system flows in the winter, to developing climate independent sources using purified recycled water.

Table 11 is a list of the Consolidated Alternatives and the Water Convention Alternatives that they were inspired by.

Table 11 – Consolidated Alternatives

Consolidated Alts #	Name	Description	Water Convention Alts #	Name & Comment
CA-01	Peak Season Reduction	Develop programs to decrease peak season demands through peak reduction or peak-demand shifting	**WCA-69**	SCWD: Peak season reductions – 10%, 25% and 50%
CA-02	Water-Neutral Development	Implement a demand offset program required for new development to offset new demands	**WCA-03**	SCDA: Water-Neutral Development
CA-03	Water conservation measures	Implement Program CREC (Maddaus Water Management, September 30, 2014, Table 4)	**WCA-20** **WCA-22** **WCA-65** **WCA-68**	McGilvray (9): Implement Conservation SCDA: Conservation Education zNano: Conservation rebate program SCWD: Program C from Long-Term Water Conservation Master Plan
CA-04	WaterSmart Home Water Reports	Use this software to promote conservation and efficient water use	WCA-04 **WCA-16**	WaterSmart: Home Water Reports Gratz: Maximize Conservation Behavior
CA-05	Home Water Recycling	Package automatic treatment system suitable for single family home or condo or multi-family development; recycles gray water for toilet flushing and landscape irrigation; requires dual plumbing	**WCA-39** **WCA-66** **WCA-70**	Garges: Residential Gray-Water zNano: Onsite Water re-use Home Water Recycling
CA-06	Landscaping, Capture, Reuse	Use gray water for irrigation; minimize irrigation for lawns; capture and use rainwater for domestic, non-potable	**WCA-01** **WCA-21**	Markowitz: Landscaping, Capture, Re-use SCDA: Climate Appropriate Landscape
CA-07	Deepwater Desalination	In cooperation with SqCWD, sign up for water delivered from the Deepwater Desalination Project at Moss Landing. Work with SqCWD to create the transfer facilities for potable water conveyance. Upgrade SCWD distribution system to accept water transferred through SqCWD.	**WCA-19** **WCA-36** **WCA-37** **WCA-67** **WCA-72**	McGilvray: (11) Seawater Desalination Aqueous: Desalination (non-membrane) Brown: Zero-emission Wave energy Tanaka Seawater desalination – Deepwater Desalination
CA-08	Water from Atmosphere	Extract water from the air to offset other demands	**WCA-38** **WCA-77**	DewPoint: Atmospheric Water Generation SKYH2O

CA-09	Winter flows capture	Capture winter flows for treatment and storage or infiltration	**WCA-29**	Malone: Winter flows capture
			WCA-31	McGilvray: (3) Water Capture and Transfers
			WCA-60	SCDA: Watershed Restoration
			WCA-63	Smallman: Water Skate Parks
			WCA-71	Quarry storage/GW recharge at Hanson Quarry
			WCA-74	Additional Pipeline – Felton Diversion to Loch Lomond (McGilvray)
			WCA-76	Olympia Quarry
CA-10	Water Reuse for aquifer recharge	Produce CAT water at City WWTP and pump to SVWD for aquifer recharge (IPR – Indirect Potable Reuse).	**WCA-44**	McGilvray: (8) Tertiary Treatment, Re-use
			WCA-62	Smallman: (17) Recycled Water
			WCA-64	Weizs: Water Recycling
CA-11	Water reuse for direct potable	Produce CAT water at City WWTP and pump to GHWTP for treatment and distribution system addition, a Direct Potable Reuse (DPR) alternative.	**WCA-11**	SCWD: Water Reuse
			WCA-46	McKinney: Water Reuse
			WCA-64	Weizs: Water Recycling
CA-12	Water Reuse for indirect potable	Produce CAT water at City WWTP and pump to Loch Lomond.	**WCA-44**	McGilvray: (8) Tertiary Treatment, Re-use
			WCA-52	Paul: (17) Detention Tub String
			WCA-62	Smallman: Recycled Water
			WCA-64	Weizs: Water Recycling
CA-13	Water Reuse for non-potable	The City would pump the Title 22 unrestricted effluent north through a new pipeline aligned along the railroad right of way, with turnouts to irrigate up to about 1,300 acres on private land and leased land. The City would use wells on ag land to produce water for treatment at GHWTP.	**WCA-09**	Ripley: Reuse for Agriculture
			WCA-40	Gratz: Recycled Water for Irrigation
			WCA-41	McGilvray: (1) Recycled Water for Irrigation
			WCA-43	McGilvray: (6,7) Pipelines Along RR Line
			WCA-45	McKinney: Additional Wells and WTPs
			WCA-64	Weizs: Water recycling

CA-14	Desalination using Forward Osmosis	Use seawater desalinating through a Trevi forward osmosis (FO) system. This alternative's other components would match those for seawater desalinating. The alternative has several outstanding issues, e.g., Trevi technology and other FO technologies are still in their infancy and being tested at a pilot scale. As described, Trevi would require a lower grade heat source for separately drawing the solution from the potable water but the alternative description did not designate a source for lower grade heat.	**WCA-13**	Trevi: Forward Osmosis Desalination (separate FAQs and technical memorandum summarize FO in its various incarnations and its implementation status around the world)
CA-15	Desalination using Reverse Osmosis	This alternative for initial comparison would use seawater desalinating through a new reverse osmosis desalination facility to produce about 2.5 mgd for addition to the City potable water supply. This alternative's components and development would match those for the previously proposed scwd2 desalination facility. The City would own and operate the facility and would use the water produced year round. Excess water would allow the City either to idle the Live Oak wells for conjunctive-use aquifer recovery or to undertake Live Oak well operation in an ASR mode to restore the aquifer more rapidly. In wet years, the City could sell excess desalinated to SqCWD and/or SVWD.	**WCA-12** **WCA-19** **WCA-36** **WCA-37** **WCA-67**	Sustainable Water Coalition: Desalination McGilvray: (11) Seawater Desalination Aqueous: Desalination (non-membrane) Brown: Zero-emission Wave energy Tanaka
CA-16	Aquifer restoration/storage	The City would sell treated water to SqCWD during normal and wet years. SqCWD would use the transferred water for either groundwater recharge or demand reduction and conjunctive use. SqCWD would sell pumped groundwater water to City during droughts. The City also should have improved production from its Live Oak wells.	**WCA-08** **WCA-28** **WCA-49** **WCA-59** **WCA-10**	Paul: (13) The Lochquifer Alternatives Malone: Regional Water Exchanges (also possibly addressed through CA-11) Paul: (14) Upgrade Water Intertie SCDA: Enhance Existing Infrastructure SCDA: Regional Aquifer Restoration
CA-17	Expand Treatment Capacity	Add a new 14-mgd water treatment plant (WTP) (pretreatment for turbidity control and membrane filtration) near the Tait Street Diversion to produce treated water that would be piped directly into the distribution system. It would increase capacity to divert to Loch Lomond and produce additional water for aquifer recharge.	**WCA-06** **WCA-27**	McKinney: Expanded Treatment Capacity Malone: Enhanced Storage and Recharge

CA-18	Off-stream water storage	Convert Liddell Quarry into 650 MG reservoir, filled with water from City North Coast diversions; use stored water to offset water demand during drought	**WCA-05**	Bevirt: North Coast Quarries (modified to include diversion of water from City existing sources)
			WCA-26	Fieberling: expand storage (addresses off stream storage)
			WCA-30	McGilvray (2): Quarries for Water Storage
			WCA-32	SCWD: Zayante Dam and Reservoir
			WCA-33	Smallman: Reservoirs
			WCA-34	Smallman: Storm Aquarries
CA-19	Ranney Collectors	Use Ranney collectors with a 12.9-mgd capacity (maximum capacity allowed under the current City of Santa Cruz [City] diversion permit), installed near the City's Felton diversion to draw water allocated under the City's existing water rights. Water drawn through the collectors would have greatly reduced turbidity and allow continuous refilling of Loch Lomond while also operating the GHWTP. It would produce additional water for aquifer recharge.	**WCA-07**	McKinney: Ranney Collectors on SLR (requires a storage component to be a viable alternative)
			WCA-42	McGilvray: (4,5) Upgrade Water Treatment
			WCA-48	Paul: (12) Diversion Alternatives
			WCA-49	Paul: (14) Upgrade Water Intertie
			WCA-57	Paul: (23) Loch-Down Alternatives
CA-20	Interagency Cooperation/ County Water Authority	Establish Santa Cruz County Water Authority to manage water resources development and use for public agencies and private diverters and groundwater users	**WCA-14**	Gratz: Regional Water Authority
			WCA-15	Smallman: Regional Water Authority
			WCA-18	McGilvray: (10) Regional Collaboration

(b) Analytical Work on Alternatives

During the spring and early summer of 2015, the technical team developed and shared information with the Committee about each of the Consolidated Alternatives. The Committee worked with this material, which included information about capital, operating, and energy costs, yield, as well as planning level information for each CA for each evaluation criteria. Based on questions raised and comments received from both Committee members and the public, the WSAC directed the technical team to do additional vetting of the CAs to understand the potential benefits and contributions to the water supply issues facing the City of Santa Cruz.

Committee members also developed and used a multi-criteria decision support (MCDS) model to individually rate CAs as well as portfolios of measures, including expressing their values by weighting the criteria. At their December 2014 and July 2015 meeting, the Committee discussed the results of their evaluations and used this information to both better understand their various interests and points of view as well as to focus the alternatives for further explanation.

Appendices A, B & C to this document include some of the key technical memos and Committee reports that provide examples of the Committee's analysis of alternatives. In addition, an archive of all of the Committee's meeting materials is available at (give a website address, here.)

(c) Alternatives Considered but Not Pursued at this Time

As the Committee explored the diverse range of CAs in some detail, some CAs emerged as being more feasible and better fitted to the WSAC's vision of how to approach improving water system reliability than others. As the technical team's research and analysis work continued, information became available about some of the alternatives that raised questions about their feasibility. For others, issues of potential scale or suitability created issues that took them out of the running. As the Committee moved into their portfolio building efforts during the summer of 2015, they directed staff and the technical team to put together a list of all the CAs that were no longer being considered. For each CA, information was provided about its current status, and the WCAs covered by that CA. Appendix ZZZ includes information the CAs, WCA's and other submittals not selected for further consideration at this time. At its September 10, 2015 meeting the WSAC, the Committee approved the information in Appendix ZZZ as its conclusions about the alternatives it evaluated and its reasons for not further pursuing these alternatives at this time.

Section 3.11 Scenario Planning

Scenario planning is a tool often used to facilitate planning in the face of uncertainty. A goal of scenario planning is to explore a range of futures that are different from what would occur if current trends continue, but not so unlikely as to be a waste of time. One way to maximize the benefits of scenario planning is to create scenarios based on what are called "deep drivers of change." For Santa Cruz, the obvious deep drivers of change are climate change and fish flows.

Scenario planning isn't intended to result in the selection of a preferred scenario to pursue but to explore and get a better understanding of the degree to which key uncertainties such as climate change could affect the problem we need to solve or the outcomes we might be able to achieve. The "best" solutions are those that address conditions in multiple scenarios.

Throughout the Recon phase of its work, the Committee used simple scenario planning to explore a range of potential water futures. For example, different scenarios were created to explore how the community's water supply needs would be affected by the need to release water for fish, the implications of climate change, and potential changes to the local economy that would make Santa Cruz a place where people could both live and work.

During the first half of 2015, the technical team worked to develop consistent information about Consolidated Alternatives so that the Committee could use them as building blocks in the two rounds of scenario planning. Among the most important information emerging from this technical analysis was the result of system simulation modeling using the Confluence model.[8] These simulations concluded that two broad approaches have the potential of completely addressing the City's water supply challenges:

1. Harvesting and storing winter flows. This approach can work, even with current water rights, DFG-5 instream flows, and climate change. The analysis considered how the Santa Cruz water system would benefit if there was additional storage in the form of a "virtual reservoir." To achieve this benefit, the "virtual reservoir" used in the Confluence analysis would have to become real, i.e. suitable infrastructure improvements and institutional arrangements would have to be made to have a place to reliably store sufficient water and to be able to recover and use a sufficient portion of that water. The analysis indicated that the estimated quantity, about three billion gallons, would need to be banked and be recoverable at required daily volumes. This would require increasing the capacities of various current infrastructure components.
2. Developing a more drought-resistant supply (i.e. one that is insulated from year-to-year variability in weather and streamflow). Examples of such a supply include desalination and use of highly-treated recycled water. These alternatives would also require development and improvement of infrastructure.

The first round of scenario planning occurred during the March 2015 meeting. In this effort, Committee members broke into small groups, with each group working on one of three scenarios:

- Changed hydrology that results from City proposed flows;
- Changed hydrology that results from DFG-5 flows; and
- DFG-5 flows and a potential extended drought that is a plausible event under future climate change conditions.

Following several hours of work in their small groups, Committee members presented the demand management and water supply improvement measures they had created to address the conditions described in their scenario. These groups of measures are called portfolios.

Two key themes emerged from this work:

1. Committee members created water supply portfolios which included additional investments in demand management; and
2. Each of the groups gravitated to some form of winter flow capture and storage as a key strategy for meeting future water supply needs for Santa Cruz. One group acknowledged the potential

[8] See Appendix XY for a description of the Confluence model and its use in the WSAC process.

need for a supplemental supply to help get the aquifer storage program going before it could be completely filled by available winter flows, and chose to fill that potential gap with recycled water.

Round two of scenario planning occurred at the Committee's April/May 2015 meeting and included two scenarios:

- DFG-5 flows with extended drought,
- DFG-5 flows with climate change.

Two working groups of Committee members were assigned to each scenario. Again, winter flow harvest was the centerpiece of each group's solution to the scenario they were given, and again, purified recycled water played a role if and as needed as a back-up resource.

Section 3.12 Portfolio Development and Evaluation

Starting in May 2015, the Committee began exploring and building portfolios of measures to close the supply-demand gap. Portfolios were typically made up of combinations of demand management and supply augmentation strategies that often included projects or approaches for improving the performance of the existing water system, particularly as it relates to its ability to capture and store winter flows.

One goal of portfolio building was to provide opportunities for Committee members explore the risks and uncertainties associated with various combinations of measures. Another was for Committee members to work with each other to create portfolios that met their common interests using interest based bargaining techniques. And a third was to give Committee members a hands-on way to engage with the information about the technical aspects of various approaches.

Especially with respect to the last goal, Committee members have received, processed, and asked for clarification of and additional information about just about every aspect of water system operation, technical and financial assumptions, and have built a substantial base of knowledge upon which to create their recommendations. The diversity of Committee member backgrounds and interests has been a significant asset to the group as it has done this important work and they have learned from each other as well as from the Technical Team and City staff participating in their work. In addition, this hands-on approach has created an unparalleled opportunity for Committee members to learn about, and learn to respect their individual perspectives and interests, which is an invaluable asset to any collaborative problem solving process.

Section 3.13 Issues of Risks and Uncertainties

At the Committee's June 2015 meeting, Committee members worked with a set of four different staff-created water supply portfolios that have at their center some form of winter water harvest. In addition to a winter water harvest approach provided as a "Plan A," each portfolio contained a proposed "Plan B" and a "trigger" that would define the conditions for moving from Plan A to Plan B.

The task was to consider the risks and uncertainties related to the various approaches, and the addition of a Plan B and a trigger was designed to get the Committee members thinking about and working with ideas related to "what ifs."

The four portfolios developed were:

1. Plan A: In lieu recharge of regional aquifers by providing system flows in during the rainy season to Soquel Creek Water District and Scotts Valley Water District to meet their customer's demand, thereby allowing them to rest their wells. Additional infrastructure or operating rule changes were added to extend the season during which in lieu recharge could be provided, thereby increasing the rate of recharge. The goal would be for groundwater to come back to Santa Cruz Water Department customers from water stored in regional aquifers when Santa Cruz needs it during drought years or other unusual events. Plan B: Purified recycled water piped back to and mixed with Loch Lomond supplies (a technique called indirect potable reuse or IPR).

2. Plan A: Active recharge of regional aquifers using injection wells (a technique called Aquifer Storage and Recovery, or ASR) by providing excess flows to SVWD or SoqCrWD for injection into the aquifers to accelerate the rate of groundwater recharge. The goal would be for groundwater to come back to SCWD from regional aquifers when needed. Plan B: Purified recycled water piped to and mixed with North Coast and San Lorenzo River supplies, retreated at Graham Hill Water Treatment Plant and delivered to customers (a technique called direct potable reuse, or DPR).

3. Plan A: ASR along with using purified recycled water to create a sea water barrier along the coast to manage and impede salt water intrusion. The ultimate goal would be for groundwater to come back to Santa Cruz from regional aquifers when Santa Cruz needs it. Creating a salt water intrusion barrier would accelerate the timeline when this source would fully meet Santa Cruz's needs. Should the ASR program ultimately completely solve Santa Cruz's problem, the stranded assets in this plan would be a complete advanced treatment plant for producing purified recycled water and related infrastructure. Plan B: Converting the purified recycled water plant producing water for the salt water intrusion barrier to a source of water for DPR use.

4. Plan A: ASR coupled with desalinated water from the proposed DeepWater Desalination plant at Moss Landing. The ultimate goal would be for groundwater to come back to Santa Cruz from regional aquifers when Santa Cruz needs it. Creating a supplemental source of potable water could result in a combined ASR and in lieu recharge strategy that would accelerate the restoration of regional aquifers, making the timeline when this source would fully meet Santa Cruz's needs shorter. Should the ASR program ultimately completely solve Santa Cruz's problem, the stranded assets in this plan would be a share of a regional desalination facility that might be sold to another party and a pipeline that might be repurposed for a different use. Plan B: DeepWater Desalination.

None of these portfolios was designed to be <u>the</u> best one. Rather, they were designed to be purposefully different from each other so that the Committee could explore the risks and uncertainties associated with different approaches. It was not part of the goal of the Committee's June meeting to select one of the portfolios as the preferred approach.

The focus on risks and uncertainties associated with the performance of these portfolios is an important one. At the level of analysis and information currently available, it is inevitable that there will be questions about actual performance of various approaches.

Section 3.14 Committee Member Portfolio Building

Between the July and August meetings (2015) Committee members worked independently or in teams to prepare portfolios that addressed the supply demand gap.

One portfolio was created by David Baskin, Peter Beckmann, Sue Holt, Charlie Keutmann and David Stearns. This proposal includes In-lieu and ASR along with direct potable reuse (a more drought resistant element to be implemented concurrently. This portfolio was designed to effectively cover the "gap" and, in the long term, would go further than by providing the capacity to supply water even if events occurred such as a wildfire around Loch Lomond.

A second portfolio was created by Greg Pepping, Rick Longinotti, Mark Mesiti-Miller and Sid Slatter. This portfolio proposed a combination of in-lieu and aquifer storage and recovery (ASR) with direct potable reuse. This group reached consensus on the component parts and found that they disagreed as to whether, to ensure success, it would be necessary to implement the parts of the proposal sequentially or concurrently. This proposal provides for concurrent implementation, and Rick Longinotti developed a separate portfolio (described below) that proposed a sequential implementation.

A third portfolio was developed by Rick Longinotti in consultation with Erica Stanojevic and members of Santa Cruz Desalination Alternatives. As noted above, this proposal scales down the in-lieu to operate initially within the capacity of the existing system, thus avoiding significant upgrade costs for modifications to the Graham Hill Water Treatment Plant. Ongoing monitoring of the response of the aquifer would provide the information needed to determine whether to maintain the level of effort or scale up as necessary.

A fourth portfolio was developed by Sarah Mansergh. This proposal shows an approach that portrays a lower level of urgency for moving forward than some of the other portfolios. The portfolio is also designed to seek and achieve multiple benefits through regional partnerships focused on restoring regional aquifers.

The fifth portfolio was developed by Erica Stanojevic. This proposal combines the storage capacity of Loch Lomond with the aquifer. By starting the project immediately and sorting out our water rights, security will be increased and we could achieve 3BG in storage by 2020.

All of these portfolios incorporated demand management.

In the discussion that followed the following agreements were articulated:

- The Committee developed consensus that the environmental benefits of fish habitat restoration is an important value and that the supply-demand gap should reflect a commitment to releasing flows to support restoration of threatened and endangered fish species. (The specifics of the DFG-5 flow proposal are not agreed to, as the Committee wants the City to work with the agencies to define the final flow proposal.)
- The Committee has developed consensus that there are substantial benefits from pursuing regional solutions for Santa Cruz's water supply issues and that reasonable regional solutions should be pursued if possible.
- The Committee developed consensus that energy requirements for any new water supply augmentation project should be met with power from renewable sources.
- The Committee reached agreement that groundwater storage strategies implemented by in lieu (passive recharge) and ASR (active recharge) are preferred and there is optimism that they will be successful.
- The Committee has developed consensus that their direction be focused on policy versus prescriptive level detail.
- The Committee has developed consensus that the plan they develop and recommend to the City Council will include an adaptation or Change Management Strategy.

Section 3.15 Alternatives that Emerged as Key Strategies to Consider

As the Committee worked through its first several meeting of Phase 2 (Analysis), information developed by the WSAC Technical Team identified challenges with some of the alternatives. For example, it would be impractical to build surface water storage reservoirs in old quarries underlain by Karst formation geology. Other alternatives emerged as being more feasible and began to appear consistently as measures included in scenario planning results. By late spring 2015 the Committee had defined a set of alternatives and approaches that became their focus. Each area is described briefly below in Section 3.17 through Section 3.21.

Section 3.16 Demand Management

During much of the Committee's work a program known as "C recommended" (Crec) was a focus of the conversation around what additional demand management activities should be pursued by the City. Crec is a combination of water conservation measures identified during the development of the City's updated Water Conservation Master Plan in a process that began in 2013 but was still underway in the spring and summer of 2014.

As the Committee gained a better understanding of the nature of the reliability problem Santa Cruz faces, it began to look at whether and how well the measures combined into Program Crec focused on peak season demand. In the spring of 2015, the Committee formed a Peak Season Demand Management Working Group to look at strategies for improving the focus of the future Demand Management program on peak season reductions.

The Working Group developed and presented some strategies focusing on peak season demand management. When their results were received, the Working Group had proposed that the City set a goal of reducing peak season demand by an additional 150 million gallons per year (mgy) using a variety of strategies. This proposal raised a concern about the potential for double counting demand management savings due to the significant impact of price elasticity in reducing future demand. Double counting of demand reductions in a concern because of the possibility that an unknown number of customers will respond to higher rates by switching to water-conserving landscapes, for example, and will also participate in a water Department rebate program while doing so. If this occurs, their water savings would be counted twice – once as a program participant and again as a response to higher rates. Double counting could lead to overestimating the potential for demand reductions from programmatic conservation.

Table 12 below, lays out the impact of price response on future water demand.

Table 12 – Peak Season Savings Due to Price Response

Peak (May-Oct) Demand Without Price Response, MG

	SFR	MFR	BUS	MUN	IRR	GOLF	**TOTAL**
2020	750	386	372	39	123	58	**1,728**
2025	763	375	373	39	138	52	**1,739**
2030	778	383	381	39	162	46	**1,790**
2035	798	393	393	39	184	46	**1,854**

Peak (May-Oct) Demand With Price Response, MG

	SFR	MFR	BUS	MUN	IRR	GOLF	**TOTAL**
2020	705	364	348	35	93	52	**1,598**
2025	703	347	342	35	104	45	**1,575**
2030	702	347	341	34	111	37	**1,572**
2035	703	347	342	33	119	35	**1,580**

Peak (May-Oct) Savings from Price Response, MG

	SFR	MFR	BUS	MUN	IRR	GOLF	**TOTAL**	**% Savings**
2020	46	22	23	4	30	5	**131**	**8%**
2025	60	28	31	5	34	7	**164**	**9%**
2030	76	36	40	6	51	9	**218**	**12%**
2035	95	46	51	7	65	11	**274**	**15%**

The price elasticity used to produce these numbers was based on the measured impact of price on the demand of various customer groups in Santa Cruz between 2000 and 2013. These elasticities were integrated into the econometric demand forecast presented to the Committee in July of 2015.

During the development of the econometric forecast, considerable effort was expended to ensure water conservation savings were not counted twice. The forecast includes an estimated 274 mgy of peak season demand reduction due to price, an estimated 170 mgy due to continuing existing programs and 248 mgy in demand reductions due to the impacts of building and plumbing codes. An additional 170 mgy in demand reduction from Program Crec was included as a supply alternative in all the Confluence modeling analyses, including those analyses used to establish the 1.4 billion gallon worst year shortage.

As the Conservation Master Plan is finalized, the new conservation measures proposed by the Working Group will be more fully analyzed and the Committee agreed that until that analysis is completed, it was best to be cautious about including the full additional 150 mgy of demand reduction in the projections.

(a) Development of Recommendations on Demand Management

At its July 24, 2015 meeting, the Committee decided they wanted their recommendations on Demand Management to combine providing the Council with their recommendations on a package of demand management programs as well as with a results-oriented, policy level direction, including guidance about key criteria.

City staff worked with two members of the Demand Management Working Group to develop recommendations reflecting both the Committee's strong interest in pursuing conservation with the uncertainties regarding costs and water savings associated with the package of measures outlined by the working group. The recommendations developed included:

1. **Expressly acknowledge the conservation savings that have been embedded into the new econometric demand forecast.** The econometric forecast carefully factored in different estimates of conservation savings that together amount to over 700 million gallons of water per year saved by 2035. These include the savings representing the passive effects of plumbing codes (278 mgy), active water savings associated with measures currently being implemented, (also referred to "Program A", 170 mgy), and the peak season savings that is related to economic effects over the 20-year planning horizon (274 mgy). These three elements play a large role in keeping water demand relatively constant over the next 20 years, and represent a combined 17 percent savings that should be communicated and highlighted as a key part of the overall solution to balancing the City's future water supply and demand.

2. **Set a goal, expressed as a range, between 200 and 250 million gallons per year of additional water savings by 2035, with emphasis on implementing measures that focus on peak season demand reduction.** Although the exact number is yet to be finalized and needs to be revisited, modeling performed by Maddaus indicates another 168 mgy of water savings is potentially attainable by 2035 through new or expanded conservation measures (referred to as "Program C"). It is also likely that

more savings is possible by incorporating the working group's recommendations into the City's Water Conservation Master Plan. Various estimates have been put forward about the savings of its recommendations, ranging from 81 to 183 mgy. The proposed goal recognizes and agrees with the Working Group that more water savings is possible, especially in the peak season, but expresses it as a range to reflect the uncertainty involved at this time.

3. Additional analysis will be completed to finalize the package of programs to be implemented and to more specifically establish the savings goal. Earlier modeling performed by Maddaus Water Management indicates another 168 mgy of water savings is potentially attainable by 2035 through new or expanded conservation measures from Program Crec. Additional programmatic savings will be identified both due to changing the $2500 per million gallon threshold used in the Maddaus Water Management modeling work conducted in 2013 to a $10,000 per million gallon average program cost recommended by the WSAC and by identifying, developing and implementing more programs focused on peak season savings.

4. **Identify the water conservation measures listed in Program C and in the working group's report as the demand management package the Committee recommends.** Providing a list such as the one presented in Table 13 below would fulfill the Committee's desire to articulate a recommended suite of demand management measures.

Table 13 – Recommended Water Conservation Measures

No.	Water Conservation	Included in Working Groups	Comments
1	System Water Loss Reduction		Project Initiated July 2015
2	Advanced Metering Infrastructure		
3	Large Landscape Budget-Based Water Rates	Yes	Identified in Peak Season Report as "Shifting Landscape Budgets Toward Climate Appropriate Irrigation Levels"; lower water budgets over time
4	General Public Information		
5	Public Information (Home Water Use Report)	Yes	Assume 3-5% savings
6	Residential Leak Assistance		
7	Single Family Residential Surveys	Yes	Identified in Peak Season Report as "Personalized Outreach to Highest Users and Generic Landscape Budgets"; combine with water budgets
8	Plumbing Fixture Giveaway/Opt		

9	Residential UHET Rebates		
10	High Efficiency Clothes Washer Rebates B	Yes	Alternative delivery/financing mechanisms
11	High Efficiency Clothes Washer - New Development		
12	Hot Water On Demand - New Development		
13	Toilet Retrofit at Time of Sale		
14	CII MF Common Laundry Room High Efficiency Clothes Washer		
15	CII Incentives	Partially	
16	Pre-Rinse Spray Nozzle Installation		Project Completed 2014
17	CII Surveys		
18	HEU Program		
19	Public Restroom Faucet Retrofit - MUN		
20	Public Restroom Faucet Retrofit - COM		
21	School Retrofit		
22	Water Efficient Landscape Ordinance		State mandated update due by end of 2015
23	Single Family Residential Turf Removal A	Yes, as part of "Climate Appropriate Landscaping and Rainwater infiltration	Recommend B (increased rebate amount)
24	Multifamily Residential/CII Turf Removal A		Recommend B (increased rebate amount)
25	Expand Large Landscape Survey/Water Budgets	Yes	
26	Sprinkler Nozzle Rebates		
27	Gray Water Retrofit		
28	Residential Rain Barrels		
29	Climate Appropriate Landscaping and Rainwater Infiltration		Includes requirement to convert spray to drip for shrub irrigation, prohibit spray irrigation in narrow areas. Rainwater infiltration component to be led by other City Department or agency
30	Conservation Pricing - Water and Sewer		Water rate project underway through separate contract with Raftelis Financial Consultants; conservation pricing for sewer service

31	Dishwashers	Not recommended by staff
32	Hot Water Recirculation Systems	Not included in Program C but worth reconsideration
33	Rewarding Businesses For Adopting Best Practices	Hotel laundry recycling one example; reduced curtailment level as reward
34	Additional Building Code Requirements for New Development	Some requirements already in place; urinals, dishwashers, graywater, pre-rinse spray nozzles
35	Innovation Incubator Program	Capitalize on local programs to support research and continue role as conservation innovators

5. **Acknowledge that a final estimate of conservation savings is subject to change pending completion of the Master Plan.** A contract amendment for a second phase of work on this project was approved by the City Council at its September 8, 2015 meeting. Work is scheduled to resume this fall and will include coordinating the consultant's DSS model with the latest demand forecast, adjusting model parameters based on input received from Committee members and the Water Commission, incorporating new measures with greater emphasis on peak season savings forwarded by the working group, and rerunning modeling scenarios. This will ensure consistency in how water savings and costs are estimated and help avoid speculation and/or double counting. In addition, staff has identified the need to revisit the sequencing and scheduling of measures listed in the latest version of Program C, and this will affect estimated savings. The final plan will, of course, be subject to public review and stakeholder input prior to its final adoption by City Council.

(b) Committee Agreement about Demand Management

At the Committee's meeting of September 10, 2015, the Committee agreed to the recommendations described in 3.15(a)above.

(c) Key Assumptions about Demand Management

The following are key assumptions about the Demand Management Program being recommended by the WSAC:

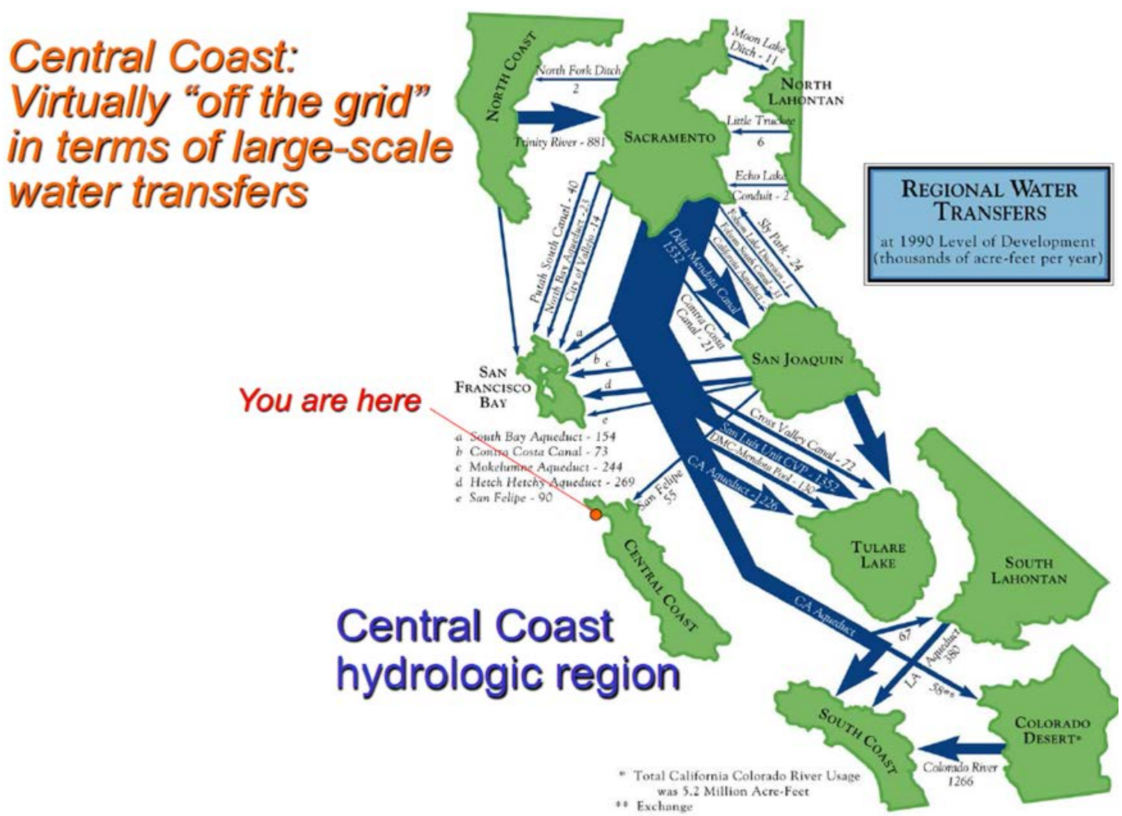
- The Econometric Demand Forecast includes significant demand reductions associated with the implementation of existing plumbing and building codes, the continuation of existing demand management programs (as a baseline) and as a function of the effect on demand of expected increases in water rates.
- A focus of new demand management programs will be on peak season demand reduction, which is also a significant focus of the expected demand reduction associated with anticipated price increases.

- New and enhanced demand management programs will be developed to build on the Water Department's current program that has contributed to reducing per capita demand in Santa Cruz to one of the lowest levels in the state.
- The programs to be implemented in the coming decade are a mix of lower cost and some higher cost measures. Those higher cost measures are meant as small-scale experiments that may be broadened if they prove popular and their costs decline over time. Together these measures incur an average total program cost of no more than $10,000 per million gallons of water saved. This figure is lower than the expected cost of supply augmentation projects recommended to be pursued as a result of WSAC's work.

Section 3.17 Supply Development

As described earlier, the Committee considered a wide range of supply augmentation alternatives during its deliberations. Figure 8tells a story that Committee members became very familiar with: Santa Cruz's options for developing additional supply are limited to options that are local. For better or worse, supply options in Santa Cruz are limited to demand management, capturing and storing surface water flows during the rainy season, or developing some form of either recycled water or desalinated water to augment existing supplies.

Figure 8 – California Regional Water Transfers[9]



[9] Figure courtesy of UCSC Professor Andrew Fisher

As the Committee worked through the process of defining the problem, and evaluating potential solutions during the winter and spring of 2015, they consistently identified winter water capture and storage through passive and active recharge emerged as an opportunity that made sense to pursue.

As previously described, the Committee's scenario planning and portfolio building efforts focused around both selecting supply alternatives and exploring the risks and uncertainties associated with the various options. During the Committee's work, the supply augmentation strategies that emerged included:

- Passive recharge of regional aquifers (in lieu);
- Active recharge of regional aquifers (aquifer storage and recovery – ASR);
- Some form of purified recycled water (indirect potable reuse or direct potable reuse); and
- Some form of desalinated water (local desalination or a regional project called DeepWater Desalination).

To help the Committee consider the effectiveness of the supply augmentation options they were most interested in pursuing, all of the options were evaluated using the Confluence model. The estimated Confluence model yields are shown in Table 14. The yields indicated are defined as the reduction in peak-season shortages that are realized when each element is fully operational, i.e., when all technical and institutional (legal, regulatory, public acceptance) uncertainties have been successfully resolved.

Table 14 – Estimated Peak-Season Yields and Remaining Shortages

	Worst Year			**Average**		
Element	**Peak-Season Yield**	**Remaining Peak-Season Shortage**		**Peak-Season Yield**	**Remaining Peak-Season Shortage**	
	mg	**mg**	**%**	**mg**	**mg**	**%**
Base Case	--	*1230*	*63%*	--	*470*	*24%*
In-Lieu	750	480	25%	350	120	6%
ASR	760	470	24%	380	90	5%
Combined In-Lieu, ASR	760	470	24%	380	90	5%
Rainfall-Independent Sources *	810	420	22%	440	30	2%
All Elements Combined	1230	0	0%	470	0	0%

* Either DPR, Deepwater Desalination, or Local Desalination.

The yield estimates are necessarily based on a variety of infrastructure and operational assumptions, including but not limited to:

- For both in-lieu storage and ASR, it is assumed that the maximum daily capacity to pump water from the aquifer and convey it to Santa Cruz is 4 million gallons per day (mgd). For ASR, it is assumed that the maximum ability to inject water is 5 mgd.
- For ASR, it is assumed that 80% of the injected water is recoverable. This is a function of assumed physical characteristics of the aquifers. For in-lieu, it is assumed that 60% of the water conveyed to neighboring water districts is available to Santa Cruz, a function of both assumed aquifer characteristics and the outcome of discussions with the city’s negotiating partners.
- For all of the rainfall-independent sources, it is assumed that the maximum available supply on any day is 3 mgd, which is based on the estimated availability of local wastewater (i.e., excluding Soquel Creek wastewater).
- In all cases, the modeling of these supply elements makes particular assumptions about how they will be operated in conjunction with current supplies.

Given these assumptions, none of the elements on its own completely eliminates all projected water shortages; however, each substantially improves water supply reliability. However, since it is likely that some or all of these and other assumptions will change as better information is generated regarding physical, operational, and institutional parameters, these yields will also undoubtedly change.

During the Committee’s scenario planning work, the idea of packaging together various demand management and supply augmentation measures into a portfolio or integrated strategy emerged as an effective way to deal with various kinds of uncertainties and unknown unknowns that are inevitably present in any kind of long range planning work.

Ultimately the Committee selected two basic strategies to pursue:

1. Strategy One: Development of groundwater storage using a combination of both passive and active recharge approaches and available surface water flows during the rainy season; and
2. Strategy Two: Development of purified recycled water or desalinated water if and as needed to address any remaining supply-demand gap.

Strategy One includes the following Elements:

- **Element 1** – in lieu, passive recharge of the groundwater aquifers with either or both the Scotts Valley Water District and the Soquel Creek Water District; and
- **Element 2** – aquifer storage and recovery, active recharge of the groundwater aquifers, with or without regional partners in regional aquifers.

Strategy Two includes the following Elements:

- **Element 3** -- purified recycled water to be used in either an indirect potable reuse or a direct potable reuse application, as the initial focus of Strategy Two approaches. In the event purified recycled water is eliminated from consideration, desalination would then become Element 3.

Section 3.18 Rationale for the Committee's Preference for the Groundwater Storage and Retrieval Strategy

Throughout the Committee's work in the spring and summer of 2015, it consistently demonstrated a preference for developing available winter flows as a supplemental supply. As the list below shows, the Committee's reasons for this preference were numerous and diverse.

1. Maximizes benefits of Santa Cruz's winter water.
2. Can contribute water to storage in most years – a lot wet years, yet even in dry years winter water is available store in local aquifers.
3. Can start returning water before the entire groundwater system is built out.
4. Can help reduce the threat of seawater intrusion.
5. Groundwater strategies are regional solutions. Regional solutions help the regional economy, and thus the local economy; they help the regional ecosystems, and thus the local ecosystems.
6. In lieu recharge strategies can start immediately with existing infrastructure (agreements already in place for winter 2015), and can grow over time.
7. Because each injection well acts as an independent and storage and recovery site, together they create a flexible, resilient and scalable system, not just for the groundwater strategy but for Santa Cruz's overall water supply portfolio.
8. Water stored underground is much less affected by current and projected increased levels of evaporation due to projected higher temperatures.
9. As aquifers are restored, base flows from groundwater to local creeks and streams will be improved and may offset some fish flow requirements.
10. It is politically acceptable.

Section 3.19 Infrastructure Constraints

As it the case with all water systems, the City of Santa Cruz water system's operation is limited by a number of infrastructure constraints. Chief among these is the inability of the Graham Hill Water Treatment Plant to efficiently treat waters with turbidities over about 15 nephelometric turbidity units[10] (NTU). Additional infrastructure constraints involve the limited hydraulic capacity and pressure constraints of the existing pipeline between the Felton Booster Station and Loch Lomond Reservoir. Another constraint that could further improve performance once the pipeline between Felton and Loch Lomond is replaced is the capacity of the existing Felton pumps.

[10] nephelometric turbidity units (NTU) is a measure of water clarity that is used in drinking water treatment and safe drinking water regulations.

In the recently completed Conjunctive Use and Water Transfer Phase II study report[11], the Graham Hill Water Treatment Plant turbidity constraint was identified as a potentially significant barrier to the idea of capturing and using winter flows for passive and active recharge of regional groundwater basins. That report laid out a phased implementation of in lieu (passive) recharge that would not require addressing the treatment plant constraints right away. The report also described various infrastructure improvements to both Graham Hill Water Treatment Plant and the Tait Street Diversion that would be required as winter water deliveries to Soquel Creek and Scotts Valley are increased.

During the Committee's scenario planning process, the technical team modified the Confluence model's operating parameters in order to assess how the water system would perform without infrastructure constraints. The Committee, City staff and the technical team gave the issue of infrastructure constraints considerable attention, and a range of possible approaches to addressing these problems was discussed.

In the "State of the Water System Report" provided to the Committee at its April/May 2015 meeting, City staff provided a high level overview of the deferred maintenance and major rehabilitation and replacement issues the system has and laid out a conceptual framework for a 15 year Capital Improvement Program (CIP) to tackle these issues. The CIP includes projects to address certain infrastructure constraints, such as the need for a replacement pipeline from Felton to Loch Lomond, but not others, like upgrades to the Graham Hill Water Treatment plant to allow it to treat higher turbidity water. The rationale for including the pipeline is that it is needed to improve system operation whether or not a winter harvest option is pursued. The need for other infrastructure improvements to address the higher turbidities of winter water, whether through the implementation of the treatment plant upgrades identified in the Conjunctive Use and Water Transfer report, or possibly the installation of Ranney collectors or other approaches, is dependent upon selection of a water supply augmentation strategy. Including such improvements in a long term CIP prior to the Committee having completed its work would not be appropriate.

While current infrastructure does allow some form initial regional cooperation efforts to get underway relatively soon, to fully utilize available winter water for in lieu and/or ASR will require substantial additional infrastructure. The minimum additional infrastructure requirements include creating an intertie with Scotts Valley, expansion of transmission capacity to Soquel Creek, and creating the infrastructure necessary to transfer water stored in aquifers back to Santa Cruz when needed during drought years.

Section 3.20 Operational Constraints

The Santa Cruz water system uses a variety of operating rules and practices to guide its daily operation. A utility's operating rules provide straight-forward and reasonable parameters for both operating the system and for modeling system performance.

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[11] Final Report, Conjunctive Use and Water Transfers – Phase II, May 2015
http://scceh.com/Portals/6/Env_Health/water_resources/Task%206%20Report%20051215%20clean.pdf

Most of the City's operating rules and practices have developed over time and are based on experience operating the system. A major influence underlying the operating rules is that avoiding problems is more effective than dealing with their consequences after the fact. Some of the key operating constraints have been incorporated into the Confluence Model to help insure that system modeling results reasonably represent reality.

The WSAC examined operating rules and constraints that limit the water system's ability to provide water. During the dry season, the key constraint is the existing operating rule curve for Loch Lomond drawdown. During the rainy season, the key constraints were related to taking first flush water and dealing with turbidity levels over 15 NTU, whether for treatment at the Graham Hill Water Treatment Plant or to send to Loch Lomond to store in years when winter precipitation is not expected to fill the reservoir.

The technical team explored modifying the operating parameters using the Confluence model to simulate different operating rules. A number of recommendations for change and further evaluation were developed. Of those, two particular operating constraints stand out: the rule curve used to operate Loch Lomond, and the first flush constraint for sending water from Felton to Loch Lomond.

The existing Loch Lomond rule curve is designed to keep about a billion gallons of water in the reservoir as drought supply for a potential third year of drought conditions. When modeling the system, the Confluence Model currently runs the system to ensure that on October 31st of the second year of a drought, the reservoir still has one billion gallons remaining in storage. This constraint could potentially be relaxed in the event the City develops additional storage. The first flush constraint is designed to allow a sufficient quantity of water to bypass the City's Felton Diversion on the San Lorenzo River to avoid introducing large quantities of nutrients and pathogens into Loch Lomond. In critically dry years the quantity of water needed to meet the first flush criterion, 48 hours at 100 cubic feet per second or greater, may never be achieved. If this criterion can be relaxed without threatening Loch Lomond's water quality or ecosystem health, the additional water diverted to Loch Lomond during dry years could have significant benefits in reducing the size of worst year shortages.

Bearing in mind the complexity of Loch Lomond's ecosystem and the need to avoid creating a problem that would likely be time-consuming and expensive to solve, the potential supply enhancing benefits of changing any of these constraints make it worthwhile to seriously explore this matter over the coming years. If it is feasible to modify this operating constraint, the fix may entail operational changes, infrastructure modifications, or both.

Section 3.21 Agreement on Elements of the Water Supply Augmentation Plan

As WSAC proceeded, the focus was on both what the plan should include and how it should be implemented. As had been the case during the Committee's scenario planning and portfolio building work during the spring and summer of 2015, the Committee found it relatively easy to coalesce around groundwater storage strategies, but more challenging to build agreement around whether or how it might make sense to include additional supply augmentation measures.

Beginning with the Committee's July 2015 meeting, the WSAC began developing an adaptive management plan that would be used to guide the implementation of the Plan. Through the August and early September 2015 meetings, the Committee continued to solidify its agreement about the elements of the Plan, while recognizing that final agreement would be based on both what the plan elements were as well as how the plan would be implemented. At its September 11, 2015, the Committee agreed to the following Plan elements, contingent on the Committee also reaching agreement on the implementation plan and adaptive management strategy.

Element 0: Demand Management, with a goal to generate an additional 200 to 250 million gallons of demand reduction by 2035 from expanded water conservation;

Element 1: In-Lieu, which starts quickly as a small program relying on existing infrastructure to provide potable water to the SqCWD. The program is intended to grow over time, if/as additional infrastructure is developed and additional agreements are reached with SqCWD and SVWD. Issues of how capital costs would be shared and water returns to Santa Cruz would be addressed in these agreements.

Element 2: Aquifer Storage and Recovery (ASR), involves development of a program to inject treated water from available winter flows into regional aquifers and recover a large portion of the stored water as a supplemental supply for Santa Cruz. This program would proceed through evaluation and piloting steps as detailed in technical reports (e.g., the May 2015 Pueblo Water Resources report) and, if successful, can be implemented on a scale sufficient needed to meet the yield goals of this Plan .

Element 3: Purified Recycled Water, is intended to supplement or replace Elements 1 and 2 to the extent they do not generate sufficient yield to fill the supply/demand gap.

In addition to developing Elements 0, 1, 2 and 3 above, the Committee suggests that the City should continuously review and take steps to address infrastructure and operating constraints that are keeping the existing system from performing as well as it could, within reason. Specific suggestions to be pursued are included in the recommendation section of this report.

Section 3.22 Implementation Strategy Options

Following the August 2015 Committee meeting, staff and the technical team worked to lay out a phased implementation plan for in lieu and ASR. The purpose of this task was to provide Committee members with a way to visualize how a staggered plan might actually be implemented, and to support a more thorough discussion of implementation strategy options.

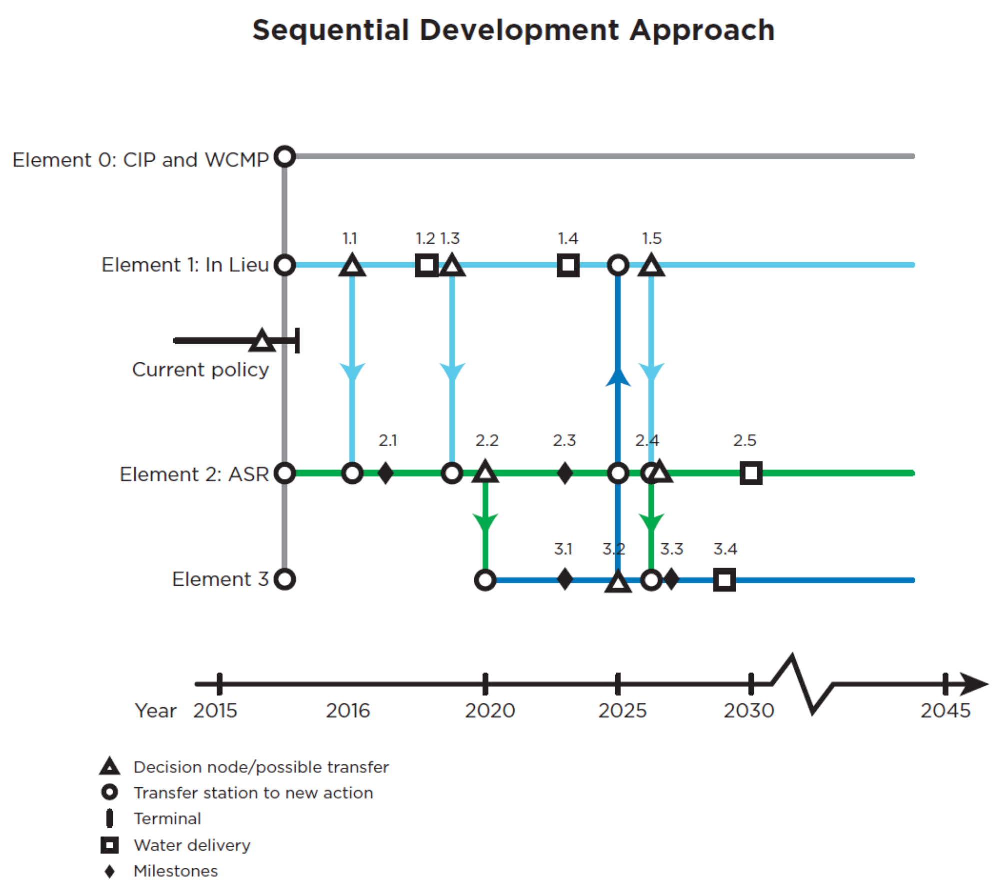
As they mixed and matched supply augmentation strategies, the Committee also considered how measures in the portfolio would be implemented. The technical team provided the Committee with a useful model for thinking about both potential implementation options and adaptive management drawn from work done in the Netherlands (see https://www.deltares.nl/en/adaptive-pathways/). (See Figure 9 for a sample adaptive pathway.)

As part of developing both the Committee's implementation and adaptive management strategies, the WSAC evaluated several implementation approaches, including sequential, staggered and parallel. Each approach is briefly described below.

- A sequential implementation plan would involve working on Priority One approaches until they either succeeded or failed. Only if these approaches fail to meet the yield target would Priority Two approaches be pursued.
- A staggered implementation plan involves advancing work on Priority One approaches to demonstrate their effectiveness, while simultaneously doing some work on Priority Two approaches with a goal of shortening the time required to produce water from a Priority Two approach should Priority One approaches not prove successful.
- A parallel approach would involve moving forward on both Priority One and Priority Two strategies with a goal of pursuing both types of projects and significantly enhancing the City water system's reliability and robustness.

Figure 9 provides an example of an adaptive pathway for the sequential implementation approach.

Figure 9 – Example of a Sequential Implementation Adaptive Pathway



There are two types of decision nodes used in the adaptive pathways: Start and possible change direction points are shown by open circles and in project transition points between one phase of the work and the next are shown by open triangles. Opportunities for initiating work or reviewing progress and making changes, either in the form of adjustments or as a result of assessments occur at these decision nodes. As an additional parameter, the Committee decided to develop thresholds that would act as triggers for considering either adjustments or assessments. The Change Management Strategy, including further information on adjustments, assessments, and thresholds, is presented in more detail in 0.

Section 3.23 Developing a Change Management Strategy

At the same time as the Committee was developing the implementation strategy, they were also thinking about how to deal with decision-making and dealing with the new and changing information that is developed as the plan or project is implemented.

(a) Exploring Example Change Management Approaches

The Committee had explored several types of strategies used by others in setting up a policy and/or procedural framework to guide implementation of various kinds of plans over time. Included in this review were several specific examples of different approaches to developing policy or implementation frameworks. The most relevant examples are listed below:

- Borrego Water Coalition Recommendations on the Groundwater Sustainability Plan being developed by the Borrego Water District.
  - Example of: Policy recommendations with phased in reduction in water production to improve groundwater sustainability and specific incremental performance targets http://www.borregospringschamber.com/bwc/documents/2014/BWC%20Policy%20Recs%20FINAL%2011-06-14.pdf
- Clackamas River Hydro Relicensing Settlement Agreement/Agreement in Principle – Fish Passage Provisions with performance based phased in of fish passage measures:
  - Example of: Performance Benchmarks used in determining additional actions, in this case, additional measures to improve/enhance the success of fish passage at a hydroelectric dam facility.

    For details of the A, B, C and D measures called for as part of the performance based implementation of fish passage improvements, see Clackamas Agreement in Principle (AIP) document, Section II – Downstream Fish Passage Measures. This section begins on page 3 and goes to page 11 of the Agreement in Principle Fish Passage and Protection Plan that is embedded in the larger document. Using the pdf document page counter, typically found in the upper left hand area of the screen, this section starts on page 39 and goes to page 47.

    Additional Information: General information about Portland General Electric's Fish Protection

Programs: https://www.portlandgeneral.com/community_environment/initiatives/protecting_fish/clackamas_river/default.aspx

- Owens Lake Dust Control – Section 5 – Framework for Resource Protection Protocols (RPP) including criteria, monitoring, indicators, triggers, and actions, significant impact thresholds, and mitigation measures.
    - Example of: Outcome oriented performance criteria; performance measurement; tiered (incremental) action oriented steps to take if performance metrics are not being met; and significant impact thresholds with required mitigation. https://owenslakebed.pubspsvr.com/masterproject/Master%20Project%20Document%20Library/Advisory%20Committee/April%202015/Owens%20Lake%20MP%20Advisory%20Committee%20Recommendations%20to%20LADWP.pdf (Section 5 starts on page 28 of the pdf that opens at this link.)

Two common themes of these examples are the idea that implementing plans is an inherently adaptive process and that, within reason, it is feasible to lay out an approach to making future decisions that maintains the integrity of the agreements on which the plans were based.

By the early summer of 2015, the WSAC understood that the planning level information available was not going to be adequate to allow them to make recommendations that would not need to be adjusted or adapted as the City acted to implement them. The Committee acknowledged that questions would arise about how to proceed when new information became available and concluded that developing a Change Management Strategy, and especially guidelines and principles that reflected their values and priorities, was as important as agreeing upon the portfolio of measures to recommend to the Santa Cruz City Council.

Section 3.24 WSAC's Change Management Strategy

A major goal of the WSAC's Change Management Strategy is to establish well understood mechanisms for dealing with changes that will need to be made to the plan over time. Without a doubt, the success of whatever is done to implement the proposed plan is dependent upon a high degree of both transparency and accountability. The Change Management Strategy the WSAC has developed is specifically designed to facilitate that success.

(a) The Plan-Do-Check-Act Cycle

The basic premise of the WSAC's Change Management Strategy is that developing and implementing any plan, and the projects within a plan, is a cyclic activity that involves planning, doing, checking and acting (PDCA). Figure 10 shows this cycle and describes each part.

Figure 10 – Plan, Do, Check, Act Cycle[12]

Plan–Do–Check–Act Procedure

1. Plan. Recognize an opportunity and plan a change.
2. Do. Test the change. Carry out a small-scale study.
3. Check. Review the test, analyze the results and identify what you've learned.
4. Act. Take action based on what you learned in the study step: If the change did not work, go through the cycle again with a different plan. If you were successful, incorporate what you learned from the test into wider changes. Use what you learned to plan new improvements, beginning the cycle again.

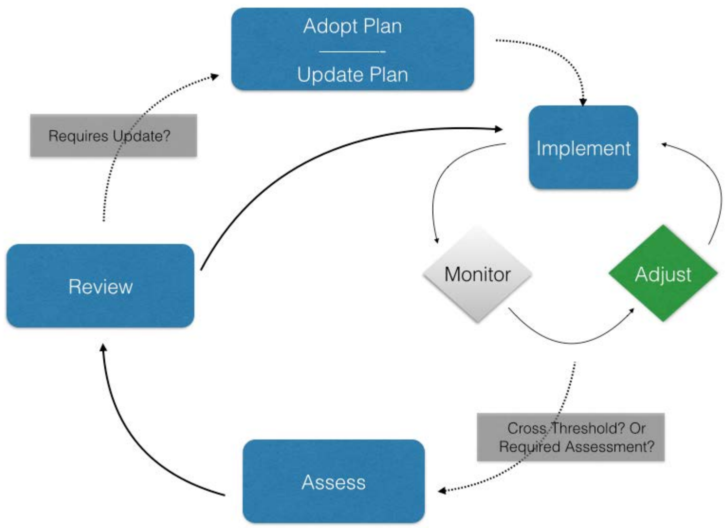
This cycle is perfectly designed to incorporate new information and well adapted to the circumstances involved in implementing the Water Supply Augmentation Plan (Plan).

The elements of the WSAC's Change Management Strategy include the following:

1. A Plan-Do-Check-Act model specifically adapted to the work being planned;
2. An Adaptive Pathway framework for implementing the three main supply augmentation elements
3. Guiding Principles reflecting the WSAC's values and priorities;
4. Procedures for implementing the strategy, including roles and responsibilities for Water Department staff and the Water Commission as they work with the Council on the issues and initiatives covered by the plan; and
5. Guidance for Decision-Making.

Figure 11 is a visual depiction of the Change Management Process WSAC developed:

Figure 11 – WSAC Change Management Process



This framework actually incorporates a smaller PDCA cycle within the larger PDCA cycle. The larger PDCA framework functions in concert with the adaptive pathways and mostly relates to adaptive decisions that would need to be made to switch from one path to another. The smaller PDCA cycle is shown on the upper right of the figure above as the "Implement, Monitor, Adjust" cycle and would be used for identify needed adjustments while implementing the various Plan Elements that are part of the Plan. For example, as in lieu and ASR are being developed, their progress in meeting their project goals would be monitored. An adjustment would be needed if, for example, eight wells were needed to produce the desired yield instead of the six originally estimated. The sections below present the parameters and mechanisms the WSAC developed to guide the implementation of the Water Supply Augmentation Plan (WSAP).

(b) Definitions and Context

The WSAC's Change Management Strategy was built around several specific definitions and application of concepts. This section provides the definitions and context used in the Change Management Strategy and the circumstances under which the various adaptation approaches would be used.

1. An **Adjustment** is a change in implementation that helps the plan stay on track. In a continuous feedback loop, Water Department will make adjustments to help achieve (or exceed) performance targets for the various plan elements.

2. A**n Adaptation** is a shift from an Element or a set of Elements to another Element or set of Elements within the Plan's Adaptive Pathway. An adaptation may be recommended when certain thresholds are reached.

3. **Guiding Principles** are policy and value based provisions that are taken into account in decision-making along with the other information to be included in decision making and described elsewhere in the Change Management and Adaptive Pathways strategies.

4. A T**hreshold** is the set of information that leads to assessment of the Plan and possible adaptation. The Committee identified thresholds for the key issues that need to be considered during decision-making about a possible Adaptation. The goal was to avoid trying to address each possible eventuality, and focus on overall program goals rather than implementation specifics. Once a threshold issue has prompted an assessment, other considerations, such as regional collaborations or the collateral benefits of an approach, may be taken into consideration. The identified thresholds include:
   - cost
   - time
   - yield

4. **Performance Metrics** are developed and used to assess how well individual Elements are tracking against their performance targets as reflected in the adaptive pathway decision nodes. As work on implementing the Plan Elements goes forward, tracking performance will generate information that will be used in several ways:
   a. Greater understanding about the system from management activities, technical work, pilot testing and modeling results and other work.
   b. Ongoing cycles of monitoring and adjusting may help the Department keep the Elements moving forward to achieve their goals and determine when and how Adjustments might affect overall goals or when Adaptation may be appropriate.
   ~~c. In general, ongoing feedback and correction within a set of Elements relates to Adjustment, not Adaptation. However, a gap between original performance targets and revised performance projections could trigger an assessment and an eventual adaptation within the Plan.~~

   The Committee had a chance to learn about the potential Performance Metrics that would be used in assessing Element 2, ASR, through all of its developmental phases. Further work will be needed to develop Performance Metrics for other Plan Elements.

5. **Catastrophic Events (**or other exogenous events), such as earthquakes or wildfire could disrupt the plan. Catastrophic Events are low probability/high consequence events.

(c) Guiding Principles ~~elines, Principles and Considerations~~

The Committee recommends that the following Guiding Principles be taken into account in all applications of the Change Management Strategy:

- **Public Health** – public health protection is every water utility's "prime directive." The SCWD, as an organization, and as individual employees, work every day to deliver an adequate and high quality supply of water for human consumption, sanitation, other domestic and commercial use and for fire protection.

The WSAC recognizes that some of the supply augmentation alternatives raise public health concerns for community members. The Committee recommends that an approach to addressing public health protection issues related to purified recycled water be developed and implemented as part of any program to developed a purified recycled water supply for use by Santa Cruz water service customers.

- **Public Acceptance** –The Committee was aware the most important reason for convening the WSAC was to address the issues of the public's concerns about the proposed desalination plant. The Committee is also very aware that public acceptance issues were raised during the WSAC process about overall costs, energy consumption, schedule for implementation and perceived public health issues associated with purified recycled water.

  The WSAC has, throughout its process, created and applied criteria reflecting the community's values. along with the yield, costs and technical feasibility of various supply augmentation alternatives, the committee also considered energy use, environmental impacts and public health implications of the alternatives it has considered. accordingly, these considerations and criteria should be taken into account in the future decision-making anticipated by the Change Management Strategy.

- **Regional Collaboration** – Where consistent with the goal of achieving a sufficient water supply, the City should act to maximize regional collaboration, synergies or collateral benefits, including, but not limited to, assisting neighboring communities to address their water supply issues, reversing or slowing seawater intrusion and habitat and fishery restoration.

- **Plan Goal**: The Committee agrees that, to improve the reliability of Santa Cruz's supply using groundwater storage, an additional 3 billion gallons of water needs to be stored in regional aquifers in a timely manner. (Using estimates developed during the Committee's planning work, storing 3 billion gallons would result in 2.4 billion gallons (80%) being available for use as drought supply.) This additional storage, along with other measures outlined in the Plan, would provide water needed to meet a worst year peak season shortage of 1.2 billion gallons.

(d) Change Management Strategy

1. As the Water Department implements this Plan, the Committee recommends that staff apply the following Committee agreements in making adjustments and recommending adaptations:
   a. For Adjustment:
      i. ~~Diligently implement the groundwater storage strategy.~~ When implementing Plan Elements related to groundwater storage, the City will take all reasonable and necessary steps to explore and demonstrate the technical feasibility of these approaches.
      ii. In addition, the City will adopt and implement communication practices that support the goals of transparency and accountability of communications about ~~of "over-communicating" progress, performance and~~ any Adjustments or Adaptations.

   b. For Adaptation:

i. Prefer groundwater storage strategies. Before making a choice to move away from groundwater storage, diligently explore all reasonable attempts to make the groundwater strategies work.

ii. Should the choice need to be made between options available within Element 3, the Committee's preference is for purified recycled water, rather than desalination, which is estimated to cost more and use more energy than at least some of the versions of purified recycled water. This preference is based on the fact that the Committee viewed recycled water as more sustainable than desalinating seawater and therefore more aligned with the community's values. However, if it is projected that recycled water cannot provide sufficient yield to eliminate future shortages, then desalination is should be pursued.

iii. System robustness, resilience, redundancy, and adaptive flexibility are important values.

2. Thresholds

Thresholds are an important element of the overall Change Management Strategy. The Committee developed its agreements based on assumptions and information available to it at the time it did its work and recognized that new information would be developed as the Plan is implemented. Establishing thresholds (which could, themselves, be updated as new information is developed and analyzed) gave the Committee a way to provide parameters within which to continue developing a an Element as well as clear sign posts for when the Plan or an Element might be failing to perform as anticipated. Exceeding a threshold value would not necessarily result in stopping a program or project, but would trigger an assessment. There are three key types of thresholds:

1. Cost
2. Yield
3. Timeliness

For several of these thresholds there is no fixed number or value. This is because for items such as cost and timeliness, the threshold value is necessarily relative to the other options available at the time the threshold is reached. The achievable schedule for implementing the Elements will become clearer as additional work is done. At a decision node, the most up-to-date information should be considered.

The Committee understood that new information would be being developed as the Plan was implemented and therefore what was important was to set the threshold metric rather than the threshold value. And, in addition, the Committee understood that numbers produced by planning level analyses cannot be considered exact and thus applying an acceptable range around a threshold metric would be an appropriate way to express the Committee's values and provide flexibility in implementing the Plan.

While thresholds may operate as independent triggers for an assessment, once an assessment is undertaken it would look at each Plan Element's status as it relates to each of the thresholds as well as to the Guiding Principles. Taking this more comprehensive approach to the Assessment is intended to avoid unintended consequences that could result from applying a more narrow focus.

i) Cost Metric

Cost-effectiveness is an important consideration in making pathway changes. In considering cost, the Committee recommends that a threshold cost metric be created based on the annualized cost per million gallons of yield. To support this analysis, the Committee selected a Cost Metric.

The Cost Metric is a calculated value for each Strategy and/or Element and is intended to be used by decision-makers in evaluating and comparing the cost-effectiveness of Strategies and/or Elements. For the Cost Metric, the Committee agreed a good metric would be the annualized cost per million gallons of yield for the average year. This metric uses both the amortized cost of capital investments plus the annual operating and maintenance cost and divides it by the estimated yield of the project for the average year.

The Committee selected this metric because it is representative of the annual cost that would be passed on to rate-payers and is also the predictor of the additional yield that would accrue to system users.

ii) Committee Value Statement Related to Cost

Recognizing the cost differential between some of the strategies the Committee considered in developing its recommendations, the WSAC wanted to express its value for the Strategy One, groundwater storage and retrieval over Strategy Two, and has agreed that as long as implementation of Strategy One does not cost more than 130% Element selected for Strategy Two, Strategy One should be pursued.

iii) Yield Metric

The Yield Metric is the most straight-forward, the most quantifiable, and the least flexible of the thresholds. As described in some detail earlier in this document, the supply-demand gap has been established at 1.2 bgy for the worst year, based on Confluence modeling of the frequency and severity of shortages. The analysis takes into account DFG-5 fish flows and a plausible ~~-~~estimate of climate change impacts.

~~While yield calculations can be readily performed for various supply augmentation projects or demand management programs, u~~Updating the supply-demand gap requires both new demand forecasts and the kinds of analyses described earlier in Sections 3.06 and 3.07. ~~Because annual variability can be so great, it doesn't make sense to redo these analyses frequently. However, they must be updated~~ This analysis will be refreshed every five years as part of the Urban Water Management Plan update. ~~From a planning perspective, this interval is relatively short and allows for the timely revision of these key parameters.~~

~~There is much to consider when thinking about putting a hedge factor on the Yield Metric. On the one hand, adding a +/- 10 or 20 or 30% factor to this goal could result in a significant shortfall if the projects~~

~~underperformed or a significant over-expenditure of limited resources if investments were made that produced more yield than needed. On the other hand, mega-droughts or climate change that are more or less severe than modeled in this planning process could result in revisions to the Yield.~~

~~The Committee did not have time to include in its evaluation an analysis of the City's existing policy on system reliability. This policy was developed during the preparation and review of the Integrated Water Plan in 2003. The policy provides that the system be designed to ensure that no water shortage exceeded 15%. The Committee agreed that reviewing this policy and recommending any changes should be undertaken as part of the Water Department's ongoing planning work. Once this work is complete, it will be feasible to appropriately adjust the Yield Metric if and as needed.~~

iv) Timeliness Metric

For the Timeliness Metric, the Committee has agreed that a 10-year window is a reasonable target to see a significant improvement ~~and a clear trend~~ in the reliability of Santa Cruz's water supply and to demonstate that we are clearly on track to achieving water supply sufficiency. ~~The Adaptive Pathway map identifies several key opportunities for producing additional supplies during this period and the Change Management Strategy emphasizes the City pursuing implementation of the plan with diligence.~~

(e) Assessments, Reviews and Update to Plan

1. Procedural Steps
    a. An **Assessment** is performed by the Water Department and includes updated information and a recommendation about whether a change to the Plan is needed.
    b. The Water Department submits a report to the Water Commission for its **Review, including development of recommendations to the Council**. Following Water Commission action, the recommendation is forwarded to the Council for its consideration.
    c. If the Council so chooses, the Plan will be **updated**.
2. Information Sharing
    a. The Water Department will report to the Water Commission and the City Council
        i. At all decision nodes identified in the Plan;
        ii. Informally, as part of the Water Director's Oral Report at each Water Commission meeting, providing specific information about work in progress, successes and failures, and challenges and opportunities;
        iii. Quarterly in the spring, summer and fall, as an agenda item with accompanying staff report on the Water Commission agenda for discussion, public comment, and action as needed; and
        iv. Formally and annually to the Water Commission and the City Council in the winter of each year during the budget cycle, including Plan performance and significant adjustments
    b. As part of the Water Commission's and City Council's review of an updated Urban Water Management Plan, including
        i. Performance
        ii. Significant adjustments

iii. Updated Plan Goals and Assumptions (including demand, climate change, systems improvements etc.)

3. If the Water Department recommends an adaptation, such a report must contain a synthesis of each Strategy and/or Element's actual performance or most current projected performance against the most current Thresholds and an evaluation of whether the performance of individual Elements warrants making a change to the Plan as a whole, or to one or more Elements within the Plan.

(f) Staggered Adaptive Pathway and Decision Nodes

At its September 10, 2015 meeting, the Committee agreed to use a staggered implementation approach. Figure 11 shows the agreed-upon adaptive pathway map, and Table 15, which follows, lists the numbered decision nodes and provides descriptions about the expected information, decision, or result anticipated at that node.

Figure 12 – Agreed Upon Staggered Adaptive Pathway Map

Figure 12 is under construction

Table 15 - Overview of Decision Nodes and Related Milestones along Adaptive Pathway Diagram *final draft of 25 Sept 2015*

NODE	ABBREVIATED DESCRIPTION	Duration/ Ending Year
In-Lieu (Element 1)		
1.1D △	Completion of near term water transfer/sale to SqCWD using North Coast water; agreements in place, any water rights issues resolved, CEQA and infrastructure issues dealt with.	<1 year (2016)
1.2M ◇	Understanding the feasibility of a larger water transfer/exchange project with SqCWD and/or SVWD using North Coast and San Lorenzo River waters. Includes affirmation of potential for sufficient return of in-lieu water (using groundwater models) from SqCWD and/or SVWD to Santa Cruz as well as understanding of water rights and agency-collaboration.	3+ years (c. 2019+)
1.3D △ □	Completion of agreements specifying terms of transfers to/from SqCWD and/or SVWD, water right modifications, planning/prelim design and CEQA. Decision point for proceeding on infrastructure improvements at diversion(s), GHWTP, pipelines, pumps, etc., to SVWD and/or expanded to SqCWD.	4 years (c. 2019)
1.4W □	Potential for some additional return of water from SqCWD, and/or SVWD, to SCWD with the identification and construction of infrastructure/treatment improvements described above.	7+ years (c. 2022)
1.5D △ ■	Assess in-lieu performance: amount to SqCWD, SVWD, and SCWD; reduced groundwater pumping, groundwater elevations, etc.	10+ years (c. 2025)

Aquifer Storage and Recovery, ASR (Element 2) Includes evaluation of Purisima and Santa Margarita		
2.1M ◇	High level feasibility work: use of groundwater model; completion of site specific injection capacity and geochemical analyses; development of pilot program.	~2 years (c. 2017)
2.2D △	Completion of all administrative items to conduct pilot testing (e.g., CEQA/permits/agreements and well modifications), completion of pilot testing, and assessment of probable ASR system performance, cost and schedule to complete build out of ASR system.	5 years (c. 2020)
2.3M ◇ □	Develop/construct ASR wells, ready to operationalize. Timing may be flexible depending upon number & location of wells.	8 years (c. 2023)
2.4D △□	Assess ASR performance against projections and ability to meet project goals.	10+ years (c. 2025)
2.5W ■	Aquifer storage target of 3 BG attained (ability to sustain return flows to SCWD at desired levels). Timing will be refined with groundwater modeling; there will likely be a ramp up period prior to 2030.	15+ year (c. 2030)
Rainfall-Independent Option (Element 3)		
3.1M ◇	Identify recycled water alternatives; increase understanding of feasibility of recycled water (regulatory framework, public outreach and education)	1 year (c. 2016)
3.2D △	Select preferred approach for Element 3 (e.g., DPR, IPR, desal) Initiate feasibility studies, demonstration testing, preliminary design, CEQA process; Continue public outreach and education.	2 years (c. 2017)
3.3D △	Preliminary design, CEQA, and permitting activities.	5 years (c. 2020)
3.4D △	Complete property acquisition, design, CEQA and permits.	7 years (c. 2022)
3.5W ■	Complete construction; plant start-up, water production begins	10 years (c. 2025)

Abbreviations

ASR = Aquifer Storage and Recovery
CEQA = California Environmental Quality Act
DDW = Division of Drinking Water
DPR = Direct Potable Reuse
GHWTP = Graham Hill Water Treatment Plant
IPR = Indirect Potable Reuse
SCWD = Santa Cruz Water Department
SqCWD = Soquel Creek Water District
SVWD = Scotts Valley Water District

Notes

- This document is intended as a companion piece to the implementation Gantt chart and subway map. Gantt chart contains additional activity detail(s) for each node.
- Node types
  - D = decision node (triangle on subway chart)
  - M = milestone (diamond on the subway chart), furthering the understanding of feasibility.
  - W = water production potentially available (squares on the subway chart; open square indicates some water; solid square represents full goal being met).
- Node types have been assigned based on a set of assumptions as to how the implementation will proceed. However, if a threshold is being tripped, the node becomes a decision node regardless of its current designation.
- Duration/Ending Year refers to the timeframe, starting in 2016, after which all work associated with achieving goal(s) will be accomplished. Values shown are approximate based on current information and project understanding. Values may adjust depending on: volumes of water available due to winter precipitation levels (which may limit amount of in-lieu and ASR); ability to establish agreements, permits, etc.; and ability to implement workload. Nodes 1.5, 2.5 and 3.5 may shift forward or backwards in time. It is understood that a backwards shift would be considered if the project were progressing in a way that indicated success only at a slightly delayed date.
- Selection of the preferred Element 3 will depend, in part, on what the CA Division of Drinking Water (DDW) issues in late 2016 regarding a framework for DPR regulations. Potable reuse may entail either DPR, IPR with water pumped up to Loch Lomond, or IPR using regional aquifers for recharge or seawater barrier. All the potable reuse alternatives are likely to entail the same basic treatment process train for the water purification facility (with a potential additional process step for DPR).
- December 2016, DDW issues framework for anticipated development of DPR regulations.
- Implementation of Element 3 based largely on the outcome of pilot testing for ASR and/or the outcome of ASR performance assessment.

As noted in earlier discussions, thresholds represent "special decision nodes" that can be reached by any Element, at any time.

(g) Guidance for Decision-Making at Decision Nodes

~~Although the ultimate Plan could contain many points of consideration and possible path changes, they boil down to a small number of decision types.~~ This section provides guidance for decision-making. ~~some detail about the kinds of decisions likely to be faced and provides some examples of how they would be approached, including the kinds of issues that would be considered, at the point when a decision is made. The goal of this guidance is to recognize that most of the decisions that will include a variety of inputs and considerations.~~

When a decision node on the adaptive pathway map is reached, or when the Plan or any Element is approaching exceedance of a threshold value at any time, the Committee's Change Management Strategy recommends a "pause and assess" step. At this juncture, there are three basic kinds of decisions:

1. A decision to stay on the same path;
2. A decision to add another path or paths; or
3. A decision to switch to a different path or paths.

A decision to stay on the same path may include consideration of a range of actions. A decision to continue to the next phase in the Plan's development could involve, for example:

- moving from preliminary engineering to design, or
- expanding an Element by deciding to make additional infrastructure investments, or
- deciding not to put additional money into an Element or approach that is struggling but maintaining the production already developed.

In general the possible decisions associated with the staying on the same pathway include:

- Start planning and/or pilot testing;
- Start preliminary engineering and/or regulatory and permitting processes;
- Start final design
- Start construction
- Build out or scale up
- Stop further investment
- Operate and maintain
- Stop pursuing altogether

A decision to switch to a different path or paths may result from concluding that a particular task cannot be accomplished, for example not reaching agreement with other regional water providers for in lieu recharge, or from failure to meet exceeding a threshold.

Recommended factors to be taken into account in decision-making about Plan implementation include the Principles, Guidelines and Considerations as well as how well Plan Elements are performing relative to their Performance Metrics or Thresholds.

i) Specific Examples of Decision Guidance or Special Considerations for Adjustments, Adaptation or Decision-Making at Specific Decision Nodes. (refer to Table 15 for details about decision nodes).

- **Element 1, Decision Node 1.3**
  - Build Out Element 1 – If agreements with one or more regional partners are reached, water rights issues have been resolved, and assumptions about the availability of river flows are confirmed, and groundwater modeling indicates sufficient water will be returned to Santa Cruz in a cost-effective manner, then proceed to build out water transfers up to the original design limits of Element 1, adding additional infrastructure as needed to optimize project effectiveness.
  - Stop Element I – If no agencies choose to participate with the City in pursuing in lieu recharge, including return of sufficient stored water in a cost-effective manner, the City will evaluate whether Element 1 should pursued further or abandoned.

- **Element 2, Decision Node 2.2**
  - Build Out Element 2 – Use results of pilot testing and estimates of cost-effectiveness and schedule for final system build-out to decide whether to continue implementing ASR up to the original design limits of Element 2.
  - Stop Element 2 – Consider stopping Element 2 if the solution is not working within acceptable performance parameters, for example, something systemic to the aquifer appears to make all test sites unsuccessful in effecting aquifer recharge, or costs greatly exceed budget, or schedule for final build-out is excessively long, and other Elements can meet or exceed their performance parameters, such that the Plan can meet its goals without Element 2.
- **Element 3, Decision Node 3.2** – Select preferred approach for Element 3 (e.g., DPR, IPR, desalination), initiate feasibility studies, demonstration testing, preliminary design, CEQA process; continue public outreach and education.
  - Start Preliminary Design Engineering for Element 3 -- Conduct feasibility studies and preliminary designs of, and continue public discussions about the selected Element 3. This effort involves activity up to, but not including, site acquisition, final design and EIR (draft EIR only at this stage). A key goal of the work would be to have element 3 ready to go into the final design stage at node 2.2.
  - Stopping Element 3 -- Decide to stop Element 3 if other Elements can meet or exceed their performance parameters, such that the Plan can meet its goals without Element 3.

As each decision is made, thresholds, performance metrics developed for each Strategy and/or Element , including budget, schedule, and objective, results oriented measures, would be reviewed and changes made either within the **Adjustment** framework by the Water Department, or within the **Adaptation** framework in collaboration with the Water Commission and under the direction of the City Council. In both cases, communication about progress, issues, and actions would be open, frequent and data based.

Section 3.25 Article III Summary – listing of all Committee Agreements

To be added.

Article IV. Recommendations

Section 4.01 The Water Supply Augmentation Plan

The Committee has worked on developing a Plan that would either eliminate or be well on its way to eliminating future water shortages by 2025. The key to achieving this goal is effectively marrying together the concepts and parameters of both the adaptive pathways implementation approach with the Change Management Strategy. The focus of the adaptive pathway is that it highlights and defines what decisions are likely to need to be made, defines at a high level the nature of the information that will be available to support decision-making and identifies when that decision is likely to occur. The Change Management Strategy, on the other hand, provides guidance about how to make the decision.

The agreed upon Water Supply Augmentation Plan (Plan) includes:

1. Certain goal for **Yield**, as well as the assumptions underlying this goal
2. A Timeframe for improving the reliability of the Santa Cruz Water Supply;
3. The **Water Supply Augmentation Plan Elements**;
4. An **Adaptive Pathway** to provide a structure within which work on the Elements can be pursued and evaluated; and
5. A **Change Management Strategy** useful for guiding adjustments and adaptations within the Plan, as described below.

Section 4.02 Yield Goal

The Committee recommends the City implement additional demand management and supply augmentation programs and projects and address key infrastructure and operating constraints to reliably make available an additional 1.2 bgy during modeled worst year conditions.

Section 4.03 Timeframe for Improvement

The Committee recommends that the City adopt a goal of completing the improvements to Santa Cruz water supply necessary to meet the specified yield goal by the end of 2025;

Section 4.04 Water Supply Augmentation Plan Portfolio Elements

The Water Supply Advisory Committee recommends that the City Council adopt a portfolio of measures for improving the reliability of the water supply. The recommended package includes the following elements:

- **Element 0:** A goal of achieving an additional 200 to 250 million gallons of demand reduction by 2035 by expanding water conservation programs;
- **Element 1:** Passive recharge of regional aquifers by working to develop agreements for delivering surface water as an in lieu supply to the Soquel Creek Water District and/or the Scotts Valley Water Districts so they can rest their wells and help the aquifers recover;

- **Element 2:** Active recharge of regional aquifers by using existing infrastructure (wells, pipelines, and treatment capacity) and potential new infrastructure (wells, pipelines and treatment capacity) in the regionally shared Purisima aquifer in the Soquel-Aptos basin and/or in the Santa Margarita/Lompico/Butano aquifers in the Scotts Valley area to store additional water that can be available for use by Santa Cruz in drought years;
- **Element 3:** Development of potable water supply using purified recycled water as its source, The WSAC recommends the Plan's default Element 3 be Direct Potable Reuse (DPR) unless the state of California indicates DPRr facilities will not be allowed. Noting there are public concerns about potable reuse of purified recycled water, the WSAC recommends the City study reuse options before committing to one of them as element 3. In the event that purified recycled water cannot meet the plan's goals, considerations, and principles, then the City would proceed with seawater desalination as element 3.
- **Element 3:** ~~Study and potential development of potable water supply using purified recycled water as its source, with a focus on indirect potable reuse, to supplement Elements 0, 1, and 2 to the extent the latter two do not perform as projected to fill the supply-demand gap. The WSAC recommends that the Plan's default Element 3 be wastewater recycling for indirect potable reuse (IPR), with consideration for Direct Potable Reuse (DPR) as regulations are formalized. Noting that there are public concerns about potable reuse of recycled water, the WSAC recommends that the City study reuse options before committing to one of them as Element 3. In the event that potable reuse cannot address the Plan's Goals, Considerations, and Principles satisfactorily, then the City would proceed with seawater desalination as Element 3.~~

Section 4.05 WSAC Value Statement on Implementing Plan Elements

The recommended Water Supply Augmentation Plan reflects the Committee's preference for pursuing a groundwater storage and retrieval strategy provided the strategy can be achieved in a cost-effective and timely manner. ~~and recommendation to actively pursue groundwater storage strategies.~~ Before making a choice to move away from groundwater storage, the Committee recommends that the City diligently explore all reasonable attempts to make the groundwater strategies work.

Further, recognizing the cost differential between some of the strategies the Committee considered in developing its recommendations, the WSAC recommends that groundwater storage strategy identified in Elements 1 and 2 be pursued over other alternatives and as long as they do not cost more than 130% of the options available under Element 3, they should be pursued.

Section 4.06 Adaptive Pathway Implementation Strategy

The Committee recommends that the Council adopt a staggered Adaptive Pathway to guide implementation of the Plan and that decision-making at the various decision-nodes identified in this Adaptive Pathway be guided by the provisions of the Change Management Strategy.

Section 4.07 Change Management Strategy

The Committee recommends that the Council adopt the Change Management Strategy described in Section 3.24 and direct the Water Department and the Water Commission to follow to the Change Management Strategy's procedures and use the underlying values and principles in developing recommendations for the Council's consideration.

Section 4.08 Additional Recommendations Related to Infrastructure and Operating Constraints

(a) Infrastructure Constraints

The Committee also supports the Water Department's plans to address certain key infrastructure constraints that are keeping the City from fully utilizing available water, especially during the high flow season. These include, but are not limited to:

- Rehabilitation of the pipeline between the Felton Diversion and Loch Lomond that would allow the City to increase diversions to Loch Lomond during the high flow season;
- Evaluation of additional pumping capacity at Felton to push more water to Loch Lomond through the replacement pipeline; and
- If proven cost-effective, complete improvements that will allow the Department's to treat water with turbidities that are higher than can be effectively treated by the current Graham Hill Water Treatment Plant facilities and processes. The specific method for how to address the water treatment constraint should include evaluating a range of potential options, including , but not limited to Ranney Collectors or satellite treatment plants, and choosing the most cost-effective approach to address this issue.

(b) Operating Constraints

Another focus of the Committee's review relates to some system operational constraints. Operating constraints typically include both daily parameters for drawing water from the City's sources and operating constraint parameters that are used in modeling system performance.

The Committee recommends that the Water Department identify and regularly evaluate operating constraints to determine whether those constraints continue to be justified as necessary to protect the system and finished water quality and support efficient and cost effective operations. Early focus should be given to issues related to Loch Lomond year-end carry over storage requirements, particularly if/when in lieu and/or ASR have provided a sufficiently available drought supply, to the "first flush" constraint impacting the City's ability to pump water from Felton to Loch Lomond under critically dry year conditions.

Section 4.09 Implementation Plan and Timeline

This is going to be some revised version of the gantt chart, which is also under construction

List of Appendices