Agenda Item 16a

DATE: August 7, 2015

TO: WSAC

FROM: Rosemary Menard

SUBJECT: Preliminary Working Draft of WSAC Agreements and Recommendations Document

Dear Committee Members – Attached is a very, very, very preliminary working draft of the WSAC Agreements and Recommendations Document for your consideration.

First, let's talk about what this document <u>is</u>:

1. The content you see in this document is largely a cut and paste of earlier documents, specifically the Recon Report (January 2015) and the WSAC Status Report for the June 23, 2015 Joint Council-WSAC meeting. It needs extensive editing to eliminate details in some areas and add details in other areas. The tone and style of the writing needs review and action to align it with the purpose of this document. **It needs additional material to reflect the agreements and recommendations that the WSAC has already developed, in some cases, and will in other cases, develop in the coming weeks.**
2. Probably the most important work that I've been doing on this is organizational. That work is reflected in the table of contents and the flow of the information and presentation of topics.
3. As I've worked on getting this document I've tried to include sections that will cover all of the important issues the Committee has dealt with.

Now, let's talk about what this document <u>is not</u>:

1. This document is not a finished report. Its content has not been fully vetted and agreed upon by the WSAC.
2. **This document is not ready for public distribution or public review. To the degree that it is reviewed by the public, it should be understood that it is a preliminary, working draft with substantial additional work needed to ensure that it accurately and appropriate conveys information about the WSAC's work and its agreements and recommendations.**
3. This document is not a Committee review draft. It is more of a "look at" draft and is intended to stimulate your thinking about what your product should be.

The feedback that would be most useful to me from the Committee's discussion of this document at its August 14th meeting would include the following issues:

1. Feedback about the organizational structure of the document.

A couple of comments will be useful here: A goal that I think it would be good for this document to serve, would be to provide a comprehensive summary of the work that the Committee did so that a reader now or in the future would have a good sense of the scope and depth of the Committee's work.

The implication of meeting this goal for the structure of the document is that it needs to cover a lot of ground. I've tried to lay that out in the Agreements section of the document with the idea being that the basic content of each section would lay out the work done on that topic and, to the extent relevant, each section would conclude with a statement of any agreements that the Committee reached about that topic, as well as a listing of key assumptions that the Committee made about the topic, or that the technical team used in creating the information the Committee worked with.

A specific example of a topic to be covered in some detail is the demand forecast. The content currently inserted in this draft includes excerpts from the June 2015 status report for the joint WSAC-Council meeting. It needs to be updated to reflect the results of the econometric demand model and the Committee's agreement about the demand forecast from the July WSAC meeting.

2. Identification of additional topics or areas that the Committee would like to see included in the document.

3. Any general feedback about level of detail of the content that has been somewhat crudely cut and pasted. For example here's a question: I think the document will be more interesting and will do a better job of communicating issues if it includes relevant charts, graphs, and tables. Do others of you have a different point of view? Are there charts and graphs that have been provided during the Committee's process that you think really effectively convey a point that is important to you? If so, please let me know.

4. Any other feedback you'd like to provide would be most welcome.

Preliminary Draft
Santa Cruz Water Supply Advisory Committee
Agreements and Recommendations

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Article I. Executive Summary

To be developed

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 Desal 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
City Resident	Erica Stanojevic
Santa Cruz Water Commission	David Stearns
Santa Cruz Water Department (ex officio)	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

(a) Uncertainty Issues and Tools for Planning in the Face of Uncertainty and Complexity

The most important element of a problem solving process is defining the problem. Yet one of the characteristics of complexity 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 chose to develop four basic tools:

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

A brief description of each of these tools is included below and scenario planning and criteria development and evaluation using MCDS are discussed in more detail in the sections that follow.

i. Scenario Planning and Portfolio Development

Scenario planning is a tool that allows users to simultaneously examine several alternative futures and, in this case, the water supply problem related to that scenario. In each scenario, the central scientific questions (i.e., how much water will we have and how much we will need) are developed based on a set of reasonable but different assumptions. Portfolios are packages of actions that are created to respond to each scenario.

The goal of scenario planning is to understand how different futures might require different sets of actions. Ultimately working with scenarios will assist the Committee in developing and reaching agreement on a set of future conditions they will plan for and the portfolio of actions they believe the City should pursue to respond to that future.

ii. Risk Analysis and Risk Management

Risk analysis is an inherent element of scenario planning. In creating portfolios to respond to scenarios, Committee members will be required to weigh and balance the benefits and costs of a variety of potential actions, consider the likelihood that various actions can achieve their desired goals of reducing demand or increasing supply, and can be implemented in the timeframe required. Risk assessment and adaptive risk management will be needed to decide how to meet the potential range of impacts from climate change into water planning

Other than generally being exposed to the risk analysis and to adaptive risk management concepts, the Committee has yet to fully engage with these tools. Their use will be essential in phase two of the Committee's work.

iii. Criteria Based Evaluation and Multi-Criteria Decision Support Model

During the Recon phase, the Committee's job is to learn about and begin evaluating what is known about both the problem and potential alternatives to address the problem. A key outcome of this work is to identify what further research and technical analysis needs to be done related to the problem and potential solutions so that informed decisions can be made during the second phase of the Committee's work.

Developing appropriate criteria for evaluating the merits of proposed solutions is essential for effective problem solving. Understanding how various alternatives or portfolios of alternatives rate against those criteria is at the heart of the problem solving process. The Committee's development of the multi-criteria decision support (MCDS) model provided a focal point for the definition of criteria, subcriteria, and rating scales. In addition, the MCDS model was designed to assist the Committee in identifying and prioritizing the additional research and technical analyses that are needed to answer key questions about alternatives or aspects of the problem.

iv. Triple Bottom Line Analysis

A triple bottom line analysis looks at a proposed action, for example an alternative or portfolio of alternatives to address Santa Cruz's water supply issues, from three perspectives: financial performance, environmental performance, and social performance. The analysis attempts to quantify and compare each element in a manner intended to fully disclose the positive and negative impacts for each perspective and allow for the comparison of actions and support communication about their similarities and differences. Importantly, these impacts are typically normalized using agreed-upon financial metrics, facilitating objective discussion of what are often "values-based" criteria.

Section 2.05 Overview of Committee Process

To be developed

Article III. Agreements

Provide an introductory paragraph about what the range of issues the committee has explored

The Water Supply Advisory Committee's (WSAC) Phase 2 work program has been designed around the use of scenario planning to explore and evaluate a range of alternatives. This status report of WSAC work during calendar year 2015 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 status report as appendices to provide more detailed information where such information was thought to be relevant and potentially of interest.

The key ingredients of 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 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.

This staff report will provide a high level summary of the Committee's progress in their work through the scenario planning phase and, where relevant, links will be 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 3.01 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 a lack of storage for available winter flows or the climate independent supply needed to ensure an adequate and dependable supply during water years classified as critically dry and, to some degree, dry.

(a) 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.
- Figure 2 shows the data sorted 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 significantly, in the number of dry and critically dry years that Santa Cruz will experience, thereby exacerbating the reliability issues the system currently faces.

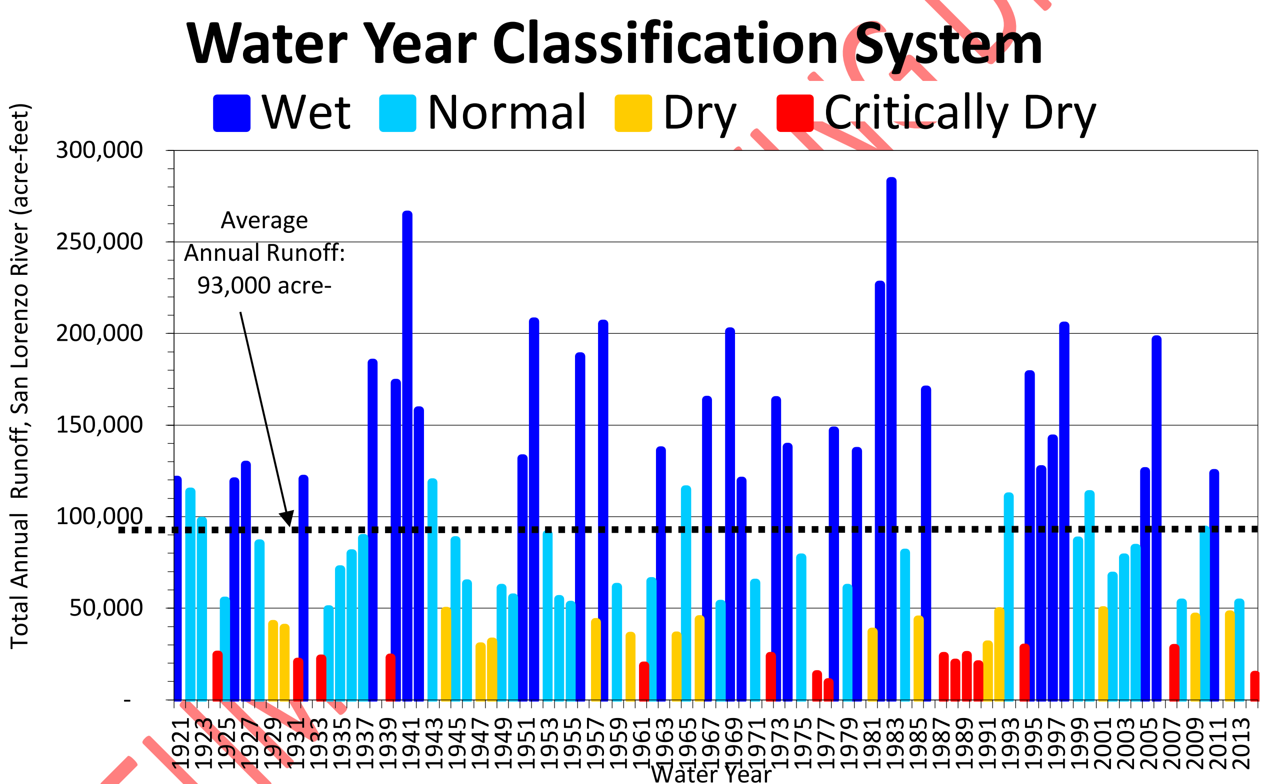


Figure 1: Water Year Classification System – Chronological Presentation

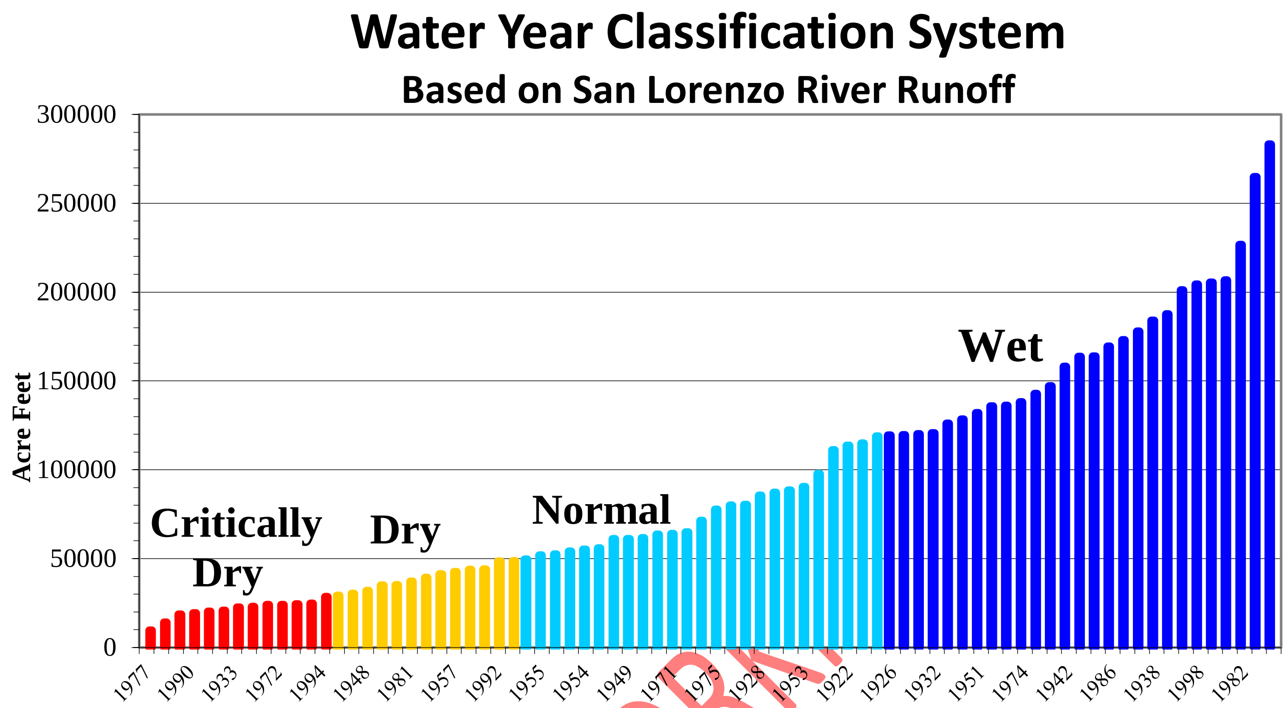


Figure 2: Water Year Classification System -- Year Type Presentation

(b) Forecast of Current and Future Water Demand

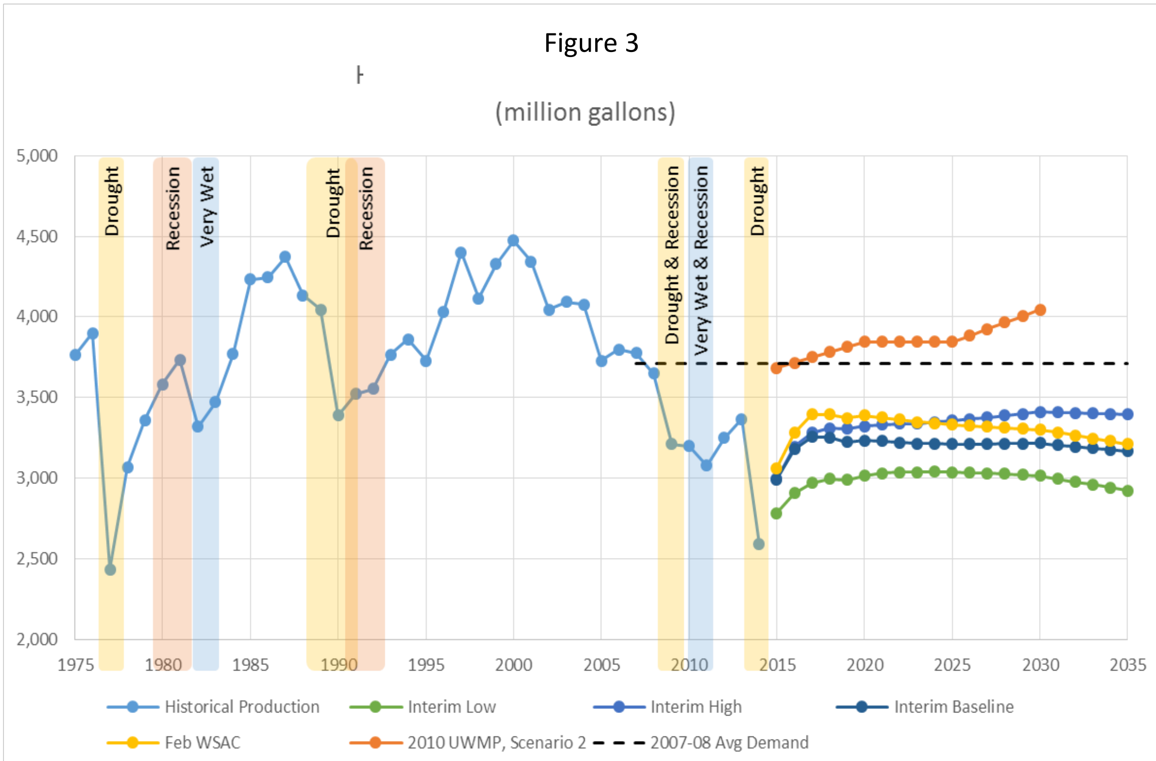
Significant work has been done to update the water demand forecast used in the 2010 Urban Water Management Plan. This demand forecast incorporates the changes in population and development that were part of the City's General Plan update as well as whatever up to date information was available at the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

Key changes to the 2010 forecast include:

- 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 price increases on water use, and
- retaining the University's projection of its ultimate build-out demand but extending its time for completion.

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

Figure 3 is the updated forecast using the econometric demand model presented to the Committee in July.



The graphic above will be replaced by a revised graphic using the econometric demand forecast.

Will provide discussion about the model and reference attachment of July tech memo (or final report)

(i) Committee Agreement(s)

Will reference the Committee's Agreement dated 7-23-15 accepting the econometric forecast.

(ii) List of Key Assumptions for Demand Forecast

- To be added

Table 1 – Comparison of Interim and Econometric Demand Forecasts 2020-2035

YEAR	2020 Forecast	2025 Forecast	2030 Forecast	2035 Forecast
Unrounded				
Econometric	3,132	3,123	3,160	3,215
Interim	3,236	3,213	3,218	3,169
Rounded				
Econometric	3,100	3,100	3,200	3,200
Interim	3,200	3,200	3,200	3,200

(c) Water Supply and Growth

Content to be added. Will cover the topics below

(i) General Plan

(ii) UCSC Future Demands

(iii) Agreements and Key Assumptions about Water Supply and Growth

(d) 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 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 will tend to underestimate the number of curtailments implemented. The key driver of this tendency is that water managers making decisions in the late winter and spring of one water year are unable to know what the next water year will bring and so will act conservatively to conserve storage in the face of this unknown. (In fact, this reality is behind City staff's recommendation for implementing Stage 3 water restrictions in this year.) In the end, when the water year is completed, the curtailment will turn out not to have been needed, but there was no way of knowing that 10 months earlier.

The key assumption of using natural flow conditions is 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 either changed hydrology, extended droughts or both. The implications of both of these factors on the City's future supply are discussed in more detail in the next section.

In spite of the positive assessment of the available supply described above, two factors will influence water availability in the future. One factor is the commitment of water the City will make for fish flow releases.

(e) 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 as potential supply implications of a lower-bound and upper-bound flow release. The lower bound flow regime is called "City Proposal" and the upper bound flow regime is called "DFG-5." These two flow regimes have different impacts on the long-term availability of water to meet City needs, with the impact of the lower bound proposal being around half of the impact on supply of the upper bound proposal.

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

Table 2 and Table 3 respectively show the forecasted peak-season shortage profiles in 2020 and 2035.

Table 2 -- 2020 Shortage Profiles[1,2]

[1] Note that the totals in any row may not add to 100% due to rounding.

[2] The data in Tables 1 and 2 was developed for the February version of the demand forecast and have not been adjusted to reflect the changes incorporated and reflected in the April forecast shown in Figure 1. Thus the results here are slightly overstated as the April demand forecast is slightly lower than the February one.

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%
City Prop	92%	7%	0%	1%	0%
DFG-5	90%	1%	4%	3%	1%

Table 3 -- 2035 Shortage Profiles

FLOWS	Likelihood of Peak-Season Shortages				
	0%	<15%	15%-25%	25%-50%	>50%
	0	<285 mg	285-475 mg	475-950 mg	>950 mg
Natural	100%	0%	0%	0%	0%
City Prop	97%	1%	0%	1%	0%
DFG-5	90%	1%	4%	3%	1%

(ii) Committee Agreements on Fish Flow Releases

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

- With 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 an 8% likelihood (6 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 90% 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.

- While similar, the 2035 profiles are slightly more favorable than the 2020 profiles due to the somewhat lower forecast demand that results from the ongoing implementation of demand management programs and the impacts of changes in plumbing and building codes.

- 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 proposals, the City faces peak-season shortages in the driest hydrologic conditions. In those driest years, those shortages can be significant, around 600 million gallons under City-Proposed flows and close to 1.4 billion gallons under DFG-5 flows.

(iii) Key Assumptions about Fish Flow Releases

(f) 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, some would say that the City's water system has 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 has been exploring the potential impacts of climate change on future water supply availability using two different considerations:

- Extended drought; and
- Hydrologic change.

i. Extended Droughts

Recent evaluations of paleoclimate records and future climate model projections indicate that longer-term drought conditions 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)[3].

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)[4] 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)[5].

Because the "historical record" assumption used in WSAC's Baseline Scenario may not adequately identify droughts the City of Santa Cruz may face in the future, and therefore needs to prepare for, the WSAC technical team created an extended-drought planning sequence that represents a discrete plausible future event that can 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 was combined with each of the fish flow

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

[4] 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

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

proposals discussed above and evaluated for the frequency and severity of the shortages that would be produced. Table 3 summarizes these results.

Table 4. Extended drought peak-season shortage statistics

	City Proposal	DFG-5
Total 8-year (mg)	702	5,108
Average	4%	32%
Maximum	32%	67%
Minimum	0%	6%
Years > 20%	1	6

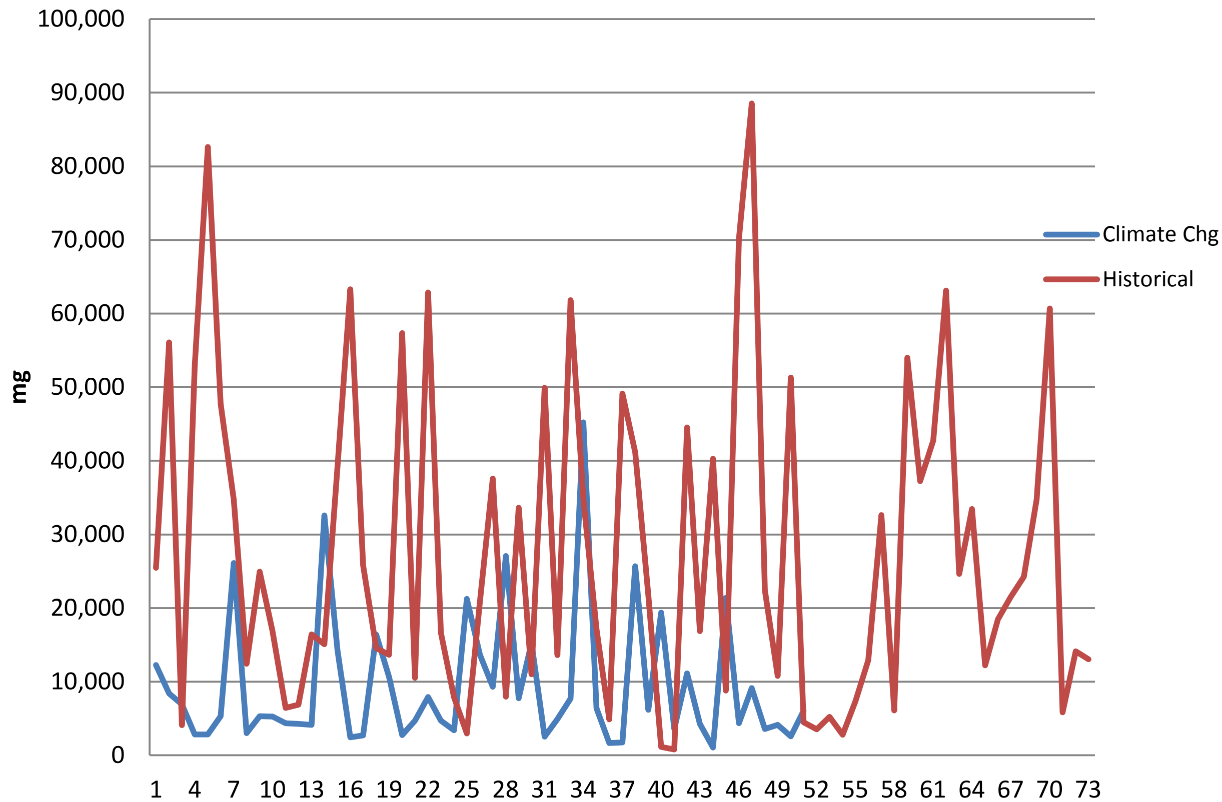
(ii) Climate Change Resulting in Changed Hydrology

Across hundreds of modeling runs, 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 strong 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 effectively analyze this 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 4 for City proposed HCP flows at Big Trees, the distribution of flows is completely different from that of the historic record.

Figure 4 -- Comparison of annual flows at Big Trees: City proposal.



The key conclusions that can be drawn from Figure 4 is that while the historic variability continues, the lows are not demonstrably lower than those occurring historically, but that the high flow events are considerably lower, meaning that there may be less water in the system overall.

(iii) Committee Agreements on Climate Change

(iv) Key Assumptions about Climate Change

(g) Modeling Results Looking at Climate Change/Hydrologic Change with City Proposed Flows:

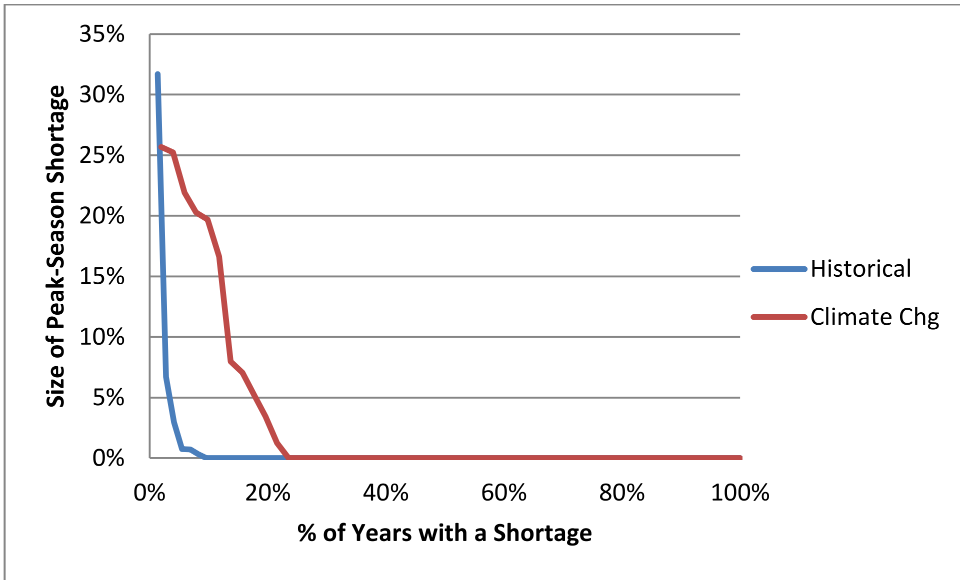
Climate change increases the likelihood of larger shortages. These results are shown in Figures 5 and 6.

(i) City Proposed Flows

Figure 5 compares the peak-season shortage duration curves for City Proposed flows with and without climate change.

Figure5 -- Peak-season shortage duration curves with and without climate change:

City proposed flows



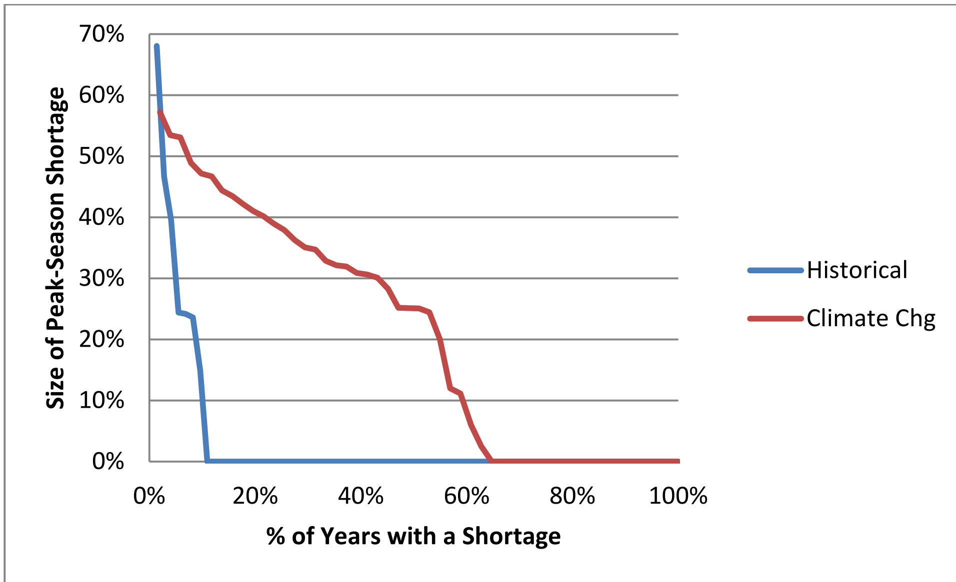
The differences between the two curves are immediately noticeable:

- 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.

(ii) DFG-5 Flows

Figure 6 shows the same system reliability comparisons for DFG-5 flows.

Figure 6 -- 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, under more than 60% of hydrologic conditions, there will be a peak-season shortage. In fact, a shortage exceeding 25% can be expected in just over half the years.

The foregoing results 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. This is clearly not the case with 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.

(iii) Agreements on Climate Change

(iv) Key Assumptions on Climate Change

Section 3.02 Problem Statement

Agreed upon Problem Statement

Section 3.03 Data Driven Decision Making

(a) Evaluation Criteria

Criteria for a good solution are essential for effective problem solving. Understanding how various alternatives or portfolios of alternatives rate against those criteria is at the heart of the 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 in 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.

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

Criterion	Questions
1. 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
2. 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.
3. 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.
4. 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?
5. 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.?
6. Supply Diversity (Portfolio Level Only)	How does the Portfolio affect the diversity of Santa Cruz water supply portfolio?
7. 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.
8. 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.
9. Regulatory Feasibility	How easy or difficult would the regulatory approval process be for these Plans?
10. 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.
11. 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?
12. 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?
13. 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.
14. Cost Metrics	How much do each of these Plans cost? Metric is annualized unit cost in dollars per million gallons, $/mg.

Section 3.04 Identifying and Evaluating Solutions:

The WSAC used an iterative approach to identifying and evaluating alternatives 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 options to develop more specific planning level information for use in evaluating alternatives.

In this section, the Committee's iterative approach to identifying and evaluating alternatives for improving the reliability of the Santa Cruz water supply are presented.

(a) Alternative Identification: Our Water, Our Future – The Santa Cruz Water Supply Convention

During the community discussions of the desal DEIR, a common criticism was that the City hadn't evaluated during the decades of water supply planning that preceded the selection of desal in the Integrated Water Planning process in early 2000s, a key element of the Council's reset decision was the desire to look in more detail at alternatives to desal while not excluding desal 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 others who might have ideas to share would have the opportunity to do so as well.

In June, the WSAC decided to include in Recon 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 suggested approaches to improving the reliability of the Santa Cruz water supply. Submissions covered 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 for an event called "*Our Water, Our Future – the Santa Cruz Water Supply Convention*."

Our Water, Our Future, the Santa Cruz Water Supply Convention was held from 11 a.m. to 9 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 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, and 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 *Our Water, Our Future* event, the Committee has 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. During Recon especially, the Committee's purpose in keeping the door open is to ensure that the arbitrary exercise of a deadline does not keep a great idea from being considered.

(b) 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 Water Supply Convention that they were most interested in using as a considering further. Stratus' job was to select a dozen or so alternatives that represented 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 Loquifer 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.

(c) Consolidated Alternatives

From the more than 80 suggestions and proposals presented by community interests, project proponents, and City staff during the October 16, 2014 Water Supply Convention, the technical team created 20 Consolidated Alternatives. "Consolidated Alternatives" are groups of alternatives with similar concepts and attributes, which include a range of alternatives 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.

Tables 5 and 6 (these tables need to be deleted or updated) provide summary information on Consolidated Alternatives provided to Committee Members during the April 30th/May 1st meeting, and more detail on each alternative is available in Attachment 1 to this document.

During the first half of 2015, the technical team has been continuously developing and refining their work on the Consolidated Alternatives, making it possible for the Committee to use them as building blocks in the two rounds of scenario planning the Committee has engaged in.

The Confluence analysis concluded that the key outcome of is that the harvesting and storage of winter flows has the potential to completely address the City's water supply challenges and enable the City to meet projected future demands. This is the case even with current water rights, DFG-5 instream flows, and climate change. To achieve these benefits, the "virtual reservoir" used in the 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 at least 3 billion gallons of water. In addition, the capacities of various current infrastructure would have to be increased.

(i) Demand Management

(ii) Operational Changes

(iii) Supply Development

Include a discussion about each and whatever agreements are relevant

Note: that tables below will be revised/or replaced as needed to be relevant to the Committee's final product.

Table 5 -- Summary of CAs 01-05 with Preliminary Water Savings and Costs						
CA-# and Title	30-Year Present Value Savings (MG)	30-Year Present Value Cost ($)	30-Year PV Cost/30-Year PV Saved ($/MG)	30-Year Average Savings (MG per Year)	30-Year Average Cost ($/yr)	Energy Saved (MWh over 30 yrs)
CA-01 Peak Season Reduction	In progress	In progress	In progress	In progress	In progress	In progress
CA-02 Water Neutral Development	N/A	N/A	N/A	N/A	N/A	N/A
CA-03 Water Conservation Measures (Program C Rec)[1]	2,788	$23.1 million	8,301	173	$1.31 million	6,318
CA-04 WaterSmart Home Water Reports	770	$3.17 million	4,119	37	$151,529	1,766
CA-05 Home Water Recycling	229	$7.8 million	34,061	11.9	N/A	571
1 Values reported for CA-03 are for a 25-year period, rather than a 30-year period						

Table 6-- Summary of CAs 07-19 with Preliminary Source Production, Yields, and Costs

CA-# and Title	Added Source Production		Yield (Peak-Season Shortage Reduction) with Historic Flows		Yield (Peak-Season Shortage Reduction) with Climate Change		Capital Cost	Discounted 30-Year PV Cost			Preliminary Annual O&M Cost Estimate	Preliminary Energy Estimate
	Average Year	Worst Year [1]	Average Year	Worst Year	Average Year	Worst Year		Total	Unit Cost per MG of Worst-Year Yield: Historic Flows	Unit Cost per MG of Worst-Year Yield: Climate Chg.		
	MG/yr	MG/yr	MG/yr	MG/yr	MG/yr	MG/yr	$ million	$ million	$/MG/yr	$/MG/yr	$ million	MWh/MG
CA-07 Deepwater Desalination	550	1,100					53 **	116			3	13+
CA-08 Water from Atmosphere	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
CA-09 Winter Flows Capture	See CA-16											
CA-10 Water Reuse for Aquifer Recharge	1,300	1,300	60	1,360	420	1,150	191	358	12,600	14,900	8	10 [2]
CA-11 Water Reuse for Direct Potable	1,300	1,300					91	166			3.6	6
CA-12 Water Reuse for Indirect Potable	1,300	1,300					218	341			5.9	10
CA-13 Water Reuse for Non-Potable	770 [3]	770 [3]	45	530	410	850	60	106	9,600	6,000	2.2	3
CA-14 Desal Using	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

Forward Osmosis												
CA-15 Desalination Using Reverse Osmosis	550	1,100					107 [4]	149			2	13
CA-16 Aquifer Restoration/Storage	560 [5]	1,100 [5]	60	1,360	420	1,150	34	55	1,900	2,300	1	2
CA-17 Expand Treatment Capacity	560	1,100					58	142			4	3
CA-18 Off-Stream Water Storage	260	260					155	176			1	12
CA-19 Ranney Collectors	560	1,100	60	1,360	290	115	17	38	1,300	15,800	1	4

*** Likely significantly low (estimate from previous work that does not directly compare. This value is being recalculated from site-specific assumptions.*

[1] Number of years when water is available will vary among CAs.

[2] Based on recharging at Hanson Quarry and extracting and returning water to Santa Cruz from Scott's Valley.

[3] A recent report lowered the projected likely yield from 770 MG to 500 MG. A value of 770 was maintained in the analysis for consistency. This issue will be addressed in the next step of the project. Will be adjusted pending additional Confluence run.

[4] 2013 scwd^2 Desalination Program study values used, scaled to March 2015 dollars and then scaled for size using the 6/10 power rule.

[5] Assumed 80 percent withdrawal from extraction wells to calculate per unit volume cost.

(d) Building Blocks Used as the Foundation for Portfolio Building

(e) Alternatives Considered but Not Pursued at this Time

Section 3.05 Scenario Planning

(a) 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.

Simplified Scenarios for December MCDS Exercise

Probably remove most of this.

As part of the December MCDS exercise, Committee members were asked to rate alternatives under three simplified scenarios with different supply-demand gaps. One of the Committee members was asked to prepare supply-demand gaps for two options and came up with worst year gaps of zero and 1 billion gallons based on different assumptions. City staff was asked by the Committee to provide a third alternative and produced a worst year gap of 650 million gallons.

For each supply-demand gap, City staff created a short name and prepared a brief descriptive narrative about circumstances related to that scenario. The goal of this was to provide context for those considering alternatives at different levels of supply-demand gaps and to show the potential for water supply to be related to other factors that may be of interest or concern to the community.

For the December MCDS exercise the simplified scenarios were as follows:

- Zero supply-demand gap: "Nada Problem"
- 650 million gallon supply-demand gap: "A Little for Fish"
- 1 billion gallon supply-demand gap: "A Deep Hole"

(i) Scenario Planning during Phase Two

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

- City proposed flows and changed hydrology;
- DFG-5 flows and changed hydrology; and
- DFG5 flows and extended drought.

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 a portfolio.

Two key themes emerged from this work:

- Committee members created water supply portfolios which included additional investments in demand management; and
- 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 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.

In preparation for the second round of scenario planning, sets of Consolidated Alternatives with different focuses were analyzed using the Confluence Model that the City uses to assess how different water supply alternatives could affect the frequency and duration of shortages.

Round two of scenario planning occurred at the Committee's April/May 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 center piece 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.

At the Committee's June 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 to consider the risks and uncertainties related to the various approaches. The analytical tool used to support this exploration is a Strengths, Weaknesses, Opportunities, Threats (SWOT) analysis.

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. In part, 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: Probably remove most of this – keeping the key focus on using scenario planning and portfolio discussions to explore risk and uncertainty.

1. Plan A: In lieu recharge of regional aquifers by providing winter flows to Soquel Creek and Scotts Valley to meet their off-peak demand allowing them to rest their wells. Additional infrastructure or operating rule changes were implemented to extend the season during which in lieu recharge could be provided, thereby increasing the rate of recharge. The ultimate goal would be for groundwater to come back to Santa Cruz from regional aquifers when Santa Cruz needs it.

   Plan B: Purified recycled water piped back to and mixed with Loch Lomond supplies (a technique called indirect potable reuse, known as IPR).

2. Plan A: Active recharge of regional aquifers using injection wells (a technique called Aquifer Storage and Recovery, known as ASR). The ultimate goal would be for groundwater to come back to Santa Cruz from regional aquifers when Santa Cruz needs it. Using ASR would accelerate the timeline when this source would fully meet Santa Cruz's needs.

   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, known as 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.

Plan A: ASR coupled with desalinated water from the proposed DeepWater Desal 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.

None of these portfolios were designed to be the 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 is not part of the goal of the Committee's June meeting to select one of the portfolios that have been developed 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. The Committee has been discussing using what is known as a contingent agreement as an approach to dealing with this reality. What this means is that major recommendations will be developed but that the Committee will recognize that there is still a lot we don't know about some of the approaches they would like to explore and implement. The agreement will likely include triggers that begin with an "IF" and include a "Then." For example,

> "If by 2025 aquifer storage and recovery using winter water isn't reliably producing 500 million gallons a year of recoverable water (for use as drought supply) then, develop a recycled water source as a supplemental supply."

A good contingent agreement of this sort requires anticipating and imagining that things might turn out in some expected and unexpected ways and then making a plan to deal with that outcome by creating a specific trigger. By including triggers and a Plan B in the portfolios, staff introduced the idea of a defined way to move through the "expected unexpected" and gave the Committee a chance to work with these ideas.

Part of the elegance of a well-crafted contingent agreement is that it prepares people in advance that things might not go as planned and gives people some say in what will happen when things don't go as planned. A well-crafted contingent agreement also helps set realistic expectations and establishes and maintains buy-in to the path laid out in the agreement. Creating a contingent agreement is more work than some other options, but if done well can be a real asset for helping to create and maintain momentum toward a larger goal.

The Committee had a very productive session at their June meeting and delved deeply into the tasks of assessing the SWOTs of the various portfolios. Their two next steps are to:

- Use the multi-criteria decision support model they have developed to do individual evaluations of the risks and uncertainties associated with the set of six portfolios that emerged from the June meeting. The result of these evaluations will be reported back to and discussed by the Committee at their July 23rd and 24th meeting; and
- Discuss their progress and the issues they're working with the City Council during the June 23rd Joint Study Session.

Section 3.06 Portfolio Building

Section 3.07 Issues of Risks and Uncertainties

Section 3.08 Agreement on solution (approach, content, to be reflected as pull outs that move into the consolidated recommendations)

Section 3.09 Strategies for Dealing with Risks and Uncertainties

Article IV. Recommendations

Section 4.01 What

(a) Portfolio elements (Plan A and Plan B, C, D…)

(b) Adaptive Management Strategy and Plna

(i) Performance Measures

(c) Policy direction

Section 4.02 How/When/Who

(a) Implementation Plan and Timeline

(b) Financing Strategy

(c) Partnering Strategy

Article V. Additional Remarks/Recommendations

Article VI. List of Appendices