Work Plan Development Update, and Subcontractor Recruitment and Preliminary Assignments

September 17, 2014

This document provides an overview of where we stand in terms of lining up technical work items needed to inform WSAC, and identifies the various sub-consultants we anticipate tasking to accomplish this work. A brief description is provided of a wide array of work scope items that either have been or will be initiated. The objective is to launch several technical investigations and mobilize information that we believe will be critical to the Committee's ability to evaluate relevant water supply and demand management alternatives. This information is provided to inform the Committee of our current and anticipated technical activities, and to provide an opportunity for the Committee to form questions.

Sub-consultants:

Table 1 provides a summary of the sub-consultants that we have put forward for WSAC review to date; credentials have already been provided for WSAC review. There have been some questions posed and responses provided to Committee members, and no notable remaining objections have been voiced by the Committee regarding any of these individuals or firms. At this time, this established team, together with the Committee, the Independent Review Panel, and City staff, appears sufficient to address relevant work scope items.

Table 1. Summary of sub-consultants

Subcontractor	Individual(s)	Specialties
Andy Fisher (UC Santa Cruz)	Andy Fisher	**Hydrogeologist**; currently doing north county passive recharge and has done Monterey County active recharge work and will likely sit on a review committee for the groundwater model work being done by the City and Soquel Creek Water District
Balance Hydrologics	Shawn Chartrand	**Hydrologist/Geomorphologist**; Water balance modeling, streamflows
Brown & Caldwell	William K. Faisst Charles W. Joyce Jenny Gain James L. "Butch" Matthews Wendy Broley	**Engineers**; Resource management, water management, regulations, water quality, economics, civil engineering; Designed 1990 upgrade to WWTF.
David Abbot	David Abbot	**Hydrogeologist**; groundwater supply, yield and watershed studies, aquifer storage
Ebin Moser + Skaggs, LLP	Sean Skaggs	**Attorney**; current HCP attorney, Fishery Endangered Species Act
Gary Fiske and Associates, Inc.	Gary Fiske	**Engineer**; Water resource planning, *Confluence*® water resource planning model

George Tchobanoglous (UC Davis)	George Tchobanoglous	**Civil engineer**; specializing in innovative water and wastewater treatment systems
Hagar Environmental Science	Jeff Hagar	**Biologist**; Fisheries, resource management, water quality
HydroMetrics	Derrik Williams	**Hydrogeologist**; resource management, hydrogeology, water quality; history with Soquel Creek Water District and the state of the shared basin.
Lennihan Law	Martha H. Lennihan	**Attorney**; Water rights, regulations
Maddaus Water Management	Bill Maddaus Lisa Maddaus Michelle Maddaus Christopher Matyas Tess Kretschmann	**Engineers;** Water resource planning
Luhdorff & Scalmanini	Vicki Kretsinger Grabert	**Hydrologist**; groundwater quality, environmental regulations, groundwater resource assessment
M-Cubed	David Mitchell	**Economist**; Resource management, water management, economics
Pueblo Water Resources	Michael Burke Martin Feeney Robert Marks Stephen Tanner	**Hydrogeologists/Engineer**; worked recently with City on Beltz 12 and Tait Street well projects, and in Monterrey County on ASR
Rose Env. Engineering	John Rosenblum	**Civil engineer**, specializing in industrial water and energy efficiency; evaluating the regional impacts of water efficiency measures on energy use and greenhouse gas emissions
Trussell Technologies	R. Shane Trussell R. Rhodes Trussell	**Engineers**; water quality, sanitary engineering, civil engineering, water reuse, desalination and filtration

Work Scope Areas and Recommendations

There are several technical issues that need to be addressed in order to provide the Committee with the types of analyses and information with which they can evaluate several of the potentially relevant Alternatives and Management Actions. These work scope areas span a range of topics and tap into an associated array of technical specialties. Below, we provide abbreviated synopses of several technical work areas we have identified as being directly relevant to the Committee's ability to conduct informed deliberations. We also recommend paths forward (including recommended sub-consultant assignments), organized according to relevant topic areas and disciplines. Several of these areas of work had already begun; others will begin shortly following the Committee meeting.

Because this is a long list of potential work scopes, we indicate some work items that may be of lesser priority and may be deferred. Also, we view most of these work items as initial scoping investigations for

Recon, with the intent of providing more context and definition to the work areas for possible further consideration during the Real Deal. In other words, the work done during these initial investigations will define what is known (about the various topics), what is not known, and what would be worth investigating further.

Specific timetables and work scopes will be developed in concert with the relevant technical experts, with the overall intent of having these initial scoping investigations completed by December. These initial investigations will articulate a focused and well-defined set of technical next steps for possible follow-on work to support the Real Deal.

1. Demand Management: Conservation, Water Use Efficiency, and Improved Forecasts

a. Where is Santa Cruz now? Assessing the response to and impact of the Current Drought.

In concert with the Water Department, we have initiated roundtable discussions with members of the local business community to assess the impact of the current drought and curtailments on enterprise-level water use and business performance. Our focus includes the "green" (e.g., plant nursery, landscaping, golf course) and hospitality (e.g., hotels, eateries) sectors. This effort is also assessing the level and manner in which water use efficiency measures have been implemented, and the degree to which conservation and the water use curtailments have reduced water consumption in some businesses. This is a recently initiated effort, conducted jointly by Stratus, David Mitchell (M-Cubed), and the Water Department. Preliminary findings will be available to the Committee at their October meeting.

b. How far can Santa Cruz go in reducing demands, what will that cost, and who bears those costs?

Amongst the principles stated in the Committee's charge is that "conservation is a cornerstone of our water profile and should be maximized." The Water Department has been working with Maddaus Water Management to develop a Long Term Water Conservation Master Plan. This plan will provide direction to the City for maximizing water conservation efforts. A supplemental effort to the on-going Maddaus work with the Water Department is required to provide WSAC with a broader understanding of what levels of aggregate (and disaggregated) water demand may be feasible, which in turn raises questions such as what additional conservation and water use efficiency measures are available, what they will cost, who will bear those costs, and what they are likely to attain in terms of water use reductions. A study focused on managing seasonal peak demand appears to be particularly relevant to the Committee's deliberations (as summer season demands are what drive the "gap" observed between supply and demand in drought years). Maddaus Water Management will be asked to initiate a scoping study of these options and associated implications.

c. Demand Forecasting: Econometric Demand Modeling

A critical aspect of effective water planning includes developing reliable demand forecasts. For many water utilities across North America, this has emerged as a significant challenge, as past traditional

forecasts have often failed to capture the level and persistence of declining per capita demands due economic, technologic and other changes. (This has become a very widespread issue throughout the water supply sector, resulting in over-estimated demands and associated "revenue gaps" and other problems).

Moving forward, demand forecasting using econometric (i.e., advanced statistical) methods enables a much more robust and useful approach to predicting and understanding how demands may change as a result of changes in prices (water rates), incomes, weather, and other relevant factors. Econometric demand forecasting also provides a measure of economic loss associated with different levels of curtailments. We are in the process of scoping out such a demand forecasting effort, with David Mitchell (M-Cubed) working in tandem with Stratus Consulting and the Water Department.

2. Climate Change: **How Will Climate Change Impact Santa Cruz's Water Future?**

a. What Impact will the range of projected changes in the levels and patterns of future precipitation and temperature have on Supply? Demands? Water Quality?

As presented to WSAC in past meetings and related written materials, climate change is likely to have a range of potentially significant impacts on Santa Cruz and its water future. In concert with developing relevant future "Scenarios" to help guide evaluations of future supplies and demands, Stratus has been developing a range of temperature and precipitation projections based on the latest IPCC- and DWR-endorsed models and methods (e.g., as circulated in written materials prior to the July meetings, and as presented during those meetings). We currently are in the process of working with Shawn Chartrand (Balance Hydrologics) and Gary Fiske (Gary Fiske and Associates) in conducting initial scoping investigations of: (1) how projected climate changes can be integrated into the hydrologic instream flow model, and then (2) how those flow results can be integrated into the *Confluence* model to project water system performance (e.g., surface water yields and associated projections of system reliability). We expect to have initial results available for WSAC review for the October meetings.

b. Sea Level Rise and Climate Change-Related Extreme Events – Developing a Preliminary Vulnerability Assessment

Climate change has numerous pathways through which it may impose risks to Santa Cruz's water resources, related infrastructure, and the community as a whole. Sea level rise (and storm surge), extreme precipitation events, drought, and wildfire are among the possible climate change-related events to which the system will be vulnerable to water quality degradation, inundation, and other adverse impacts. A preliminary assessment of such vulnerabilities has been explored by the Water Department, and Stratus will work with the Department to convey these risks within a "risk profile matrix" (an approach presented by Karen Raucher in a recent AWWA-sponsored webcast focused on climate change, and viewed by several WSAC members).

3. Energy Requirements and Carbon Footprints of Potential Water Options

a. Preliminary assessment of energy requirements and carbon footprints for key alternatives

Energy use and the associated carbon footprints of various potential water supply alternatives are a significant concern in Santa Cruz. Each of the possible water-related futures for the City (including the status quo "baseline") has an associated energy requirement and carbon footprint. A preliminary assessment of the energy and carbon footprint implications of key water technologies and management strategies will help guide initial evaluations and focus where more in-depth analysis may be warranted. We will work with John Rosenblum (Rose Environmental) to provide a preliminary assessment in which he develops preliminary estimates of energy use and carbon footprints associated with the baseline (including possible water treatment or pumping upgrades as may be required for continued water quality compliance), desal, water reuse, water exchanges, demand management, and other relevant options. This effort will draw on available past studies and may entail engineering-related support from Brown and Caldwell and/or Trussell Technologies.

b. Opportunities for tapping green energy and/or providing meaningful carbon offsets

Extracting, treating, and distributing water inevitably requires a considerable amount of energy consumption. Are there meaningful ways in which the City can minimize its water-related energy use, tap into green energy, and/or provide meaningful carbon offsets? This may be a topic WSAC wishes to explore, possibly after (or in concert with) the work item defined above (3a). The Stratus Team is in a position to address many if not all of these issues.

4. Fisheries: Flow Requirements and Impacts on Yields

a. What will HCP requirements entail for surface water yields? How does Climate Change potentially interface with HCP instream flow requirements and impact yields?

In concert with the Habitat Conservation Plan (HCP), the City is already working with Jeff Hagar and Shawn Chartrand to evaluate how fish flow requirements translate into instream flows and hence (via Gary Fiske and the *Confluence* model), into water system yields and performance. As noted above (item 3a), we are working with these subject area experts to factor climate change impacts into these calculations. The coupling of potential climate change impacts with HCP-driven fishery flow requirements is an essential component of examining Santa Cruz's water future under various scenarios (including the baseline, climate change, and worse case scenarios).

b. How would going beyond HCP -- to ensure "110%" of salmonid needs -- impact surface water yields?

A possible extension of item 4a, above, entails examining the implications of an approach in which fish flow requirements are based on going beyond HCP requirements to provide greater assurance of the

protection of special status fish (tied to possible "Fish First" scenario). Jeff Hagar (Hagar Environmental) can be tasked with providing the associated fish flows, which would then be used as input to the stream flow hydrology work described above, and then worked through the *Confluence* model to reveal impacts on the City water system surface water yields and performance. This may not be an immediate priority, but it is an issue that can be examined in a relatively straightforward manner.

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Additional information will likely be required for the Committee to better understand the various water supply alternatives to be considered. The following work efforts will serve to provide this information in terms of what is known about each topic, what is not known, and what is worth pursuing further.

5. Water Storage (Inter-seasonal and/or Inter-annual)

Water storage is a critical and extremely valuable component for managing water supplies where demands and yields tend to vary considerably across seasons, and across years (e.g., summer months when demands tend to be greatest but precipitation and water supply availability tend to be limited). Developing additional on-stream surface water storage (e.g. a new or expanded reservoir) has not been an institutionally feasible option over the past few decades. The current drought and related water bond on the November ballot may facilitate new surface storage efforts.s Hence, some surface water storage investigations may be warranted (on stream and/or off-stream) and will remain on our radar screen for possible consideration. Meanwhile, suggested work items addressing two other water storage-related alternatives are provided below.

a. On-stream (surface) Storage – What if we modify how we operate Loch Lomond?

WSAC discussions have revealed an interest in assessing whether changes in how the existing Loch Lomond reservoir is managed may better align available supplies with demands. This is a line of inquiry that may be investigated through application of the *Confluence* model to explore various alternative Loch-related management strategies (e.g., sensitivity analyses). This also entails providing WSAC with a better understanding of the inner workings of the *Confluence* model (e.g., transparency regarding required inputs, calculating routines, and outputs). This may best be accomplished through convening a small "Modeling and Forecasting Working Group" (including some of Committee members) to become more familiar with the model and how the Loch is (and might be) managed.

b. Groundwater storage -- Feasibility of Aquifer Storage and Retrieval (ASR)

Aquifer systems can provide extremely valuable settings for storing and retrieving water. This can be a viable and valuable approach where hydrogeologic conditions enable ASR (physical and technical feasibility), and where there are waters periodically available for storage. In Santa Cruz, water for possible ASR storage could be provided by high winter season streamflows, and/or by using highly purified reclaimed water (water reuse). Other sources of water for potential storage may also be available.

A key suite of technical questions for Santa Cruz is whether any of the regionally available aquifer systems is suitable for ASR. Some of the applicable technical questions include: Is there underground capacity in any of the regionally available aquifer formations to store a useful quantity of water? Is there a reasonable way to place water into those systems (e.g., recharge basins, injection wells)? Can the water placed in these aquifer systems be stored and retrieved (without large losses)? Will there be undesirable water quality impacts?

We will initiate a technical review of the existing knowledge about regional groundwater systems, to provide WSAC with a summary of what is known, and what key unknowns remain, regarding the potential viability of ASR. Our preliminary understanding is that the groundwater systems in the region are complex, and that there is limited definitive knowledge about several key hydrogeologic issues (i.e., the physical ability of any of these systems to provide a reliable setting for storing and retrieving water). Pueblo Water Resources appears to be best suited to continue this effort, with review and input from Andy Fisher (as available), and with subsequent review and input from the Independent Review Panel (IRP, notably, Mike Cloud). Input and involvement from other hydrogeologists and regional water experts (e.g., John Ricker) may be valuable as well.

6. Groundwater Supplies and Management

a. ***Feasibility of Aquifer Storage and Retrieval (ASR)*** (see item 5b, above)

b. Viability of Developing North Coast Brackish Wells

In our review of "past alternatives" considered in the region, we found that the option of developing brackish groundwater wells along the North Coast had emerged as the most promising alternative in the mid-1990s. However, the planned investigation of that alternative was aborted before test wells could be developed and pilot tested. We recommend that a review be developed of what is known about the feasibility, potential yields, and potential challenges associated with the possibility of developing this alternative. We believe this should be a low-level effort initially, until and unless the information assembled provides a reasonable indication that this alternative may indeed be technically and institutionally feasible, and may provide reasonably-sized yields. We will investigate which of our team members are best suited to perform this work (this may entail a combination of Brown and Caldwell and one of the hydrogeology specialists).

c. ***Seawater intrusion and coastal wellfields – how large a risk, and what might be done?***

Seawater intrusion into coastal aquifer systems is a concern for City wells, as well as for water systems in neighboring communities (most notably, Soquel Creek Water District). Sea level rise and elevated storm surge from climate change are likely to exacerbate challenges associated with current extraction levels. The City has completed a preliminary assessment of what is known about these vulnerabilities (WSAC August agenda); their implications (e.g., for yields, water quality, and treatment requirements), and potential remedies should be further evaluated (e.g., the potential feasibility of hydrologic barrier

wells to recharge coastal aquifers while concurrently managing seawater intrusion). The intent of this work effort is to gather and articulate what is known, and to define what core questions need to be examined in order to more fully assess the risks and potential remedies.

Hydrogeologic expertise is required, and we are in the process of identifying which potential team member(s) may be best suited for this assignment (e.g., HydroMetrics may already have some direct experience). We will seek review and input from Andy Fisher (as available) and anticipate subsequent review and input from the IRP (notably, Mike Cloud). Input and involvement from other hydrogeologists and regional water experts (e.g., John Ricker) may be valuable as well.

7. Water Recycling

Water reuse is an alternative that may be viable and valuable to consider. There are various forms of reuse, typically characterized as

- Nonpotable reuse (NPR, such as may be used for irrigation or industrial processes)
- Indirect potable reuse (IPR, such as may be implemented through ASR, for example, and which is gaining fairly widespread application throughout California and other locations), and
- Direct potable reuse (DPR, for which the State of California currently is developing enabling regulations – due by 2016).

A series of investigations are warranted for water recycling, as described below.

a. How much reclaimed water might be available (potential yield)?

A core question is how much water is available for potential reclamation in Santa Cruz. The answer depends on the volume of wastewater effluent discharged from the wastewater treatment plant (which in turn is driven largely by the volume of indoor water use in the City). Other potentially important factors may include the volume of effluent discharge that the City needs to meet regulatory requirements (e.g., dilution, flows, which may vary seasonally), and the percentage of product water generated by the "advanced treatment" process train deployed for reclaimed water. Developing this estimate should be fairly straight-forward, using knowledge already held at the Water Department, coupled with some expertise from one of the engineering team members (e.g., George Tchobanoglous, Trussell Technologies, or Brown and Caldwell).

b. Potable Reuse: what are the options, public health implications and perceptions?

Potable reuse is gaining increasing acceptance from the scientific and regulatory community, as well as from the general public (as evident through potable reuse programs in Orange County, San Diego, Santa Clara Valley, Chino Basin, El Paso, Singapore, and elsewhere). We recommend providing WSAC with an overview of the key issues, approaches, and comparative advantages and disadvantages of the various water reuse options (IPR, NPR, as well as DPR). This may take the form of an "enrichment" presentation (e.g., by Rhodes Trussell, see item 9, below), a short written report (which can be based largely on a White Paper being completed by Bob Raucher and George Tchobanoglous for the WateReuse Research

Foundation), and (or) a short briefing presentation in an upcoming WSAC meeting.
The Water Department, in cooperation with the City's Public Works Department, the County of Santa Cruz, and Soquel Creek Water District, is currently applying for several grants to further analyze the potential uses of recycled water.

8. Lifecycle Costing and Technical Scoping for Key Alternatives (Water Supply Options)

The Committee will ultimately need to have reasonably accurate estimates of the cost, technical feasibility, scalability, and other key aspects of the various water supply (and demand management) alternatives it wishes to consider. Brown and Caldwell can be tasked with initiating this exercise in the near term, so that initial findings can help guide Recon efforts, and more detailed analysis needs for the Real Deal can be better identified and prioritized.

Efforts should include assessments of infrastructure and treatment needs, including pipe/pumping needs, land acquisition, and so forth – as well as permitting costs – as needed to develop preliminary estimates of initial capital outlay (implementation) costs. Operation and maintenance (O&M) costs also need to be characterized, as well as energy and residuals management requirements. Water Department expertise and past reports will help guide and inform this effort. This work also needs to be coordinated with the initial scoping of energy requirements and carbon footprints (item 3a, above). Options to explore should include the baseline, water reuse, water exchanges, seawater desal, and others as put forward by the Committee.

9. Enrichment Series

Because there are many technical analysis issues to be considered within the context of the Committee's deliberations, and because there is limited time available for such presentations and discussions within the constraints and other priorities associated with WSAC meetings, we suggest offering a series of supplemental "enrichment" presentation/discussions. These may be provided immediately preceding the formal WSAC meetings, and/or at other times and venues as convenient for Committee members. Some of the topics that may be considered for the Enrichment Series include:

a. Water and regional economic vitality (David Mitchell, Friday Sept 26, 1:15 pm)
b. Conservation/Demand management
c. History of Water Treatment Technology, and Where we are Headed (membranes, UV and Ozone today, and whether Forward Osmosis likely to be viable in the near future) – perhaps presented by Rhodes Trussell, perhaps in October)
d. Potable Water Reuse – Water Quality, Regulatory Development, and Public Health Perspectives
e. Energy requirements and carbon footprints
f. Others? We are open to suggestions and requests!