September 23, 2021

Ken Kules' comments on the December 2020 Final Water System and Resources Plan

SUMMARY

- The WSRP relies heavily on input from a stakeholder panel process that was deeply flawed
- The deteriorated condition of the Raymond Basin has been understated in the WSRP and climate change has not been accounted for
- The WSRP does not lay out a meaningful plan to address Raymond Basin groundwater decline
- The WSRP must include an overarching policy that determination of the current sustainable safe yield of the Raymond Basin and development of Basin protection policies by the Raymond Basin Management Board (RBMB) must be a precedent to implementing projects that earn pumping credits
- The City Council should be skeptical regarding:
  - Feasibility, cost and benefit of the Local Non-Potable Project
  - Projected project costs and yields in general
  - Scope of new well construction
  - Proposed use of Aquifer Storage and Recovery (ASR) through a Pasadena Groundwater Storage Program that is likely to fail
  - The proposed pipeline replacement schedule

These issues are discussed in the following paragraphs.

The WSRP relies heavily on input from a stakeholder panel process that was deeply flawed

The Stakeholders were uninformed on several key issues relevant to selection of the WSRP Portfolio F. The WSRP language that "This report is culmination of joint thinking and collaborative efforts of the community, elected and appointed public officials, subject matters experts and personnel from several City departments"[1] infers that the Stakeholders concurred in the selection of Portfolio F. This is critiqued in detail in the "Comments of Ken Kules and Morey Wolfson on the Water System and Resources Plan (WSRP)" (Attachment 1).

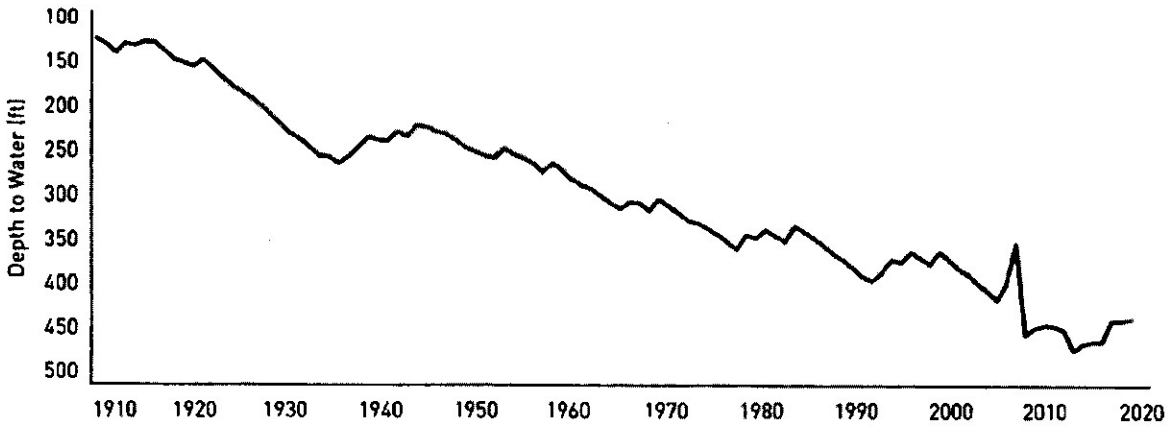
The deteriorated condition of the Raymond Basin has been understated in the WSRP and climate change has not been accounted for

The Pasadena Area

The discussion of Groundwater Reliability includes the following graph that shows groundwater decline in the Pasadena Area Sub-basin of the Raymond Basin:[2]

[1] WSRP, p. ES-1
[2] WSRP, p.2-17

Historic Pasadena Area Groundwater Levels



Source: RMBM, Draft Opportunities to Enhance Groundwater Levels in Pasadena Subarea

The accompanying discussion says that:[3] (emphasis added)

> *Aging infrastructure and existing groundwater recharge facilities and governing practices confound groundwater pumping capacity in the area. Declining water levels in the basin are the main challenges for the water agencies relying on groundwater. PWP and the regional partners must implement new policies to improve groundwater quality and quantity in order to achieve the reliability goals of the basin. In addition, PWP has initiated new capital improvement projects and sought partnerships to pursue recharge efforts aimed towards the objective of a reliable groundwater supply in the future.*

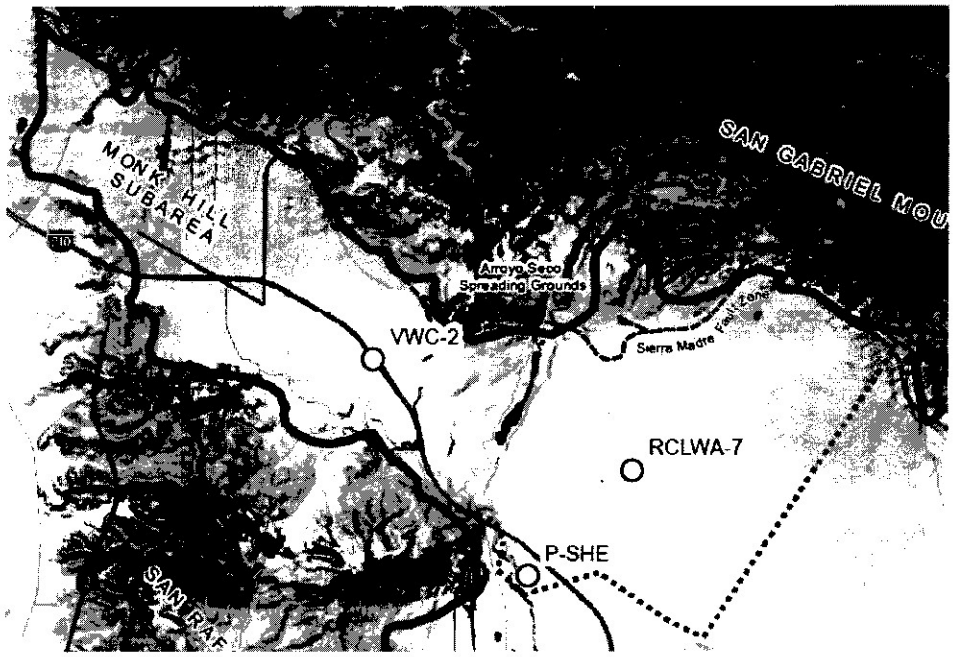
That was the entire discussion in a section entitled "Groundwater Reliability."

Monk Hill Basin

There is **NO** discussion at all of Monk Hill Basin reliability in the WSRP. Since the WSRP seeks to leverage every drop of water possible from the Monk Hill Basin, I present what information is available to me here.

There is data for three "key wells" in the Monk Hill Basin that has been reported by the RBMB: Valley Water Company, Well No. 2 (VWC-2); Pasadena's Sheldon Well (P-SHE); and Rubio Canon Land & Water Association, Well No. 7 (RCLWA-7).

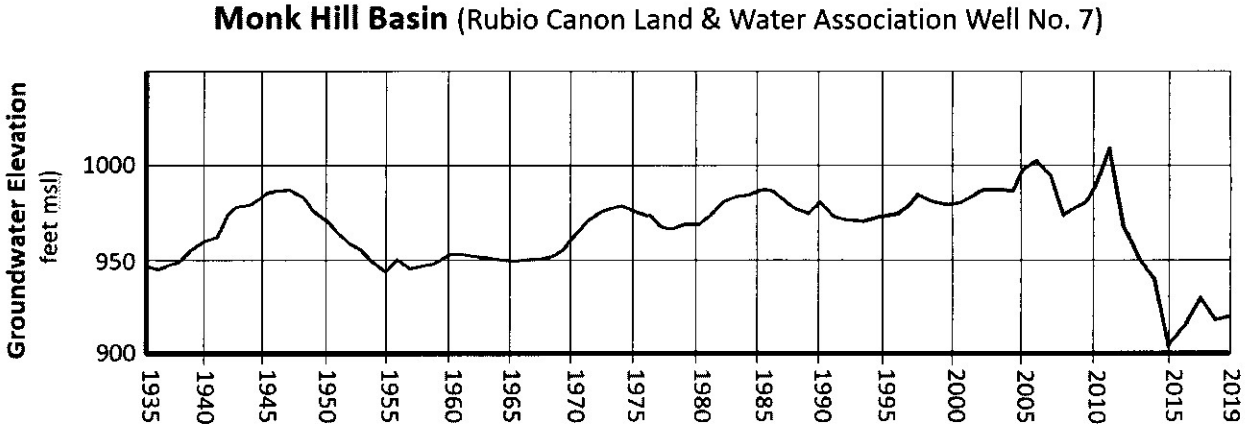
[3] *Ibid*



Source: RBMB July 1, 2018-June 30, 2019 Annual Report, p. 22

The VWC-2 well is not a good metric for evaluation of natural replenishment as it is under the influence of injection of imported Metropolitan Water District supplies into the groundwater. The P-SHE (Sheldon) well has not been used in many years and does not reliably reflect drawdown effects that result from pumping in the Monk Hill Basin. The RCLWA-7 well is down-gradient of the Arroyo Seco replenishment facilities and is a better indicator of groundwater levels in the study area.

The following is a composite graph showing groundwater levels for the RCLWA-7 well going back to 1935 (prior to the initial Raymond Basin adjudication):

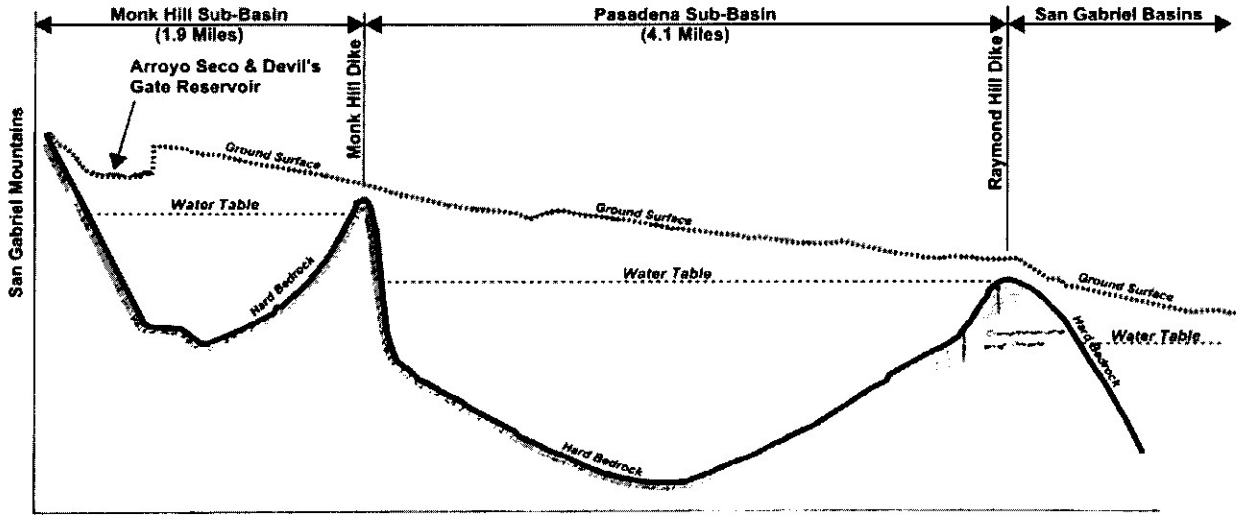


Source: Adapted from RBMB Annual Reports for 1992-93, 2003-04, 2007-08 & 2018-19 (Data for 1935-2004 adjusted to use ground surface datum of 1159.6 msl)

This figure shows that groundwater levels are below the levels that preceded the basin adjudication and are at a historic low by about 30 feet. Listing the causes for the changes in groundwater levels would be highly speculative, but it's probable that the cessation of pumping because of perchlorate contamination from 2001 to 2011 contributed to higher groundwater conditions during that period and

the recent drought - along with resumption of pumping after completion of perchlorate treatment facilities - caused the dramatic decline between 2011 and 2015.

It's worth noting that while the decline in the Monk Hill Basin is far lesser magnitude than in the Pasadena Area, the Monk Hill Basin is also significantly shallower with far less volume as shown below and the degree of impact correlates to depth and volume of groundwater:



Source: PWP November 2019 Water System & Resources Plan workshop

These and additional reliability concerns related to water quality are discussed further in "Ken Kules' supplemental Comments on Pasadena's 'Public Draft Urban Water Management Plan (April 2021)'" (Attachment 2).

In a section on "Water Supply Reliability Assessment", the WSRP says that the following would guide analysis of groundwater supplies:[4] (emphasis added)

> *The analysis uses **historical data from 1922 to 2018** to evaluate future years under multiple hydrologic conditions*
>
> ***Climate change variables were not applied to future years***
>
> *To determine local supply availability, the model simulated local hydrology using **historical data from the Arroyo Seco and Eaton Wash** and accounted for **diversion rights, spreading credits** and **adjudicated pumping rights** as well as capacity constraints on existing facilities. **This analysis was used to quantify the reliability of groundwater** and surface water and determine the ability of the existing water supply portfolio to meet future water demands.*

In summary, the reliability assessment ignores the facts that the groundwater has been declining and the threat of climate change is real and blindly asserts that the safe yield that was established in 1955 is appropriate for planning purposes in 2020.

<u>The WSRP does not lay out a meaningful plan to address Raymond Basin groundwater decline</u>

The only WSRP "plan" to restore the Raymond Basin is in the form of establishing **goals**:[7]

---

[4] WSRP, p. 4-2

[7] WSRP, p. 2-12

PWP's established goal is to partner with other water agencies implementing specific projects in the Raymond Basin to reduce the loss of groundwater to the Main San Gabriel Basin, determine the current sustainable yield of the Raymond Basin, revise established Final Water System and Resources Plan Pasadena Water System and Resources Pasadena Water & Power 2-13 December 2020 policy on Basin sustainability, and develop Basin protection policies and guidelines to be adopted by all other land users and pumpers in the Basin.

It should be kept in mind that the WSRP outlined the "plan" in May 2020.[8] These are the RBMB's comments regarding the WSRP "plan" (emphasis added):[9]

The WSRP indicates Pasadena will be (1) implementing specific projects in RB to reduce loss (leakage) of groundwater to MSGB, (2) revise policy on Basin sustainability, (3) develop Basin protection policies and guidelines for Basin wide adoption. RBMB advises these are the roles and responsibilities of the RBMB. Pasadena is on the RBMB and all committees. ***Pasadena has not introduced any of these concepts in any form to the RBMB.***

It's clear that the "plan" lacks vision, commitment or any sense of urgency and that must be addressed.

The WSRP must include an overarching policy that determination of the current sustainable safe yield of the Raymond Basin and development of Basin protection policies by the Raymond Basin Management Board must be a precedent to implementing projects that earn pumping credits

The conditions described above for the Monk Hill Basin and the Pasadena Area were anticipated in 1954. The California Department of Water Resources (DWR; formerly the Department of Public Works) was the "Referee" in the adjudication that analyzed the groundwater conditions and developed the assessment that led to the 1955 Amended Raymond Basin Judgment (Judgment) Safe Yield that is currently in force. In the final report to the Court that was used as the basis for the increase in the adjudicated Safe Yield from the initial 1945 determination, DWR opined:[13]

...although the present safe yield of the Area is substantially greater than in 1937-38, it is probable that future lining of stream channels and extension or sewerage facilities, which factors tend to decrease ground water recharge, will overbalance compensating factors such as expansion or artificial spreading operations, and the net result will be a decrease in the present safe yield of Raymond Basin Area.

In the discussion of "Water Supply Sources", the WSRP says (emphasis added):[14]

There are three main threats to the Basin. ***PWP is working to address with near-term actions:*** *groundwater contamination,* ***basin management practices,*** *and regulatory overreach by the State.*

PWP's established goal is to partner with other water agencies implementing specific projects in the Raymond Basin to reduce the loss of groundwater to the Main San Gabriel Basin, ***determine the current sustainable yield of the Raymond Basin, revise established policy on Basin sustainability,*** *and* ***develop Basin protection policies and guidelines to be adopted by all other land users and pumpers in the Basin.***

[8] Water System and Resources Plan Public Draft, May 2020, p. 2-13

[9] WSRP, Appendix K, comment 15 of RBMB letter

[13] Report of Referee on A Review of the Determination of the Safe Yield of the Raymond Basin Area, Los Angeles County, California (July 1954), p.83

[14] WSRP, P. 2-9

As discussed above, the Raymond Basin is in a state of overdraft.[15] While the following projects proposed in the WSRP will attempt to take actions that are claimed to improve the groundwater conditions, the actions are coupled with an expectation that PWP will be able to earn credits that will allow them to pump groundwater in addition to the adjudicated safe yield:[16]

- Arroyo Seco Canyon Project (LSW-0 - 80% pumping credit)
- Arroyo Seco to Eaton Canyon Raw Water Pipeline (LSW-1a) (80% pumping credit)
- Arroyo Seco Pump Back Project (LSW-1) (60% pumping credit)
- Natural infrastructure (LSW-5) (60% pumping credit)

While it might be argued that these projects will result in a net basin benefit, that benefit would amount to less than 900 AF/Y – a small fraction of what is needed to mitigate the overdraft. These projects are also the "low hanging fruit" that might be critical to a strategy to arrest the overdraft if implemented by the RBMB Board.

It should be noted that, at an oral briefing of the Municipal Services Committee in May 2021, the Executive Officer of the RBMB made the following remarks:

> *"I think that we really need to go back and look - take one more step and look at the current spreading credits that are allowed and how that accounting is done and really if that actually is making any impact on lowering water levels or it is a true sustainable program."*
>
> *"...you're not necessarily going to have all this extra water that's spread to your benefit under the current rules and regulations..."*

It would be unwise for Pasadena to move forward with projects that rely on new pumping credits without first addressing Raymond Basin reliability through RBMB deliberations/actions, and Pasadena should adopt a policy that places a very high priority on that process.

The City Council should be skeptical regarding the feasibility, cost and benefit of the Local Non-Potable Project

Tunnel Water. One source of supply for this project is "tunnel water" and it is assumed that it would include Devil's Gate Tunnel water and Richardson Tunnel as described for Option NP-1.[17] In 2015, the combined production from those tunnels was estimated to be 238 AF/Y.[18] The yield from the Devil's Gate Tunnel for the period 1971-1995 has been reported to be 160 AF/Y[19] which suggests that the Richardson Tunnel yield is 80 AF or less. The Devil's Gate Tunnel has been dry since August 2013[20] which corresponds to the severe decline in the Monk Hill groundwater levels discussed above. It is likely that the Richardson Tunnel has suffered the same fate.

High-nitrate Well Water. High nitrate levels in well water is constrains limits its use in potable water systems. The cost-effective historic method of making the high-nitrate water suitable for municipal uses has been to blend that water with imported water. The WSRP proposes to mitigate nitrate contamination through treatment in all but two wells in the westerly part of the system that have high

---

[15] Groundwater overdraft occurs when groundwater use exceeds the amount of recharge into an aquifer, which leads to a decline in groundwater level. (https://waterinthewest.stanford.edu/groundwater/overdraft/)
[16] WSRP Appendix F
[17] WSRP, p. 5-15
[18] Pasadena Non-Potable Water Project DEIR, Table 2-1
[19] "Hydrogeologic Investigation - Devil's Gate Water Collection Tunnel", Converse Consultants West, 8-29-1995, p.7
[20] City of Pasadena "Reports of Licensee" submitted to the State Water Resources Control Board since 6-30-2014

nitrate levels,[21] and the water from the two wells would support the Local Non-Potable Project. The capital cost of treating those two wells would be about $7.5 million[22] which is a fraction of the $13 million cost of the Local Non-Potable Project ($10 million plus $3 million for connecting the wells to the system[23]).

The City Council should be skeptical regarding the projected project costs and yields in general

The WSRP is confusing in its description of project components.

- It says that the Arroyo Seco to Eaton Canyon Raw Water Pipeline project will involve pumping 1,070 AF/Y of water from behind Devil's Gate Dam for delivery to the Eaton Wash Spreading Grounds.[24] It goes on to describe a separate Arroyo Seco Pump Back Project that will pump 1,000 AF/Y of water from behind Devil's Gate Dam for delivery to the Arroyo Seco Spreading Grounds.[25] It's inconceivable that these two project don't overlap.
- It includes $10 million for the Local Non-Potable Project[26] (not including the $3 million cost of the GW-3 project). The WSRP is not clear, but it appears that cost is associated with building a "cross town" pipeline from the Arroyo Seco area.[27] It's not clear whether this project somehow overlaps with the Arroyo Seco to Eaton Canyon Raw Water Pipeline project.
- The project that treats Monk Hill groundwater for nitrates claims a project yield of 2,400 AF/Y[28] that may be the production capacity, but it will not increase the amount of water allowed to be pumped under the Judgment.
- The above ambiguities not only cast a shadow on the collective project costs, but also confuse the expected project yields.
- Much of the confusion comes from the failure to include graphics that depict the various project features.

The City Council should be skeptical regarding the scope of new well construction

The current well production capacity exceeds the groundwater allocation under the Judgment.[29] Determination of the need for and construction of new wells should not occur until the Raymond Basin safe yield can be validated (or re-determined) as discussed above.

The City Council should be skeptical regarding the proposed use of Aquifer Storage and Recovery (ASR) through a Pasadena Groundwater Storage Program that is likely to be unsuccessful

The WSRP proposes a Pasadena Groundwater Storage Program[30] that would require construction of new injection/extraction wells at a capital cost of $16 million.[31] Those wells would be used to recharge the groundwater by injection of imported Metropolitan Water District (MWD) treated water at a capital cost

[21] WSRP, p. 5-25
[22] Based on the cost of project GW2a that adds well-head nitrate treatment for 2 wells
[23] WSRP, p. 7-13
[24] WSRP, p. 8-1
[25] *Ibid*
[26] WSRP, p. 7-13
[27] WSRP, p. 5-16
[28] WSRP, p. 5-25
[29] WSRP, pp. 4-7, 5-24
[30] WSRP, p. 5-8
[31] WSRP, p. 7-13

of $6 million.[32] Water would be stored over a series of wet years and subsequently extracted over multiple dry years.

One limiting factor in implementing the Program is that MWD water delivered to Pasadena tends to contain high levels of TDS that exceed the Basin Plan Objectives and replenishment would be regulated by the Regional Water Quality Control Board through the permitting process and the Raymond Basin Salt and Nutrient Management Plan.[33]

Replenishment with MWD water has been permitted in both the Monk Hill Basin and the Santa Anita Subarea. In both cases, imported water is recovered through extraction in the same year and the TDS of the down-gradient groundwater area is not affected. Where replenished water is allowed to remain over multiple years, the natural flow of groundwater will transport the higher-TDS injected water away from the "pumping cone" of the well at the time of extraction and the TDS in the down-gradient area will increase.[34] Unless the RWQCB accepts the degradation, the Program will be doomed to failure.

ASR wells are also considered where useful in circumstances where replenishment using spreading basins is constrained by dense land use. That is not the case for the Raymond Basin as there is excess capacity in the Eaton Wash spreading basins to replenish with imported supplies and it is very close to MWD's supply pipeline.

If direct replenishment is not attractive, "recharge" can be accomplished by taking imported water "in lieu" of pumping groundwater and leaving the groundwater in the basin. Unlike ASR, the cost of this method is limited to the cost for the purchase of water and does not require any operations or facilities costs.

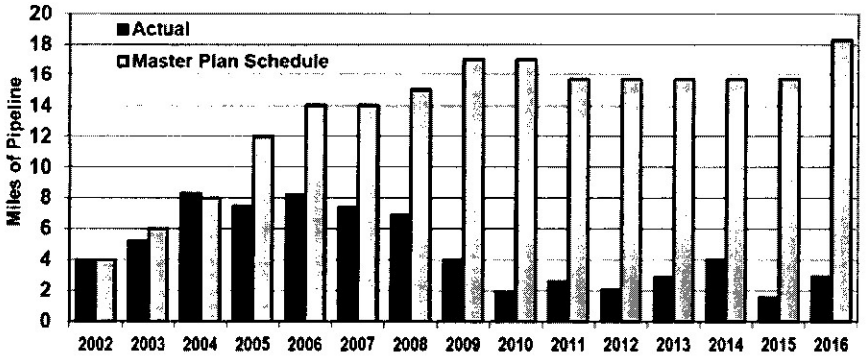
The City Council should be skeptical regarding the proposed pipeline replacement schedule

The following was presented to the Municipal Services Committee on March 28, 2017 (emphasis added):[35]

> *As shown in Figure 3, the Master Plan pipeline replacement schedule was intended to accelerate over time,* ***starting at four miles per year in FY2002 then increasing to 18 miles per year by FY 2016****. This schedule would have resulted in replacing or cement lining 273 miles (54 percent) of PWP's water pipelines by year 2020. However,* ***PWP soon realized this schedule was far too aggressive. When more than five miles of pipelines were installed it was found to be quite disruptive to the community****. As a result, lower annual goals have been set with each CIP budget since FY 2005 and only 70 miles of pipelines have been replaced in the last 14 years at an* ***average rate of five miles per year****. This pace was also affected by available funding and resources.*

[32] Injection of untreated water in groundwater the vicinity of potable water extraction wells is not permitted.
[33] WSRP, p. 8-8
[34] See https://agupubs.onlinelibrary.wiley.com/doi/full/10.1029/2011WR010605
[35] https://www.cityofpasadena.net/wp-content/uploads/sites/31/2017-03-28-Municipal-Services-Committee-Agenda.pdf?v=1602984643729

Figure 3 – Pipeline Replacement Program, FY2002-2016



The Master Plan had anticipated that 83 miles of the 273 miles of pipelines would be cement lined, rather than replaced. Cement lining is a less disruptive process that involves scraping out the rust and deposits in the pipe and lining the inside of the pipe with a thin coating of cement. Unfortunately, PWP experienced many adverse issues with cement lining program. While it was assumed that this process would extend the useful life the pipeline for about thirty years, some of these pipelines began to fail after the work was completed and one such project caused a major water quality issue that initiated boil water alert. Due to these adverse experiences, the cement lining program was discounted soon after the implementation of the Master Plan. At the average completion rate of five miles per year, it would take 104 years to replace all the pipelines in PWP's 520 mile system. While this is a reasonable schedule given the estimated 100 year useful of these pipes, there are still approximately 80 miles of pre-1930 pipe remaining in the water system. Thus, without an accelerated schedule some pipes could reach an age of 120 years or more before being replaced. Table 2 compares PWP water pipe replacement cycle to other water agencies.

Table 2 – Pipeline Replacement Cycle

Agency	Replacement Cycle
PWP Master Plan Schedule (15 miles/year)	33 years
PWP Average Actual Rate (5 miles/year)	104 years
Los Angeles Department of Water and Power	225 years
Glendale Water and Power Department	200 + years*
Burbank Water and Power Department	200 + years*

** Rough estimate based on spending levels on pipeline replacement from annual financial reports.*

To maximize the reliability benefits of the pipeline replacement program PWP has concentrated its efforts based on the age of the pipe and fire flow requirements, focusing on major traffic corridors and business districts where water main breaks could cause significant disruptions. On an average, PWP experiences about 24 water main breaks a year, which is relatively low for the size and age of PWP's water system.

The WSRP proposes to replace pipelines at a rate of more than 10 miles per year[36] - twice the current rate - but makes no mention of the challenges associated with that goal other than estimating the total cost of about $293 million over 25 years.[37]

[36] WSRP, p. 6-3 (Table 6-2)
[37] WSRP, p. 6-4 (Table 6-3)

No consideration is given to pursuing alternative risk mitigation strategies that might be implemented through innovative technology efforts.[38]

Attachment 1: Comments of Ken Kules and Morey Wolfson on the Water System and Resources Plan (WSRP) Stakeholder review process

Attachment 2: Ken Kules' supplemental Comments on Pasadena's "Public Draft Urban Water Management Plan (April 2021)"

[38] https://www.waterworld.com/technologies/flow-level-pressure-measurement/article/14183739/reducing-water-loss-with-smart-technologies?trk_msg=RFRHLIQURPCKR31RI1ER12GKUO&trk_contact=NS5C0GNGNU6NFG713MQHHNKDTK&trk_sid=18GPRI8TABA2MTDOP6RN258B5G&utm_source=listrak&utm_medium=email&utm_term=https%3a%2f%2fwww.waterworld.com%2ftechnologies%2fflow-level-pressure-measurement%2farticle%2f14183739%2freducing-water-loss-with-smart-technologies&utm_campaign=TopStories&utm_content=TopStories
https://smartwatermagazine.com/news/fido/breakthrough-leak-detection-uk-pioneered-ai-learns-identify-water-leaks-size
https://www.mswmag.com/online_exclusives/2021/03/drones-to-predict-where-water-pipes-are-at-risk-of-bursting

Ken Kules' WSRP Comments - Attachment 1

March 28, 2021

Comments of Ken Kules and Morey Wolfson on the Water System and Resources Plan (WSRP) Stakeholder review process

Background.

There were five "scheduled" Stakeholder Meetings beginning in October 2018 and ending in September 2019. The following comments summarize key discussions held at the last two meetings at which analyses of WSRP portfolio options were presented. We were among the "Stakeholders" that attended those meetings.

Portfolio Options, Evaluation and Selection.

At Stakeholder Meeting #4, PWP proposed evaluation of six "portfolio options" for consideration based on qualitative input from the Stakeholders from prior meetings. Portfolio components were identified and only "rolled-up" capital costs were provided (see Attachment 1 example of "Portfolio: Maximize Value of Groundwater/Non-potable Supplies). Interest was expressed by Stakeholders in seeing the unit cost ($/acre-foot) and yield of the water supply components for the six portfolios and were told that information would be provided later. While the Stakeholder Meeting agenda and the WSRP discussion (p. 1-5) describe the meeting as including selection of a portfolio, no consensus of Portfolio preference was expressed by the Stakeholders at Meeting #4 due to lack of projects' cost and yield information.

Stakeholder Meeting #5 began with a Powerpoint presentation of a table that shows cost and yield for only Portfolio F and not the other five portfolios (Attachment 2). An enlarged excerpt of the "Supply and Production Program Components" is also attached (Attachment 3). That table was not distributed to the Stakeholders in advance of the meeting and the Stakeholders requested that it be provided at a larger legible scale so we could review it. The PWP consultant agreed that the Stakeholders should have time during the meeting to examine the table prior to discussing it, made copies available and deferred discussion until later in the meeting. Despite a later request to discuss the table, the meeting ended without the PWP/consultant having discussed the table due to expiration of the room reservation "window." In summary, Portfolio F was selected by PWP without meaningful deliberation by the Stakeholders.

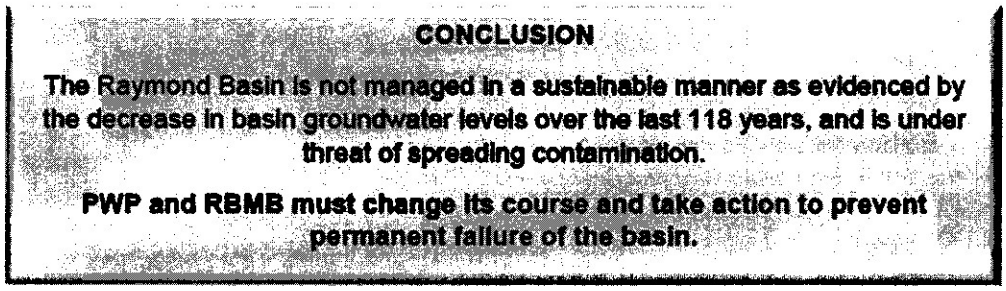
It's worth noting that the table discussed here - or one resembling it - was not included in the WSRP and that there are significant differences between the table and the project costs and yields included in the WSRP.

Raymond Basin Reliability and Sustainability.

The selection of Portfolio Option F relied heavily on the reliability and sustainability of the Raymond Basin groundwater source and the policy of "maximizing the value of the Raymond Basin." When asked during Stakeholders Meeting #5 - the last scheduled meeting - to educate the stakeholders in the group regarding the declining conditions of the basin, the PWP/consultant response was "I don't know that we

have the time today to do a huge deep dive on how the Raymond Basin works at this point in the process."

On the same day as Stakeholder Meeting #2, PWP received a report from their Zanjero consultant (Attachment 4) that drew the following conclusions:



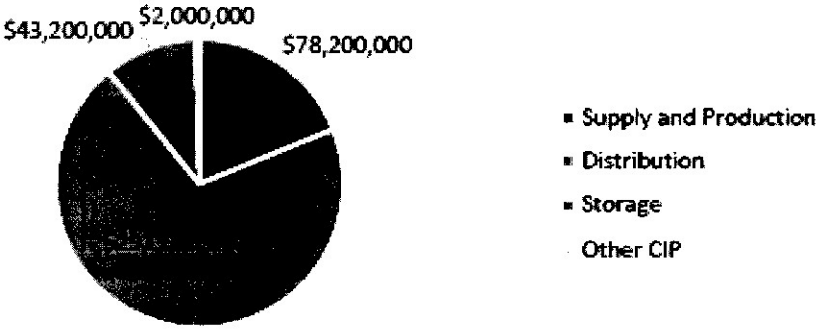
Access to this information would certainly have informed the views of the Stakeholders regarding support of option choices and made a compelling case for questioning the prudence of selecting a Portfolio that relies on further exploitation of the Raymond Basin.

Conclusion.

The discussion above makes it clear that the Stakeholders were uninformed on several key issues relevant to selection of the WSRP Portfolio F. The WSRP language (p. ES-1) that "This report is culmination of joint thinking and collaborative efforts of the community, elected and appointed public officials, subject matters experts and personnel from several City departments" infers that the Stakeholders concurred in the selection of Portfolio F. That is not accurate from our perspectives and we cannot support the WSRP as proposed.

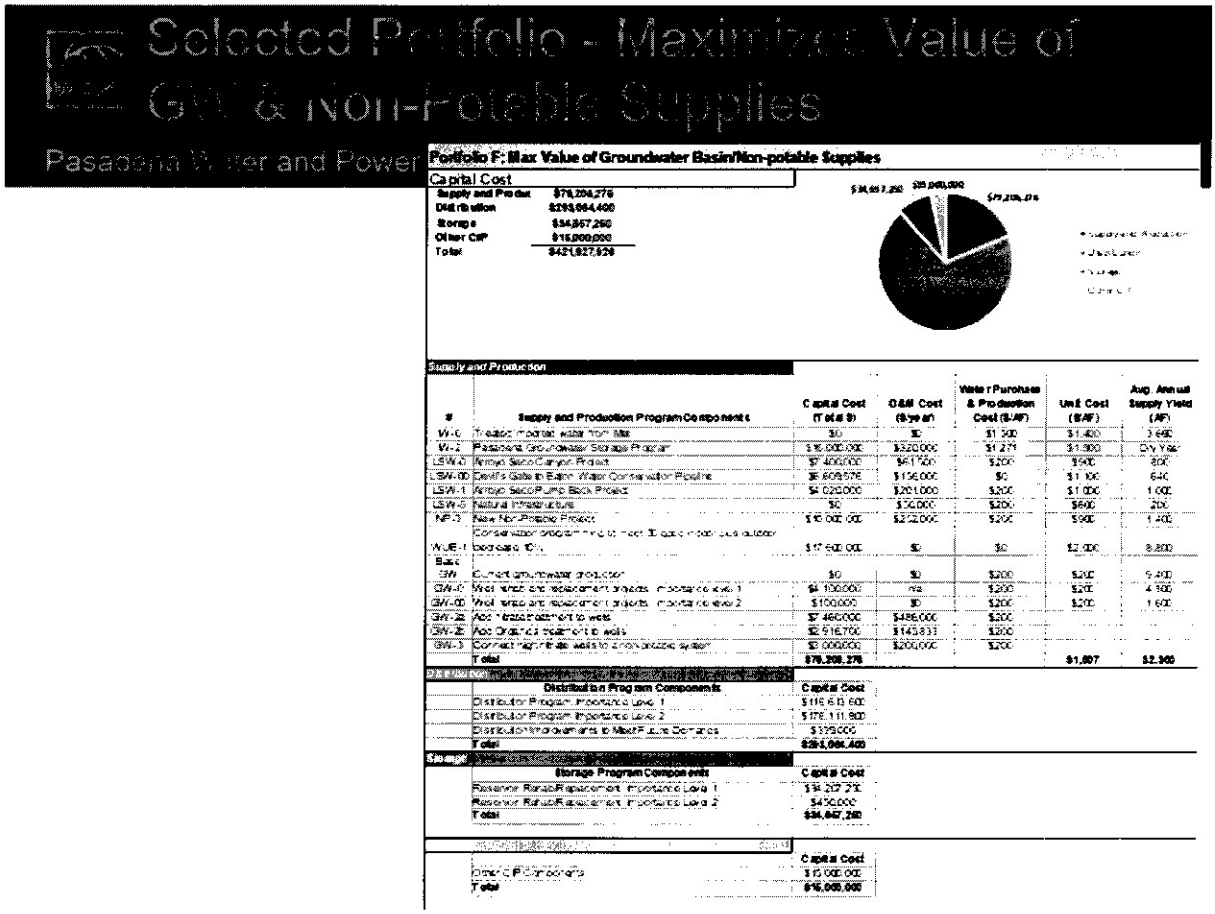
Capital Cost

Supply and Production	**$78,200,000**
Distribution	**$291,600,000**
Storage	**$43,200,000**
Other CIP	**$2,000,000**
Total	**$415,000,000**



Supply and Production Components		
IW-0	Treated, Tier 1 imported water from Metropolitan Water District of So Cal	
IW-2	Pasadena Groundwater Storage Program	
LSW-0	Arroyo Seco Canyon project	
LSW-00	Devil's Gate Dam to Eaton Wash water recharge basin conservation pipeline	
LSW-1	Arroyo Seco Pump Back project	
LSW-5	Natural infrastructure (will allow more water to naturally recharge)	
NP-1	Tunnel Water to Brookside Golf Course - Devil's Gate Tunnel	
NP-2	Arroyo Seco Diversions to Brookside Golf Course - out of the channel	
NP-3	New non-potable supply project	
WUE-0	Conservation programming to meet 50 gpcd indoor use	
Base GW	Current groundwater production	
GW-0	Well rehab and replacement projects, critical	
GW-00	Well rehab and replacement projects, needed	
GW-2a	Add nitrate treatment to wells	
GW-2b	Add organics treatment to wells	
GW-3	Connect high nitrate wells to a non-potable system	
	Total Capital Cost	**$78,200,000**
Distribution Improvement Components		
Critical rehabilitation and replacement distribution projects		
Needed rehabilitation and replacement distribution projects		
Distribution expansions to meet future demand		
	Total Capital Cost	**$291,600,000**
Storage Improvement Components		
Critical rehabilitation and replacement storage projects		
Needed rehabilitation and replacement storage projects		
	Total Capital Cost	**$43,200,000**
Other capital improvement program components		
	Total Capital Cost	**$2,000,000**

Attachment 2



Attachment 3

Supply and Production

#	Supply and Production Program Components	Capital Cost (Total $)	O&M Cost ($/year)	Water Purchase & Production Cost ($/AF)	Unit Cost ($/AF)	Avg. Annual Supply Yield (AF)
MW-0	Treated imported water from Met	$0	$0	$1,500	$1,400	3,660
MW-2	Pasadena Groundwater Storage Program	$16,000,000	$320,000	$1,271	$1,900	Dry Year
LSW-0	Arroyo Seco Canyon Project	$7,400,000	$61,500	$200	$900	800
LSW-00	Devil's Gate to Eaton Water Conservation Pipeline	$6,609,576	$156,000	$0	$1,100	640
LSW-1	Arroyo Seco Pump Back Project	$4,020,000	$201,000	$200	$1,000	1,000
LSW-5	Natural infrastructure	$0	$50,000	$200	$600	200
NP-3	New Non-Potable Project	$10,000,000	$252,000	$200	$900	1,400
WUE-1	Conservation programming to meet 50 gpcd indoor plus outdoor decrease 10%	$17,600,000	$0	$0	$2,000	8,800
Base GW	Current groundwater production	$0	$0	$200	$200	9,400
GW-0	Well rehab and replacement projects, importance level 1	$4,100,000	n/a	$200	$200	4,800
GW-00	Well rehab and replacement projects, importance level 2	$100,000	$0	$200	$200	1,600
GW-2a	Add nitrate treatment to wells	$7,460,000	$486,000	$200		
GW-2b	Add Organics treatment to wells	$2,916,700	$145,833	$200		
GW-3	Connect high nitrate wells to a non-potable system	$3,000,000	$200,000	$200		
	Total	**$79,206,276**			**$1,007**	**32,300**

Ken Kules' WSRP Comments - Attachment 2

June 4, 2021

Ken Kules' supplemental Comments on Pasadena's
"Public Draft Urban Water Management Plan (April 2021)"

The California Department of Water Resources provides guidance for water suppliers regarding the Urban Water Management Plan (UWMP) in its "Urban Water Management Plan Guidebook 2020." The introduction to Chapter 6 (Water Supply Characterization) says:

> *A thorough characterization and analysis of water supplies can provide a realistic reliability assessment of a Supplier's water assets under various hydrological and regulatory conditions. A thorough analysis examines surface water rights, water entitlements (i.e., contracts for water delivery), groundwater supplies, raw water supplies, and recycled water supplies.*
>
> *The water supply analysis is critically important to Suppliers. The conclusions drawn about supply availability under various hydrological and regulatory conditions permeate all other components of the UWMP.*
>
> *Suppliers will need to characterize each source of water supply and consider any information pertinent to the reliability and risk analyses, including changes in supply due to climate change.*
>
> *The more details addressed in a water supply analysis, the better. Some details that are important to be considered for each water asset include: ... any uncertainties in the water asset itself ... that may impact the reliability of the water supply...*

In its instructions regarding groundwater supplies, it recommends including:

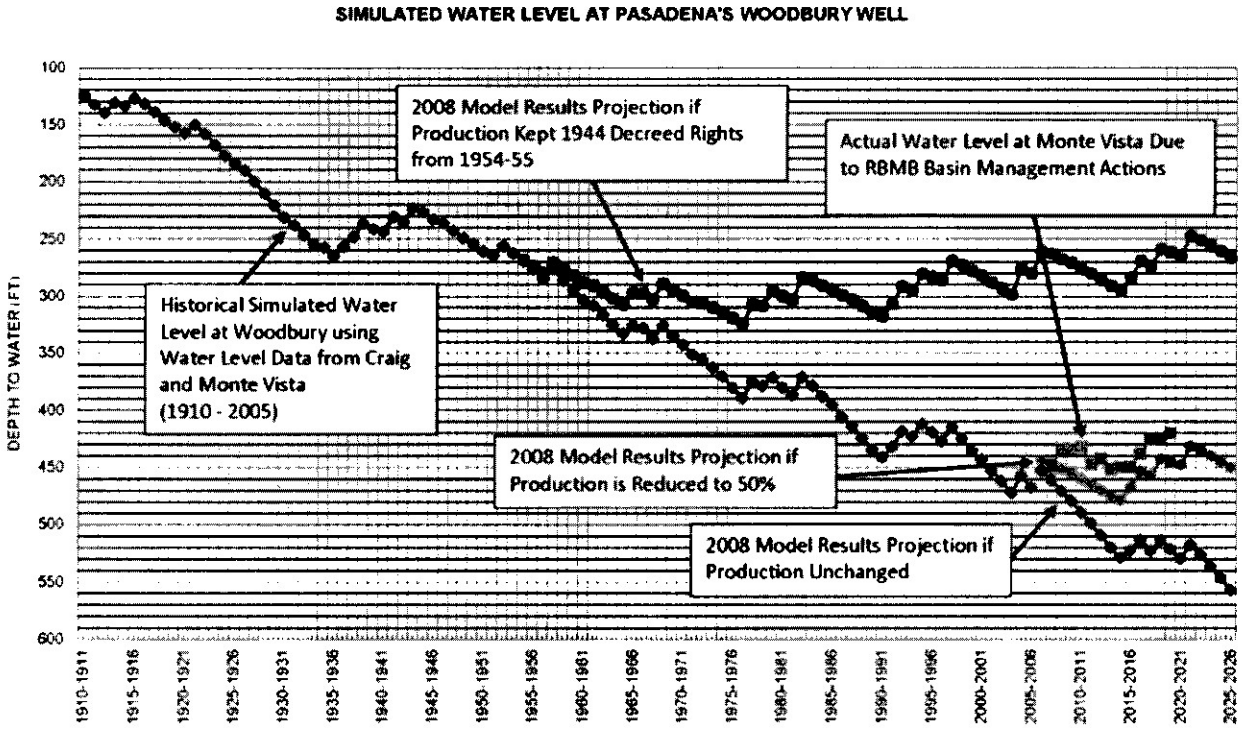
> *...a discussion of any known issues including changes in groundwater levels, water quality issues, yield, subsidence, or any information that may affect present or future groundwater use.*

Pasadena's UWMP fall short in its description of groundwater resources in Chapter 6 with regard to both groundwater reliability and quality as discussed below.

Reliability

The 1944 Raymond Basin Judgment (Judgment) established a safe yield[1] for the basin and allocated the right of each pumper in the basin to pump a share of the safe yield.[2] That allocation was adjusted upward in a subsequent amendment to the Judgment in 1955. Studies by the Raymond Basin Management Board have concluded that - in retrospect - the 1955 amendment resulted in an over-estimate of the basin safe yield for the Pasadena Subarea of the Raymond Basin (magenta line):

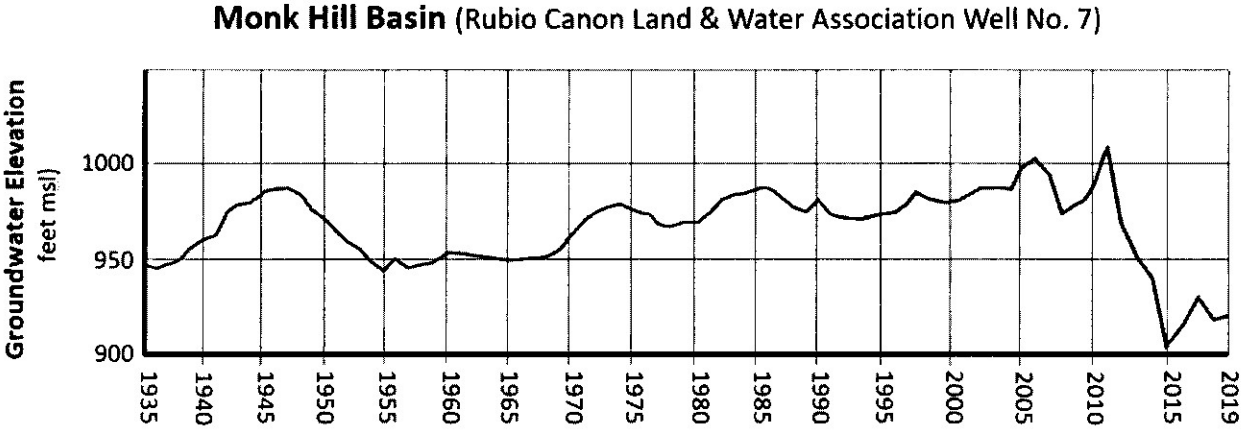
[1] "Safe yield" was defined in the Judgment as "the average annual amount or ground water that could be artificially extracted from the basin over an indefinitely long period of years...without causing a net lowering of ground water levels."
[2] See UWMP Figure 6-2 for basin and subarea boundaries.



Source: Tony Zampiello (RBMB Executive Officer) May 11, 2021 Municipal Services Committee presentation

Action was taken by the RBMB in 2009 to reduce pumping in the Pasadena Subarea by 30% over a "ramp-down period" of 5 years. The RBMB then studied the impact of groundwater level decline in 2015 and concluded that the groundwater levels declined 14 feet during the ramp-down period – a slight reduction from the over 3-foot historic decline to just under 3 feet for the 2009-2014 period when the safe yield was reduced. Note that the above graph suggests that a 50% reduction in safe yield will be needed to have a durable effect on groundwater decline.

There are similar concerns regarding the Monk Hill Basin (another subarea of the Raymond Basin) but the conditions are less obvious:



Source: Composite of graphs from RBMB Annual Reports for 1992-93, 2005-06, 2007-08 & 1018-2019

In recent years, the Monk Hill groundwater elevations have declined to record low levels. While the 2012-16 drought was a major contributing factor to the decline, basin management policies related to spreading and pumping credits have also contributed to the decline. No analysis appears to have been done to assess the Monk Hill condition, but the RBMB have re-convened a Monk Hill study group to discuss concerns of some pumpers that the decline has affected their well production.

In 2017, the drought ended, there were several wet years and groundwater levels remained relatively stable. In response to concerns that there is insufficient action being taken by the RBMB to mitigate the declining groundwater, Pasadena has said that "Based on RBMB, reports submitted to the State conclude that for the last few years groundwater level is stable."[3] That is what was probably said in 1968, 1993 and 1998 when groundwater levels appeared to stabilize. Dry conditions began to return in 2020 and it is being reported that the current water year is the "third-driest year on record" and is drier than any of the 2012-2016 drought years.[4] The RBMB Executive Officer has said that "the Basin cannot sustain current pumping indefinitely."[5]

Climate Change

Chapter 10 of the UWMP says that "Information in this chapter covers both adaptation and mitigation, and includes an assessment of climate change vulnerability specifically for the water resources system in which PWP is embedded." There is much discussion on the challenges associated with analyzing climate change impacts but in the discussion of groundwater concludes that:[6]

> *Given that there is a lack of consensus on the effect of climate change on precipitation, there is little basis on which to estimate the impact of climate change to groundwater supplies. While the impact is likely to occur given the close correlation between local precipitation and yield (natural and operational), that impact cannot be predicted without a specific comprehensive study at the local level.*

In fact, the GoldSim model used to analyze reliability of water supply does not take into account climate change.[7] There is a study that has analyzed climate variability "at the local level" that PWP has relied on in the UWMP: the Kimbrough (2019) study referred to on p. 10-2. The Conclusion that the UWMP draws from that report is:

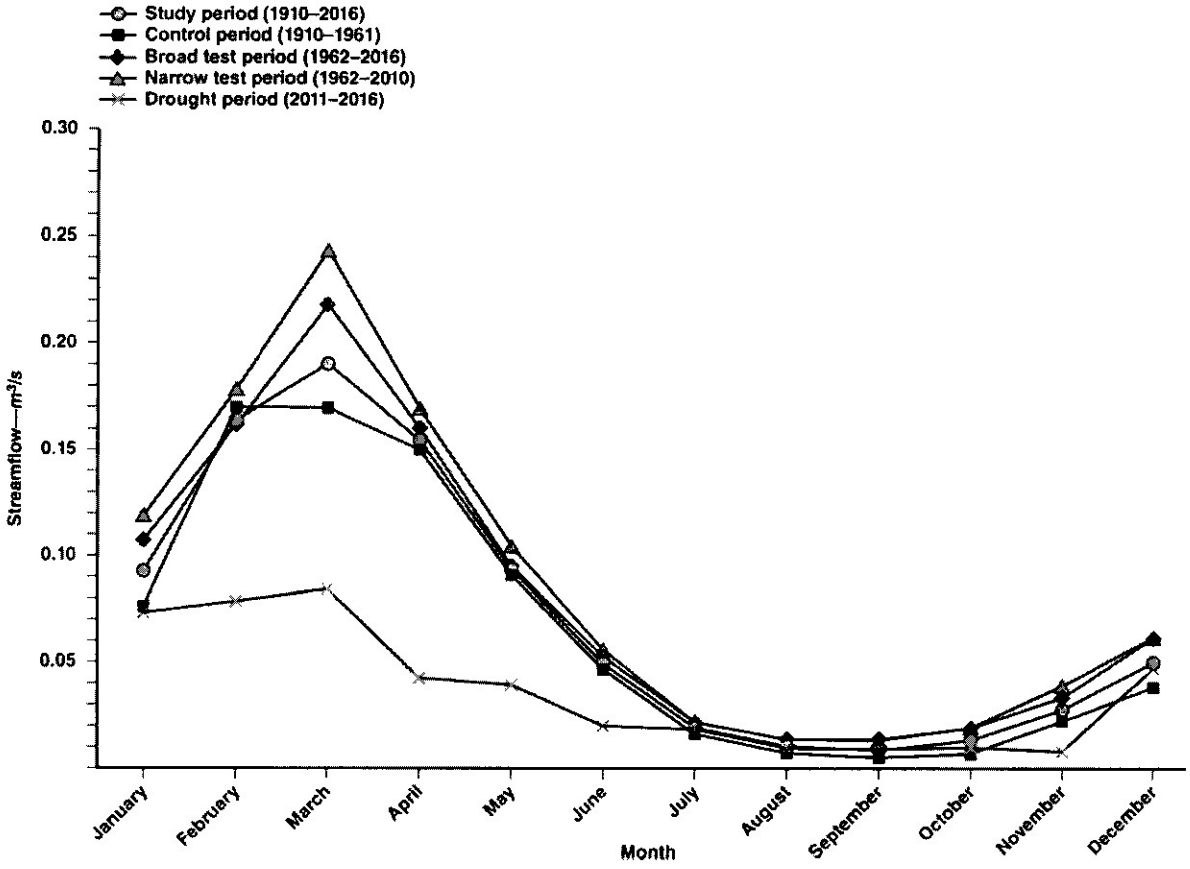
> *In the study analyzing climate change effects on streamflow, the streamflow in the Arroyo Seco was analyzed. Pasadena, Calif., has used the Arroyo Seco as a source of water for more than 100 years. During this period, local air temperatures have risen dramatically, resulting in a significant increase in streamflow.The median streamflow in the period 1962–2016 was 30% higher than the median streamflow in the period 1910–1961. A substantial portion of that increase has been in the form of extreme flow episodes, with flows greater than 1 m^3/s. If the data from the recent drought (2011–2016) are eliminated, the increase*

[3] Steve Mermell, May 13, 2021
[4] https://www.accuweather.com/en/weather-news/california-reports-third-driest-year-on-record/927591
[5] Tony Zampiello, May 11, 2021 Municipal Services Committee meeting
[6] UWMP, p. 10-6
[7] "The analysis uses historical data from 1922 to 2018 to evaluate future years under multiple hydrologic conditions" and "Climate change variables were not applied to future years." UWMP pp. 7-1 & 7-2

in streamflow is even greater. The study would suggest that the impacts of local climate change in the Pasadena area are positive for water supply, given that more water is flowing in the stream.

That conclusion does not translate to an increase in groundwater supplies because streamflows greater than 1 m^3/s cannot readily be percolated into the ground and are conveyed out of the Raymond Basin through concrete-lined flood control channels. An examination of the following graph from the Kimbrough (2019) report points out the impact of drought periods on streamflows:

FIGURE 3 Median streamflow by month, 1910–2016



It is clear that drought conditions severely affect stream flows in February through June months and increased drought frequency resulting from climate change will reduce groundwater replenishment in the future. The Kimbrough (2019) report provides the data for a sensitivity analysis that can assess the magnitude of that adverse impact and that has not been done for the UWMP.

Water Quality

The UWMP Guidebook says:

An analysis of reliability would not be complete or useful to the Supplier without pertinent information on the constraints to water supply sources. To the extent practicable, Suppliers should include a description of any constraints on their water supply that have been identified by the Supplier, such as inconsistent availability or water quality issues.

The UWMP glosses over the magnitude of the water quality issues in the groundwater supplies and dismisses them by saying that "PWP uses a combination of removing wells from service, blending, and treatment to ensure water delivered to customers does not exceed the Maximum Contaminant Levels (MCLs) established by the State Board and the United States Environmental Protection Agency."[8]

The following table provides insights into the pervasive problems with Pasadena's groundwater supply quality:[9]

Table 4-1: Well Water Quality Deficiencies

	Well	Water Quality Detections
	Active Wells	
1	Arroyo	Perchlorate, carbon tetrachloride (CTC), trichloroethylene (TCE), tetrachloroethene (PCE), and 1,2,3-trichloropropane (1,2,3-TCP)
2	Bangham	Nitrate, perchlorate, TCE, PCE, and 1, 2, 3-TCP
3	Chapman	Nitrate
4	Sunset	Nitrate, perchlorate, TCE, PCE, cis-1,2-Dichloroethylene (c-1,2-DCE) and 1,2,3-TCP
5	Twombly	Nitrate
6	Ventura	Nitrate, perchlorate, TCE, PCE and 1,2,3-TCP
7	Wadsworth	Nitrate , PCE, TCE and 1,2,3-TCP
8	Well 52	Nitrate, perchlorate, TCE and PCE
9	Woodbury	Nitrate, perchlorate and 1,2,3-TCP
	Inactive Wells	
1	Copelin	Nitrate, perchlorate, TCE, PCE, and DCE
2	Sheldon	Nitrate and PCE
3	Craig	Nitrate and perchlorate
4	Eaton	Under influence of surface water
5	Garfield	Nitrate, perchlorate
6	Jourdan	Nitrate, PCE, TCE and DCE
7	Monte Vista	Nitrate, perchlorate, 1, 2, 3-TCP, and CTC
8	Villa	Nitrate, perchlorate, and TCE
9	Windsor	Well used for irrigation since September 2020. Current water quality meets the state and federal drinking water regulations; In the past the well exceeded the nitrate, perchlorate, VOC drinking water limits.

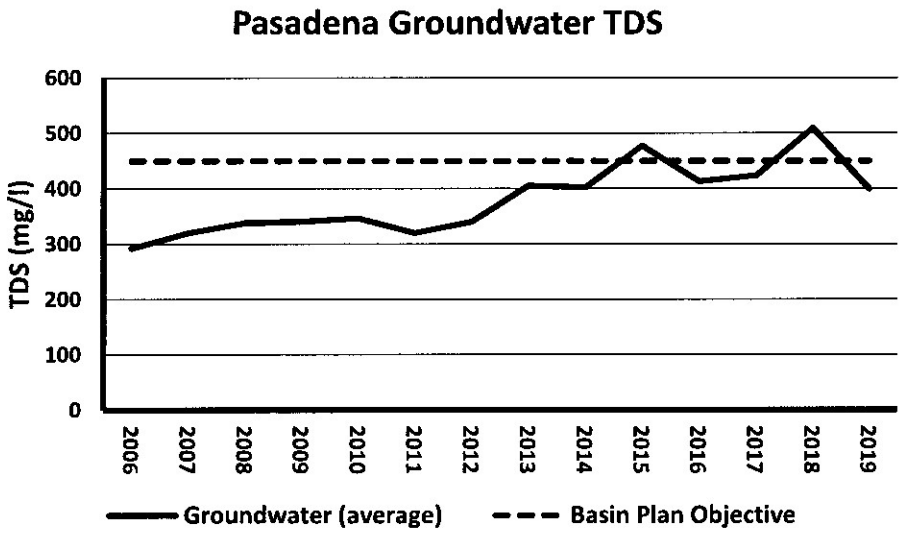
All of the groundwater delivered to the four major reservoirs in Pasadena's water delivery system are blended with imported supplies to meet drinking water quality regulations. The both reservoirs at Sunset Reservoir

[8] UWMP, p. 6-9.

[9] WSRP Final Report (December 2020), Table 4-1

complex "were taken out of service in 2020 after it was determined that they did not meet the state's drinking water requirements."[10] The contaminated wells that deliver water to that complex were also taken out of service as the blending capability was no longer available. A replacement reservoir is planned but will not be completed until 2025.[11] That circumstance was a contributing factor in Pasadena's reduced pumping in 2019.[12]

Total Dissolved Solids in Pasadena's groundwater is also a limiting factor. The following graph was developed using data from Pasadena's annual Consumer Confidence Reports:



As the data shows, TDS levels began increasing in 2013 and in recent years has exceeded the Regional Water Quality Control Board's Basin Plan Objectives. This is not reflected in the Raymond Basin Management Board's Salt and Nutrient Management Plan that determined that there is assimilative capacity in the basin but did not included post-20212 data in its analysis. This would likely affect Pasadena's ability to implement recycled water projects or use imported water from Metropolitan Water District to replenish the Raymond Basin groundwater. This is a serious omission from the UWMP.

[10] Steve Mermell, May 13, 2021
[11] UWMP, Section 6.7.1
[12] See UWMP, Table 6-2

Iraheta, Alba

Subject: Water Conservation & the WSRP
Attachments: As the wet season starts, we face difficult truths (Peter Gleick LA Times Op-Ed 10-1-2021).pdf; As the drought persists and reservoirs fall to new lows, state officials say they will consider mandatory water restrictions (LA Times 10-1-2021).pdf

From: Ken Kules
Sent: Friday, October 1, 2021 10:49 AM
To: Gordo, Victor <vgordo@cityofpasadena.net>; Masuda, Gene <gmasuda@cityofpasadena.net>; Wilson, Andy <awilson@cityofpasadena.net>; Williams, Felicia <fwilliams@cityofpasadena.net>; Rivas, Jessica <jerivas@cityofpasadena.net>; Hampton, Tyron <THampton@cityofpasadena.net>; Kennedy, John J. <JohnJKennedy@cityofpasadena.net>; Madison, Steve <smadison@cityofpasadena.net>; Mermell, Steve <smermell@cityofpasadena.net>; Jomsky, Mark <mjomsky@cityofpasadena.net>
Cc: Tim Brick <[redacted].org>; Morey Wolfson <[redacted]m>; David Cutter <[redacted]om>; Robert Kurkjian <[redacted]m>; Daniel Rossman <[redacted]om>; Porras, Susana <sporras@cityofpasadena.net>; Sullivan, Noreen <nsullivan@cityofpasadena.net>; Bawa, Gurcharan <gbawa@cityofpasadena.net>; Mark Nay <[redacted]om>
Subject: Water Conservation & the WSRP

PWP's WSRP will be before the City Council on Monday. See attached articles from the Los Angeles Times that include the following:

> "...we must rethink water supply, demand and use in our cities and suburbs. The old approach of building another reservoir or aqueduct or moving water from the next distant river is dead. There's no new water to be had in the West. Indeed, it is time to give up some of the water we've already claimed. The good news is there is still untapped potential to increase the productivity of our water use and expand its reuse. Let's continue to invest in appliances and industries that use water efficiently, find and eliminate home and business leaks, and replace landscapes and lawns that suck up water (and require fertilizers and pesticides) with native low-water gardens." *Peter Gleick, Pacific Institute*

> "Department of Water Resources Director Karla Nemeth said it's time for 'that next leap in conservation ethic. Whether or not that needs a mandatory push to make it happen, I think remains to be seen. But those are conversations we're having. And it is definitely on the table as a tool,' Nemeth said. There are some steps short of statewide mandatory restrictions that could also be taken, [California Natural Resources Secretary, Wade] Crowfoot said, such as prohibitions on hosing down driveways or other water-saving rules. And local water suppliers can activate shortage measures on their own.

> "'We've heard from local water agencies that they really want to take the lead on weathering through the drought,' Crowfoot said, adding that the time is now to urge 'local water partners to step up and to demonstrate water conservation.'"

10/04/2021
Item 8

OP-ED

As the wet season starts, we face difficult truths

By Peter Gleick

HAPPY NEW WATER YEAR. For those of us who work on California water challenges, the start of the new year isn't Jan. 1; it's Oct. 1, the official beginning of the state's wet season. This is the time of year we start to look out over the Pacific for the storms we hope will bring life-giving precipitation, replenishing our rivers and streams, coating our mountains with snow, refilling our reservoirs and recharging our soils, forests, wetlands and groundwater.

And while we hope for a good water year, we also hope for moderation in the face of ever-worsening climate change, for storms that don't overwhelm our levees, flood our cities and towns, or wash away our farms and homes.

We're looking ahead with no small amount of worry. The last two years have been bad: years of drought, heat, fire and ecological collapse. A repeat of the last two years would be catastrophic. Every drought is different, but with climate change upping the ante, the current drought has been one for the record books.

We've seen rapidly disappearing snow that simply evaporated off the mountains rather than producing runoff, the death of native salmon when the temperatures in our rivers rose to lethal levels, parched farms, extreme fires that even now are sweeping through our dry forests, expanses of exposed mud at the bottom of our emptying reservoirs, and the nonstop overdraft of groundwater sucked up by stronger and stronger pumps from deeper and deeper wells, causing Central Valley communities on the front lines to lose access to safe and affordable drinking water.

Will the next water year be wet or dry? We don't know. We can only watch the weather patterns swirl and shift, the storms form, move and dissipate. But we can do far more than that to actively prepare California's water system for whatever shapes up over the Pacific.

We can change the way we collect, treat, move and use water. We can rethink how to have a healthy agricultural community that grows more food with far less water, and how to protect California's rich but deeply threatened environment.

It's long past time to face some difficult truths. The first is that climate change is real, accelerating and overturning long-held assumptions about how much water we can expect, when we can expect it and how we should manage it.

For years, climate scientists have told us that extreme events will become more extreme. My early climate research 35 years ago warned of dramatic losses of snowpack and changes in river flows from climate change, and observations now show these projections are coming true, but our dams, treatment plants and water institutions were designed for the climate of the last century. Let's turn engineers, policymakers, businesses and communities to the task of managing water for the future, not the past.

Second, experience shows that the greatest impact of drought falls on natural ecosystems and small communities, not our farms or cities.

Even during good water years, we're losing native fisheries, destroying wetlands critical for migrating birds and mismanaging forests. Californians are justly proud of the state's remarkable diversity of landscapes, but we have utterly failed to acknowledge the ecological damage our current water policies are doing.

The antiquated system of water rights and infrastructure, much of it put in place more than a century ago, focuses on urban populations and agriculture; the health of the environment wasn't considered. As a result, current environmental protections are only a Band-Aid on deep wounds to the very life-support systems that are part of what makes California a treasure. We must return water to the environment as a top priority and meet basic needs for safe water and sanitation for all.

It is also time for an honest conversation about farming and ranching. California is a wonderful place to grow food. We have great soils, a (mostly) wonderful climate and (usually) decent amounts of water.

But we must admit we've brought too much land into production given how much water can be reliably and sustainably delivered. We grow too many water-intensive crops that would be better raised in places with more reliable rainfall. We massively overdraft groundwater, leading to depleted aquifers, collapsing infrastructure and drying streams.

And the dysfunctional and poorly enforced water-rights rules now in place fail to encourage efficient agricultural water use, equitable distribution of resources or flexible responses to a new climate reality. Shifting to a future in which California agriculture continues to thrive but on less land, with less water, with no detrimental overdraft of aquifers and with better environmental outcomes is both imperative and possible. This will require social and political conversations we've been reluctant to — but now must — have.

Finally, we must rethink water supply, demand and use in our cities and suburbs. The old approach of building another reservoir or aqueduct or moving water from the next distant river is dead. There's no new water to be had in the West. Indeed, it is time to give up some of the water we've already claimed.

The good news is there is still untapped potential to increase the productivity of our water use and expand its reuse. Let's continue to invest in appliances and industries that use water efficiently, find and eliminate home and business leaks, and replace landscapes and lawns that suck up water (and require fertilizers and pesticides) with native low-water gardens.

And there is still vast potential to treat wastewater to high standards and make it a reliable source of supply, as well as in replumbing our streets and stormwater systems to capture and use more of the water we get, rather than shunting it out to sea.

Every new year is a chance for reflection, for resolutions to finally, this year, do things differently. Let's invest in the changes California needs and create policies and systems that use water carefully and sustainably for the benefit of all.

Happy New Water Year.

PETER GLEICK, a hydrologist and climatologist, is co-founder and president emeritus of the Pacific Institute, a nonpartisan, nonprofit global water think tank based in Oakland.

ALLEN J. SCHABEN Los Angeles Times

KAYAKERS journey down the Colorado River near the outflow area of Hoover Dam, located on the border of Nevada and Arizona. The river's largest reservoirs are at their lowest levels ever.

Tightening the spigot

As the drought persists and reservoirs fall to new lows, state officials say they will consider mandatory water restrictions

BY IAN JAMES

With California's extreme drought persisting and reservoirs declining to new lows, state officials said they will consider imposing mandatory water restrictions if dryness continues this winter.

Gov. Gavin Newsom called on Californians in July to voluntarily reduce water use by 15%, saying state water regulators would track progress toward that target and decide whether additional measures would be necessary.

Natural Resources Secretary Wade Crowfoot said Thursday that bigger steps may be needed if the drought doesn't ease this winter, and turning to statewide mandatory conservation measures will be an option.

GARY CORONADO Los Angeles Times

THIS bovid starved on a ranch in the Mexican state of Sonora. Severe drought on both sides of the border has dried up grass on which cattle feed.

"We're going to be watching very closely here in the coming ... months how that voluntary water conservation goes," Crowfoot said in a call with reporters. "We've achieved 16% water-use reduction since the last drought. So we know that Californians can step up. But the governor has been clear that we need to consider additional actions, and mandatory restrictions, you know, need to be on the table here as, if and when the

[See Spigot, B2]

State considering mandatory water limits

[**Spigot,** from B1]
drought worsens."

Californians in cities and towns across the state reduced water use by 1.8% overall in July as compared with the same month last year. State officials said they'll be watching to see how the water conservation numbers look for August and subsequent months.

Crowfoot said the state has been focusing on supporting cities and water agencies in pursuing "customized approaches" to conservation based on their different drought situations, and has been scaling up California's Save Our Water campaign to get the word out about the need to conserve.

He and other state water officials spoke ahead of the Oct. 1 start of the new water year. California gets much of its rain and mountain snow between November and March, and the next several months will determine whether the state must cope with a third dry winter.

"Heading into this winter, we'll be watching, one, how Californians do on voluntary conservation toward that 15%," Crowfoot said. "There's no set sort of trigger date for considering mandatory conservation, but we'll be watching it closely."

Though California naturally goes through dramatic swings between dry spells and deluges, higher temperatures brought on by climate change are making droughts more intense.

The snowpack this year in the northern Sierra Nevada, which feeds the state's reservoirs, peaked at 72% of average in April, and then rapidly melted during the hottest spring on record. Extreme heat has baked much of the West and left parched soils, which have soaked up a portion of the runoff and left diminished flows in rivers.

"Drought is part of California's natural environment, but is now supercharged by accelerating climate change," Crowfoot said. "Those high temperatures meant that more of our melting snow in the mountains either was absorbed into very dry soils or evaporated into the air."

This second year of drought, he said, has created conditions comparable to the severe drought of 1976-77. There was less precipitation in 1977 than this year. But the amount of runoff in streams and rivers ended up being about the same, state officials say, because of the hotter temperatures.

"Science that we funded five to 10 years ago anticipated the impacts that we're experiencing now being experienced at the end of this century," Crowfoot said. "So we are really working nimbly to adapt to climate change."

The drought has left California reservoirs from Lake Shasta to San Luis Reservoir at some of their lowest levels ever.

Cities and water districts have obtained just 5% of their full water allotments this year from the State Water Project, which delivers water with pumps and canals from the Sacramento-San Joaquin River Delta to Southern California. And the Colorado River, also a major source for Southern California, is headed for a federally declared shortage next year.

"Conditions across California differ but are growing worse," Crowfoot said. "All areas of the state will have big problems if we have another, third dry winter in a row."

For part of the 2012-16 drought, then-Gov. Jerry Brown ordered a mandatory 25% reduction in urban water use. Many Californians responded by cutting back and taking steps such as converting lawns to drought-tolerant plants. Many of these changes have had a lasting effect in reducing water use.

Department of Water Resources Director Karla Nemeth said it's time for "that next leap in conservation ethic."

"Whether or not that needs a mandatory push to make it happen, I think remains to be seen. But those are conversations we're having. And it is definitely on the table as a tool," Nemeth said.

There are some steps short of statewide mandatory restrictions that could also be taken, Crowfoot said, such as prohibitions on hosing down driveways or other water-saving rules. And local water suppliers can activate shortage measures on their own.

"We've heard from local water agencies that they really want to take the lead on weathering through the drought," Crowfoot said, adding that the time is now to urge "local water partners to step up and to demonstrate water conservation."

The State Water Resources Control Board has been tracking the monthly water usage of more than 400 cities, towns and water districts.

If the board moves toward mandatory reductions in urban water use, officials would look to have not a "one-size-fits-all" approach but one that would account for how much different communities have already conserved, said Joaquin Esquivel, the board's chairperson.

Just as the declining reservoirs are leading to shortages, the low water levels in streams pose serious threats for fish such as Chinook salmon.

"Streams across the state are growing warm and disconnected," Crowfoot said. "And as a result, the Department of Fish and Wildlife is monitoring conditions and wherever possible relocating native fish, as well as amphibians, and increasing hatchery production to make up for loss as a result of these conditions."

He and other officials touted California's newly approved $15-billion budget package for addressing climate change, drought and wildfires, which Newsom signed last week.

The budget includes $5.1 billion to support drought response efforts and water projects. Portions of the funds are to go toward water infrastructure projects, water recycling, flood management and efforts to protect watersheds and ecosystems, among other things.

"It's a quantum leap of investment," Crowfoot said. "Our policymakers are quickly leading the effort to adapt to these changes. But these climate changes are coming fast and furious."

Esquivel said these investments will help the state "stretch through these dry times."

The drought has also affected deliveries of water to agriculture. This summer, the state water board issued an emergency order barring thousands of water rights holders, including farmers and other landowners, from diverting water from the delta.

"This is the first drought where we've had such an extensive landscape impacted by the drought conditions," Food and Agriculture Secretary Karen Ross said.

"The curtailment process has been especially painful this year, although it came late in the year, when many of our crops, annual crops, were already in the ground, and people were just trying to finish out the crops."

She said the budget package brings critical funding that will help the state capitalize in years when atmospheric rivers bring deluges, which can be captured and used to recharge depleted aquifers.

Ross said the funding will also "improve our resiliency and our ability to survive from one drought to the next."

billion to support drought

> 'Drought is part of California's natural environment, but is now supercharged by accelerating climate change.'
>
> — WADE CROWFOOT, secretary of the state's Natural Resources Agency