Agenda

Santa Cruz Mid-County Groundwater Sustainability Plan

Advisory Committee Meeting #17

Wednesday, March 27, 2019, 5:00 – 8:30 p.m.
Simpkins Family Swim Center
Room B - 979 17th Avenue Santa Cruz CA 95062

Meeting Objectives

- Discuss groundwater modeling results for various sustainability strategies
  - Reconfigured Aquifer Storage and Recovery
  - Combined projects
- Discuss draft proposed Sustainable Management Criteria for "Groundwater Storage" Sustainability Indicator and updated Sustainable Management Criteria for "Seawater Intrusion" Sustainability Indicator
- Receive primer and share initial reflections on the topic of "who pays for what?"
- Review and confirm representative monitoring wells for each sustainability indicator

Agenda

Item No.	Time[1]	Topic	Presenter & Materials
	4:30 p.m.	*Arrivals/Committee members collect food for dinner*	
1.	5:00 p.m.	Welcome, Introductions, Meeting Objectives, and Agenda Review • Review updated project timeline	• Ralph Bracamonte, Central Water District • Eric Poncelet, Facilitator *Materials:* *1.1 Agenda* *1.2 Santa Cruz Mid-County Basin Groundwater Sustainability Plan Advisory Committee Objectives for January - November 2019* *Refer to PowerPoint Presentation*
2.	5:10 p.m.	Oral Communications • *Members of the public to comment on non-agenda items*	• Public
3.	5:20 p.m.	Project updates • Upcoming GSP Advisory Committee meeting schedule • Santa Margarita Basin informational meetings • Surface Water Interaction	• Darcy Pruitt, Regional Water Management Foundation • Sierra Ryan, County of Santa Cruz • Georgina King, Montgomery & Associates

[1] The times allotted on this agenda are approximate and are subject to change.

Item No.	Time[1]	Topic	Presenter & Materials
		o April 8 working group meeting o Updated approach • Land Use and Water Enrichment Session	
4.	5:25 p.m.	Review and discuss groundwater modeling results for sustainability strategies • Combined projects	• Cameron Tana, Montgomery & Associates • Advisory Committee *Materials:* *Refer to PowerPoint Presentation*
5.	6:15 p.m.	Public Comment	• Public
6.	*6:25 p.m.*	*Break*	
7.	6:40 p.m.	Discuss Proposed Draft Sustainable Management Criteria • Review updated Sustainable Management Criteria for "Seawater Intrusion" Sustainability Indicator • Provide initial input on draft proposal for significant and unreasonable, minimum thresholds, and measurable objectives for "Groundwater Storage" Sustainability Indicator	• Georgina King, Montgomery & Associates • Advisory Committee *Materials:* *7.1 Technical Staff Proposal: Updated Seawater Intrusion Sustainable Management Criteria* *7.2 Technical Staff Proposal: Reduction of Groundwater in Storage Sustainable Management Criteria* *Refer to PowerPoint Presentation*
8.	7:30 p.m.	Receive primer and share initial reflections on the topic of "who pays for what?"	• Sierra Ryan, County of Santa Cruz • Advisory Committee *Materials:* *8.1 Proposed Santa Cruz Mid-County Groundwater Agency Ongoing Funding Approach*
9.	8:00 p.m.	Confirm representative monitoring wells for each sustainability indicator	• Georgina King, Montgomery & Associates • Advisory Committee *Materials:* *9.1 Technical Staff Proposal: Representative Monitoring Wells* *Refer to PowerPoint Presentation*
10.	8:10 p.m.	Public Comment	• Public
11.	8:20 p.m.	Confirm: • February 27, 2019 GSP Advisory Committee Meeting Summary	• Advisory Committee • Eric Poncelet, Facilitator *Materials:*

Item No.	Time[1]	Topic	Presenter & Materials
			11.1 Draft Meeting Summary Groundwater Sustainability Plan Advisory Committee Meeting #16, February 27, 2019
12.	8:25 p.m.	Recap and Next Steps	• Eric Poncelet, Facilitator
	8:30 p.m.	*Adjourn*	

Written Communication and Correspondence (included in the packet materials)

1. Email communication from G. Lindstrum, dated March 10, 2019, and response.

Santa Cruz Mid-County GSP Advisory Committee Objectives for January – November 2019

2019

3/19 4/19 5/19 6/19 7/19 8/19 9/19 10/19 11/19 12/19

Santa Cruz Mid-County GSP Advisory Committee Objectives for January – July 2019

Mar 2019

- Discuss modeling results for Reconfigured Aquifer Storage and Recovery and combined projects
- Discuss Sustainable Management Criteria for Groundwater Storage and Seawater Intrusion
- Receive primer and share initial reflections on "who pays for what?" related to projects and rationale behind funding/payment
- Review and confirm representative monitoring wells for each sustainability indicator

***Enrichment Session on Water Use Forecasting:** Conservation, Population, and Land Use (to be scheduled in mid- April)

Apr 2019

- Discuss implementation plan schedule (Section 5 of GSP)
- Introduce Mid-County sustainability goal
- Discuss next round of modeling results for Surface Water Interaction
- Receive and discuss overview of initial draft GSP recommendations (Section 3 of GSP), including refined sustainability indicator management criteria for all sustainability indicators

May 2019 (Joint MGA/Advisory Committee):

- Discuss Mid-County sustainability goal
- Discuss implementation plan, funding tools and milestones (Section 5 of GSP)
- Discuss draft compilation of recommendations and modeling results for Sustainable Management Criteria (Section 3 of GSP)

June 2019

- Refine recommendations for Sustainable Management Criteria
- Discuss level of support for Advisory Committee recommendations to the MGA Board
- End of Advisory Committee process

**Committee work is anticipated to conclude*

July 2019

- Deliver draft GSP and set of recommendations on Sustainable Management Criteria to MGA Board
- Public/Open House Meeting

Sep 2019

- MGA Board Report Back on final deliberations related to GSP
- MGA Board final action on GSP

Nov 2019

- MGA Board Follow-up on final GSP actions as needed

1/19 2/19 3/19 4/19 5/19 6/19 7/19 8/19 9/19 10/19 11/19 12/19

Revised 03/13/2019

Santa Cruz Mid-County Basin
Updated Seawater Intrusion Sustainable Management Criteria

This updated document is an evolving draft that documents development of seawater intrusion Sustainable Management Criteria to be included in the Groundwater Sustainability Plan (GSP). Specifically, the Sustainable Management Criteria included in this document are bulleted below and were last discussed at the May and September 2018 GSP Advisory Committee meetings.

- Seawater intrusion conditions which are considered **significant and unreasonable**.
- The set of conditions that cause **undesirable results** which will lead to significant and unreasonable seawater intrusion.
- **Minimum Thresholds** are the metrics included as part of the set of conditions for undesirable results. Groundwater quality above the Minimum Threshold and groundwater elevations below the Minimum Thresholds would be undesirable.
- **Measurable Objectives** are quantitative goals that reflect the Santa Cruz Mid-County Groundwater Sustainability Agency's (MGA) desired groundwater conditions in the Basin and will guide the MGA to achieve its sustainability goal.

This proposal contains updates to what was presented and discussed in May 2018 and includes the addition of Representative Monitoring Wells for the Purisima AA/Tu units and their associated Minimum Thresholds, plus the listing of Measurable Objectives that were previously discussed at the September 2018 GSP Advisory Committee meeting. Changes to the previous proposal are indicated in red font.

Seawater Intrusion Significant and Unreasonable Conditions

Seawater moving farther inland than has been observed in the past five years.

Rationale: This statement reflects the major consensus of Advisory Committee members not wanting to see seawater intrusion advancing. The statement is also much simpler than the original proposed statement but has the same intent. The period of five years is included because although there has not been much recent change in the distribution of seawater intrusion, there has been one seawater intruded well (Moran Lake Medium) that has experienced decreased chloride concentrations which are now below 250 mg/L. By specifying the past five years, we ensure that we do not allow intrusion back into this area, whereas if we used the historical maximum concentration we would allow concentrations at Moran Lake Medium to increase to 700 mg/L (see Table 1 for averages and maximum concentrations for the full record and the past five years).

Table 1. Summary of Intruded Coastal Monitoring Well Chloride Concentrations in mg/L

Monitoring Well Name	Shallowest Intruded Unit	Historical Maximum Chloride	Historical Maximum Year	2013-2017 Average Chloride	2013-2017 Maximum Chloride	Current Chloride	Threshold Chloride Concentration
Moran Lake Med	Purisima A	700	2005	147	230	78	230
Soquel Point Med	Purisima A	1,300	2005	1,104	1,200	1,000	1,200
SC-A8A	Purisima F	8,000	2015	7,258	8,000	7,200	8,000
SC-A2RA	Purisima F	18,480	2001	14,259	16,000	14,000	16,000
SC-A3A	Aromas	22,000	2010	17,955	20,000	17,000	20,000

Seawater Intrusion Undesirable Results

1. Undesirable Results for Intruded Coastal Monitoring Wells

Undesirable Results for Intruded Coastal Monitoring Wells
Any coastal monitoring well with current intrusion has a chloride concentration above its past five year maximum chloride concentration. This concentration must be exceeded in 2 or more of the last 4 consecutive quarterly samples.

Rationale: if seawater intrusion had not been reported in wells inland of the coastal monitoring wells when chloride concentrations in the coastal monitoring wells were at their historic high, the likelihood of seawater intruding them in the future if coastal monitoring well concentrations increased back that level again is low. Using the past five years' historical maximum chloride concentration provides greater flexibility in avoiding undesirable results than using the past five-years' average and is more protective than using the historical maximum, which is mostly higher than the maximum concentration over the past five years.

The number of chloride concentration exceedances should be set at 2 per year to account for occasional fluctuations not related to seawater intrusion. Three or four samples exceeding the recent historical maximum indicates that seawater intrusion has advanced farther inland, which would be considered significant and unreasonable.

Table 1 above includes a list of historical maximum chloride values versus 2013 - 2017 average and 2013 – 2017 maximum chloride concentrations for coastal monitoring wells that have had or have seawater intrusion. A proposed threshold concentration for each intruded well is provided based on its past five year maximum concentration. Note that Moran Lake was previously impacted by seawater (700 mg/L) and its chloride concentration has now decreased to below 250 mg/L.

2. Undesirable Results for Unintruded Coastal Monitoring Wells, and Inland Monitoring and Production Wells

A. Any Unintruded Coastal Monitoring Well has a chloride concentration above 250 mg/L. This concentration must be exceeded in 2 or more of the last 4 consecutive quarterly samples.

Rationale: Coastal monitoring wells are the basin's early warning system and first line of defense against seawater intrusion, if their chloride concentrations increase to 250 mg/L this is a clear indication that seawater is advancing onshore father than it is today. There are seven coastal monitoring wells that do not show seawater intrusion. These wells' groundwater quality are summarized in Table 2.

Water with more than 250 mg/L chloride has a salty taste but is still drinkable to 500 mg/L, which is the state's upper maximum contaminant level. To make sure we have confidence that tested water sample concentrations are not anomalies, the exceedance of 250 mg/L must be repeated within a year must to be undesirable.

Table 2. Summary of Unintruded Coastal Monitoring Well Chloride Concentrations in mg/L

Monitoring Well Name	Deepest Unintruded Unit	Historical Maximum Chloride	Historical Maximum Year	2013-2017 Average Chloride	Current Chloride	Threshold Chloride Concentration
Pleasure Point Med	Purisima A	38	2012	34	35	250
SC-1A	Purisima A	51	2013	41	35	250
SC-3A	Purisima A/AA	66	1984	39	55	250
SC-5A	Purisima A	94	2001	55	51	250
SC-9C	Purisima BC	63	1984	28	36	250
SC-8B	Purisima BC	32	2003	14	17	250
SC-8D	Purisima DEF	65	2016	28	21	250

B. Any Unintruded Inland Monitoring Well (which includes municipal production wells closest to the coast and other non-coastal monitoring wells) has a chloride concentration above 150 mg/L. This concentration must be exceeded in 2 or more of the last 4 consecutive quarterly samples.

All wells used as data points to develop the chloride isocontour should have TDS and chloride tested on at least a semi-annual ~~quarterly~~ schedule until an exceedance occurs, which triggers quarterly testing. Additionally, seawater must be the cause of the chloride increase and not some other source, such as a localized chemical spill.

Rationale: In the City of Santa Cruz and Soquel Creek Water District's current Cooperative Monitoring/Adaptive Management Agreement, a conservative chloride concentration above 150 mg/L is used together with an increasing chloride trend for production wells closest to the coast to indicate possible seawater intrusion. To ensure seawater does not move farther into the basin and since native chloride concentrations are very low in unintruded wells (generally less than 100 mg/L), monitoring wells inland of the coastal monitoring wells are considered in the early stages of seawater intrusion if their concentrations exceed 150 mg/L. It is possible that inland monitoring wells could have concentrations of 150 mg/L or above, while the coastal monitoring wells still have concentrations below 250 mg/L. In this case, the exceedance of 150 mg/L chloride alerts the MGA that there is a possibility that increases in chloride concentrations may imminently be observed at coastal monitoring wells or that the seawater may have bypassed the coastal monitoring well and threaten production wells.

> Ag and Chloride
> Chloride moves readily within soil and water and is taken up by the roots of plants. It is then transported to the stems and leaves. Sensitive berries and avocado rootstocks can tolerate only up to 120 mg/L of chloride, while grapes can tolerate up to 700 mg/L or more. (University of California Agriculture and Natural Resources, http://anrcatalog.ucanr.edu/pdf/8066.pdf).

Table 3 lists potential inland wells that could be used as Representative Monitoring Wells for exceedances of threshold concentrations. The table includes chloride historical maximums and the average chloride concentrations over the past five years. Note there is one inland Aromas monitoring well (SC-A5A) which is already intruded by seawater. This well is screened approximately 100 feet below SC-A5B and the Seascape production well, which are unintruded. We therefore propose to set a threshold concentration of the past five year maximum for that well (this was in 2015 and is the same as the historical maximum), based on the same rationale used for setting the thresholds for intruded coastal monitoring wells.

Table 3. Summary of Inland Monitoring Well Chloride Concentrations in mg/L

Well Name and Type	Aquifer Unit Screened	Historical Maximum Chloride	Historical Maximum Year	2013-2017 Average Chloride	Current Chloride	Threshold Chloride Concentration
Altivo (PW)	Aromas	25	1997	19	25	150
SC-A5A (MW) screened ~100 ft below Seascape	Purisima F	9,800	2015	8,575	7,600	9,800
SC-A5B (MW) screened ~20 ft below Seascape	Purisima F	130	2018	95	91	150
San Andreas (PW)	Purisima F	79	2011	21	20	150
Seascape (PW) screened ~20 ft above SC-A5B	Purisima F	29	1996	20	15	150
Country Club (PW)	Purisima F	40	2003	34	36	150
Aptos Creek (PW)	Purisima DEF & BC	50	1986	41	42	150
T. Hopkins (PW)	Purisima DEF	71	2011	46	44	150
Estates (PW)	Purisima BC & A	63	1990	45	49	150
SC-17B (MW)	Purisima BC	Historically not sampled Will need to be equipped with sampling equipment				
Garnet (PW) next to SC-13 in Tu	Purisima A	90	2009	81	81	150
SC-22AA	Purisima AA	45	2018	39	36	150
Corcoran Lagoon Deep (MW)	Purisima AA	120	2011	20	20	150
Schwan Lake (MW)	Purisima AA	97	2008	91	94	150
Beltz#2 (MW)	Purisima A	97	2008	63	61	150
Beltz#8 (PW)	Purisima A/AA	56	2012	51	52	150
Beltz#9 (PW)	Purisima A	75	2011	50	46	150

3. Undesirable Results for Protective Groundwater Elevations

<Five- or Ten-year> average groundwater elevations below protective groundwater elevations in Coastal Monitoring Wells for any Coastal Monitoring Well.

Rationale: It is expected that as the GSP is implemented from 2020 to 2040, projects and management actions will improve basin conditions and groundwater elevations will increase over time. Having a five-year groundwater elevation average will make it easier to avoid undesirable results. However, as it is only after 2040 that we need to show we have groundwater levels higher than protective elevations to be sustainable, having a longer averaging period will provide more flexibility in meeting protective elevations and prove sustainability.

There appears to be support for returning to the five-year average groundwater elevation initially proposed to the GSP Advisory Committee in April 2018. This should be explored more during the GSP Advisory Committee. Figure 1 provides an example of the difference between the 5-year and 10-year averaging of groundwater elevations.

The larger the averaging period, the greater the smoothing out effect is on the data. Figure 1 shows the 10-year average groundwater elevations not exhibiting the same highs and lows that the 5-year averaging period does. Thus, the larger the averaging period, the greater the flexibility in avoiding undesirable results.

Staff recommends a five-year average because it will identify short-term issues quicker and because it will coincide with the required five-year annual updates to the GSP. The time period for averaging groundwater elevations to determine undesirable results for other sustainability indicators where an average is proposed, i.e., reduction in groundwater in storage, should match undesirable result seawater intrusion averaging time period.

GSP Advisory Committee action item: select an averaging period over which to evaluate undesirable results

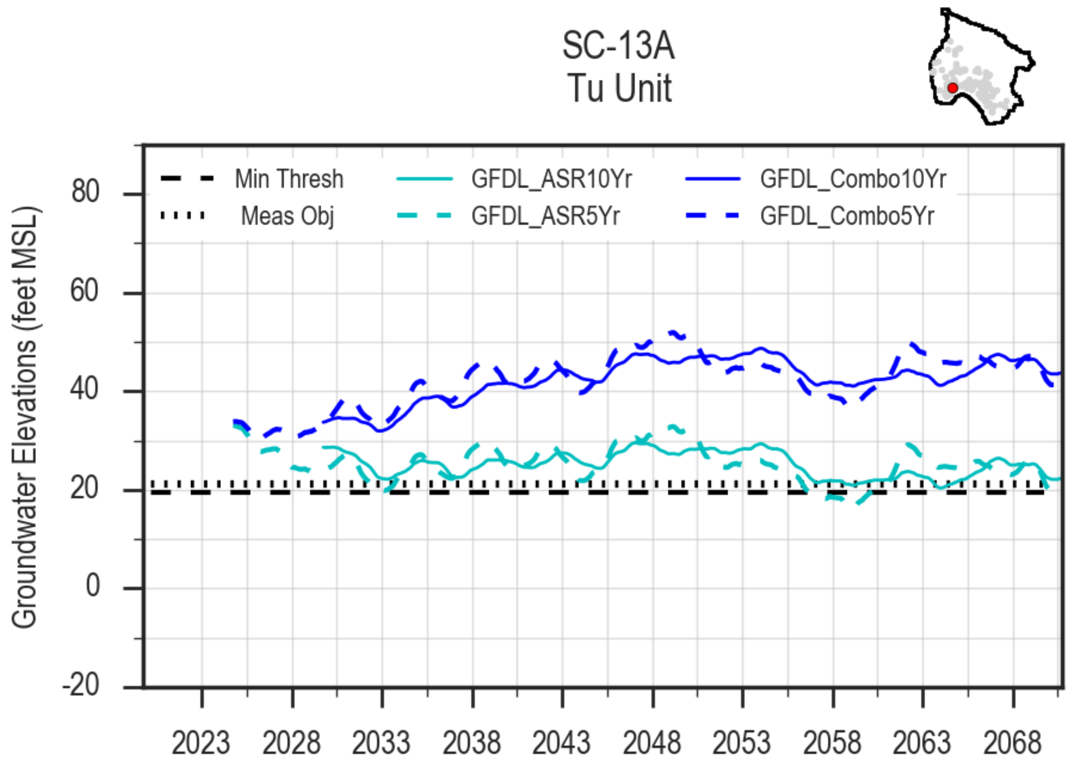


Figure 1. Comparison between 5-Year and 10-Year Averaging of Groundwater Elevations

Minimum Thresholds for Seawater Intrusion

Minimum Thresholds are numeric values for each sustainability indicator used to define undesirable results. The chloride concentrations included in the undesirable results recommendations are the Minimum Thresholds for seawater intrusion monitoring wells. Per GSP regulations, the Minimum Threshold metric for seawater intrusion is the location of a chloride isocontour on a map. Contrary to the general rule for setting Minimum Thresholds, the seawater intrusion Minimum Threshold does not have to be set at individual monitoring sites. Rather, the Minimum Threshold is set along an isocontour line in a basin or management area. However, with the way undesirable results need to be defined and how the observed isocontour is evaluated based on monitoring wells, for practical purposes, we recommend setting thresholds of 250 mg/L and 150 mg/L at selected monitoring wells used to define the isocontour.

In addition to the chloride isocontour Minimum Threshold, we will use protective groundwater elevations at coastal monitoring wells as a proxy for seawater intrusion. Protective groundwater elevations are easier to measure and manage with respect to controlling seawater intrusion, compared to chloride concentrations.

Chloride Isocontour

The revised technical recommendations in the preceding sections, based on GSP Advisory Committee input, included undesirable results with chloride concentration metrics at specific wells. These concentrations are used to determine the location of the chloride isocontour representing a Minimum Threshold for seawater intrusion.

To provide for more locational certainty of the chloride isocontour, we propose to anchor the isocontour, where possible, at coastal monitoring wells, which are located along the coast in the area of municipal production. All but two of the 12 coastal monitoring wells in the basin are within 1,000 feet of the coast. Anchoring the isocontour at coastal monitoring wells allows us to definitively ascertain if concentrations at a data point on the isocontour (coastal monitoring well) have increased beyond the concentration set for the isocontour, i.e., that point on the isocontour is represented by a monitoring well from which concentration data can be obtained and no interpolation is needed.

Additionally, because our statement of significant and unreasonable seawater intrusion conditions is based on historical observations at monitoring wells, it is appropriate to use the same monitoring wells to gauge changes to the location of the isocontour in the future. It is difficult to monitor the chloride isocontour if it is set at the coast, as there is no data point on the coast from which to obtain concentration data to know if that concentration has been exceeded or not.

Using monitoring wells also will prevent seawater intrusion from advancing to shallower elevations. For example, SC-A5A is intruded and therefore the 250 mg/L chloride isocontour is plotted inland of this site and the Seascape production well (Figure 2). The Seascape well and monitoring well SC-A5B are screened approximately 100 feet shallower than the intruded SC-A5A monitoring well and are unintruded. Setting Minimum Thresholds at each of these wells will prevent seawater intrusion from advancing upwards into the production well.

Figure 2 presents proposed draft Minimum Thresholds for seawater intrusion in both the Aromas and Purisima aquifers, represented by the 250 mg/L chloride isocontour. A chloride concentration of 250 mg/L is selected for the Minimum Threshold for the Santa Cruz Mid-County Basin because native chloride concentrations in groundwater are generally below 100 mg/L. Thus an increase up to the basin water quality objective of 250 mg/L is considered significant. Note that a chloride isocontour of 250 mg/L is relatively low and likely represents some seawater mixed in with native groundwater. Full strength seawater has a chloride concentration of 19,000 mg/L.

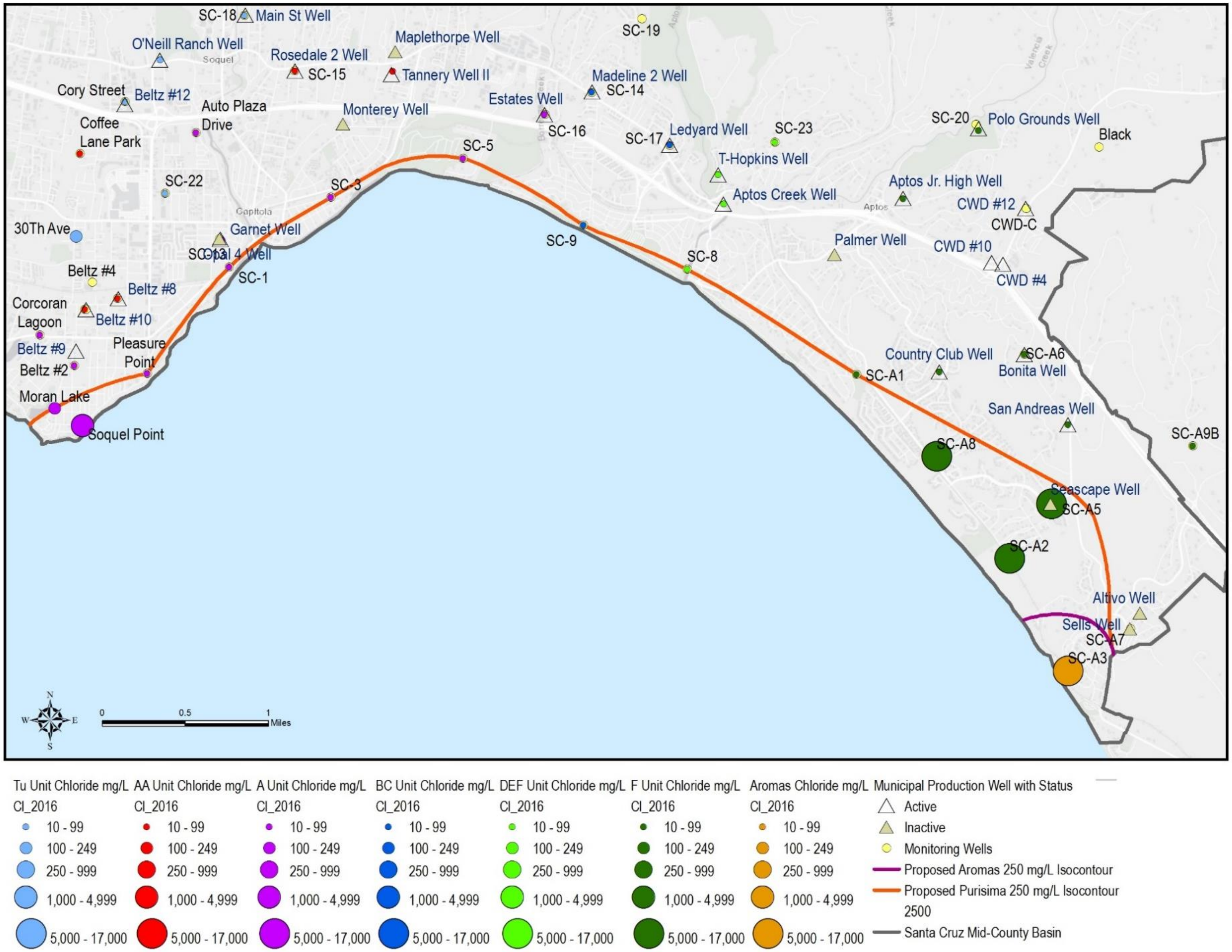


Figure 2. Proposed Draft 250 mg/L Chloride Isocontours for the Aromas and Purisima Aquifers

If chloride concentrations range between current concentrations and the threshold proposed, we feel confident that seawater is not advancing. If chloride concentrations in wells inland of the isocontour increase to above the threshold levels we have proposed, this will indicate that seawater is moving inland and management actions to remedy it need to take place to ensure that by 2040, chloride concentrations inland of the 250 mg/L isocontour remain below 250 mg/L.

Protective Elevations

Current protective elevations for coastal monitoring wells are listed in Table 4. These groundwater elevations will be used as proxies as additional Minimum Thresholds for seawater intrusion. The wells in red font are wells in the deeper Purisima AA/Tu aquifers that have been added as Representative Monitoring Wells since May 2018. Where screened information were available, the protective elevations for these wells was established using the Ghyben-Herzberg relationship between fresh and salt water, similar to how the medium well completions of the City of Santa Cruz's Moran Lake, Soquel Point, and Pleasure Point monitoring wells' protective elevations were established. These wells were added because SkyTEM geophysical data shows salty water just offshore from these locations. As there is groundwater production in these deeper aquifers, it is prudent to include these wells to ensure protection of the deepest aquifers. In some locations there is no deep well screen from which to calculate protective elevations. New deep monitoring wells need to be constructed as part of the GSP implementation and protective elevations established when the construction details of those wells is available.

Figure 3 shows the location of the Representative Monitoring Wells using groundwater elevations as a proxy for seawater intrusion. The values plotted for each well are the protective elevations / Minimum Thresholds.

Table 4. Representative Monitoring Wells with Groundwater Elevations to be Used as Proxies for Minimum Thresholds and Measurable Objectives

Coastal Monitoring Well with Aquifer Unit in Parenthesis	Proxy Protective Elevation / Minimum Threshold (feet mean seal level)	Basis for Protective Elevation	Proxy Measurable Objective (feet mean seal level)	Basin for Measurable Objective
Moran Lake Medium (A)	5	GH BS	6.8	GH BU
Moran Lake Deep (AA)	6.7	GH BS	16	GH BU
Soquel Point Medium (A)	6	GH BS	7.1	GH BU
Soquel Point Deep (AA)	7.5	GH BS	16	GH BU
Soquel Point or alternate City location (Tu)	New monitoring well needed	-	24	GH BU
Pleasure Point Medium (A)	6.1	GH BS	6.5	GH BU
Pleasure Point Deep (AA)	7.7	GH BS	16	GH BU
SC-1A (A)	4	XS 70th	6	XS >99th
SC-13A (Tu)	17.2	GH BS	19	GH BU
SC-3A (A)	10	XS 70th	12	XS >99th
SC-3 (AA)	New monitoring well needed	-	10.4	GH BU
SC-5A (A)	13	XS 70th	15	XS >99th
SC-9C (BC)	10	XS 70th	11	XS >99th
SC-8B (BC)	19	XS 70th	20	SC-8D + GH
SC-8D (DEF)	10	XS 70th	11	XS >99th
SC-A1B (F)	3	XS 70th	5	XS >99th

Coastal Monitoring Well with Aquifer Unit in Parenthesis	Proxy Protective Elevation / Minimum Threshold (feet mean seal level)	Basis for Protective Elevation	Proxy Measurable Objective (feet mean seal level)	Basin for Measurable Objective
SC-A8A (F)	6	XS 70th	3	XS >99th
SC-A2A (F)	3	XS 70th	4	XS >99th
SC-A3A (Aromas)	3	XS 70th	7	XS >99th

Notes:

GH BS = Ghyben-Herzberg bottom of screen

GH BU = Ghyben-Herzberg bottom of aquifer unit

XS 70th = Cross-sectional model with 70th percentile of runs being protective

XS >99th = Cross-sectional model with greater than 99th percentile of runs being protective

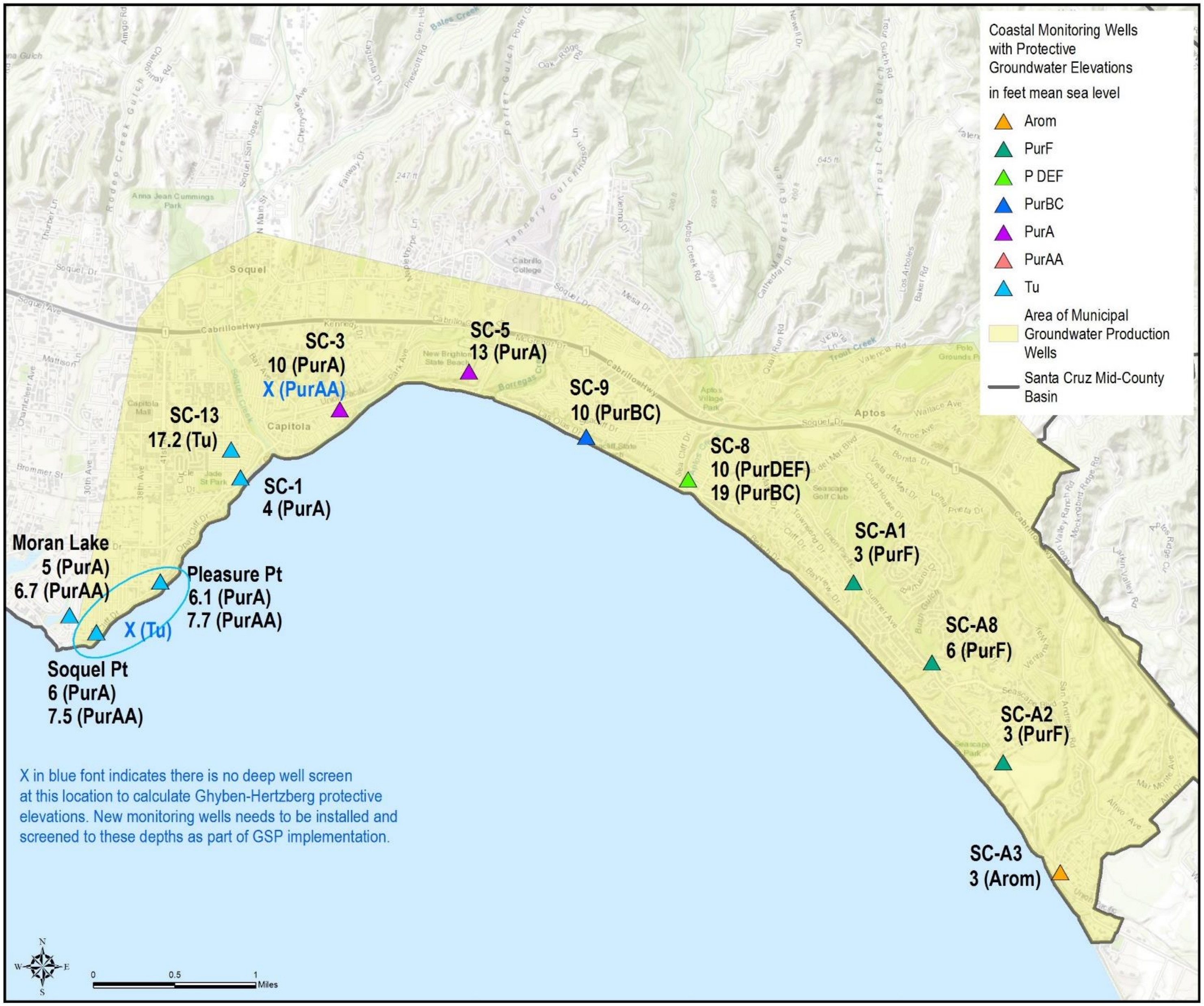


Figure 3. Representative Monitoring Wells Used as Proxy Minimum Thresholds for Seawater Intrusion

Measurable Objectives for Seawater Intrusion

Approaches for developing Measurable Objectives were presented at the September 2018 Advisory Committee meeting. Proposed approaches presented included both an isocontour Measurable Objective and proxy groundwater elevation Measurable Objectives.

Isocontour Measurable Objective

All historical unintruded coastal monitoring well concentrations are below 100 mg/L. We therefore propose that the Measurable Objective isocontour have the same location as the Minimum Threshold isocontour shown on Figure 2 but the concentration be reduced from 250 mg/L (Minimum Threshold) to 100 mg/L (Measurable Objective). Having the Measurable Objective isocontour at the same location as the Minimum Threshold means the same monitoring wells along that isocontour can be used to monitor groundwater quality. Table 1 and Table 2 list the historical maximum, 2013-2017 average, and current concentrations alongside the proposed Minimum Threshold and Measurable Objective concentrations for each coastal monitoring well used to define the isocontour.

Groundwater Elevations as a Proxy Measurable Objectives

For development of groundwater elevations as a proxy Measurable Objectives, technical staff proposes two different approaches to determine the metric depending on whether cross-sectional groundwater model data are available or not.

1. Cross-sectional model data available: the Measurable Objectives are the groundwater elevations that represents >99% of 100 cross-sectional model simulations being protective against seawater intrusion for each monitoring well with a protective elevation. For wells where seawater intrusion has not been observed, cross-sectional models estimate protective elevations to protect the entire depth of the aquifer unit of the monitoring wells' lowest screen. For wells where seawater intrusion has been observed, the cross-sectional models estimate protective elevations to prevent seawater intrusion from advancing.
2. Cross-sectional model data ***not*** available: the Measurable Objectives are the groundwater elevations that represent protective groundwater elevation estimated by using the Ghyben-Herzberg method to protect the entire depth of the aquifer unit the monitoring wells are screened in.

Table 4 includes proposed Measurable Objectives based on the approaches above.

Technical Staff Proposal
Reduction of Groundwater in Storage
Sustainable Management Criteria

This document is organized into the following sections:

1. Background – Reduction of Storage Sustainability Indicator
2. Technical staff proposal for what would represent a Significant and Unreasonable condition (what we want to avoid)
3. Technical Staff Proposal - Undesirable Results
4. Technical Staff Proposal – Minimum Threshold
5. Technical Staff Proposal – Measurable Objective
6. Technical Proposal – Representative Monitoring Points

1. BACKGROUND – REDUCTION OF STORAGE SUSTAINABILITY INDICATOR

Groundwater in storage is the volume of groundwater held in all sediments below the groundwater table and above the bedrock basement of the basin. However, the reduction in storage sustainability indicator is not measured by change in groundwater in storage. Rather, the reduction in groundwater in storage sustainability indicator requires a minimum threshold that is "a ***total volume of groundwater that can be withdrawn from the basin*** without causing conditions that may lead to <u>undesirable results</u>. Minimum thresholds for reduction of groundwater storage are supported by the ***sustainable yield*** of the basin, calculated based on historical trends, water year type, and projected water use in the basin" (DWR GSP regulations, emphasis added). The Sustainable Management Criteria metrics only require one volume number for the Basin, although the MGA can provide separate volumes by aquifer and management areas, if needed.

The sustainable yield is the net amount that can be pumped from the Basin without causing undesirable results. Sustainable yield is dependent on the locations of wells and how much they pump. The analysis of sustainable yield has not yet been completed because projects and management actions have not been finalized. A rough idea of sustainable yield can be obtained from looking at historical pumping, precipitation, and groundwater elevations from the Basin's different aquifers. Looking at change in groundwater in storage is not appropriate because the greatest changes in storage occur preferentially in the unconfined surface aquifers that are influenced more strongly by recharge from rainfall than by pumping.

As the only currently known and occurring undesirable result that has been caused in the Basin is seawater intrusion by pumping, we know that historical pumping has been unsustainable. This is a good starting point - the Minimum Threshold will need to be a volume less than historic pumping

2. TECHNICAL STAFF PROPOSAL FOR WHAT WOULD REPRESENT A SIGNIFICANT AND UNREASONABLE CONDITION (what we want to avoid)

Advisory Committee Objective: Accept or adapt a statement of what represents significant and unreasonable reduction of groundwater in storage in the basin.

Technical staff's proposal:

> **A significant and unreasonable reduction of groundwater in storage would be a net volume of groundwater extracted that will likely cause other sustainability indicators to have undesirable results.**

Rationale: the metric is the net volume of groundwater extracted- not a measured reduction in groundwater in storage. Net volume of groundwater extracted is the volume of groundwater pumped minus volume of managed aquifer recharge added to the Basin. Historic pumping has caused undesirable results through seawater intrusion. This is a condition we need to avoid in the future.

3. TECHNICAL STAFF PROPOSAL - UNDESIRABLE RESULTS (what set of conditions would cause significant and unreasonable reduction of groundwater in storage impacts to occur)

Advisory Committee Objective: Accept or adapt a statement of what undesirable results would look like for significant and unreasonable reduction of groundwater in storage.

Technical staff's proposal:

> **Five-year average net extraction exceeding the Sustainable Yield (Minimum Threshold) for the Aromas aquifer and Purisima F unit, five-year average net extraction exceeding the Sustainable Yield (Minimum Threshold) for the Purisima DEF, BC, A, and AA aquifers, or five-year average net extraction exceeding the Sustainable Yield (Minimum Threshold) for the Tu aquifer.**

Rationale: The Minimum Threshold will be determined by estimating the long-term Sustainable Yield using the predicted water budget of the groundwater model over at least the next 20 years. The predicted water budget has not yet been completed because projects and management actions have not been finalized for the GSP

Separate Sustainable Yields (Minimum Thresholds) will be developed for specified groups of Aromas, Purisima, and Tu aquifer units. Pumping wells that are screened across multiple units generally pump from within these groups. It is important in the Basin to manage pumping in these aquifer unit groups separately. For example, if the total Basin pumping (Aromas and Purisima F + other Purisima + Tu aquifer) were to be occur only in the Tu aquifer, there most certainly will be undesirable results.

The 5-year averaging period proposed is consistent with the averaging of groundwater elevation data used to define undesirable results for seawater intrusion. The five-year period is proposed because it identifies short-term issues quicker and because it will coincide with the required five-year annual updates to the GSP.

4. **TECHNICAL STAFF PROPOSAL – MINIMUM THRESHOLD** (annual volume of groundwater pumped from the Aromas and Purisima aquifers that causes any undesirable results)

Technical staff's proposal:
Sustainable Yield representing the net annual volume of groundwater extracted (pumping minus annual volume of managed aquifer recharge) for each of the groups of aquifers:

- **Aromas aquifer and Purisima F aquifer** (still to be estimated)
- **Purisima DEF, BC, A, and AA aquifer** (still to be estimated)
- **Tu aquifer** (still to be estimated)

Rationale: The Sustainable Yield is a volume of groundwater pumped that will be determined based on historical groundwater level trends, water year type (dry or wet), and projected water use in the basin under the future operation of the basin taking into account projects and management actions to be implemented as part of the GSP to achieve the Basin's sustainability goal. The future water budget will also be used to estimate Sustainable Yield. Exceeding the Sustainable Yield (Minimum Threshold) will cause undesirable results as defined for each of the Basin's relevant sustainability indicators.

5. **TECHNICAL STAFF PROPOSAL – MEASURABLE OBJECTIVE** (annual net volume of groundwater pumped from the Aromas and Purisima F, other Purisima aquifers, and Tu aquifer that provides operational flexibility to ensure the minimum thresholds are not exceeded)

Technical staff's proposal:
The net annual groundwater that needs to be extracted that ensures that if there were four subsequent years of maximum projected net groundwater extraction, net annual groundwater extractions greater than the Minimum Threshold will not occur for each of the following groups of aquifers:

- **Aromas and Purisima F aquifers**
- **Purisima DEF, BC, A, and AA aquifers**
- **Tu aquifer**

Annual net extractions for the different aquifer groups will be used to compare against Measurable Objectives, and not the five-year average of net extractions. This is because the Measurable Objective is what we need to be pumping each year if the next four years all had maximum projected pumping, and undesirable results are to be avoided.

Rationale: The Measurable Objective for this sustainability indicator needs to be an annual volume of groundwater pumped that is less than the Sustainable Yield. Like other sustainability indicators, the Measurable Objective should provide operational flexibility such as unforeseen climatic conditions. The volume of groundwater representing Measurable Objectives for the different aquifer groups will ensure the Minimum Threshold is met even if there are four consecutive years of maximum projected net extractions.

A hypothetical scenario is provided on Figure 1 to show how the Measurable Objective is estimated, and how the five-year average compares to the Minimum Threshold. There are some years (e.g., 2030) where the annual net pumping exceeds the Minimum Threshold. Because we are proposing a 5-year average, this would still be considered sustainable if the previous four years' net pumping were low enough that the 5-year average is below the Minimum Threshold.

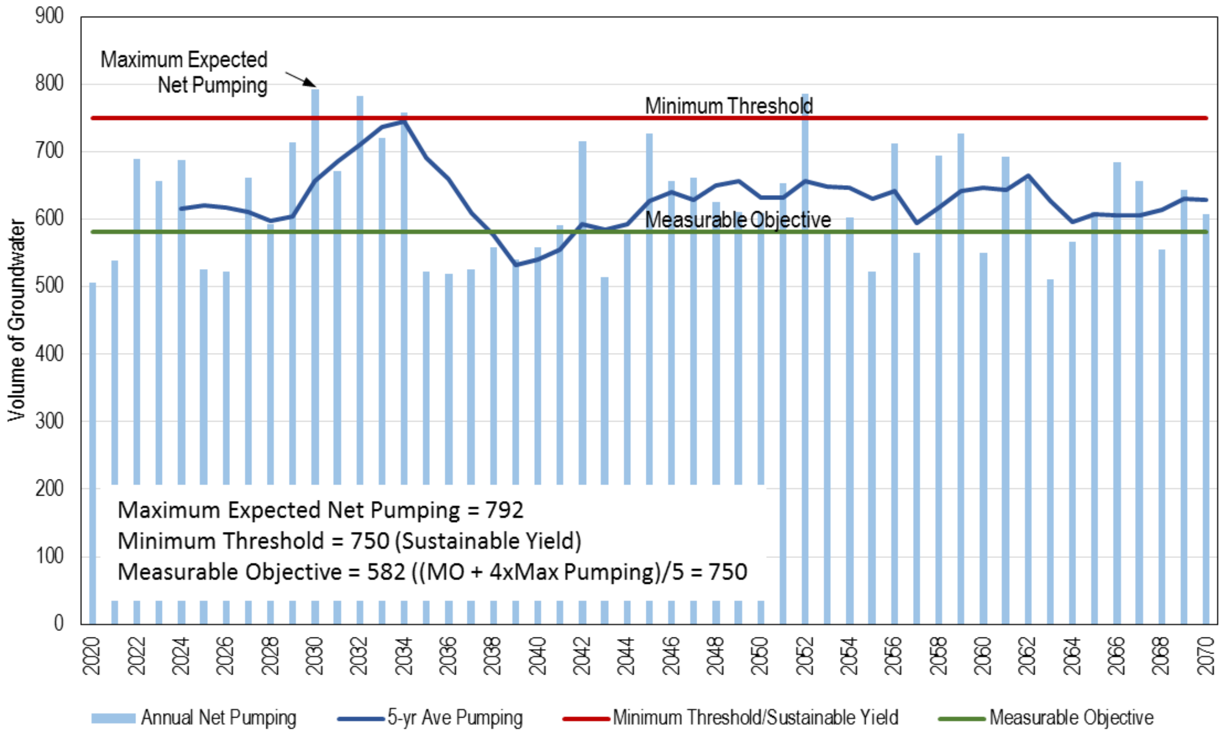


Figure 1. Hypothetical Estimation of Measurable Objective for a Theoretical Aquifer

6. Technical Staff Proposal – Representative Monitoring Points

(wells or points that will be used to measure the Minimum Threshold and Measurable Objective metrics)

Technical staff's proposal:

- All metered municipal wells in the Basin. Extractions will be separated by aquifer group: Aromas and Purisima F aquifers, Purisima DEF, BC, A, and AA aquifers, and Tu aquifer.
- All metered managed recharge facilities, whether they are wells or surface features. Managed recharge will be separated by aquifer group into which the recharge occurs: Aromas and Purisima F aquifers, Purisima DEF, BC, A, and AA aquifers, and Tu aquifer.
- Non-municipal use that is unmetered (private domestic and agricultural users) will have their groundwater extraction estimated. Private domestic groundwater extractions will be estimated based on buildings/residential parcels multiplied by a water use factor that is obtained from metered small water systems (see bullet below). Both large-scale and agricultural irrigation groundwater extractions will be estimated based on acreage of irrigated crops, crop type and evapotranspiration. Extractions will be

separated by aquifer group: Aromas and Purisima F aquifers, Purisima DEF, BC, A, and AA aquifers, and Tu aquifer.

- Small water systems report their groundwater extractions to the County. Where these metered data are available, they will be used to both represent direct water extractions and to estimate the annual water use factor (acre-feet per year) to apply in the estimate of private domestic extractions (see bullet above). Extraction will be separated by aquifer group: Aromas and Purisima F aquifers, Purisima DEF, BC, A, and AA aquifers, and Tu aquifer.

Rationale: As the metric for the reduction of storage sustainability indicator is a total net volume of groundwater that can be withdrawn from the basin without causing conditions that may lead to undesirable results, all wells extracting groundwater from the Basin and managed facilities recharging water to the Basin need to be used as representative monitoring points.

Proposed Santa Cruz MGA Ongoing Funding Approach

Purpose: To address Article 5, subarticle 5 - estimated costs and plans to meet those costs.

Background: The Santa Cruz Mid-County Groundwater Agency (MGA) will require ongoing funding to implement its Groundwater Sustainability Plan (GSP) once it has been accepted by the State. The topic of what will need to be paid for and who will be required to pay it have been regularly brought up by both the Board and the public throughout the Plan development process. As the GSP is moving closer to completion, staff have started looking to the future of implementation of the Plan. After much study, analysis, and deliberation, the following understandings have emerged:

- The MGA Board determined at its November 2018 meeting that it is not the MGA role to be the lead implementation entity of major projects. Instead, that role resides with the individual JPA agencies.

- The MGA may play a limited role in funding projects and/or management actions. This will most likely take the form of match or in-kind contributions. Most of the responsibility of the MGA will be around the following topic areas:
    - Administration
    - Annual reviews
    - Monitoring beyond existing network, including installation of monitoring devices (wells and stream gages)
    - Data Management
    - 5-year reporting
    - Ongoing modeling as needed
    - SkyTEM updates
    - Outreach and possible conservation incentives

- The MGA has long indicated that any fees will be based on impact to the basin. Recent modeling was done to assess the impact of the private pumpers on groundwater levels and seawater intrusion. The results show that those pumpers are having minimal impact on basin groundwater levels, particularly along the coast. There is also not yet enough information to establish a quantifiable link between de minimis pumping and stream depletion. Due to this, de minimis users will likely be exempted from charges for basin sustainability for the foreseeable future.

- The Joint Powers Authority (JPA) Member Agencies will continue to contribute both cash and in-kind work for GSP implementation. This includes seeking grant funds for MGA-related activities.

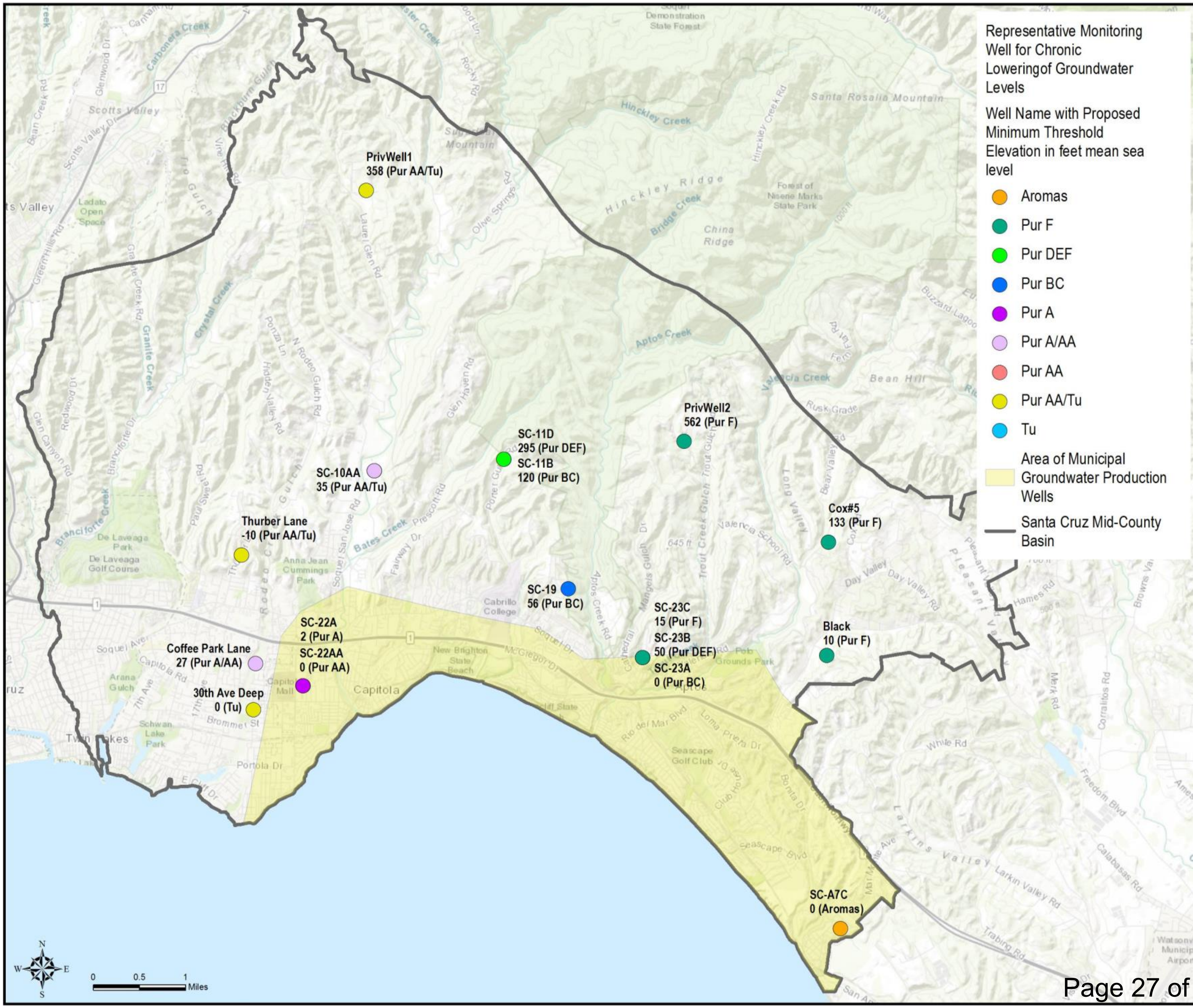
- The non-de minimis pumpers in the basin will be required to meter their wells and report their use, but not pay any fees initially, until such time that the MGA Board deems it appropriate to charge fees and the authority and mechanism for charging fees is further clarified by the courts.

Proposed Next Steps:

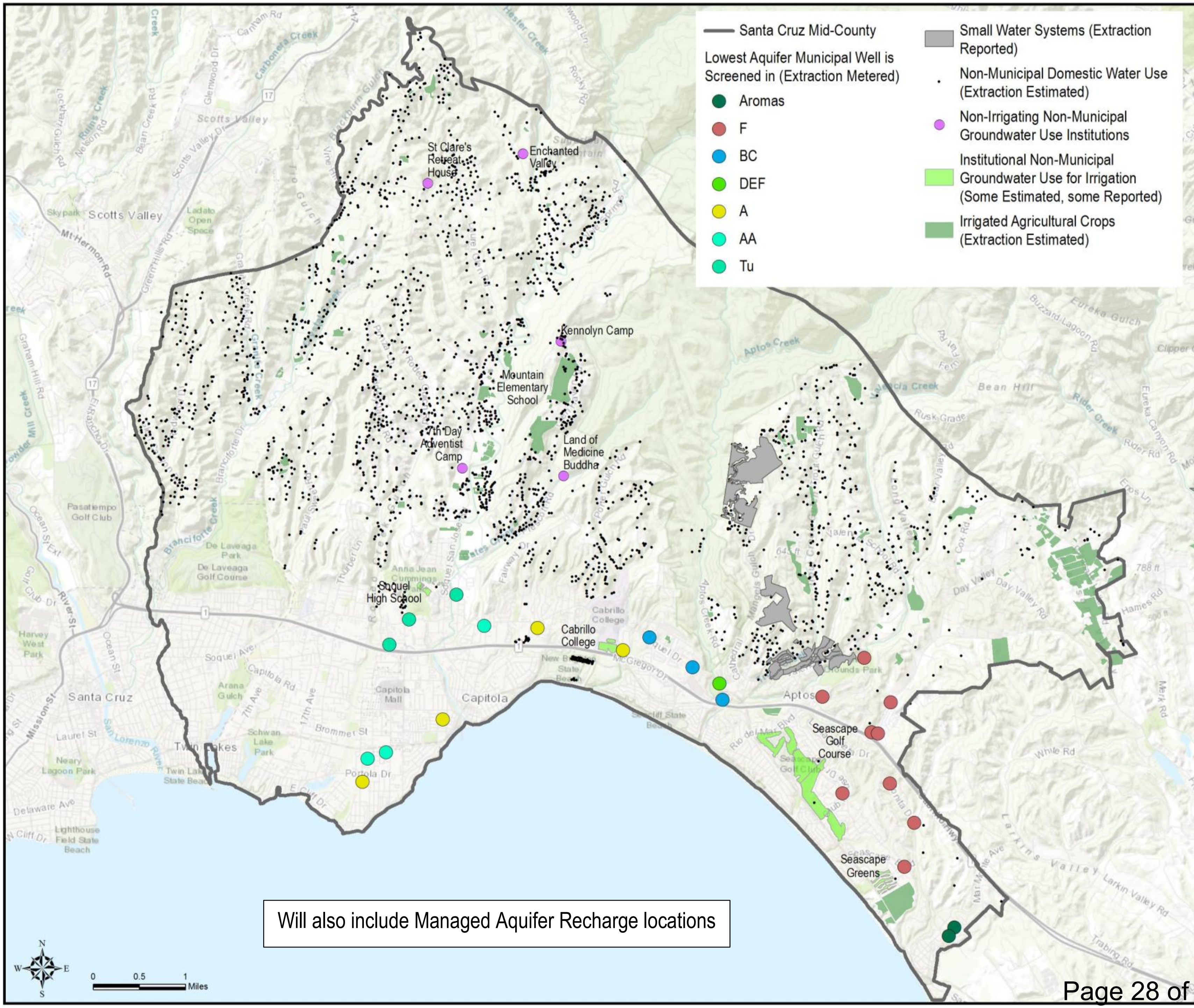
1) Identify an operating and management budget for MGA to implement the GSP, which will be based on the list of items above.

2) Determine annual contribution for the following agencies: Soquel Creek Water District, County of Santa Cruz, City of Santa Cruz, and Central Water District.
3) Contract with Raftelis to write a white paper to identify the best mechanism for including non-de minimis private pumpers in the funding of the MGA. Ultimately, de minimis pumpers may also be included under some form of funding mechanism as well.
4) Require metering on parcels that meet certain criteria that are yet to be determined. The purpose initially will be to collect data to evaluate water use in the basin for sectors that have previously not been required to meter and report use. Once we have the data on water use and the ability to evaluate that water use using the groundwater model, we can make a defensible argument to implement fees on certain users if deemed necessary and appropriate.

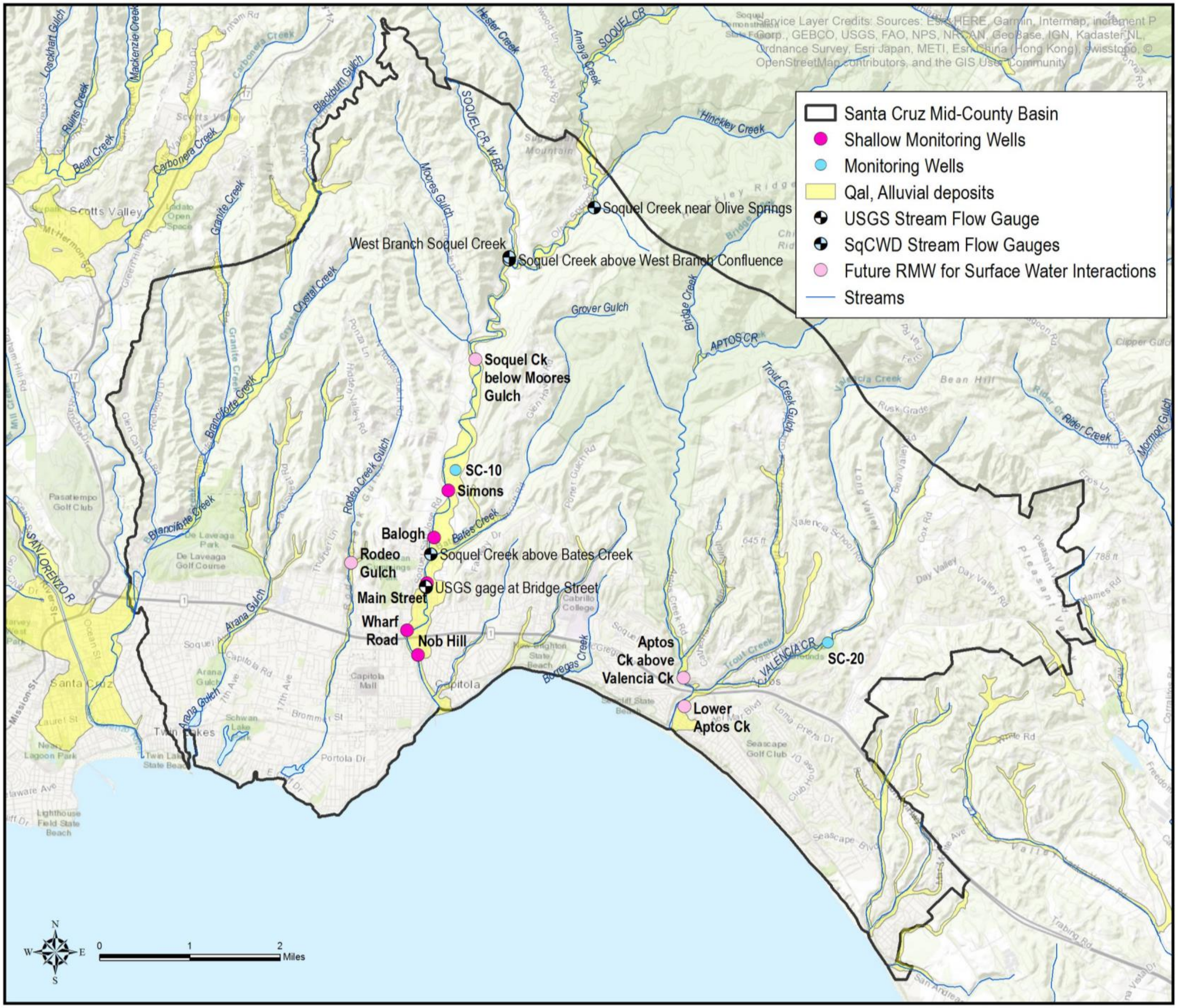
Proposed Representative Monitoring Wells for Chronic Lowering of Groundwater Levels



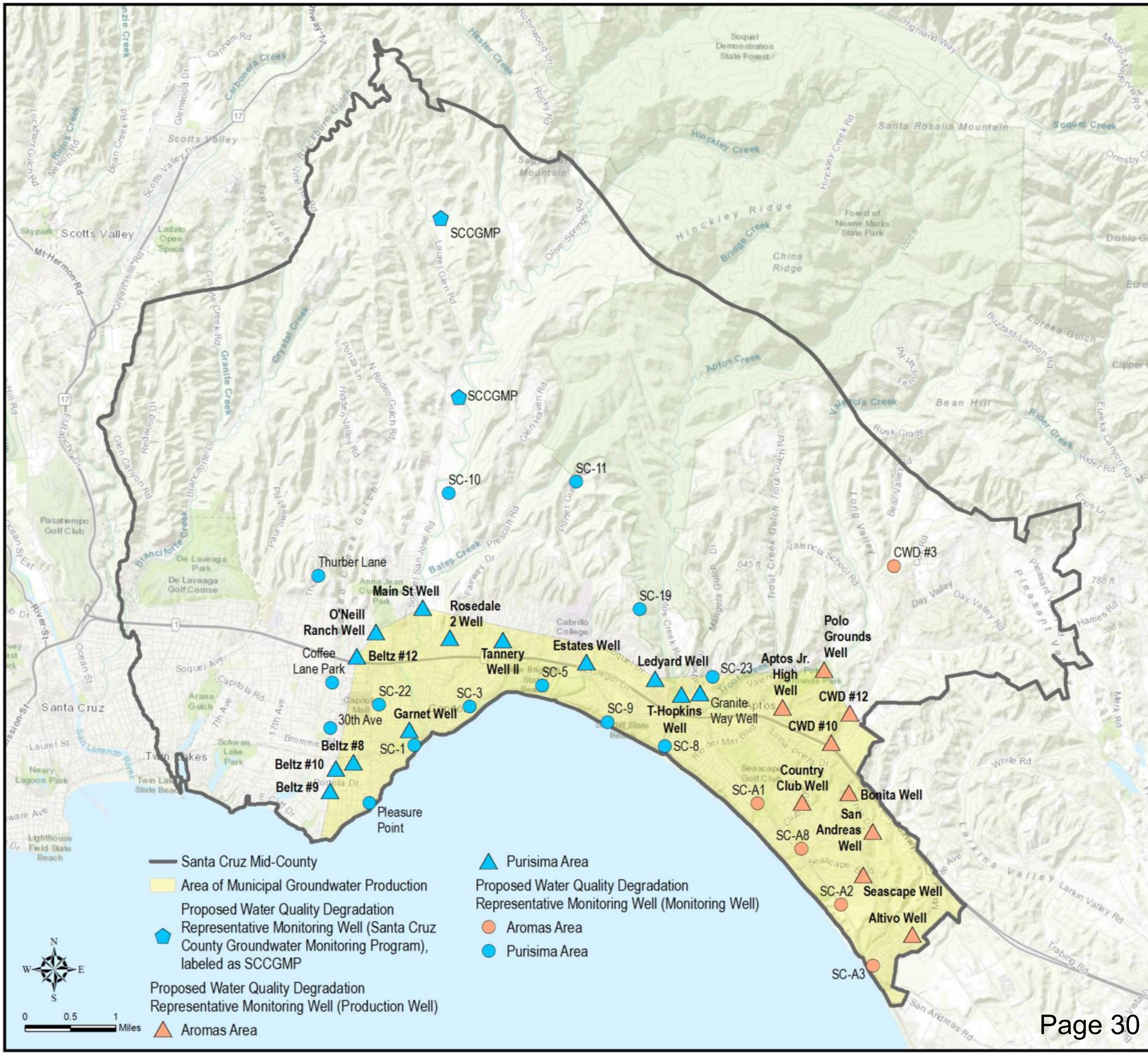
Proposed Representative Monitoring Points for Reduction of Storage



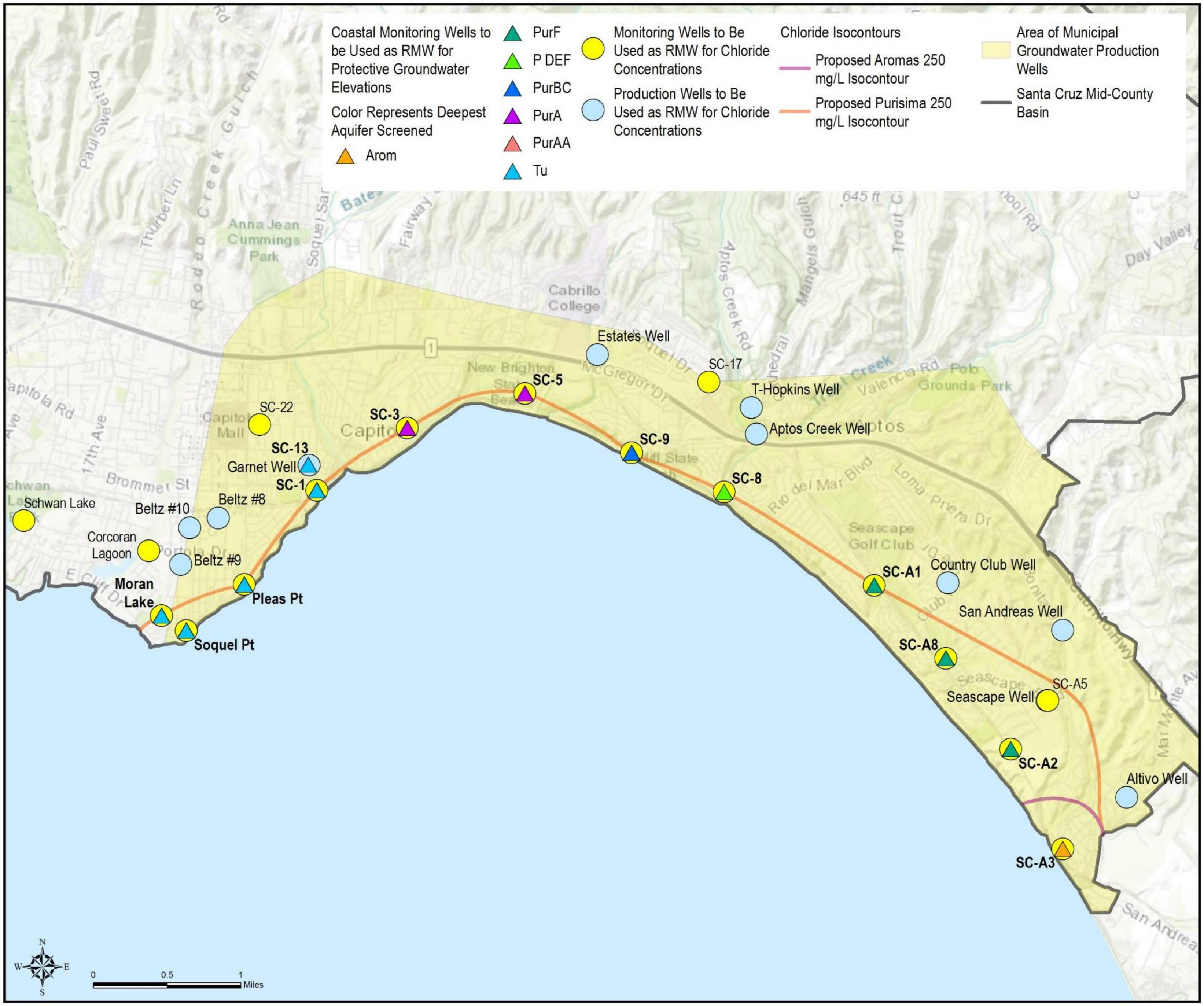
Proposed Representative Monitoring Wells for Depletion of Interconnected Surface Water



Proposed Representative Monitoring Wells for Degradation of Groundwater Quality



Proposed Representative Monitoring Wells for Seawater Intrusion



From:	Darcy Pruitt
To:	"G.L. Lindstrum"
Cc:	Jessica York
Subject:	RE: GSP Advisory Committee Packet Available
Date:	Monday, March 11, 2019 10:49:15 AM

Dear Mr. Lindstrum,

Thank you for your note and for passing on the article link. As requested, I will have it included in the March 21, 2019 MGA Board packet as public communications. This will put the article at the end of the MGA Board agenda, in case you are planning to speak to the issue.

The article is also timely for the March 27, 2019 Groundwater Sustainability Plan (GSP) Advisory Committee packet. Unless you object, I will also have it included in the committee's materials as public communications.

Water quality is an important concern for groundwater management and is one of the sustainable management criteria included in the GSP. We continue to discuss setting appropriate groundwater basin management criteria in our remaining GSP Advisory Committee meetings (March through June).

Thank you for raising these water quality issues again. The article you provided discusses conventional wastewater treatment processes, rather than ultra-purification as proposed by Soquel Creek Water District. Water quality is an important topic for review, analysis, and public conversation. I appreciate your participation in the GSP planning process.

Please let me know if you have additional concerns.

Best,

Darcelle Pruitt **Senior Planner**
Groundwater Sustainability Planning for the Santa Cruz Mid-County Groundwater Agency
Regional Water Management Foundation
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From: G.L. Lindstrum [mailto:aptoscalifornia95003@gmail.com]
Sent: Sunday, March 10, 2019 2:38 PM
To: Darcy Pruitt <DPruitt@cfscc.org>
Cc: Jessica York <jyork@santacruzsentinel.com>
Subject: Re: GSP Advisory Committee Packet Available

Hi Darcy,

Just wanted to pass this very important URL along to you also. I think it should be passed on to at least the MGA Board Members...if not to everyone on the MGA mailing list. This is exactly what I was talking about during last years campaign. Becky Steinbruner, I and countless others have repeatedly brought this very point to the attention of Soquel Creek Water Distric employees including Ron Duncan, the entire Board of Directors.

I hope this is finally going to get through to every person involved with the Soquel Semi Pure Water Project that this is not the way to solve the saltwater intrusion problem! Transfers are...period...enough said. They are dealing with the health of thousands of rate payers, well users and the public in general. Think of all of the unknowing public that vacations here within the Soquel Creek Water District every year, year after year. This recycled sewage would effect them as well. Soquel Creek Water District has absolutely no right to gamble with anyone's life...period.

These facts may not even be enough to change your mind for your sake but what about that of your daughters and all the other children within the district? They have no say in this matter yet it could very well effect their lives and there children's lives. People need to think about these very things before making decisions to gamble with other peoples lives.

Let it be known that I have every intention to expose this "url" below to all local media, the state departments and even the federal departments that would give Grant's for the very purpose of building this dangerous and totally unnecessary Semi Pure Water Project. I want every health department to know about it, as well as every citizen. I intend to get it on the radio stations, in the newspapers and on local television stations and every social media site known. Should have it completed within the next week or so. The public needs to be made aware of these facts and the many others that are bound to pop up as time goes on. I do not want to see our precious water source distroid by a few narrow minded science based Directors and General Manager of the Soquel Creek Water District. Sorry to speak so low of them but I have reached a point where respect is now going to have to be earned.

Thank you for your time and another thank you for all you do for the MGA and the community in general, it is greatly appreciated.

With great regards,

Gary Lindstrum

https://m.phys.org/news/2019-03-antibiotic-resistance-wastewater-treatment.html?fbclid=IwAR0uvWRGT-DTI49b3ypDYnJRI-oChwNZpir7FZb28peZW7RB5YpSW5LsNdI

On Feb 22, 2019 3:01 PM, "MGA - Santa Cruz Mid-County Groundwater Agency" <dpruitt@cfscc.org> wrote:

> View this email in your browser

Antibiotic resistance is spreading from wastewater treatment plants

6 March 2019

Credit: CC0 Public Domain

The products of wastewater treatment have been found to contain trace amounts of antibiotic resistant DNA. These products are often reintroduced to the environment and water supply, potentially resulting in the spread of antibiotic resistance. As such, researchers at the University of Southern California Viterbi School of Engineering have been studying the development of these potentially harmful and dangerous genes in wastewater treatment processes. Their findings, published in *Environmental Science & Technology*, indicate that even low concentrations of just a single type of antibiotic leads to resistance to multiple classes of antibiotics.

"We're quickly getting to a scary place that's called a "post-antibiotic world," where we can no longer fight infections with antibiotics anymore because microbes have adapted to be resilient against those antibiotics," said Adam Smith, assistant professor of civil and environmental engineering at USC and lead investigator of the study. "Unfortunately, engineered water treatment systems end up being sort of a hot-bed for antibiotic resistance."

The majority of the antibiotics we consume are metabolized in our bodies. However, small amounts pass through us in our waste, which are then carried to wastewater treatment plants. At these plants, one of the common ways in which the wastewater is treated is with a membrane bioreactor, which uses both a filtration system and a biological process where microscopic bacteria consume waste products.

While consuming the organic waste, the bacteria encounters the antibiotics and expresses resistance genes that reduce effectiveness of these medicines. These resistance genes can then be passed on from parent to daughter cell and between neighbors through a process known as horizontal gene transfer.

As the bacteria eats, reproduces and grows, an excess is accumulated called biomass. A typical wastewater treatment plant produces tons of biomass every day. Once treated, it is disposed of in landfills or used as a fertilizer for agriculture and livestock feed crops.

In an even more dire scenario, small amounts of antibiotic resistant bacteria and free-floating DNA make it through the filtration membrane and come out the other side of the treatment plant in what is called the effluent, or the water stream that leaves the facility. In Los Angeles, some of this will be dumped into the L.A. River and Pacific Ocean, while the rest is recycled for irrigation, car washes, firefighting, or to replenish groundwater supplied, a common source of drinking water.

The team, also including Ali Zarei-Baygi, the study's first-author and Ph.D. student at USC, Moustapha Harb, postdoctoral scholar at USC, Philip Wang, Ph.D. student at USC, and Lauren Stadler, assistant professor at Rice University, believe that the amount of antibiotic resistant organisms formed in treatment plants could be reduced through alterations in the treatment processes. For example, by employing oxygen free, or anaerobic, processes rather than aerobic processes, and by using membrane filtration.

Accordingly, for their study, they used a small-scale anaerobic membrane bioreactor and compared the resulting antibiotic resistance profiles in the biomass and effluent to each other and to the varying concentrations and types of antibiotics they introduced into the system.

They discovered two key findings: the resistance in the biomass and effluent are different and therefore one cannot be used to predict the other; and the correlations they found between the added antibiotic and the resistance genes weren't always clear cut. In fact, their results indicated multi-drug resistance in which bacteria had genes allowing for resistance to multiple classes of antibiotics.

"The multi-drug resistance does seem to be the most alarming impact of this," Smith said. "Regardless of the influent antibiotics, whether it's just one or really low concentrations, there's likely a lot of multi-drug resistance that's spreading."

They believe this is due to the presence of gene elements called plasmids. One plasmid may carry resistance genes for several different types of antibiotics, resulting in positive correlations between one type of antibiotic and the resistance gene of another. This not only further complicates things, but can be extremely dangerous. Because of their extremely small size—1,000 times smaller than bacteria—free-floating plasmids can easily make it through the filtration system in the treatment process and exit the plant in the effluent.

The team is now looking more closely at the composition of the effluent and plans on applying what they learned to other waste streams, such as animal waste, through a partnership with the USDA.

More information: Ali Zarei-Baygi et al, Evaluating Antibiotic Resistance Gene Correlations with Antibiotic Exposure Conditions in Anaerobic Membrane Bioreactors, *Environmental Science & Technology* (2019). DOI: 10.1021/acs.est.9b00798

Provided by University of Southern California

APA citation: Antibiotic resistance is spreading from wastewater treatment plants (2019, March 6) retrieved 11 March 2019 from https://phys.org/news/2019-03-antibiotic-resistance-wastewater-treatment.html