MONTGOMERY & ASSOCIATES
Water Resource Consultants

Groundwater experts since 1984

DRAFT TECHNICAL MEMORANDUM

DATE: February 5, 2021 **PROJECT #:** 9090.0901

TO: Ad Hoc Sustainable Groundwater Planning Advisory Committee (GSU22 Committee)

CC: Brian Lockwood, P.G., C.Hg. and Casey Meusel
Pajaro Valley Water Management Agency

FROM: Cameron Tana, P.E., and Luis Mendez

PROJECT: Basin Management Plan: Groundwater Sustainability Update 2022 (GSU22)

SUBJECT: Proposed Statement of Significant and Unreasonable Conditions for Seawater Intrusion and Approach to Developing Sustainable Management Criteria

BACKGROUND

The Pajaro Valley Water Management Agency (PV Water) submitted a Groundwater Sustainability Plan (GSP) Alternative for the Pajaro Valley Subbasin (Basin) on December 31, 2016 per the Sustainable Groundwater Management Act (SGMA). The California Department of Water Resources (DWR) assessed the Alternative and approved PV Water's GSP-Alternative. DWR's assessment staff report recommended PV Water develop sustainable management criteria for seawater intrusion as follows:

- Recommended Action 6: [DWR] Staff recommend that the Agency should define a specific location of an isoconcentration contour or some other equivalent method that can be used on an ongoing basis to assess progress toward eliminating undesirable results associated with seawater intrusion to assess the goal of eliminating seawater intrusion through implementation of projects and management actions as described in the Plan.

- Recommended Action 7: [DWR] Staff recommend that the Alternative should be updated to set objective criteria consistent with achieving the stated goal that a 100 percent reduction in annual seawater intrusion rate is the operational goal for the Basin or to ~~provide~~ quantify (sic) the extent to which additional seawater intrusion would not be significant and unreasonable *(correction to assumed typo added)*.

In response to DWR's recommendations, PV Water plans to develop specific seawater intrusion sustainable management criteria (SMC) for inclusion in the Basin Management Plan: Groundwater Sustainability Update 2022 (GSU22). The GSU22 will be submitted as the five-year update for the GSP Alternative to DWR by January 1, 2022.

In order to address DWR's recommendation, the GSU22 Committee will answer the following questions to form statements of significant and unreasonable conditions for beneficial uses sensitive to seawater intrusion and provide the basis of the GSU22's seawater intrusion SMCs:

- **Question 1: How should we define whether seawater intrusion is occurring in the Basin?**
- **Question 2: How far inland is seawater intrusion acceptable and why?**

SUMMARY OF SEAWATER INTRUSION SMC DEVELOPMENT TO DATE

The first Technical Memorandum for development of seawater intrusion SMC was titled *Seawater Intrusion Sustainable Management Criteria Chloride Isocontour Value* and dated December 11, 2020. We presented this technical memorandum to the GSU22 Committee at its December 15, 2020 meeting. The general question asked of the Committee at that meeting was **"How should we define whether significant and unreasonable seawater intrusion is occurring in the Basin?"** The aim was to receive feedback on what chloride concentration would result in significant and unreasonable conditions for beneficial uses.

Although the GSU22 Committee provided feedback that the drinking water standard of 250 mg/L chloride concentration is too high for crops and therefore not the preference for agricultural uses, the GSU22 Committee generally indicated that it needed more information to provide input on defining a specific chloride concentration for the seawater intrusion SMC. The additional information requested by the GSU22 Committee includes consideration of the second main question the GSU22 Committee will help answer in describing significant and unreasonable conditions for seawater intrusion: "**How far inland is seawater intrusion acceptable and why?"**

To facilitate feedback from the GSU22 Committee, this Technical Memorandum proposes a draft statement of significant and unreasonable conditions focusing on the second question. Using the proposed draft statement as a starting point for consideration, the GSU22 Committee can then return to the first question and consideration of what chloride concentration represents significant and unreasonable seawater intrusion.

DRAFT

Following the draft statement of significant and unreasonable conditions in this Technical Memorandum is a description of the approach for developing the SMC guided by the statement of significant and unreasonable conditions.

EXAMPLE STATEMENTS OF SIGNIFICANT AND UNREASONABLE CONDITIONS FOR SUBMITTED GROUNDWATER SUSTAINABILITY PLANS

As introduced at the second meeting of the GSU22 Committee in November 2020, the first step in developing SMC for any sustainability indicator is to qualitatively describe significant and unreasonable conditions for the indicator. DWR Recommended Action 7 describes the need for PV Water to describe significant and unreasonable conditions for seawater intrusion.

Appendix A provides summaries of three critically overdrafted coastal basins where GSPs have been submitted: the adjacent Santa Cruz Mid-County Basin and Salinas Valley 180/400 Foot Aquifer Subbasin as well as the Oxnard Subbasin in Ventura County. All three statements of significant and unreasonable conditions focus on "**How far inland is seawater intrusion acceptable?"**

- Santa Cruz Mid-County Basin: "Seawater moving farther inland than has been observed from 2013 through 2017" (MGA, 2019).
- Salinas 180/400 Foot Aquifer Subbasin: "Seawater intrusion in excess of the seawater intrusion line defined by MCWRA in 2017" (SVBGSA, 2020).
- Oxnard Subbasin: "Seawater intrusion that results in a net landward migration of the 2015 saline water impact front beyond the already impacted area west of Highway 1 and south of Hueneme Road…" (FCGMA, 2019)

All three basins use existing conditions to define how far inland seawater intrusion is acceptable. The GSU22 Committee can recommend defining a location for acceptable seawater intrusion different from the above examples that is either closer to the coast or more inland.

PROPOSED STATEMENT OF SIGNIFICANT AND UNREASONABLE CONDITIONS FOR BENEFICIAL USES SENSITIVE TO SEAWATER INTRUSION

As introduced in the December 11, 2020 Technical Memorandum *Seawater Intrusion Sustainable Management Criteria Chloride Isocontour Value*, there are two primary beneficial uses of groundwater sensitive to seawater intrusion in the Basin: agricultural and domestic. The

DRAFT

proposed statement of significant and unreasonable conditions includes two parts related to each beneficial use.

<u>Agriculture:</u> ***It would be significant and unreasonable for seawater intruding into the Aromas aquifer to raise salinity to concentrations exceeding levels tolerable for crops currently grown in the Basin beyond the greatest inland extent of either the intrusion observed from 2017-2020 or PV Water's Delivered Water Zone.***

Seawater intrusion within PV Water's Delivered Water Zone is not a significant and unreasonable condition for agriculture because growers have access to an alternate supply of irrigation water. However, there are some areas outside the Delivered Water Zone with existing seawater intrusion (Figure 1). Similar to the three examples from other GSPs presented above, the proposed statement considers existing seawater intrusion as acceptable. Additional seawater intrusion is not acceptable in areas where growers do not have access to the delivered water.

DRAFT

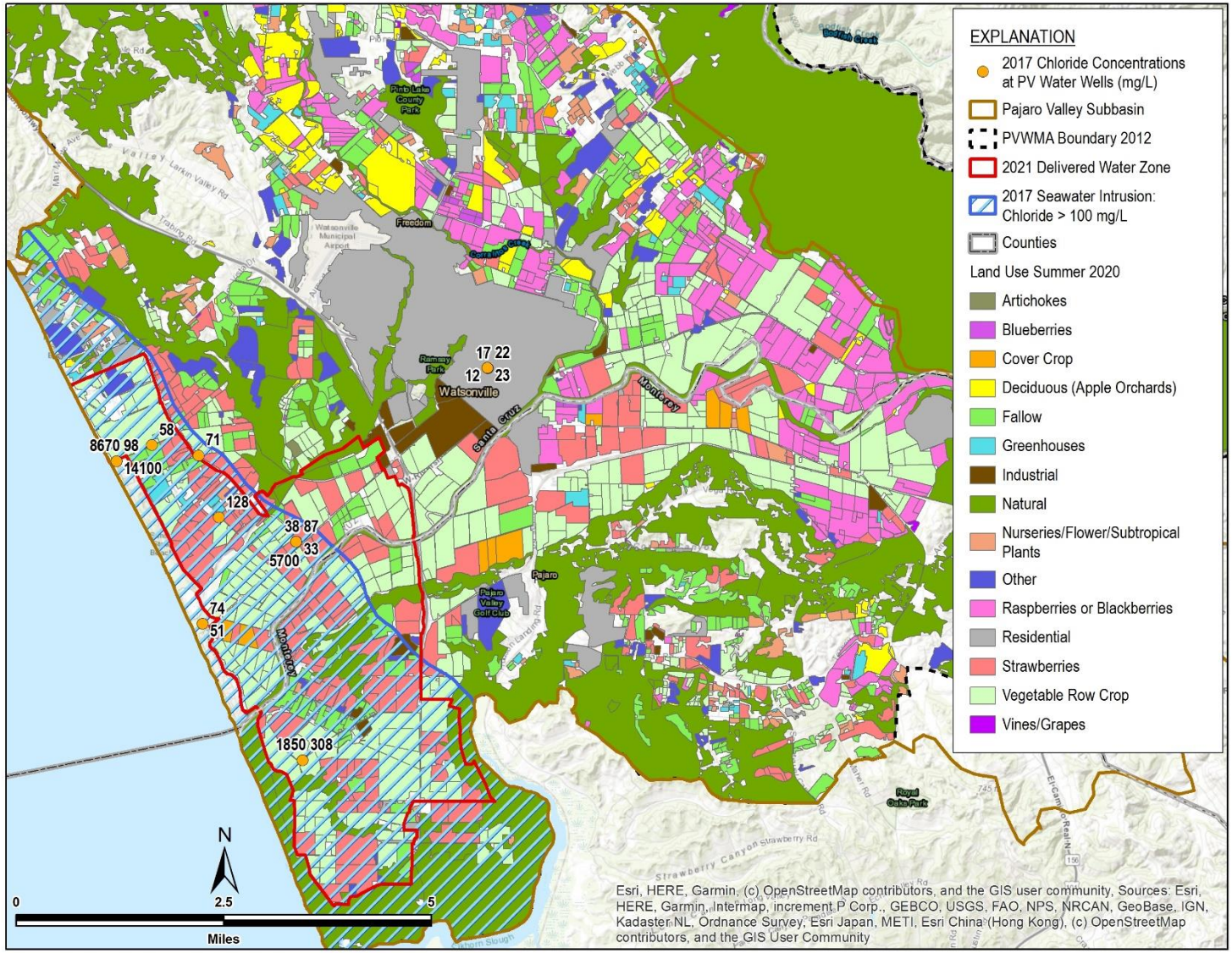

Figure 1. Pajaro Valley Subbasin Delivered Water Zone, Land Use and 2017 Seawater Intrusion

Domestic: ***It would be significant and unreasonable for seawater intruding into the Aromas aquifer to raise salinity to concentrations exceeding the drinking water standard beyond the inland extent of the intrusion observed from 2017-2020.***

People who get their water for domestic purposes from private wells, or who are connected to water systems are not eligible to receive PW Water's delivered water. PV Water's delivered water supply includes tertiary treated recycled water, which is not permitted for domestic use. There are domestic users of groundwater near the coast (**Error! Reference source not found.**) that could have unacceptable taste and odor effects from seawater intrusion even if seawater intrusion does not extend beyond the Delivered Water Zone.

We are seeking feedback from the GSU22 Committee on these statements so that they can be revised to reflect the Committee's answer to "**How far inland is seawater intrusion acceptable and why?"**

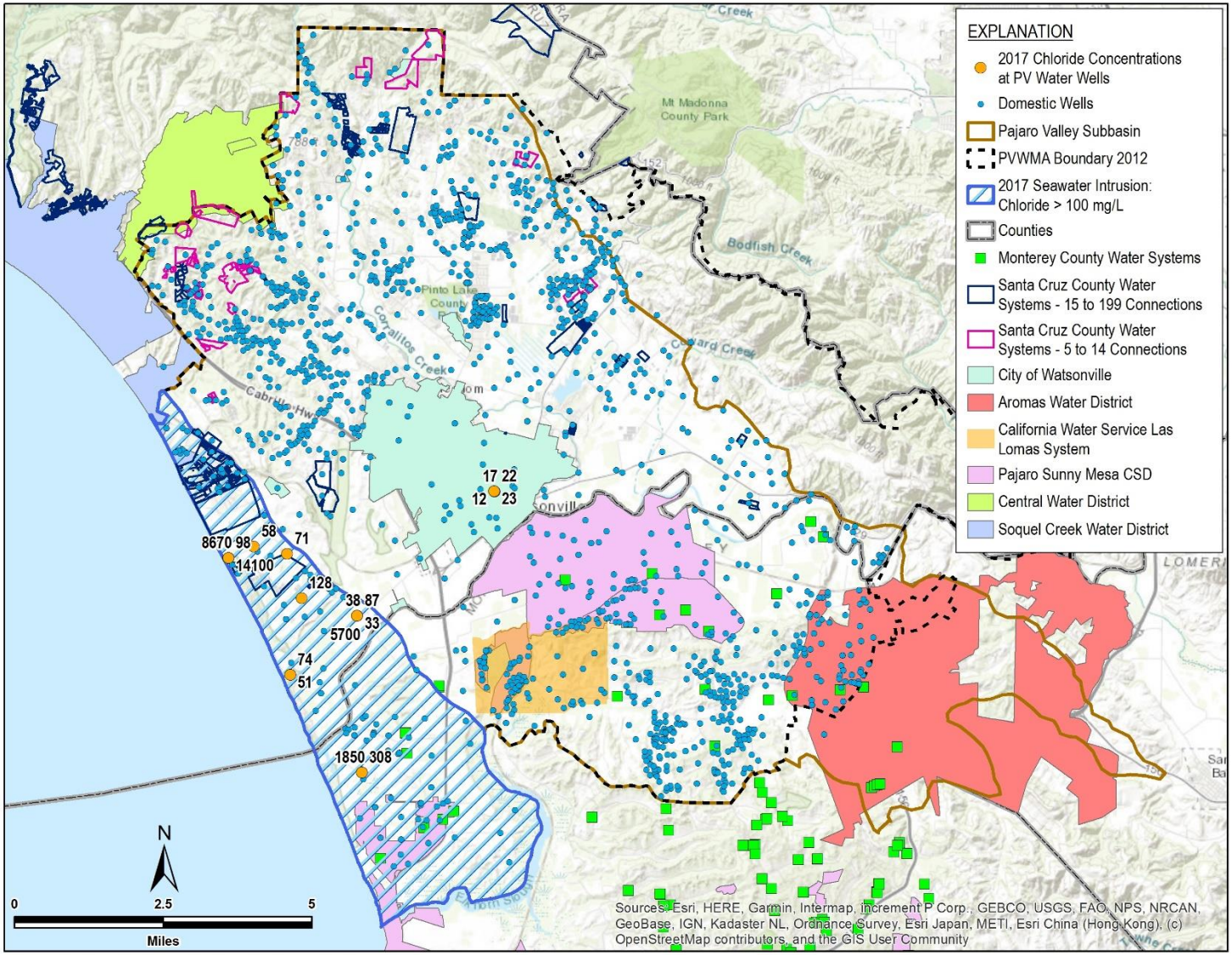

Figure 2. Water Systems, Private Wells and 2017 Seawater Intrusion

CHLORIDE CONCENTRATIONS REPRESENTING SIGNIFICANT AND UNREASONABLE CONDITIONS

SGMA requires the use of a chloride concentration to define whether significant and unreasonable seawater intrusion is occurring. The chloride concentration is the minimum threshold that may lead to undesirable results. The December 11, 2020 Technical Memorandum *Seawater Intrusion Sustainable Management Criteria Chloride Isocontour Value* provides information that indicates the following chloride concentration ranges represent a significant and unreasonable condition:

- For agriculture, the maximum chloride concentration ***tolerable for crops currently grown in the Basin*** is likely within 120-250 mg/L based on salt sensitivity of strawberries, one of the more salt-sensitive crops presently grown in the coastal portion of the Pajaro Valley.
- For domestic use, ***the drinking water standard*** for chloride concentration ranges from 250-500 mg/L, the recommended secondary maximum contaminant limit (MCL) and upper limit to consumer acceptance contaminant level range.

Selection of the chloride concentration used for the seawater intrusion minimum threshold will consider existing chloride concentrations observed in areas known to be free of seawater intrusion. Ideally, the minimum threshold will be set higher than the background chloride concentrations so seawater intrusion can be clearly distinguished.

We are seeking feedback from the GSU22 Committee on what specific chloride concentrations should be used to define **"How should we define whether seawater intrusion is occurring in the Basin?"**

APPROACH TO DEVELOPING MINIMUM THRESHOLD ISOCONTOURS

DWR's Recommended Action 6 recommends defining a chloride isoconcentration contour (isocontour) to assess undesirable results. This is consistent with regulatory requirements for GSPs to define a chloride isocontour as the minimum threshold.

- GSP Regulations § 354.28 (c)(3): "The minimum threshold for seawater intrusion shall be defined by a chloride concentration isocontour for each principal aquifer where seawater intrusion may lead to undesirable results."

DRAFT

An isocontour is a geographic line where chloride in groundwater is estimated to be a specified concentration. Figure 3 is a graphic from DWR's Sustainable Management Criteria Best Management Practices (BMP) guidance document (2017) that provides an example isocontour set at 250 mg/L as the orange line in the shallow aquifer. If the isocontour is the seawater intrusion minimum threshold, chloride concentrations inland of the isocontour (grey area in Figure 3) that are above the example 250 mg/L isocontour concentration would be considered an exceedance of the minimum threshold. Chloride concentrations on the coastal side of the isocontour (orange areas in Figure 3) greater than the example 250 mg/L isocontour concentration would not be considered an exceedance of the minimum threshold.

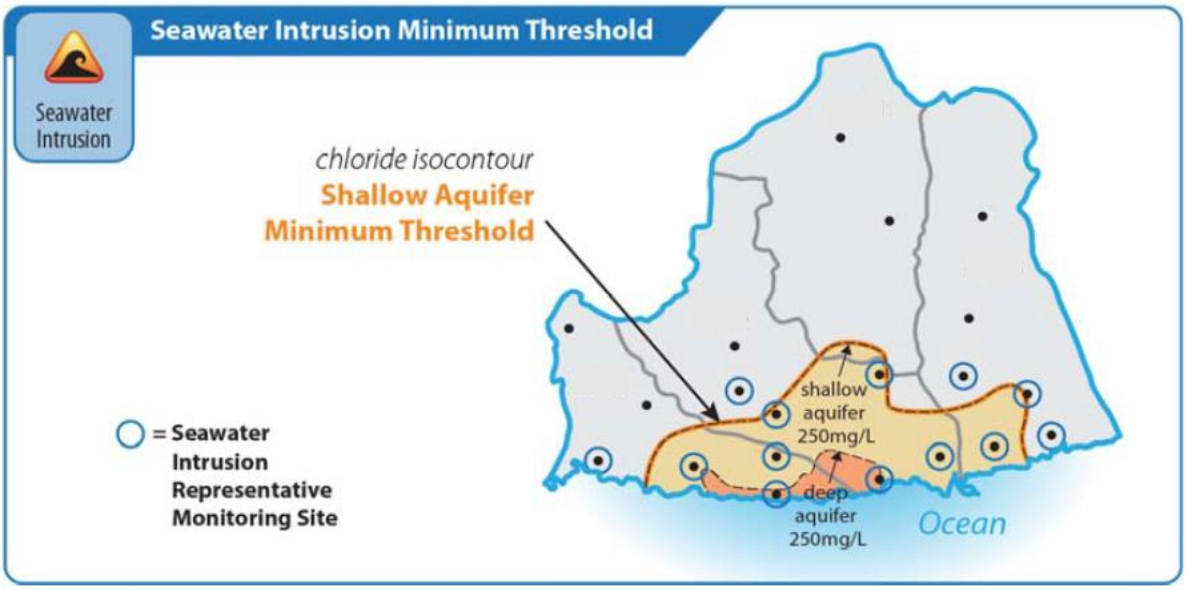

Figure 3. Example Seawater Intrusion Minimum Threshold Established at the Chloride Iscontour (modified from DWR, 2017)

With seawater intrusion, higher chloride concentrations will generally occur closer to the coast with concentrations reducing with distance from the coast. This aligns with the differences in chloride concentrations that represent significant and unreasonable conditions for agricultural and domestic beneficial use. The range for the ***drinking water standard*** is higher than the range for the chloride concentration that may not be ***tolerable for crops currently grown in the Basin***. Given agricultural acreage outside of the Delivered Water Zone (Figure 1) is generally inland of wells that provide domestic supply closest to the coast (Figure 2), it is reasonable that there could be an isocontour closer to the coast with a higher concentration that prevents significant and unreasonable conditions for domestic use that is likely to also prevent significant and unreasonable contours for agricultural use. We propose to identify the location of such an isocontour as the minimum threshold for seawater intrusion.

Figure 4 provides an illustration of this approach where the minimum threshold (MT) isocontour is set close to the coast at a concentration between of 250 and 500 mg/L based on the ***drinking water standard*** similar to the black line around the dark orange area. As a check on the location of the MT isocontour, we would delineate a projected isocontour farther inland based on the assumption that the minimum threshold is achieved at the MT isocontour and there is a decrease in chloride concentrations from the isocontour to inland areas. The projected isocontour represents the chloride concentration that is ***tolerable for crops currently grown in the Basin*** (between 120 and 250 mg/L). This more inland projected isocontour would be similar to the dark orange line surrounding the light orange area on Figure 4. We will compare the projected isocontour to Delivered Water Zone, crop areas, and existing intrusion to assess whether the MT isocontour closer to the coast is likely to prevent significant and unreasonable conditions for agricultural use. If the MT isocontour is not likely to prevent significant and unreasonable conditions, its location and/or concentration will be adjusted such that both beneficial uses are likely to be protected.

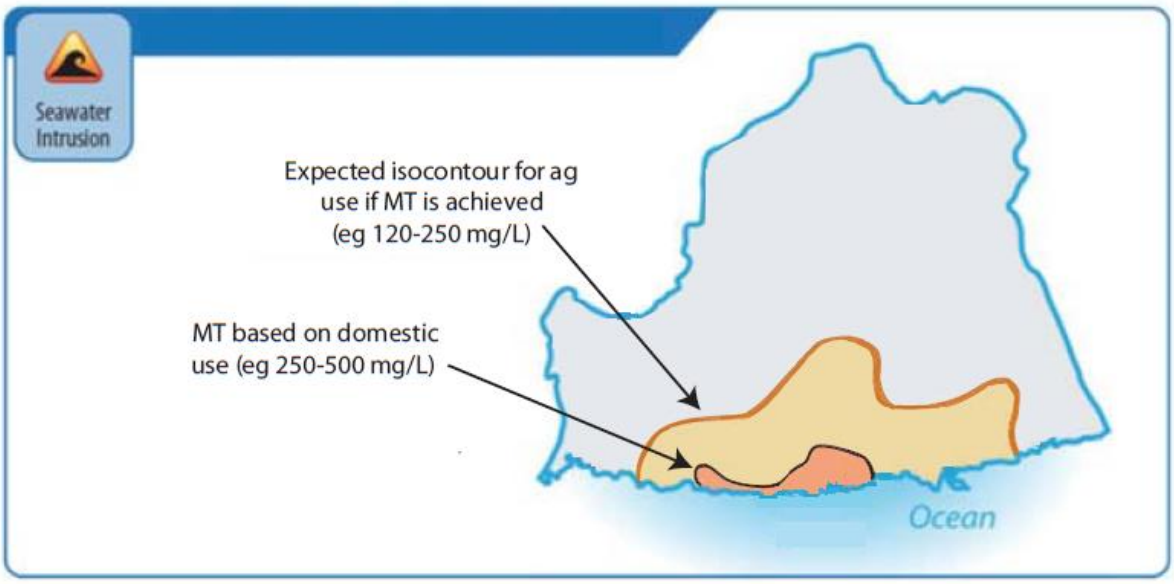

Figure 4. Illustration of Single Mininum Threshold Isocontour Preventing Significant and Unreasonable Conditions for Both Beneficial Uses (modified from DWR, 2017)

Another important consideration in evaluating a chloride isocontour for seawater intrusion will be to account for changes with depth within the Aromas aquifer. Due to higher density of saltwater than freshwater, the saltwater wedge will intrude underneath freshwater as shown in Figure 5. Therefore, higher concentrations are likely to be observed at greater depths as shown in the cross-section along the coast of the Basin in Figure 6 where the deepest monitoring well screen intervals marked D have the highest chloride concentration at each well cluster.

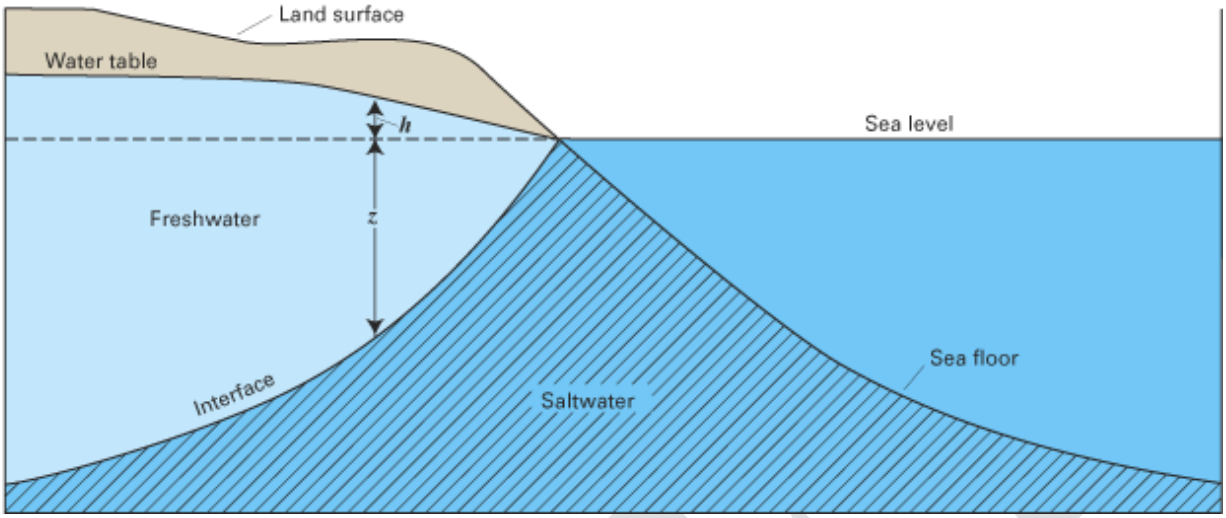

Figure 5. Schematic Showing Typical Saltwater Interface for Seawater Intrusion (Barlow et al., 2003)

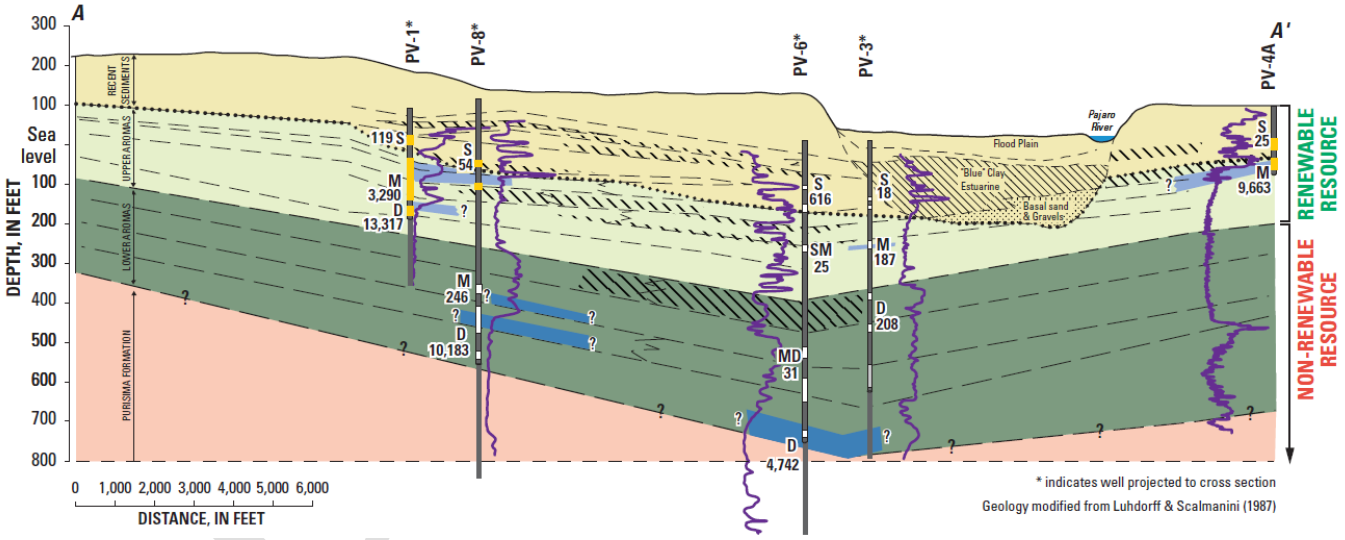

Figure 6. Cross-section Along Coast with Chloride Concentrations (mg/L) at PV Water Monitoring Wells (USGS and PV Water, 2003)

The minimum threshold chloride isocontour will include clear description of its vertical location. Therefore, chloride concentrations higher than the minimum threshold below the elevation of the isocontour would not be considered a minimum threshold exceedance. The expected inland chloride isocontour at a lower concentration to protect agricultural use will also be evaluated to make sure that it is representative of depths of agricultural well screens.

APPROACH TO DEFINING REPRESENTATIVE MONITORING POINTS AND UNDESIRABLE RESULTS

Ongoing assessment of whether there are exceedances of the chloride isocontour minimum threshold will be based on annual mapping of isocontours based on available chloride concentration data. Wells used in that evaluation that can be disclosed publicly will be identified as representative monitoring points (RMPs). We will seek feedback from DWR on whether it is possible for wells used for annual mapping to not be publicly identified as RMPs.

Annually mapped isocontours located inland and/or shallower than the MT isocontour will be considered a minimum threshold exceedance. For example, if the MT isocontour is the dashed black line in Figure 4, then a mapped isocontour of chloride observations that is located inland of that dashed black line at any point would be a MT exceedance. Undesirable results are proposed to be a combination of multiple exceedances of the MT isocontour. This is to ensure that MT exceedances represent long-term movement of significant and unreasonable seawater intrusion. Sustainability of a basin is measured by avoiding undesirable results. If undesirable results based on multiple exceedances of the minimum threshold isocontour occur after 2040, the State Water Resources Control Board (SWRCB) can take over management of the Basin from PV Water.

It should be noted that chloride concentrations inland of the MT isocontour could technically be as high as the minimum threshold concentration and would not result in MT exceedances or undesirable results. For example, if the MT isocontour is the dashed black line on Figure 4 and set at a concentration of 250 mg/L, chloride concentrations of up to 250 mg/L within the light orange area would not be MT exceedances. This may result in concentrations that are not preferred for agricultural use. The plan is to set the minimum threshold such that these higher than preferred concentrations would be unlikely to occur beyond the Delivered Water Zone or currently existing intrusion. However, it is possible that these higher concentrations could occur beyond these areas. If this did occur, intervention by SWRCB to manage the Basin would not be triggered.

APPROACH TO DEFINING MEASURABLE OBJECTIVES

In order to manage the Basin such that significant and unreasonable conditions impacting agriculture do not occur, it is proposed that PV Water set an inland chloride isocontour as the measurable objective (MO) with a lower concentration that prevents detrimental effects on crops grown in the Basin. This concentration could be as low as 100 mg/L to be consistent with prior planning and reporting in addition to ensuring crop tolerance. The location of the MO isocontour would be the greatest inland extent of either the MO concentration resulting from seawater intrusion observed from 2017-2020 or PV Water's Delivered Water Zone. An example of setting this MO is shown in Figure 7.

DRAFT

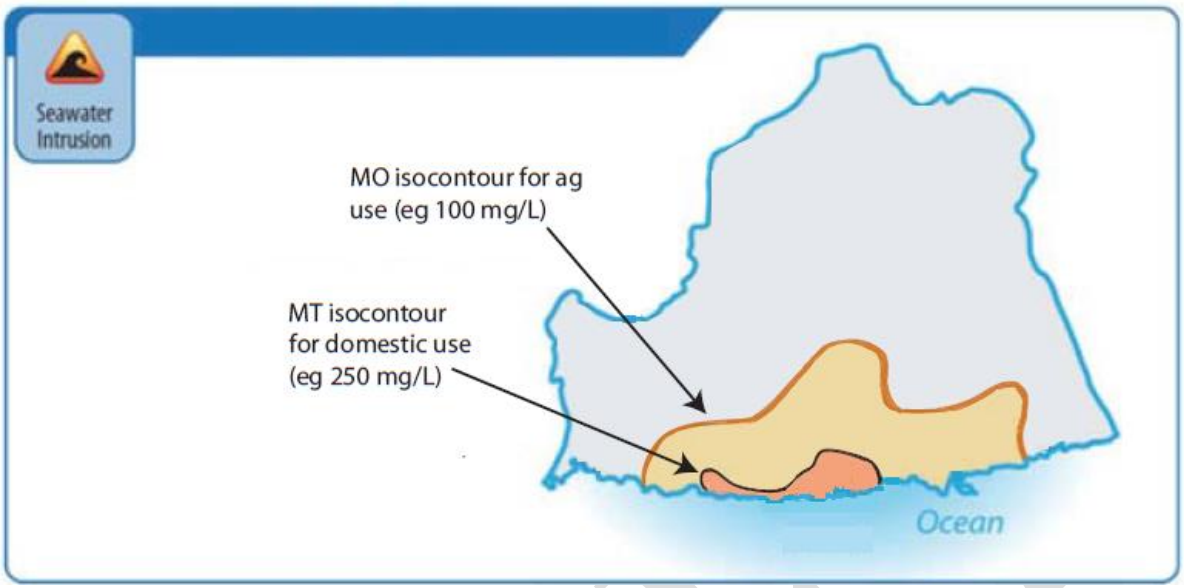

Figure 7. Example of Minimum Threshold and Measurable Objective Isocontours

This approach is consistent with regulatory requirements for GSPs:

- GSP Regulations § 354.30 (c)(b): "measurable objectives shall be established for each sustainability indicator, based on quantitative values using the same metrics and monitoring sites as are used to define the minimum thresholds."

Measurable objectives are not enforceable by SWRCB so SWRCB intervention will not occur even if the MO isocontour is not met. PV Water will implement its Basin Management Plan with the goal of meeting its measurable objective.

GROUNDWATER ELEVATION PROXIES

The GSP Regulations provide an option for using groundwater elevations as a metric for seawater intrusion minimum thresholds and measurable objectives. GSP Regulations § 354.36 (b) states, "Groundwater elevations may be used as a proxy for monitoring other sustainability indicators…" However, groundwater elevations can only be used as a proxy for seawater intrusion if the GSP establishes adequate evidence of the relationship between groundwater elevations and intrusion. This relationship is relatively straightforward given the well understood relationship between groundwater elevations and seawater intrusion. This relationship is based on seawater being denser than freshwater thus freshwater groundwater elevations must be higher than sea level to prevent intrusion. In Figure 5, the elevation marked "h" above sea level is needed to prevent the saltwater interface at depth "z" below sea level from moving farther inland.

DRAFT

It is important to note groundwater elevation proxies may not replace chloride contour isocontours as criteria based on our reading of the Sustainable Management Criteria Best Management Practice guidance (DWR, 2017):

> The minimum threshold metric for seawater intrusion shall be the location of a chloride isocontour. Contrary to the general rule for setting minimum thresholds, the seawater intrusion minimum threshold is not set at individual monitoring sites. Rather, the minimum threshold is set along an isocontour line in a basin or management area.

It is possible to supplement the isocontour with groundwater elevation proxies in conjunction with a chloride isocontour. For example, the Santa Cruz Mid-County Basin GSP took this approach. One of the primary drivers for the Mid-County Basin to use groundwater elevation proxies is the acknowledged risk of seawater intrusion in areas along the coast where chloride concentrations have not yet indicated seawater intrusion. The groundwater elevation proxies are also used to evaluate expected benefits of different projects for the GSP.

Groundwater elevation proxies are also used for seawater intrusion in the Oxnard Subbasin GSP (Appendix A). The primary driver for the use of groundwater elevation proxies in the Oxnard Subbasin is the concern that chloride concentrations will not be able to distinguish between seawater intrusion and background groundwater quality.

At this time, we do not recommend using groundwater elevation proxies for seawater intrusion in the Pajaro Valley Basin. The drivers for Mid-County and Oxnard Basins are not as relevant for Pajaro Valley. Chloride concentrations indicate seawater intrusion along most of the Basin's coast and distinguish intrusion from background conditions. The Basin Management Plan is an approved Alternative by DWR that defines projects to address seawater intrusion. Tracking how the Basin Management Plan helps meet criteria as defined by chloride isocontours should be sufficient for tracking this sustainability indicator at this time. Groundwater elevation proxies can be added in future updates if a clear benefit is identified for groundwater management.

REFERENCES

Barlow, P. M., 2003, Ground Water in freshwater-saltwater environments of the Atlantic coast, U.S. Geological Survey Circular 1262.

California Department of Water Resources (DWR), 2017, Best Management Practices for the Sustainable Management of Groundwater: Sustainable Management Criteria BMP, Draft.

Fox Canyon Groundwater Management Agency (FCGMA), 2019, *Groundwater Sustainability Plan for the Oxnard Subbasin*, December.

DRAFT

Montgomery & Associates, 2020, *Seawater Intrusion Sustainable Management Criteria Chloride Isocontour Value*, technical memorandum to GSU22 Committee, December 11.

Salinas Valley Basin Groundwater Sustainability Agency (SVBGSA), 2020, Salinas Valley Groundwater Basin 180/400-Foot Aquifer Subbasin Groundwater Sustainability Plan, prepared by Montgomery & Associates, January 3.

Santa Cruz Mid-County Groundwater Agency (MGA), 2019, Santa Cruz Mid-County Groundwater Sustainability Plan, November.

United States Geological Survey (USGS) and Pajaro Valley Water Management Agency (PV Water), 2003, Geohydrology of Recharge and Seawater Intrusion in the Pajaro Valley, Santa Cruz and Monterey Counties, California, USGS Fact Sheet 044-03, August.

DRAFT

MONTGOMERY & ASSOCIATES

Appendix A

Seawater Intrusion Sustainable Management Criteria in Select GSPs

MONTGOMERY & ASSOCIATES

Seawater Intrusion Sustainable Management Criteria in Select GSPs

Table A-1 summarizes the seawater intrusion (SWI) sustainable management criteria (SMC) in select completed GSPs including undesirable results, minimum thresholds (MT), and measurable objectives (MO). Approaches in the table are sorted from top to bottom based on potential applicability to stakeholder objectives and hydrogeology in the Pajaro Valley Subbasin. The paragraphs following Table A-1 provide more information on the rationale behind the SWI SMC. Locations of basins where example approaches are presented are displayed on Figure A-1.

Table A-1. Summary of Seawater Intrusion Sustainable Management Criteria in Select Groundwater Sustainability Plans

Basin or Subbasin	Significant and Unreasonable Conditions	Minimum Threshold (MT)	Undesirable Result	Measurable Objective (MO)	Factors Applicable to Pajaro Valley Subbasin
Salinas Valley Subbasin (180/400)	Seawater intrusion in excess of the seawater intrusion line defined by MCWRA in 2017	The MT is the 2017 extent of the 500 mg/L chloride concentration isocontour as mapped by MCWRA	There shall be no exceedances of any the MT isocontours set in each of the aquifers based on the annual average in any one year.	The MO is to move the 500 mg/L chloride isocontour to the line defined by Highway 1	Coastal subbasin in critical overdraft with measured SWI, historical GWL decline, agricultural interests, and neighbor to Pajaro Valley.
Santa Cruz Mid-County Basin	Seawater moving farther inland than has been observed from 2013 through 2017	The 2013-2017 extent of the 250 mg/L isocontour. MT for intruded RMPs are the max concentrations for 2013-2017. MT for unintruded RMPs is 250 mg/L. Groundwater elevation proxies for minimum thresholds are also set at coastal RMPs.	Occur if either of the following criteria are met: - RMP has a chloride concentration exceedance in 2 or more of the last 4 consecutive quarterly samples above the MT. - Five-year average groundwater elevations below protective groundwater elevations for any Coastal representative monitoring well.	The MO chloride isocontour is set as 100 mg/L at the same location as the MT Isocontour. The MO for intruded RMPs are their 2013–2017 average concentration and is 100 mg/L for all unintruded RMPs	Coastal basin in critical overdraft with measured SWI and neighbor to Pajaro Valley.
Oxnard	Seawater intrusion that results in a net landward migration of the 2015 saline water impact front beyond the already impacted area.	Groundwater levels that were selected to prevent lateral seawater intrusion based on future groundwater model simulations	Groundwater levels that are below groundwater elevation proxy MT after 2040.	The groundwater level at which there is neither seawater flow into nor freshwater flow out of either aquifer	Coastal basin in critical overdraft with measured SWI, historical GWL decline and agricultural interests.

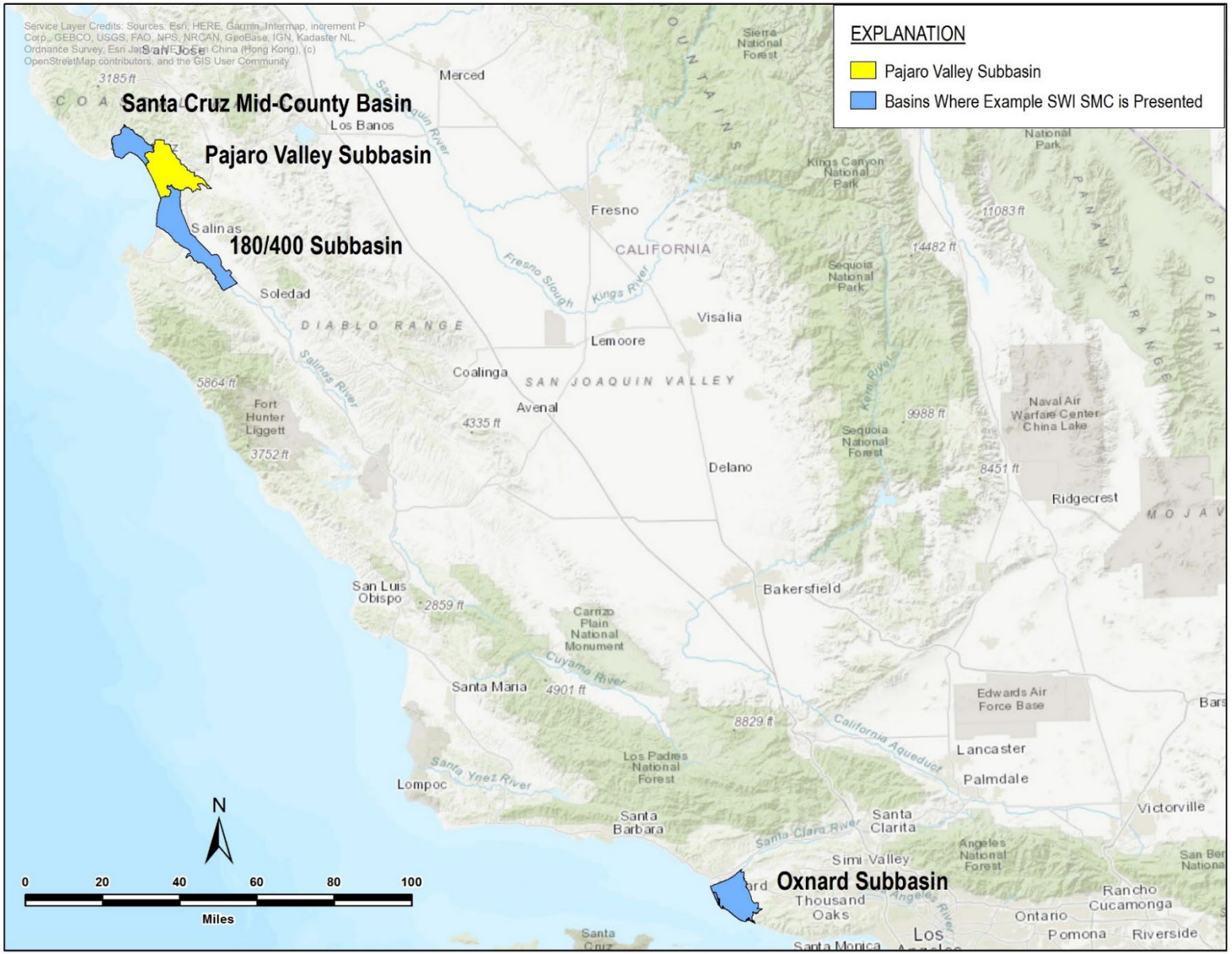

Figure A-1. Basin Where Example SWI SMC is Presented

Salinas Valley Subbasin (180/400-Foot Aquifer)

The Salinas Valley 180/400-Foot Aquifer Subbasin is a high priority basin in critical overdraft located southeast of Pajaro Valley in the Salinas Valley. Descriptions of the Salinas Valley 180/400-Foot Aquifer SWI SMC representative monitoring points (RMPs), significant and unreasonable conditions, undesirable results, measurable objective, and minimum threshold are summarized below (SVBGSA, 2020). The minimum threshold for seawater intrusion in the 180-Foot Aquifer is shown on.

Significant and Unreasonable Conditions: Seawater intrusion in excess of the seawater intrusion line defined by MCWRA in 2017.

Representative Monitoring Points*:* None specified for SWI, but data from RMPs for other sustainability indicators are used to map isocontour for comparison to SMC.

Minimum Thresholds: The 2017 extent of the 500 mg/L chloride concentration isocontour as mapped by MCWRA is adopted as the seawater intrusion minimum threshold for both the 180- and 400-Foot Aquifers. Separate minimum threshold isocontour locations are defined for the 180-Foot Aquifer (Figure A-2) and the 400-Foot Aquifer (Figure A-3).

Undesirable Results: Because even localized seawater intrusion is not acceptable, the basinwide undesirable result is no exceedances of any of the minimum threshold isocontours. For the Subbasin, the seawater intrusion undesirable result is:

- There shall be no exceedances of any minimum threshold isocontour based on the annual average in any one year.

Measurable Objectives: In the 180/400-Foot Aquifer Subbasin, the measurable objective for the seawater intrusion SMC is to move the 500 mg/L chloride isocontour to the line defined by Highway 1 in both aquifers. This will improve the Subbasin's groundwater quality and provide access to usable groundwater to additional beneficial users.

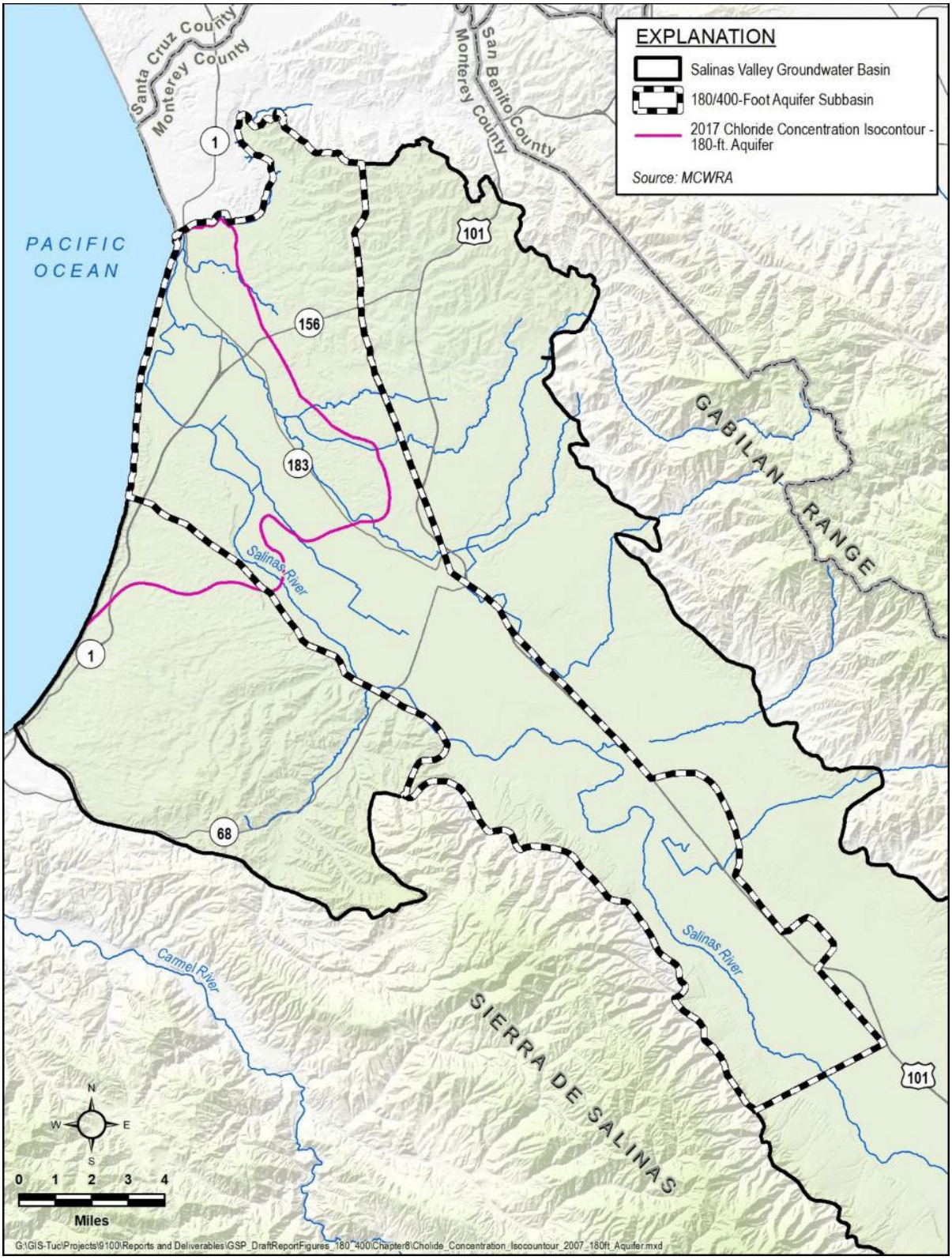

Figure A-2. Minimum Thresholds for Seawater Intrusion in the 180-Foot Aquifer (SVBGSA, 2020)

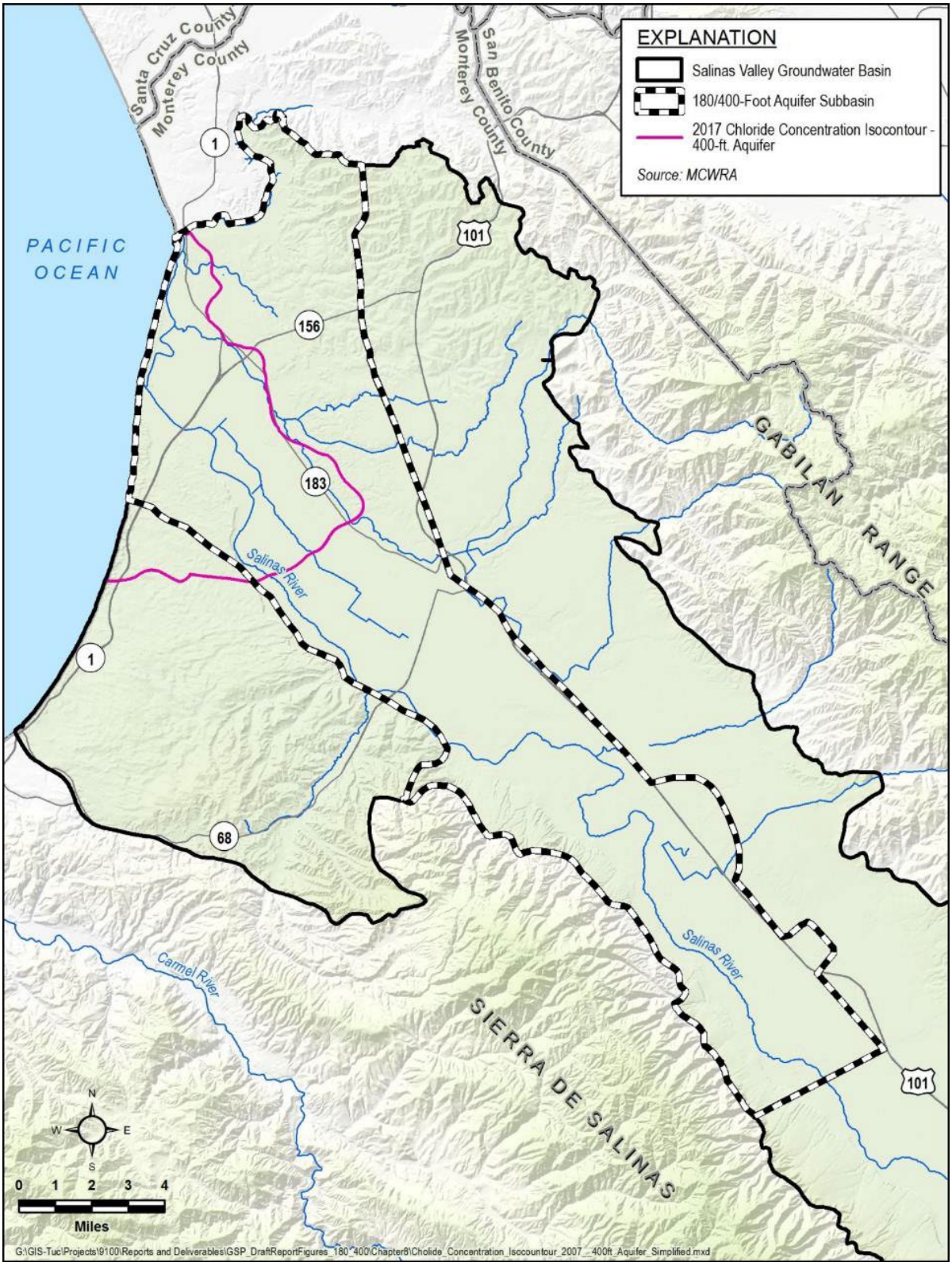

Figure A-3. Minimum Thresholds for Seawater Intrusion in the 400-Foot Aquifer (SVBGSA, 2020)

Santa Cruz Mid-County Basin

The Santa Cruz Mid-County Basin is a high priority basin in critical overdraft neighboring the Pajaro Valley Subbasin to the west. Descriptions of the Santa Cruz Mid-County Basin SWI RMPs, qualitative definition of significant and unreasonable conditions, undesirable results, measurable objective, and minimum threshold are summarized below (SCMGA, 2019).

Significant and Unreasonable Conditions: Locally defined significant and unreasonable seawater intrusion in the Basin is seawater moving farther inland than has been observed from 2013 through 2017.

Representative Monitoring Points*:* Production and monitoring well RMPs to measure chloride concentrations are set on both sides of the chloride concentration isocontours. Several coastal monitoring wells where groundwater elevations protective against seawater intrusion have been estimated are set as RMPs to measure groundwater elevations for comparison to groundwater elevation proxies for seawater intrusion SMC.

Minimum Thresholds: Seawater intrusion minimum thresholds are not required to be set at individual monitoring sites. Rather, the minimum thresholds are set along isocontour lines for each principal aquifer in the basin (Figure A-4). However, for practical purposes of monitoring the isocontour, minimum thresholds are set at selected monitoring and production wells used to define the isocontour. At intruded coastal monitoring wells, the minimum threshold is 2013–2017 maximum chloride concentration. At unintruded coastal monitoring wells, the minimum threshold is 250 mg/L. At unintruded inland monitoring wells and production wells, the minimum threshold is 150 mg/L.

Minimum threshold groundwater elevation proxies for seawater intrusion are the current protective groundwater elevations set at coastal monitoring wells and used for groundwater management over the past 10 years. The protective groundwater elevations used as proxy minimum thresholds are based on cross-sectional groundwater models for some RMPs and the Ghyben-Herzberg relationship in some RMPs is available for the area or not.

- Cross-Sectional model available: 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 in at least 70 percent of the model runs. For wells where seawater intrusion has been observed, the cross-sectional models estimate protective elevations to prevent seawater intrusion from advancing from its current position in at least 70 percent of the model runs.

- Cross-sectional model not available: minimum thresholds for the groundwater elevations that represent protective groundwater elevation estimated by using the Ghyben-Herzberg method to protect the depth of bottom of the monitoring well screen.

Undesirable Results: Occur if either of the following criteria are met for undesirable results:

- Any RMP has a chloride concentration above the minimum threshold for the RMP. This concentration must be exceeded in 2 or more of the last 4 consecutive quarterly samples.

- Five-year average groundwater elevations below protective groundwater elevations for any coastal RMP with a protective groundwater elecation

Measurable Objectives: The measurable objective chloride isocontour has the same location as the minimum threshold isocontour. The measurable objectives for intruded wells are their 2013 – 2017 average concentration and for all unintruded wells is 100 mg/L.

Groundwater elevations as a proxy measurable objective are determined based on whether the cross-sectional groundwater model is available for the area or not.

- Cross-Sectional model available: 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 in at least 99 percent of the model runs. For wells where seawater intrusion has been observed, the cross-sectional models estimate protective elevations to prevent seawater intrusion from advancing in at least 99 percent of the model runs.

- Cross-sectional model not available: 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.

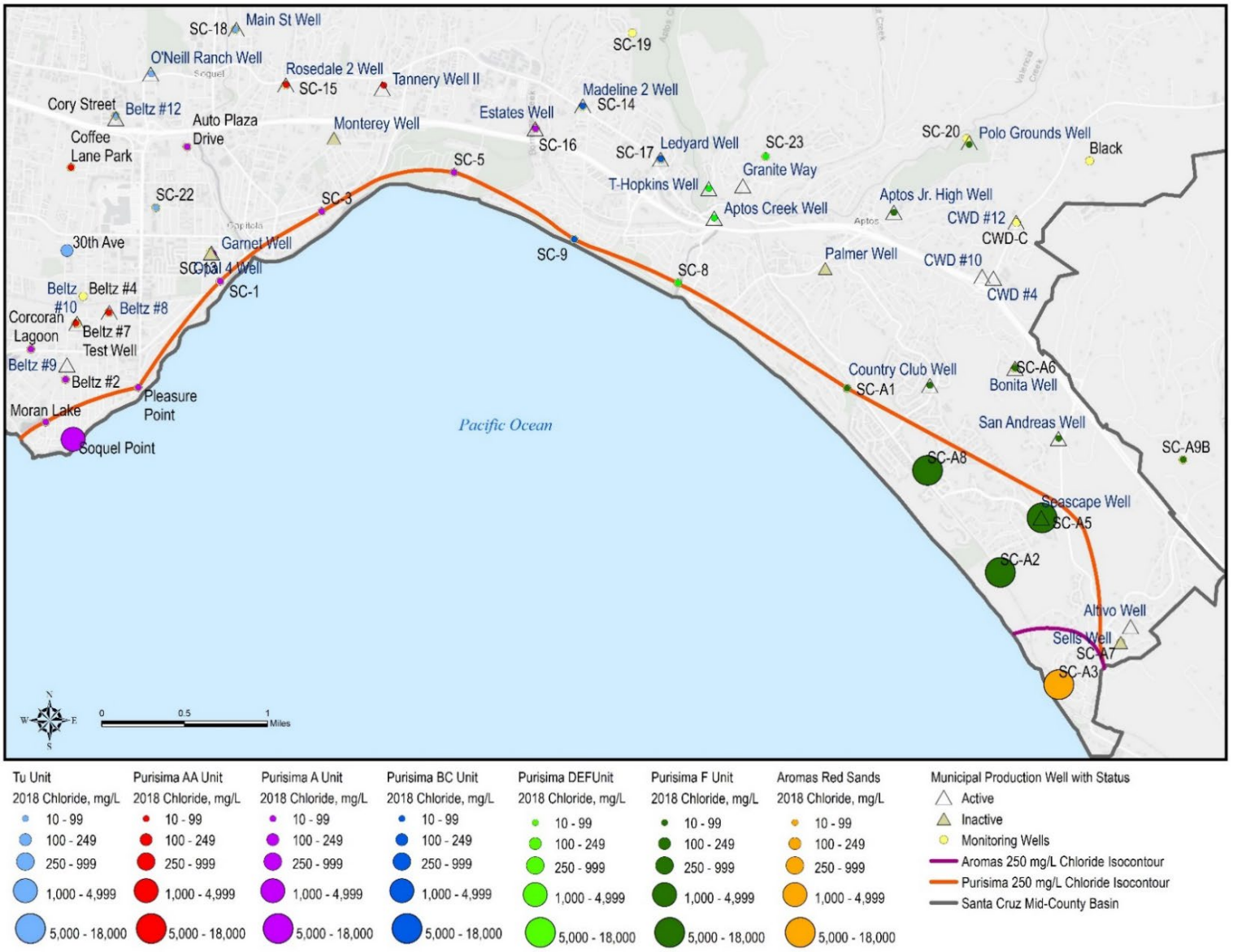

Figure A-4. 250 mg/L Chloride Isocontour for the Aromas and Pursima Aquifer (MGA, 2019)

Oxnard (Fox Canyon Aquifer)

The Oxnard Subbasin is a coastal alluvial groundwater basin, located in Ventura County, California, that is in hydrologic communication, to varying degrees, with adjoining groundwater basins to the north and east, and with the Pacific Ocean to the west and southwest. The principal aquifers of the basin are grouped into the Upper Aquifer System (UAS) and the Lower Aquifer System (LAS). Descriptions of the Oxnard Subbasin SWI RMPs, qualitative definition of significant and unreasonable conditions, undesirable results, measurable objective, and minimum threshold are summarized below (FCGMA, 2019).

Significant and Unreasonable Conditions: Significant and unreasonable seawater intrusion is defined as seawater intrusion that results in a net landward migration of the 2015 saline water impact front beyond the already impacted area west of Highway 1 and south of Hueneme Road from 2040 through 2069.

Representative Monitoring Points: Key wells were primarily selected using wells screened in a single aquifer and will be used to monitor groundwater elevations.

Minimum Thresholds: The minimum thresholds metric against which seawater intrusion will be measured is water levels that were selected to prevent lateral seawater intrusion based on future groundwater model simulations. These groundwater elevations are equal to, or higher than, previous historical low water levels. The threshold groundwater levels differ between the UAS and the LAS and differ with geographic location in the Subbasin. Some of the minimum threshold groundwater elevations in the LAS are below sea level (Figure A-5). These elevations were selected based on model results that indicate groundwater elevations could be this low and still limit seawater intrusion. They were also selected in concert with groundwater elevations in adjacent management areas and are not expected to negatively impact the ability of the adjacent management areas to meet their sustainability goals.

Undesirable Results: Seawater intrusion is the primary sustainability indicator in the Oxnard Subbasin. Seawater intrusion occurs in the Subbasin as groundwater levels fall below threshold levels that maintain sufficient hydrostatic pressure to keep seawater from moving landward. If water levels fall below the minimum threshold elevations, the Subbasin is likely to experience net landward migration of the 2015 saline water impact front after 2040.

Measurable Objectives: The groundwater level at which there is neither seawater flow into nor freshwater flow out of the UAS or LAS. The measurable objective groundwater level was selected for each of the key wells based on the median predicted groundwater elevation between 2040 and 2070 from groundwater model simulations that minimized the migration of the 2015 saline water impact front after 2040. At each of the key wells, the difference between the

measurable objective and the minimum threshold is greater than 10 feet, which provides a margin of safety for operational flexibility in the Subbasin.

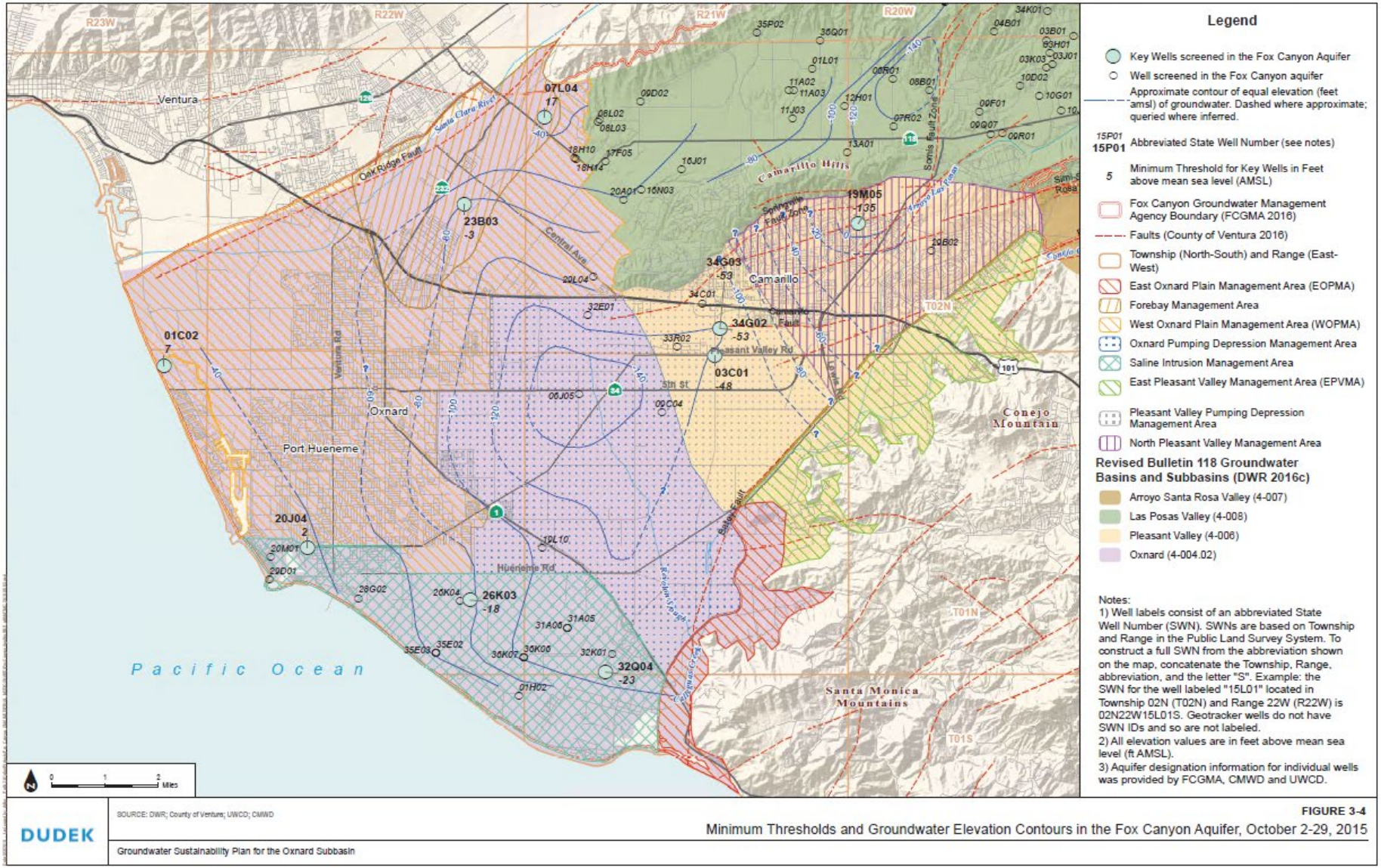

Figure A-5. Minimum Thresholds and Groundwater Elevation Contours in the Fox Canyon Aquifer, October 2-29, 2015 (FCMGA, 2019)

References

Fox Canyon Groundwater Management Agency (FCGMA), 2019, *Groundwater Sustainability Plan for the Oxnard Subbasin*, December.

Salinas Valley Basin Groundwater Sustainability Agency (SVBGSA), 2020, Salinas Valley Groundwater Basin 180/400-Foot Aquifer Subbasin Groundwater Sustainability Plan, prepared by Montgomery & Associates, January 3.

Santa Cruz Mid-County Groundwater Agency (MGA), 2019, Santa Cruz Mid-County Groundwater Sustainability Plan, November.