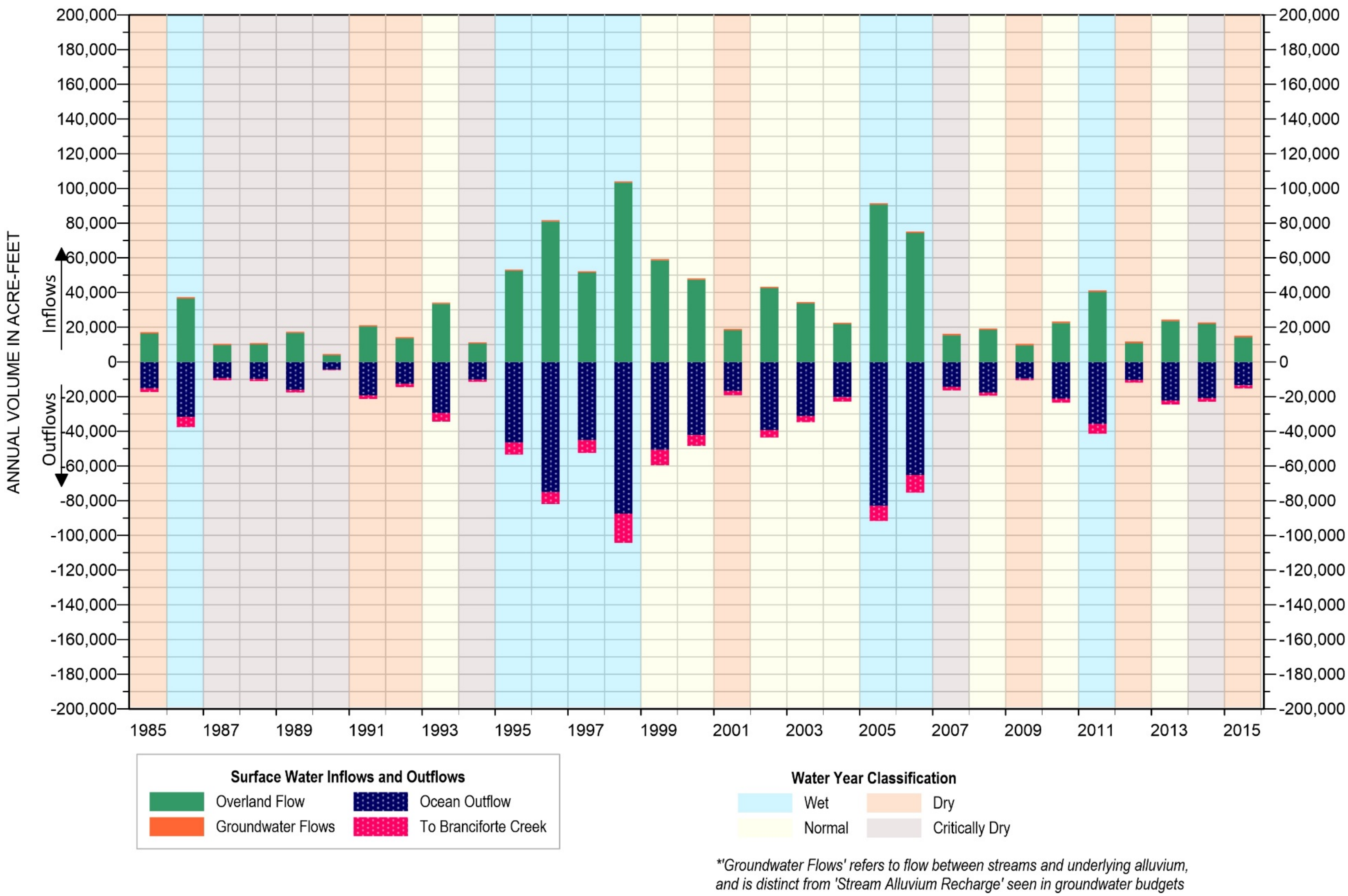

Figure 2-57. Soquel Creek Watershed Historical Budget

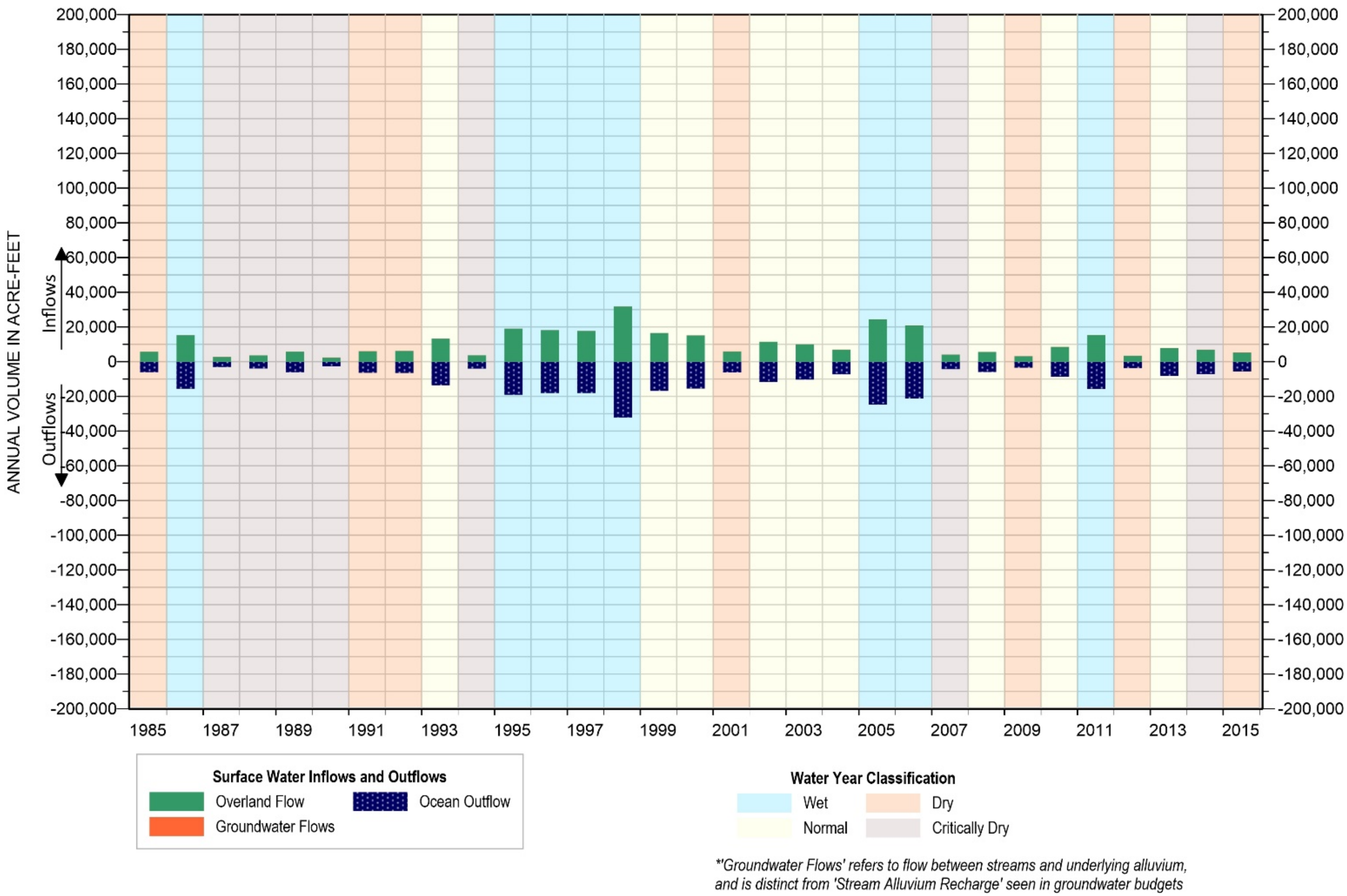

Figure 2-58. Aptos Creek Watershed Historical Budget

Figure 2-59. Corralitos Creek Watershed Historical Budget

2.2.5.4.2 Santa Cruz Mid-County Basin Historical Groundwater Water Budget

Approximately 60% of Basin groundwater inflow during the historical period comes from surface recharge: UZF recharge (direct percolation of precipitation and return flows) constitutes 34%, while recharge from stream alluvium and terrace deposits contribute 10% and 16%, respectively (Table 2-12). The rest of Basin inflows are fairly consistent subsurface flows across the northern Basin boundary from the Purisima Highlands Subbasin (40% of inflows). Those inflow components that rely on rainfall (UZF recharge and recharge from stream alluvium and terrace deposits) are the most variable due to prolonged wet or dry climatic cycles, as described below.

Table 2-12. Santa Cruz Mid-County Basin Historical Groundwater Budget Summary (1985 – 2015)

Groundwater Budget Component	Annual Minimum	Annual Maximum	Annual Average	Average % (rounded)
Inflows (acre-feet per year)				
UZF Recharge	1,550	7,840	4,460	34%
Net Recharge from Stream Alluvium	780	2,130	1,260	10%
Recharge from Terrace Deposits	1,490	3,340	2,080	16%
Subsurface Inflow from Purisima Highlands Basin	4,940	5,570	5,270	40%
		Total Inflow	**13,070**	**100%**
Outflows (acre-feet per year)				
Pumping	5,260	8,460	7,410	59%
Subsurface Outflow to Santa Margarita Subbasin	260	390	310	3%
Net Subsurface Outflow to Pajaro Valley Subbasin	3,770	4,370	4,080	32%
Net Outflow to Offshore	150	1,060	790	6%
		Total Outflow	**12,590**	**100%**
	Cumulative		**Average**	
Change in Storage (acre-feet per year)	+14,910 acre-feet		+480	

Note: all values are rounded to the nearest foot. This causes slight discrepancies between average and cumulative change in groundwater in storage

Primary groundwater outflows during the historical period are groundwater pumping and subsurface flow to Pajaro Valley Subbasin, which are 59% and 33% of total outflows, respectively (Table 2-12). The remaining 9% of Basin outflow consists of flows offshore (6%) and subsurface flows to Santa Margarita Subbasin (3%).

Historically, the Basin experienced net recharge from stream alluvium to the primary aquifers and aquitards of the Basin (Table 2-12). There are locations where groundwater in stream alluvium discharges to streams but overall there is also net recharge from stream alluvium to the primary aquifers of the Basin. Net recharge from stream alluvium occurs even where the stream alluvium discharges groundwater to streams because groundwater levels in the stream alluvium are generally higher than groundwater levels in underlying aquifers. Therefore net recharge from stream alluvium does not necessarily mean the stream is recharging groundwater in that area.

Over the historical period, there is a Basin-wide average increase in groundwater in storage of approximately 480 acre-feet per year, or 14,910 acre-feet cumulatively (Table 2-12). The cumulative change in storage line (dashed) on Figure 2-60 shows three distinct cumulative change in storage trends:

- From 1985 to 1994 (10 years) basin-wide pumping in excess of 7,930 acre-feet per year and an extended dry climate which limited recharge contributed to a cumulative decline in groundwater in storage of about 8,000 acre-feet (an average decrease of 800 acre-feet per year) which corresponds to declining groundwater levels in the area of municipal production.

- The years from 1995 through 2006 had a cumulative increase of groundwater in storage of approximately 28,000 acre-feet (an average increase of 2,300 acre-feet per year). This 12-year period only has one year classified as a dry water year, with all the other years being either normal or wet. Notably, the period starts and ends with wet years: four consecutive wet years from 1995 through 1998 and two wet years in 2005 and 2006 (Figure 2-60). Because of the normal to wet climatic conditions, surface recharge increased thereby causing an increase in groundwater in storage.

- From 2007 through 2015 (nine years), there are only three years of normal or wet water years, which resulted in less groundwater recharge than occurred in the prior 12 years (Figure 2-60). Even though this period has below normal rainfall, there has only been a cumulative loss of 4,000 acre-feet (or an average of 440 acre-feet per year) in groundwater in storage because from 2005 onwards, municipal groundwater pumping is on average 10% less compared to the average pumping from 1985 – 1994. Reduction in groundwater pumping was achieved through focused water conservation measures and responsive groundwater management.

Overall, the Basin's historical groundwater budget consists of inflows from surface recharge and subsurface inflows from the Purisima Highlands Subbasin. Outflows are primarily from groundwater extraction and outflow to the Pajaro Valley. Over the 31 years of the historical water budget period, there has been an overall increase in groundwater in storage. This overview does not reflect the groundwater budgets of specific aquifers, some of which may still have overall losses of groundwater in storage and therefore cause undesirable results such as seawater intrusion. Table 2-13 provides a summary of the historical groundwater budget by aquifer and annual groundwater budgets for individual aquifers are contained in Appendix 2-F.

Flows between the Basin and the ocean (offshore) are an important component of the water budget for evaluating groundwater sustainability because seawater intrusion is the sustainability indicator that is the basis for the Basin's overdraft condition. Figure 2-61 plots each aquifer's offshore inflows and outflows. Net outflows (negative on the water budget chart on Figure 2-61) of some magnitude is required to prevent seawater intrusion. Net inflows (positive on the water budget chart on Figure 2-61) are indicative of flow conditions that will eventually result in seawater intrusion. Inflows from offshore consistently occur in the Purisima DEF/F and Purisima A aquifer units. These are the aquifers where seawater intrusion is occurring. The Tu aquifer has small volumes of inflow from offshore, which reverses to offshore flow in wet years.

Although inflows to the Basin from the ocean have decreased since 2005, corresponding with reduced municipal pumping (Figure 2-61), inflows from offshore still indicate seawater intrusion risk. However, groundwater budget results should not be the primary method for evaluating seawater intrusion because freshwater outflow offshore may not be enough to prevent denser seawater from intruding. In addition, net flows representing flows across the entire coastal boundary may not represent the localized risk near pumping centers. The primary model results for evaluating seawater intrusion should be simulated groundwater levels at coastal monitoring wells compared to established protective elevations as discussed in more detail in Section 3.

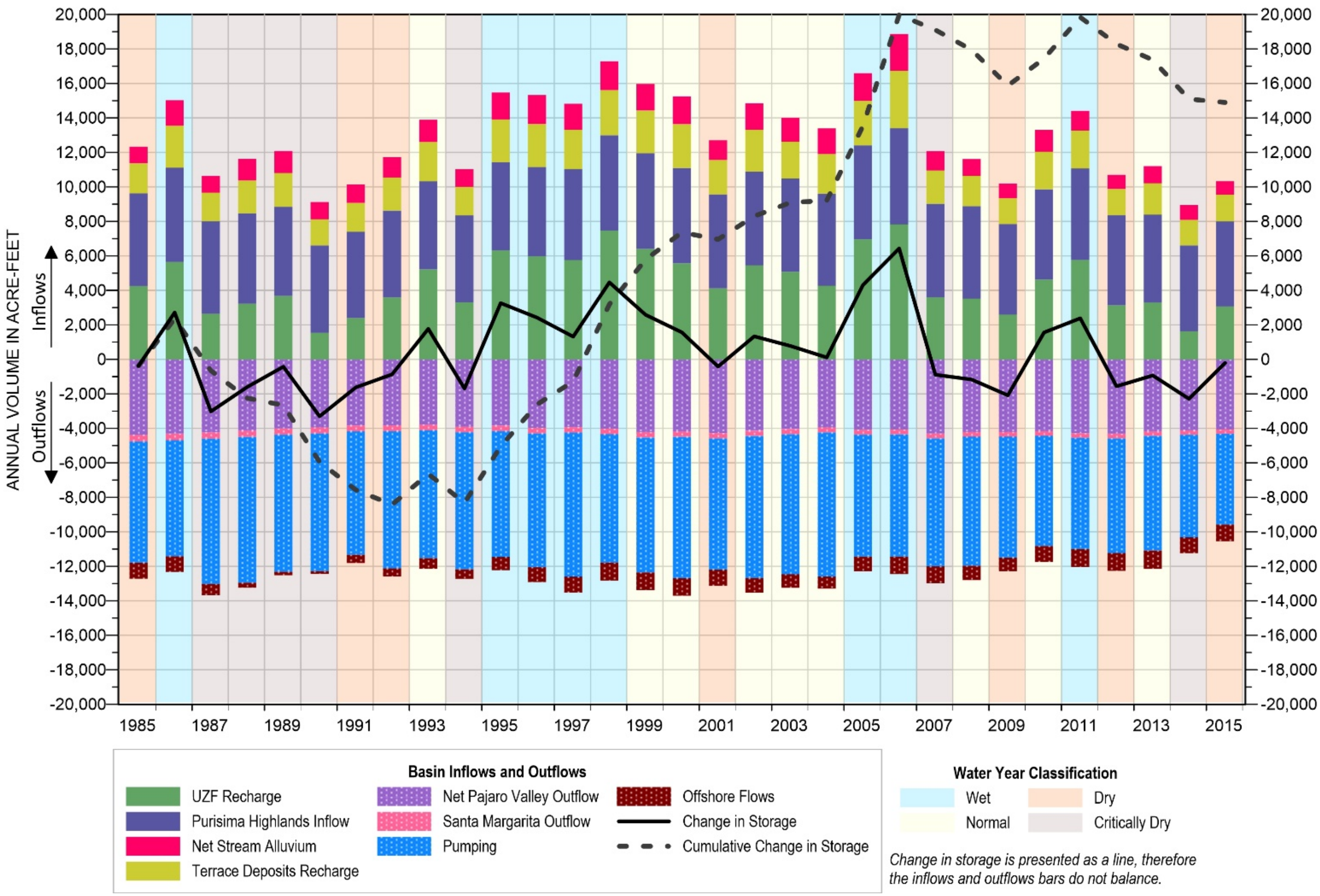

Figure 2-60. Santa Cruz Mid-County Basin Historical Annual Groundwater Budget (1985 – 2015)

Table 2-13. Santa Cruz Mid-County Basin Historical Groundwater Budget by Aquifer Summary (1985 – 2015)

Groundwater Budget Component	Aromas Red Sands (L2)	Purisima DEF/F (L3)	Purisima D (L4)	Purisima BC (L5)	Purisima B (L6)	Purisima A (L7)	Purisima AA (L8)	Tu (L9)	Total
Annual Average Inflows (acre-feet per year)									
UZF Recharge	770	780	200	190	220	570	540	1,190	4,460
Recharge from Stream Alluvium	530	130	_	280	_	380	190	10	1,520
Recharge from Terrace Deposits	1,050	170	_	290	100	230	240	_	2,080
Subsurface Inflow from Purisima Highlands Subbasin	_	2,870	330	320	360	590	780	20	5,270
Offshore Inflow	_	80	_	_	_	30	_	10	120
Inter-Layer Flow	_	740 (L2) 50 (L4)	_	100 (L4)	40 (L5)	140 (L6)	20 (L7)	_	1,090
Total Inflow	**2,350**	**4,820**	**530**	**1,180**	**720**	**1,940**	**1,770**	**1,230**	**14,540**
Annual Average Outflows (acre-feet per year)									
Pumping	980	2,130	<10	900	150	1,590	1,110	550	7,410
Discharge to Stream Alluvium	_	_	80	_	180	_	_	_	260
Subsurface Outflow to Santa Margarita Basin	_	_	_	_	_	_	_	310	310
Subsurface Outflow to Pajaro Valley Subbasin	420	2,590	300	100	150	330	190	_	4,080
Outflow Offshore	210	_	10	140	100	_	450	_	910
Inter-Layer Flow	740 (L3)	_	50 (L3) 100 (L5)	40 (L6)	140 (L7)	20 (L8)	_	_	1,090
Total Outflow	2,350	4,720	540	1,180	720	1,940	1,750	860	14,060
Change in Storage (acre-feet per year)	**0**	**100**	**-10**	**0**	**0**	**0**	**20**	**370**	**480**

Notes: The abbreviation L is for model layer, e.g., L2 is model layer 2

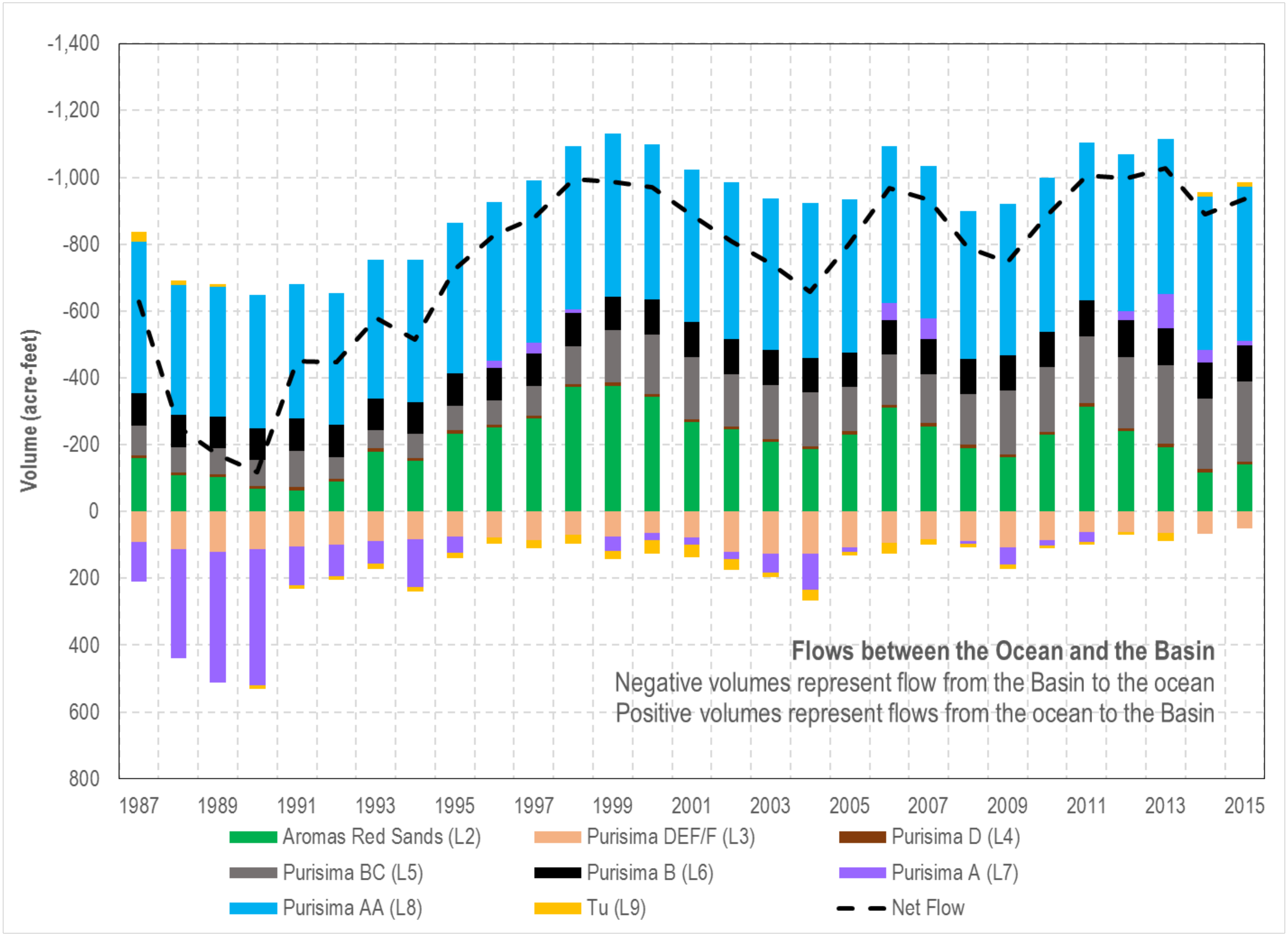

Figure 2-61. Offshore Groundwater Flow to Santa Cruz Mid-County Basin by Model Layer

2.2.5.4.3 North of Aptos Area Faulting Historical Groundwater Budget

Historical groundwater inflows into the area north of the Aptos area faulting consist of inflows from the Purisima Highlands Subbasin (66%) and UZF recharge (34%) (Table 2-14).

As the area north of the Aptos area faulting does not support a large population like the more urban area south of the Aptos area faulting, groundwater pumping is not the primary outflow. Instead 64% of the outflow is by means of subsurface outflow to Pajaro Valley. Nineteen percent of outflows are to the area south of the Aptos area faulting. The remainder of outflows are from groundwater pumping (8%), subsurface outflow to the Santa Margarita Basin (4%), and groundwater discharge to streams (4%). The balance of inflows and outflows results in a slight increase in groundwater in storage of approximately 30 acre-feet per year. This indicates that the historical water budget north of the Aptos area faulting is well balanced. A graphical representation of the historical annual water budget is provided in Table 2-14.

Cumulative change in storage trends for the area north of the Aptos area faulting are similar to the basin-wide change in storage trends: an extended dry period during the 1980's through to the mid-1990's contributing to storage losses, followed by a period of recovery and storage gain starting in 1995, and stabilizing from 2007 through 2015. The recent drought from 2012-2105 appears to have impacted the area north of the Aptos area faulting with cumulative storage declining 3,000 acre-feet from 2012 - 2015. The range in UZF recharge (maximum less minimum), which predominantly includes direct percolation of rainfall, is greater in the area north of the Aptos area faulting (Table 2-14) compared to the area south of the Aptos area faulting (Table 2-15). This may be due to the greater area that has impermeable surfaces in the more urban area south of the fault that limits areal recharge.

Table 2-14. North of Aptos Area Faulting Historical Groundwater Water Budget Summary (1985 – 2015)

Groundwater Budget Component	Annual Minimum	Annual Maximum	Annual Average	Average % (rounded)
Inflows (acre-feet per year)				
UZF Recharge	750	5,410	2,730	34%
Subsurface Inflow from Purisima Highlands Subbasin	4,940	5,570	5,270	66%
		Total Inflow	**8,000**	**100%**
Outflows (acre-feet per year)				
Pumping	440	850	690	8%
Discharge to Streams	170	560	360	4%
Subsurface Outflow to Santa Margarita Subbasin	240	380	300	4%
Subsurface Outflow to Pajaro Valley Subbasin	4,810	5,360	5,110	64%
Subsurface Outflow to South of Aptos Area Faulting	1,470	1,530	1,510	19%
		Total Outflow	**7,970**	100%
	Cumulative		Average	
Change in Storage (acre-feet per year)	+910 acre-feet		+30	

Note: all values are rounded to the nearest foot. This causes slight discrepancies between average and cumulative change in groundwater in storage

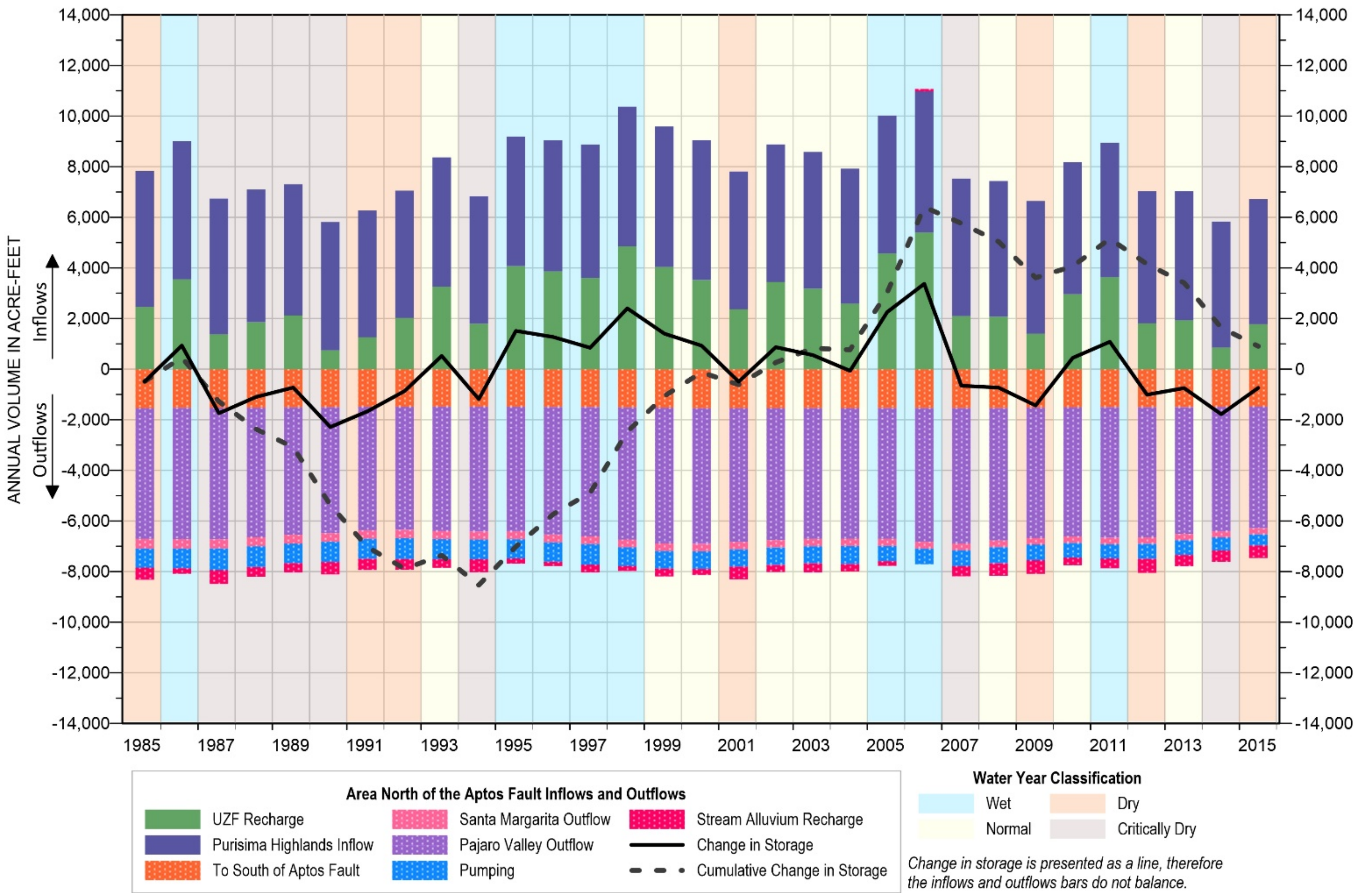

Figure 2-62. North of Aptos Area Faulting Historical Annual Groundwater Budget (1985 – 2015)

2.2.5.4.4 South of Aptos Area Faulting Historical Groundwater Budget

Historical groundwater inflows to the portion of the Basin south of the Aptos area faulting are summarized in Table 2-15. Primarily inflows are from terrace deposits (26%), UZF recharge (22%), and recharge from stream alluvium (20%). Slightly lesser inflows are from subsurface sources: the area north of the Aptos area faulting (19%) and Pajaro Valley (12%). On average, combined natural recharge constitutes around 68% of groundwater inflow with subsurface inflow from the north and Pajaro Valley comprising the remaining 32%.

Groundwater outflows in the area south of the Aptos area faulting are primarily from groundwater pumping, which comprises 89% of average outflows (Table 2-15). The remaining 11% comprised almost completely of flows offshore, with a very minor amount of 10 acre-feet flowing into the Santa Margarita Basin. For the area south of the Aptos area faulting, the average change in storage over the 31-year historical period is an increase of approximately 470 acre-feet per year. A graphical representation of the historical groundwater budget over the historical period is provided in Figure 2-62.

Cumulative change in storage trends for the area south of the Aptos area faulting are similar to the whole Basin change in storage trends: an extended dry period during the 1980’s through to the mid-1990’s contributing to storage losses, followed by a period of recovery and storage gain starting in 1995, and stabilizing from 2007 through 2015. The storage loss in the area south of the Aptos area faulting (Figure 2-63) from 1985-1994 is less pronounced than in the area north of the Aptos area faulting (Figure 2-62) due in part to the presence of flows from offshore and seawater intrusion. As surface sources of recharge decrease during this period, flow offshore also decreases substantially, indicating conditions supporting seawater intrusion. From 1995 onward, cumulative storage is gained and flows offshore are consistent. Even though there is overall offshore flow, seawater intrusion and risk of further seawater intrusion is still present and MGA activities such as MAR will be necessary to prevent further seawater intrusion.

Table 2-15. South of Aptos Area Faulting Historical Groundwater Water Budget Summary (1985 – 2015)

Groundwater Budget Component	Annual Minimum	Annual Maximum	Annual Average	Average % (rounded)
Inflows (acre-feet per year)				
UZF Recharge	790	2,620	1,730	22%
Recharge from Stream Alluvium	1,280	2,030	1,630	20%
Recharge from Terrace Deposits	1,490	3,340	2,080	26%
Subsurface Inflow from Pajaro Valley Subbasin	760	1,230	1,030	13%
Subsurface Inflow from North of Aptos Area Faulting	1,470	1,530	1,510	19%
		Total Inflow	**7,980**	**100%**
Outflows (acre-feet per year)				
Pumping	4,830	7,640	6,710	89%
Subsurface Outflow to Santa Margarita Subbasin	<10	20	10	<1%
Net Outflow Offshore	150	1,060	790	11%
		Total Outflow	**7,510**	**100%**
Change in Storage (acre-feet per year)	**Cumulative**		**Average**	
	+13,980 acre-feet		+470	

Note: all values are rounded to the nearest foot. This causes slight discrepancies between average and cumulative change in groundwater in storage

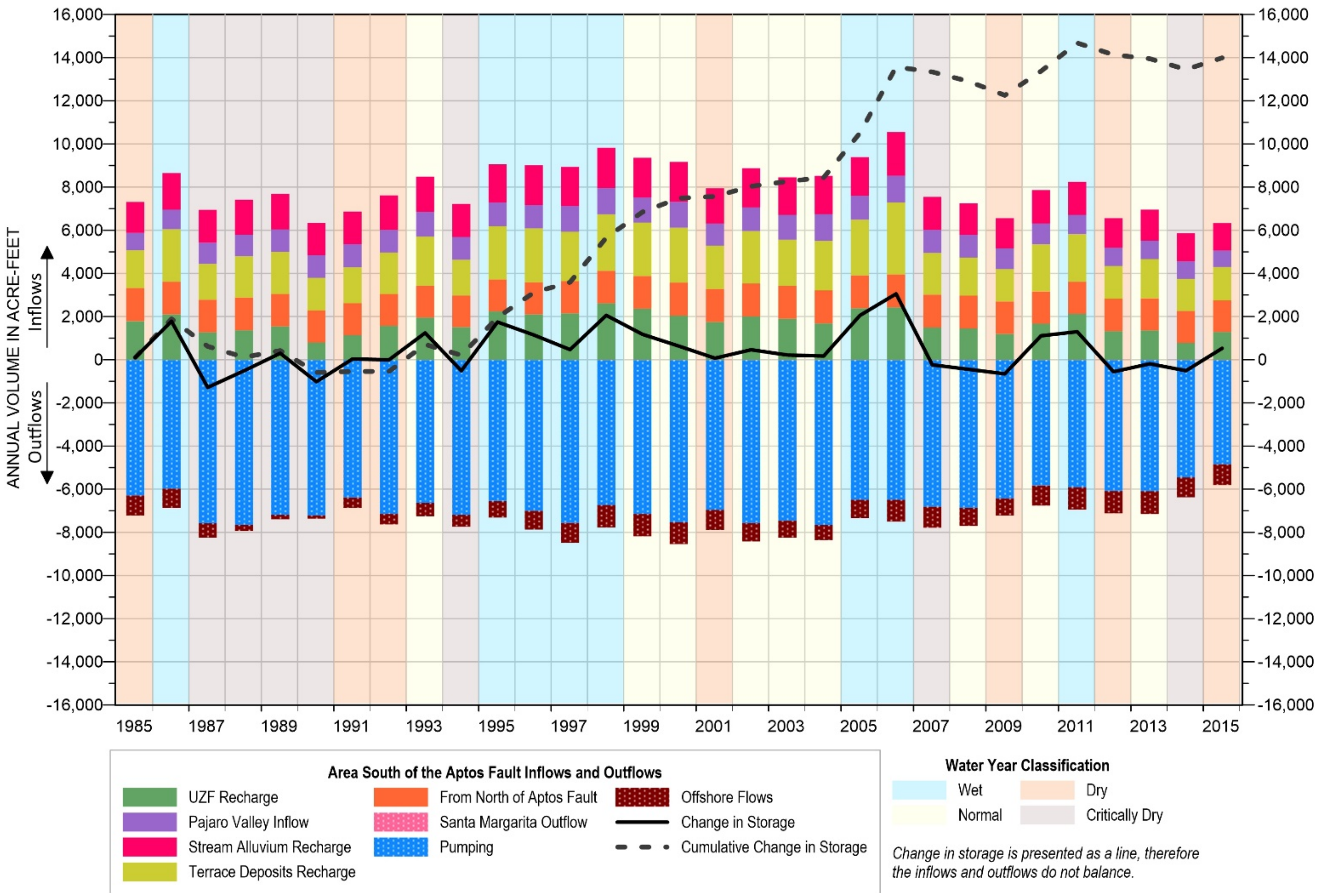

Figure 2-63. South of Aptos Area Faulting Historical Annual Groundwater Budget (1985 – 2015)

2.2.5.5 Current Water Budget

The current water budget for the Basin includes the most recent information available, and covers the period from Water Year 2010-2015. This period was selected as it encompasses both the recent 2012 – 2015 drought and two relatively wet years resulting in an average rainfall of 24.3 inches per year at the Santa Cruz Co-op station. The current water budget period represents overall drier conditions with 5.7 inches less rainfall than the 1985 - 2015 average of 29 inches per year.

2.2.5.5.1 Santa Cruz Mid-County Basin Current Surface Water Budget

From Water Year 2010 through 2015, 5.7 inches less rainfall than historical conditions at the Santa Cruz Co-op station translates to an average of approximately 14,600 acre-feet per year less water available for evapotranspiration, overland flow, groundwater recharge and soil moisture (Table 2-10 and Table 2-16). Evapotranspiration during these drier years declined by approximately 4,350 acre-feet per year, but it used up relatively more of the available water in the Basin (72% compared to 66% in the historical period). Water available for overland flow was on average 6,750 acre-feet per year less than over the historical period. Groundwater recharge was on average 910 acre-feet less per year while the relative percentage of recharge remained the same. Conditions during the current period were so dry, water from soil moisture occurred, likely to evapotranspiration, which is why its value is negative in Table 2-16.

Table 2-16. Percentage Distribution of Current Precipitation in Santa Cruz Mid-County Basin

Precipitation Budget Component	Average Annual (acre-feet)	Average Percent of Precipitation
Precipitation	81,600	100%
Evapotranspiration	59,300	72%
Overland Flow	18,660	23%
Groundwater Recharge from Precipitation	3,910	5%
Soil Moisture	-270*	0%

Note: * a negative soil moisture value indicates soil moisture was lost and not gained

The lower rainfall results in the current surface water budget having 13,740 acre-feet less surface water flowing into the Basin and 11,940 acre-feet less flowing out to the ocean compared to the historical period (Table 2-11 and Table 2-17). Despite the overall inflow decrease, relative volumetric proportions between groundwater components are consistent with the historical budget. The surface water budget is shown graphically on Figure 2-64.

Table 2-17. Santa Cruz Mid-County Basin Current Surface Water Budget

Surface Water Budget Component	Annual Minimum	Annual Maximum	Annual Average	Average % (rounded)
Inflows (acre-feet per year)				
Overland Flow	8,060	30,580	18,670	58%
Flows from Upstream of the Basin	6,520	25,930	12,570	39%
Net Flows from Groundwater	810	900	870	3%
		Total Inflow	**32,110**	**100%**
Outflows (acre-feet per year)				
Ocean Outflow	14,000	51,310	29,070	91%
Outflow in Branciforte Creek	1,420	5,730	2,630	8%
Pajaro Valley Subbasin	10	690	280	<1%
Outflow to Carbonera Creek	70	350	130	<1%
		Total Outflow	**32,110**	**100%**

Note: ‘Groundwater Flows’ refers to flow between streams and underlying alluvium, and is distinct from ‘Stream Alluvium Recharge’ seen in groundwater budgets.

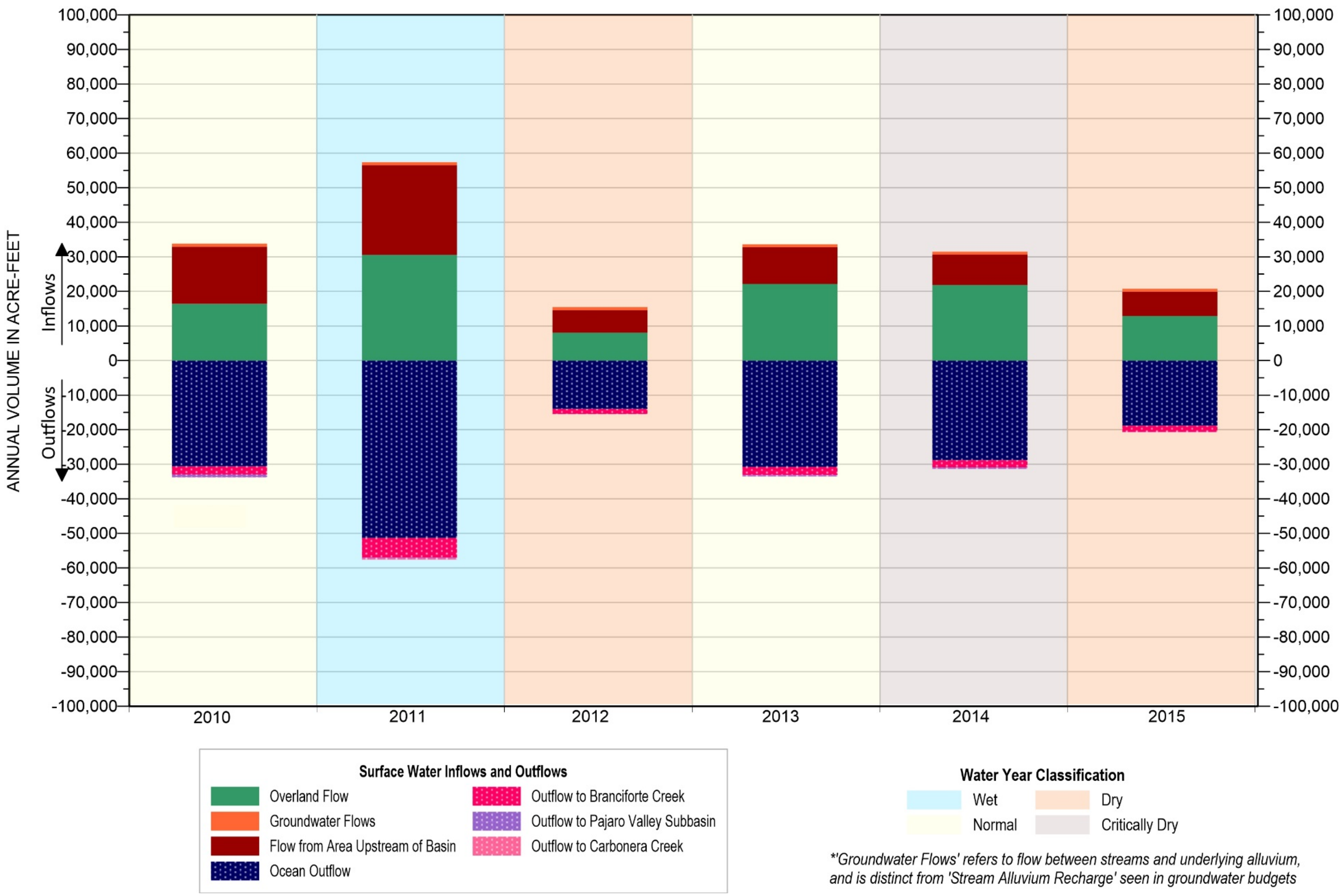

Figure 2-64. Santa Cruz Mid-County Basin Current Annual Surface Water Budget

2.2.5.5.2 Santa Cruz Mid-County Basin Current Groundwater Budget

The inflow and outflow components for the current groundwater budget are the same components as the historical budget, and their relative contributions are similar. Table 2-18 summarizes the minimum, maximum, and average annual inflows and outflows, and average annual change in groundwater in storage. A graphical representation of the current annual groundwater budget over the current period is provided in Figure 2-65.

On average, combined surface recharge sources constitute approximately 55% of Basin inflows, with inflow from subsurface flow from the Purisima Highlands Subbasin comprising the remaining 45%. Current inflows are about 1,580 acre-feet per year less than during the historical period due to below normal rainfall which occurred over most of this period.

For the current water budget period, Basin outflow from groundwater pumping is on average 1,190 acre-feet less than during the historical period. This reflects the reduction in pumping that occurred across the Basin through conservation in response to the 2012-2015 drought and the groundwater emergency declaration by Soquel Creek Water District. Subsurface outflow offshore is greater during the current period than the historical period because of higher groundwater elevations in the area of municipal production. Increased groundwater elevations are a direct result of historically low pumping in the Basin. The MGA anticipates a bounceback in groundwater demand so the GSP does not rely on historically low pumping continuing into the future to help achieve sustainability. Management actions employed also have included redistributing municipal pumping to increase groundwater levels along the coast to protective elevations.

The average loss of groundwater in storage for the Basin was 160 acre-feet per year (Table 2-18) which is approximately 320 acre-feet per year less than the historical period (Table 2-12). During the normal and wet years of 2010 and 2011, the Basin gained almost 2,000 acre-feet of cumulative groundwater in storage. By 2015, four consecutive dry years contributed to a loss of all the groundwater gained in 2010 and 2011, plus additional losses for an overall cumulative groundwater in storage loss of approximately 1,000 acre-feet over the six-year period. A comparison of Basin inflows and outflows between the current and historical periods is provided on Figure 2-66.

Table 2-18. Santa Cruz Mid-County Basin Current Groundwater Budget Summary (2010-2015)

Groundwater Budget Component	Annual Minimum	Annual Maximum	Annual Average	Average % (rounded)
Inflows (acre-feet per year)				
UZF Recharge	1,640	5,770	3,600	31%
Net Recharge from Stream Alluvium	780	1,260	970	8%
Recharge from Terrace Deposits	1,490	2,200	1,790	16%
Subsurface Inflow from Purisima Highlands Basin	4,940	5,310	5,130	45%
		Total Inflow	**11,490**	**100%**
Outflows (acre-feet per year)				
Pumping	5,260	6,650	6,220	53%
Subsurface Outflow to Santa Margarita Basin	250	270	270	2%
Net Subsurface Outflow to Pajaro Valley Subbasin	4,050	4,300	4,170	36%
Net Outflow Offshore	920	1,060	990	9%
		Total Outflow	**11,650**	**100%**
	Cumulative		**Average**	
Change in Storage (acre-feet per year)	-970 acre-feet		-160	

Note: all values are rounded to the nearest foot. This causes slight discrepancies between average and cumulative change in groundwater in storage.

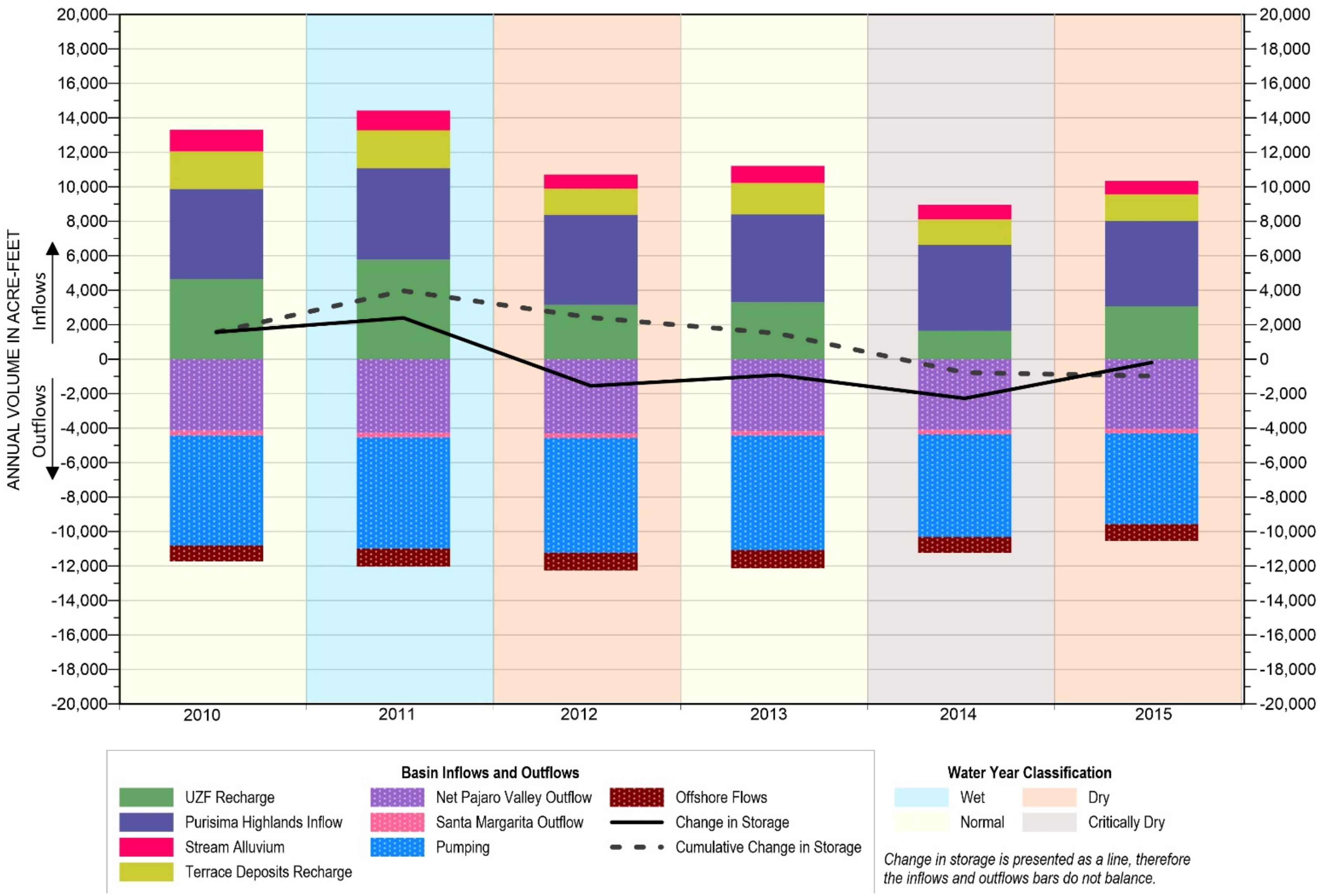

Figure 2-65. Santa Cruz Mid-County Basin Current Annual Groundwater Budget (2010 – 2015)

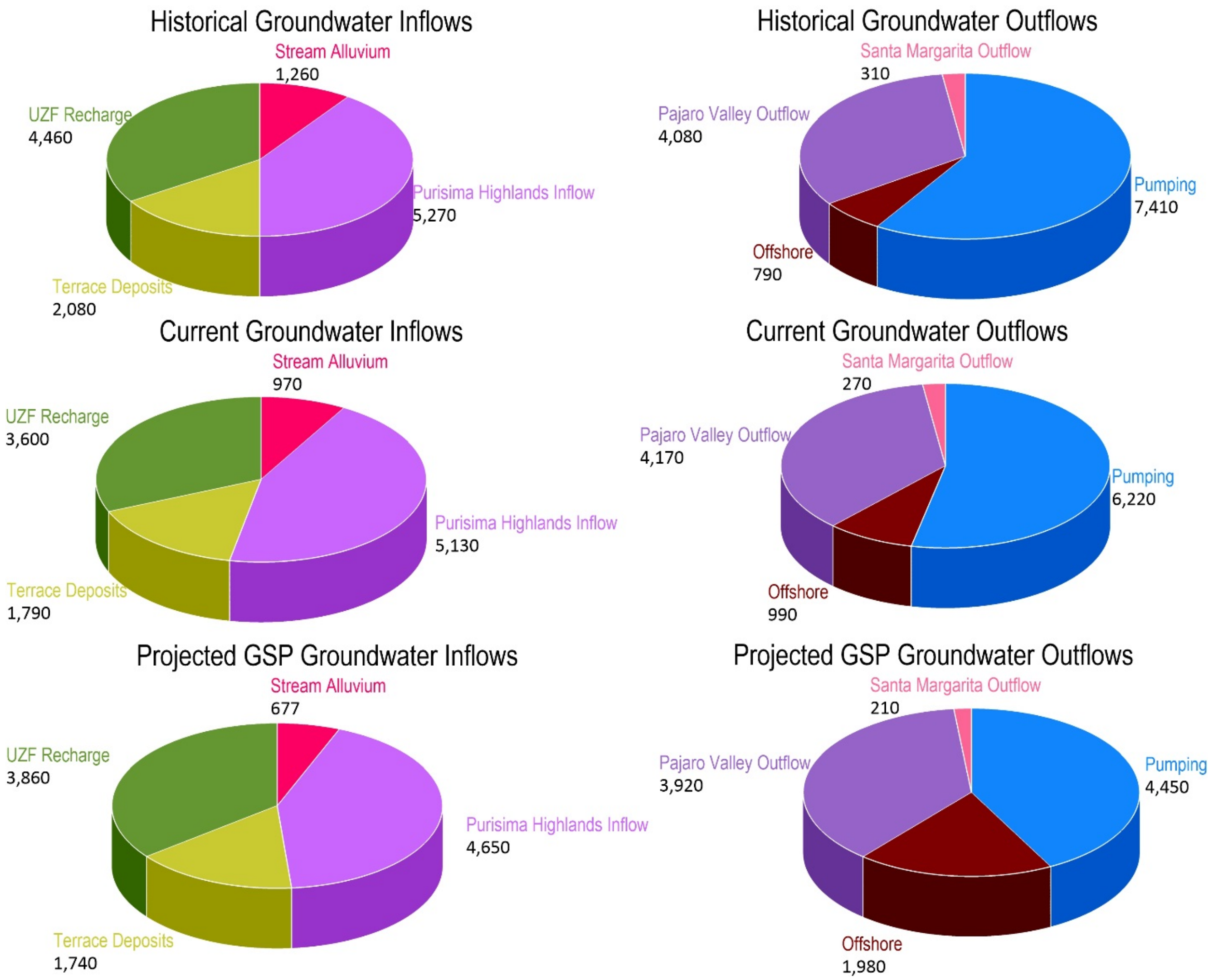

Figure 2-66. Comparison of Historical, Current, and Projected GSP Groundwater Inflows and Outlflows (acre-feet per year)

Table 2-19. Santa Cruz Mid-County Basin Current Groundwater Budget by Aquifer Summary (1985 – 2015)

Groundwater Flow Component	Aromas Red Sands (L2)	Purisima DEF/F (L3)	Purisima D (L4)	Purisima BC (L5)	Purisima B (L6)	Purisima A (L7)	Purisima AA (L8)	Tu (L9)	Total
Annual Average Inflows (acre-feet per year)									
UZF Recharge	614	550	160	148	179	485	460	1,004	3,600
Recharge from Stream Alluvium	393	119	_	274	_	267	157	_	1,200
Recharge from Terrace Deposits	827	136	_	274	69	246	241	_	1,793
Inflow from Purisima Highlands	_	2,813	326	323	361	549	734	23	5,129
Offshore Inflow	_	54	_	_	_	_	_	4	58
Inter-Layer Flow	_	544 (L3) 50(L4)	_	79 (L4)	27 (L5)	112 (L6)	33 (L7)	_	1,214
Total Inflow	**1,834**	**4,256**	**486**	**1,098**	**636**	**1,659**	**1,625**	**1,031**	**12,994**
Annual Average Outflows (acre-feet per year)									
Pumping	788	1,770	1	766	123	1,1284	1,019	482	6223
Discharge to Stream Alluvium	_	_	64	_	164	_	_	_	228
Outflow to Santa Margarita	_	_	_	_	_	_	_	267	267
Outflow to Pajaro Valley	515	2,597	302	100	143	328	188	_	4,173
Offshore Outflow	211	_	10	217	108	41	464	_	1,051
Inter-Layer Flow	544 (L3)	_	50 (L3) 79(L5)	27 (L6)	112 (L7)	33 (L8)	_	_	1,213
Total Outflow	**2,058**	**4,367**	**506**	**1,110**	**650**	**1,686**	**1,661**	**749**	**13,155**
Change in Storage	**-224**	**-111**	**-21**	**-12**	**-13**	**-26**	**-36**	**281**	**-162**

Notes: The abbreviation L is for model layer, e.g., L2 is model layer 2

2.2.5.5.3 North of Aptos Area Faulting Current Groundwater Budget

Similar to the historical period, groundwater inflows in the area north of the Aptos area faulting comprise inflow from Purisima Highlands (70%) and UZF recharge (30%) during the current period (Table 2-20). Outflows are primarily flows to Pajaro Valley (65%), with minor flows to Santa Margarita (3%) and discharge to streams (6%) (Table 2-20). During the current period, the average change in groundwater in storage represented a loss in storage of around 450 acre-feet per year. A graphical representation of the historical annual groundwater budget north of the Aptos area faulting over the current period is provided on Figure 2-67.

The change from an average groundwater in storage gain during the historical period to an average storage loss for the current period is influenced by a decline in both average inflows from the Purisima Highlands Subbasin and UZF recharge. The recharge reductions are due to limited surface recharge during the 2012-2015 drought that is included in the current water budget period. Overall, the area north of the Aptos area faulting lost about 2,710 acre-feet in cumulative storage over the six years included in the current water budget period (Table 2-20).

Table 2-20. North of Aptos Area Faulting Current Groundwater Budget Summary (2010 – 2015)

Groundwater Budget Component	Annual Minimum	Annual Maximum	Annual Average	Average % (rounded)
Inflows (acre-feet per year)				
UZF Recharge	860	3,640	2,170	30%
Subsurface Inflow from Purisima Highlands	4,940	5,310	5,130	70%
		Total Inflow	**7,300**	**100%**
Outflows (acre-feet per year)				
Pumping	440	590	540	7%
Discharge to Streams	300	560	440	6%
Subsurface Outflow to Santa Margarita Subbasin	240	260	250	3%
Subsurface Outflow to Pajaro Valley Subbasin	4,940	5,310	5,030	65%
Subsurface Outflow to South of Aptos Area Faulting	1,470	1,500	1,490	19%
		Total Outflow	**7,750**	**100%**
	Cumulative		**Average**	
Change in Storage (acre-Feet per year)	-2,710 acre-feet		-450	

Note: all values are rounded to the nearest foot. This causes slight discrepancies between average and cumulative change in groundwater in storage

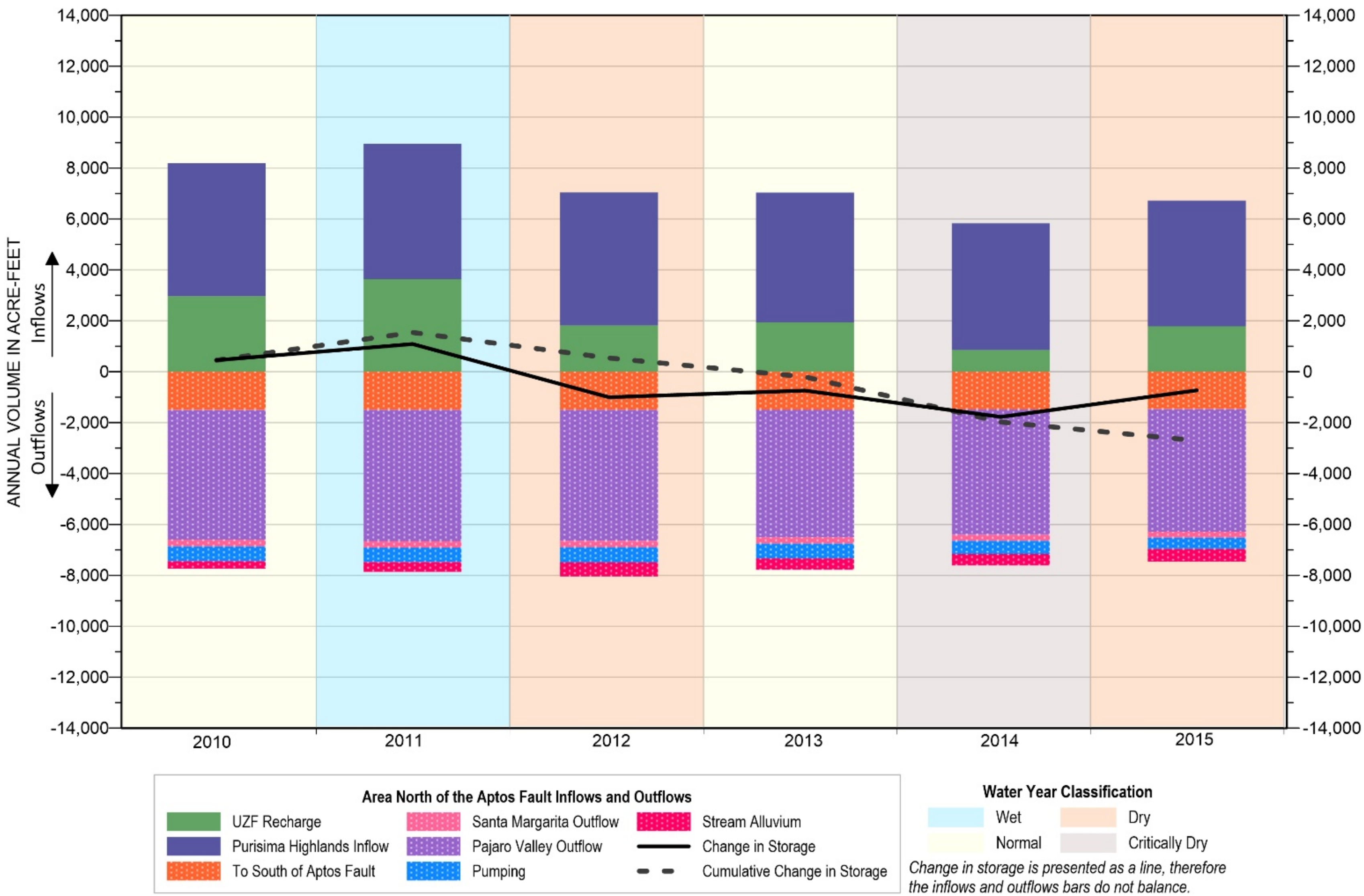

Figure 2-67. North of Aptos Area Faulting Current Annual Groundwater Budget (2010 – 2015)

2.2.5.5.4 South of Aptos Area Faulting Current Groundwater Budget

Similar to the distribution of groundwater inflows during the historical period, current groundwater inflows in the area south of the Aptos area faulting are comprised of inflow from recharge through alluvium and terrace deposits (combined 46%), inflow from the area north of the Aptos area faulting (21%), UZF recharge (22%), and from Pajaro Valley (12%) (Table 2-21). Outflows are primarily by groundwater pumping (85%) and offshore (14%) (Table 2-21). A graphical representation of the historical annual groundwater budget north of the Aptos area faulting over the current period is provided on Figure 2-68.

During the current water budget period, there is an increase in groundwater storage of approximately 290 acre-feet per year. Due to a reduction in overall groundwater inflow during the 2012-2015 drought, average change in groundwater in storage was 180 acre-feet per year lower than during the historical period, yet still gaining. Overall, the area south of the Aptos area faulting gained approximately 1,730 acre-feet in cumulative storage over the current water budget period (Table 2-21). Increased groundwater levels in the area of municipal pumping is the reason for this unexpected gain in storage during a drought period. As mentioned previously, increased groundwater elevations are a direct result of specific management actions focused on controlling seawater intrusion. Management actions include redistributing municipal pumping to increase groundwater levels along the coast to protective elevations and water conservation.

Table 2-21. South of Aptos Area Faulting Current Groundwater Budget Summary (2010 – 2015)

Groundwater Budget Component	Annual Minimum	Annual Maximum	Annual Average	Average % (rounded)
Inflows (acre-feet per year)				
UZF Recharge	790	2,130	1,430	21%
Recharge from Stream Alluvium	1,280	1,560	1,410	20%
Recharge from Terrace Deposits	1,490	2,200	1,790	26%
Subsurface Inflow from Pajaro Valley Subbasin	760	920	850	12%
Subsurface Inflow from North of Aptos Area Faulting	1,470	1,500	1,490	21%
		Total Inflow	**6,980**	**100%**
Outflows (acre-feet per year)				
Pumping	4,830	6,060	5,680	85%
Subsurface Outflow to Santa Margarita Subbasin	<10	20	10	<1%
Net Outflow Offshore	920	1,060	990	15%
		Total Outflow	**6,690**	**100%**
	Cumulative		**Average**	
Change in Storage (acre-feet per year)	+1,730 acre-feet		+290	

Note: all values are rounded to the nearest foot. This causes slight discrepancies between average and cumulative change in groundwater in storage

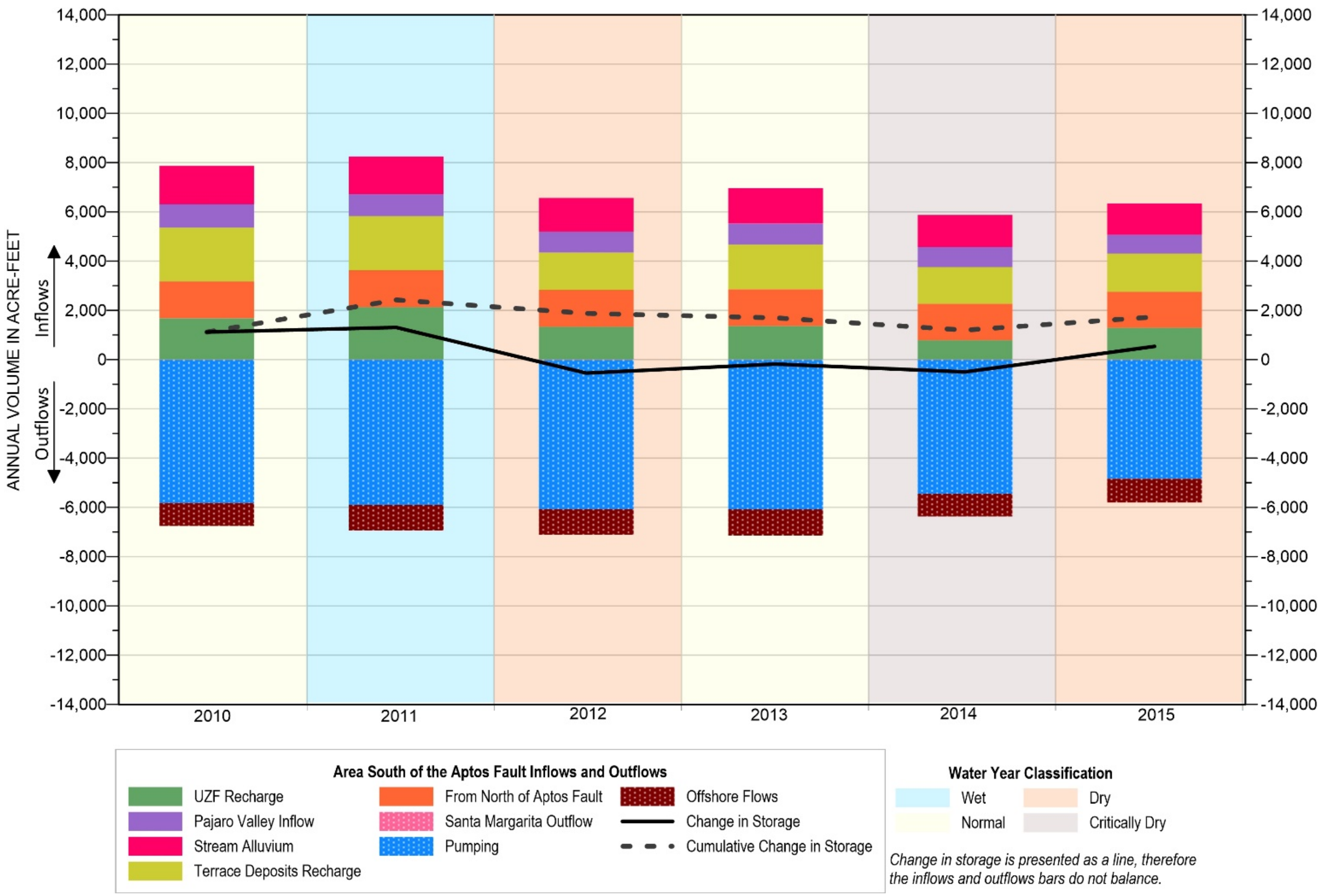

Figure 2-68. South of Aptos Area Faulting Current Annual Groundwater Budget (2010 – 2015)

2.2.5.6 Projected Water Budget

SGMA regulations require the development of a projected water budget based on at least 50 years of historical data. The projected water budget is used to estimate changes in water supply, demand, and aquifer conditions in response to GSP implementation. The projected water budget covers a 54-year period from Water Years 2016 through 2069, and includes a predictive period of 53 years that starts in 2017. This projection provides a baseline that is used in the GSP to evaluate Basin impacts from GSP implementation. The water budgets included in this subsection are (1) a projected baseline water budget that does not include projects and management actions as part of GSP implementation (Baseline) and (2) a projected water budget with projects and management actions implemented as part of the GSP (GSP Implementation).

2.2.5.6.1 Assumptions Used in Projected Water Budget Development

Assumptions included in the model used to estimate the projected water budget are made based on best available data to account for predicted changes in Basin climate, sea-level, projected groundwater demand, supplemental water sources, and management actions. More documentation on the projected simulations and assumptions are included in Appendix 2-I. Model assumptions for predictive simulations are summarized briefly below.

Climate

The projected water budgets account for future climate generated from a catalog of historical climate data from warm years in the Basin’s past to simulate the warmer temperatures predicted by global climate change. Specifically, the Catalog Climate uses historical data from the Santa Cruz Co-op and Watsonville Waterworks climate stations. This approach was recommended by the model Technical Advisory Committee (TAC) to address the uncertainty regarding precipitation forecasts in coastal California in a variety of global climate models. The catalog approach preserves the integrity of the climate data and ensures temperature and precipitation values are associated with real data. The Catalog Climate has an increase of 2.4 °F in temperature and decrease of 1.3 - 3.1 inches per year in precipitation over the long-term record at climate stations in Santa Cruz and Watsonville. There is a corresponding increase in evapotranspiration of about 6%. Appendix 2-G is a technical memorandum that describes the development of the Catalog Climate data in more detail.

In comparison to the CMIP5 ensemble of 10 Global Circulation Models (GCM) often applied in California, the modeled catalog climate is slightly cooler and drier than most CMIP5 scenarios. A panel of local experts recommended the Catalog Climate approach as appropriate for Basin planning. More technical information on a comparison of climate change scenarios is contained in Appendix 2-H.

Sea-Level

Global sea-level rise is incorporated in projected water budgets because changes in sea-level impact the location of the saltwater/freshwater interface and can alter the volume and direction of flows offshore. The model includes projections from the California Ocean Protection Council and California Natural Resources Agency sea-level rise guidance (California Natural Resources Agency, 2018), which gives a range of sea-level rise predictions for Monterey based on possible greenhouse gas emission scenarios. Based on that data source, the model from which the water budgets are derived assumes around 2.3 feet of sea-level rise between 2000 and 2070.

Land Use

Future land use is assumed to remain the same as historical land use.

Projected Groundwater Demand

Historically, almost all water supply to the Basin is pumped from aquifers within the Basin. The Soquel Creek Water District and Central Water District rely solely on groundwater. The City of Santa Cruz water system relies predominantly on surface water supplies sourced from outside of the Basin, only 5% of its supply is from groundwater. Although a small component of its water supply, groundwater is a crucial component of the Santa Cruz water system for meeting peak season demands, maintaining pressure in the eastern portion of the distribution system, and for weathering periods of drought. Projected Basin water demand assumes groundwater will remain the main source of water supply, and that surface water sources within the Basin will not be used.

Projected non-municipal groundwater demand for domestic use assumes pre-drought (2012 – 2015) water demand of 0.35 acre-feet per year per household. The assumed water demand is applied to projected annual population growths of 4.2% pre-2035 and 2.1% post-2035. Groundwater demand for larger institutions such as camps, retreats, and schools, and agricultural irrigation remain the same as historical demands.

Municipal groundwater demand from the Basin is different for the projected Baseline (no projects) water budget and projected with projects and management actions water budget. This is because projects afford the MGA agencies the ability to operate wells differently.

Projected Baseline municipal groundwater demand (without projects and management actions) is based on several different assumptions:

- Central Water District - pre-drought average groundwater production from Water Year 2008 through 2011of 550 acre-feet per year.
- Soquel Creek Water District - 2015 Urban Water Management Plan (UWMP) projects demand to increase to 3,900 acre-feet per year after historically low

pumping achieved from 2010-2015. The 2015 UWMP projects subsequent long-term decline of demand to 3,300 acre-feet per year, but SqCWD has concluded that its demand projections may be underestimated when considering effects such as statewide efforts to address the housing crisis including laws facilitating accessory dwelling uses and is therefore not assuming a long-term decline in demand for planning purposes. For projected water budget, the GSP projects that Soquel Creek Water District groundwater demand will be stable at 3,900 acre-feet per year.

- City of Santa Cruz – projections of groundwater pumping based on City of Santa Cruz Confluence modeling to meet demand during 2016-2018. The City considers this demand appropriate for current planning because unlike most other communities in the Bay Area and California, City water demand has not increased much from restricted consumption during the 2012-2015 drought (SCWD, 2019, and M.Cubed, 2019). The GSP projects that City of Santa Cruz groundwater pumping will average approximately 350 acre-feet per year without any projects, but is assumed to vary annually based on surface water supplies.

Groundwater Management Activities

The projected water budget with projects and management actions accounts for activities to be conducted by MGA member agencies during GSP implementation. The general project types include in-lieu recharge, injection, and ASR. Projects included in the future simulations are:

- Pure Water Soquel to replenish the Basin and protect against further seawater intrusion using advanced water purification methods to purify recycled water, and

- City of Santa Cruz ASR of excess San Lorenzo River flows to meet City water shortfall (modeled as part of project feasibility study).

Management actions included are enhancements to municipal pumping distribution that are possible in combination with Pure Water Soquel.

Bar charts showing the projected net groundwater pumping for both the Baseline (transparent bars) and the scenario incorporating projects and management actions (non-transparent bars) are shown on Figure 2-69 for Water Years 2016 – 2039 and Figure 2-70 for Water Years 2040 – 2069. There are no projects or management actions which would reduce demand from Baseline for Central Water District, domestic pumping, or agricultural pumping. Projected groundwater demand for the City of Santa Cruz is reduced by City of Santa Cruz ASR activities which store surplus surface water during wet years. Projected net groundwater pumping for Soquel Creek Water District is reduced significantly after the year 2023 by operation of Pure Water Soquel, which will inject approximately 1,500 acre-feet into the Purisima A and BC-unit aquifers annually. Overall, the average annual projected net pumping with projects and management actions (4,910 acre-feet) is 1,430 acre-feet less than what is projected in the Baseline scenario (6,340 acre-feet).

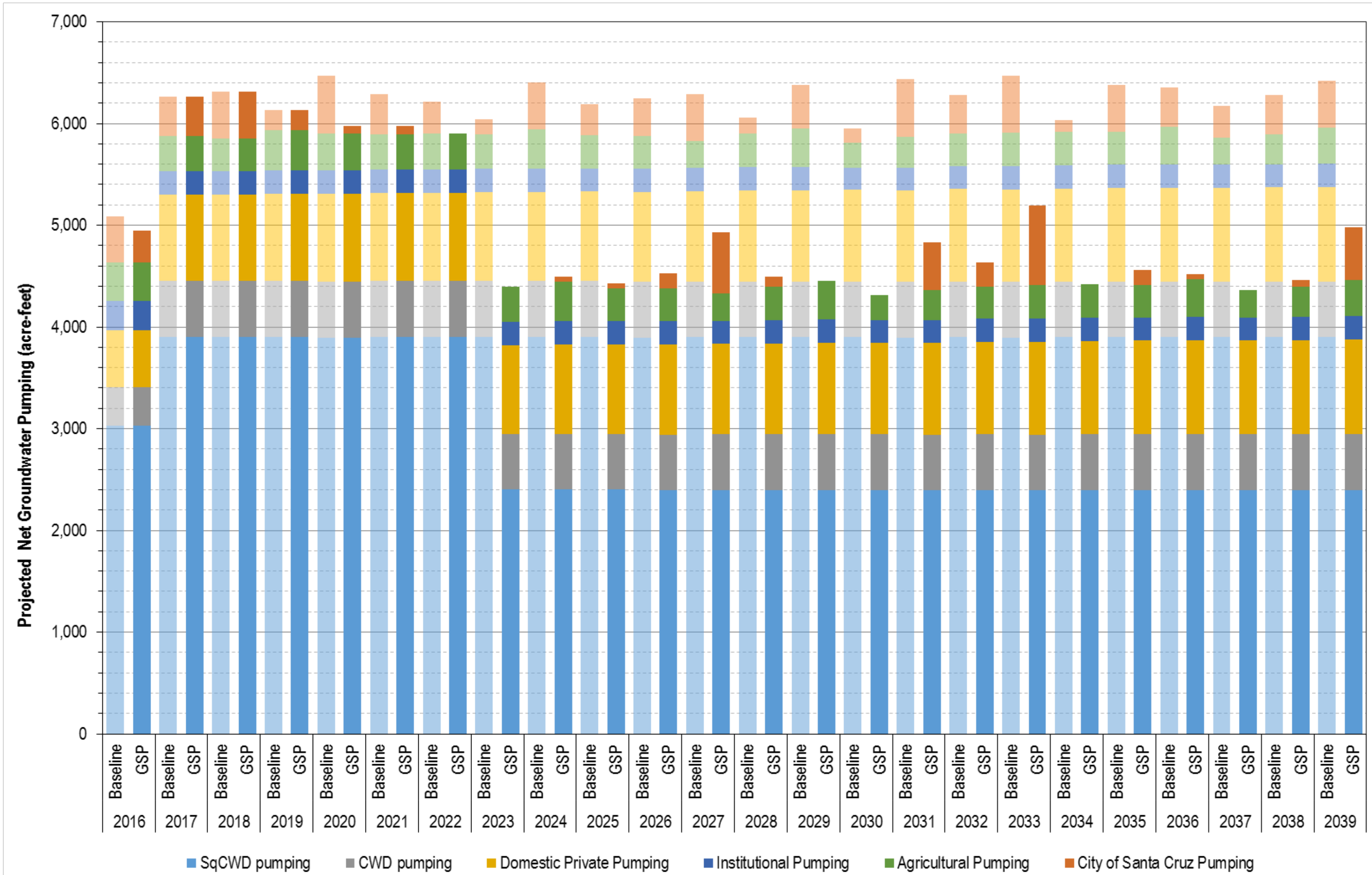

Figure 2-69. Projected Baseline vs. Projected GSP Implementation Net Groundwater Pumping in the Santa Cruz Mid-County Basin (2016-2039)

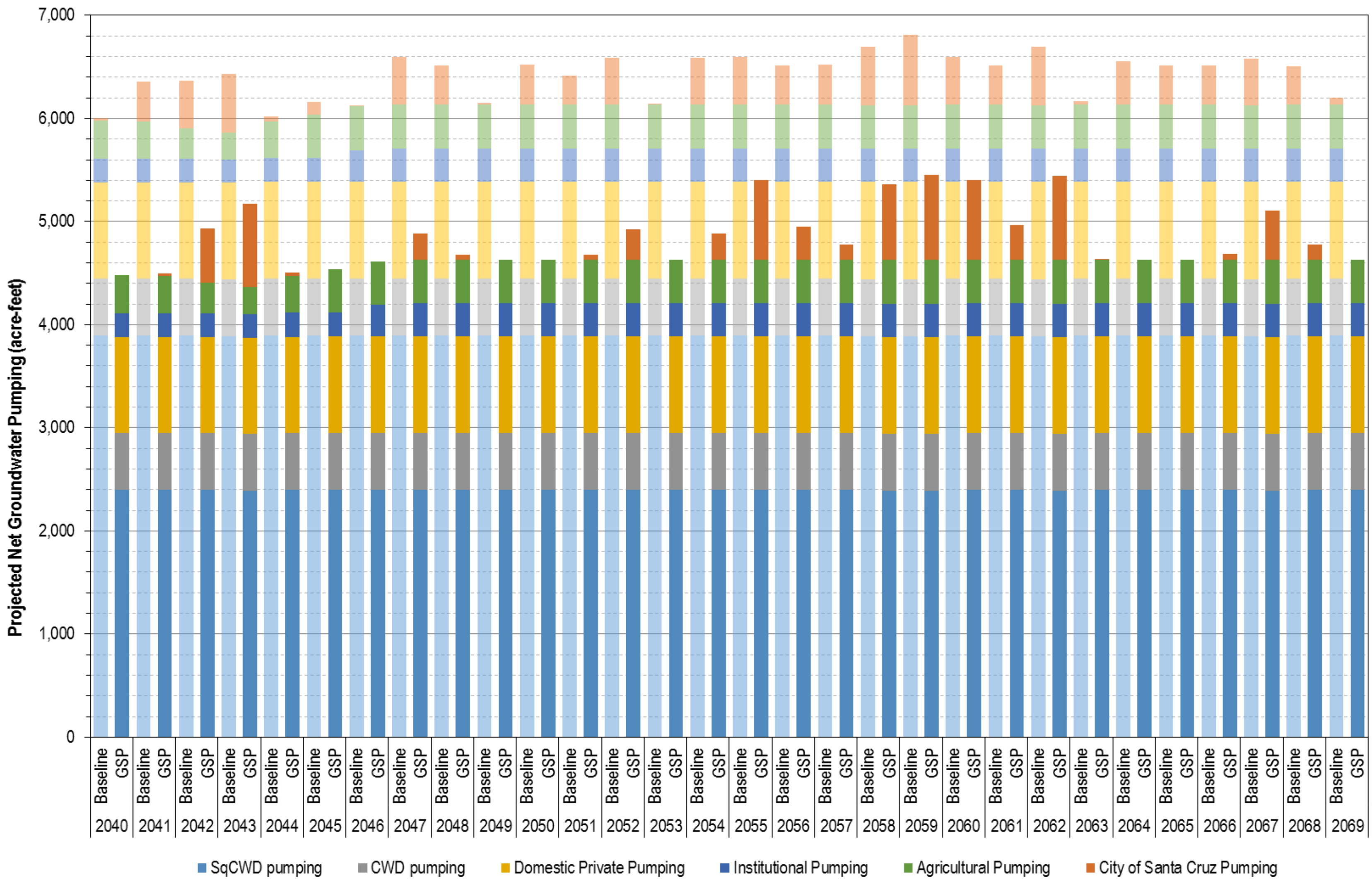

Figure 2-70. Projected Baseline vs. Projected GSP Implementation Net Groundwater Pumping in the Santa Cruz Mid-County Basin (2040-2069)

2.2.5.6.2 Santa Cruz Mid-County Basin Projected Surface Water Budget

Projected precipitation in the Basin is on average about 15% lower compared to the historical period. This translates to an average decrease in precipitation of just under 8,930 acre-feet annually (Table 2-10 and Table 2-22). Evapotranspiration, relative to other components, is simulated to increase by 3% (Table 2-10 and Table 2-22), which reflects higher average temperatures in the Basin over the projected period. With the decrease in precipitation and relative increase in evapotranspiration, overland flow and groundwater recharge are simulated to decrease on average by 2% and 1%, respectively. In terms of volume, it is projected that there will be 3,570 acre-feet less surface water and 2,330 acre-feet less groundwater recharge from precipitation available within the Basin (Table 2-10 and Table 2-22).

Table 2-22. Percentage Distribution of Projected Precipitation in Santa Cruz Mid-County Basin

Precipitation Budget Component	Average Annual (acre-feet)	Average Percent of Precipitation
Precipitation	87,280	100%
Evapotranspiration	60,000	69%
Overland Flow	22,030	25%
Groundwater Recharge from Precipitation	3,140	4%
Soil Moisture	2,110	2%

The relative percentages of projected surface water budget components mirror the historical budget. However, the projected surface water budget is characterized by a decrease in average surface water inflows of approximately 8,450 acre-feet per year compared with historical averages (Table 2-11 and Table 2-23). Over the projected period, total surface water inflows and outflows decrease by about 18% each, which reflects the drier climatic conditions predicted in the future. The amount of water flowing through the Basin's stream system ranges from 156,660 acre-feet to 6,270 acre-feet annually (Figure 2-71).

Despite the predicted drier conditions in the projected simulation, the average annual amount of groundwater contributing to surface water inflows will be slightly higher (280 acre-feet per year) than during the historical period due to overall higher groundwater levels predicted in response to projects and management actions.

As mentioned previously, surface water is not a significant agricultural, municipal, or domestic water source within the Basin, and is therefore not included in the projected model simulations since it is not expected that more surface water will be diverted for use in the future.

On a Basin-wide scale, the difference in average inflow and outflow surface water budget components between the projected Baseline condition and GSP Implementation with projects and management actions is only 350 acre-feet per year. However, slight decreases (<1%) in the inflow to surface water from groundwater is projected to result in relatively large increases in groundwater contribution to Soquel Creek. Starting around 2024, PWS and City ASR projects are simulated to increase groundwater inflow to Soquel Creek over the Baseline condition (Figure 2-72). This increase in baseflow reflects higher groundwater elevations throughout the Basin that supports increased creek baseflow that would not occur without those projects. As discussed in the calibration report in Appendix 2-F, the magnitude of groundwater flows to streams are not well calibrated so simulation results are only meant to demonstrate that there are expected benefits to streamflow from the projects as opposed to quantifying the benefit.

Table 2-23. Santa Cruz Mid-County Basin Projected GSP Implementation Surface Water Budget

Surface Water Budget Component	Annual Minimum	Annual Maximum	Annual Average	Average % (rounded)
Inflows (acre-feet per year)				
Overland Flow	3,750	89,840	22,040	59%
Flows from Upstream of the Basin	2,520	66,780	14,280	38%
Net Flows from Groundwater	850	1,190	1,080	3%
		Total Inflow	**37,400**	**100%**
Outflows (acre-feet per year)				
Ocean Outflow	6,870	141,570	33,580	89%
Outflow in Branciforte Creek	397	15,900	3,340	9%
Pajaro Valley Subbasin	<10	2,310	320	1%
Outflow to Carbonera Creek	20	890	160	<1%
		Total Outflow	**37,400**	**100%**

Note: ‘Groundwater Flows’ refers to flow between streams and underlying alluvium, and is distinct from ‘Stream Alluvium Recharge’ seen in groundwater budgets.

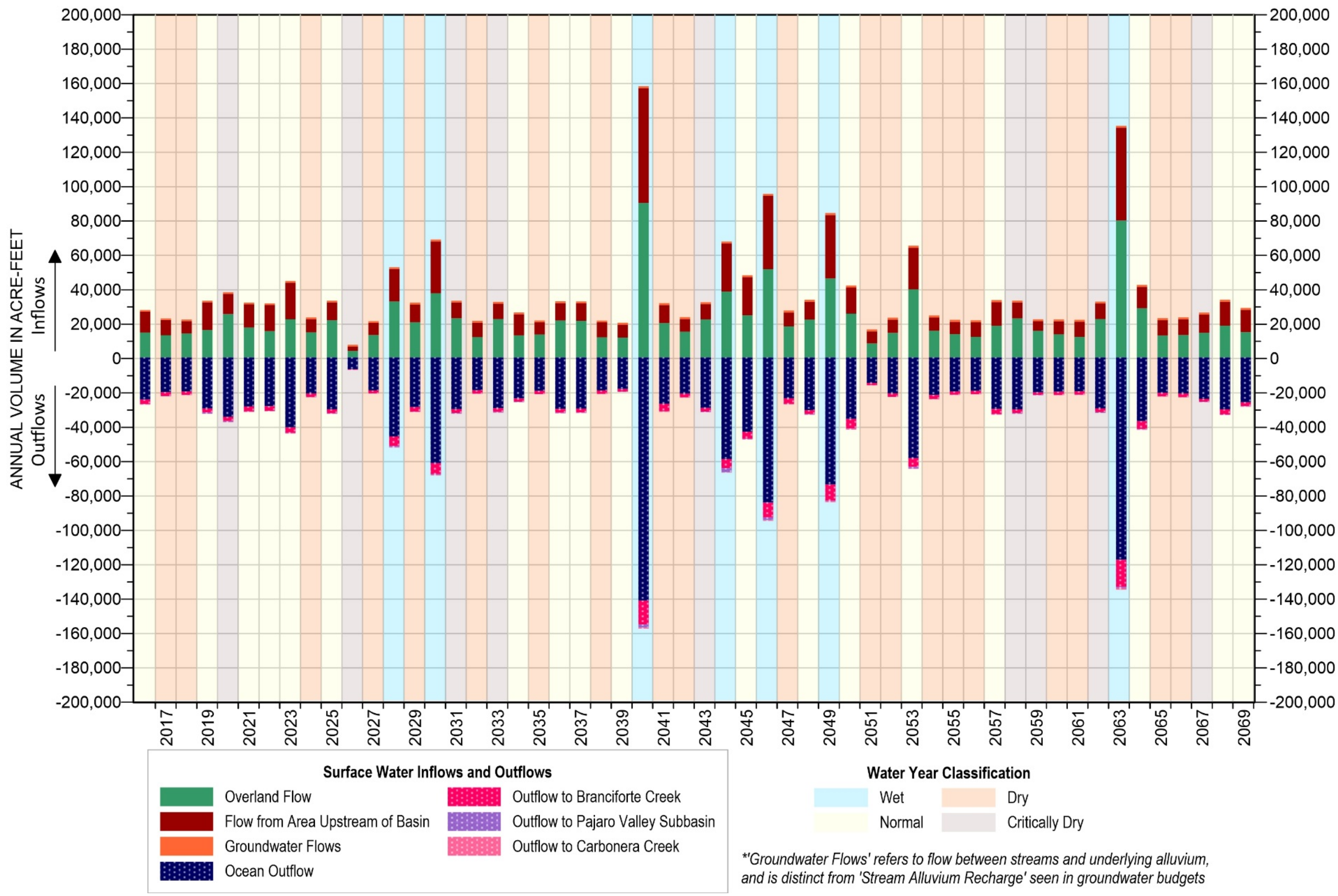

Figure 2-71. Santa Cruz Mid-County Basin Projected Annual Surface Water Budget (2016 – 2069)

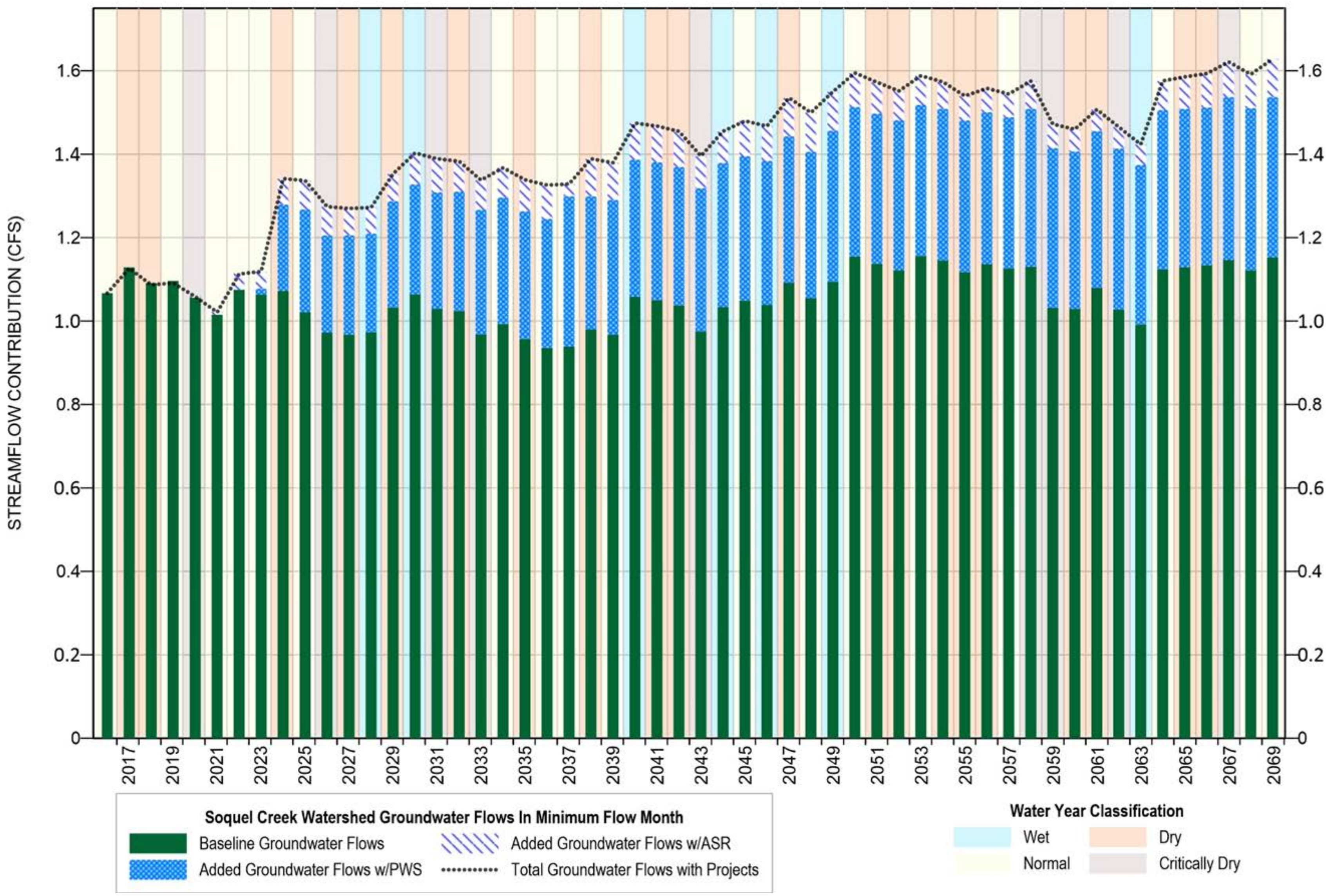

Figure 2-72. Effect of Projects and Management Actions on Soquel Creek Watershed Groundwater Contribution (2016 – 2069)

2.2.5.6.3 Santa Cruz Mid-County Basin Projected Groundwater Budget

The projected inflow and outflow components for the projected groundwater budget are the same as the historical and current budgets, and their relative contributions are similar (Figure 2-66). For both projected water budgets, the catalog climate implemented to represent climate change only has three wet years over the 54-year period; reflecting overall warmer and drier conditions. This results in less natural recharge in both projected scenarios.

For the Baseline projection with no projects and management actions, groundwater inflows to the Basin are reduced by around 200 acre-feet per year compared to current conditions and 1,780 acre-feet per year compared to historical conditions. Projected groundwater pumping in the Baseline groundwater budget is almost the same as recent pumping. As a result of the projected recharge and pumping conditions, outflow to the ocean under Baseline conditions remains similar to current outflows which are not sufficient to prevent seawater intrusion. Without projects and management actions implemented to achieve groundwater sustainability (Baseline scenario), it is projected the Basin will experience a loss of groundwater in storage of 3,240 acre-feet cumulatively over the fifty-four-year period.

With projects and management actions implemented to achieve groundwater sustainability (GSP Implementation), projected net pumping is reduced by 1,740 acre-feet per year because groundwater demand is offset by supplemental water injected into the Basin. This results in an increase in average groundwater outflow of 840 acre-feet per year (an increase of 73%) to the ocean that will ensure seawater intrusion does not move onshore farther than it is currently, could potentially even push seawater intrusion back. It is projected that with projects and management actions, there will be an average annual increase in groundwater in storage of 280 acre-feet, which equates to a cumulative gain over 54 years of 18,530 acre-feet.

Table 2-24. Santa Cruz Mid-County Basin Projected Groundwater Budget Summary (2016 – 2069)

Groundwater Budget Component	Projected Baseline		Projected GSP Implementation		Difference between GSP Implementation and Baseline
	Annual Average	Average % (rounded)	Annual Average	Average % (rounded)	
Inflows (acre-feet per year)					
UZF Recharge	3,860	34%	3,860	35%	0
Net Recharge from Stream Alluvium	1,000	9%	670	6%	-330
Recharge from Terrace Deposits	1,780	16%	1,740	16%	-40
Subsurface Inflow from Purisima Highlands Subbasin	4,650	41%	4,650	43%	0
Total Inflow	**11,290**	**100%**	**10,920**	**100%**	**-370**
Outflows (acre-feet per year)					
Pumping	6,190	55%	4,450	43%	-1,740
Subsurface Outflow to Santa Margarita Subbasin	210	2%	210	2%	0
Net Subsurface Outflow to Pajaro Valley Subbasin	3,670	33%	3,920	37%	250
Net Outflow Offshore	1,150	10%	1,990	19%	840
Total Outflow	**11,220**	**100%**	**10,570**	**100%**	**-650**
	Average	**Cumulative**	**Average**	**Cumulative**	**Average**
Change in Storage (acre-feet per year)	+70	-3,240 acre-feet	+350	+18,530 acre-feet	+280

Note: all values are rounded to the nearest foot. This causes slight discrepancies between average and cumulative change in groundwater in storage

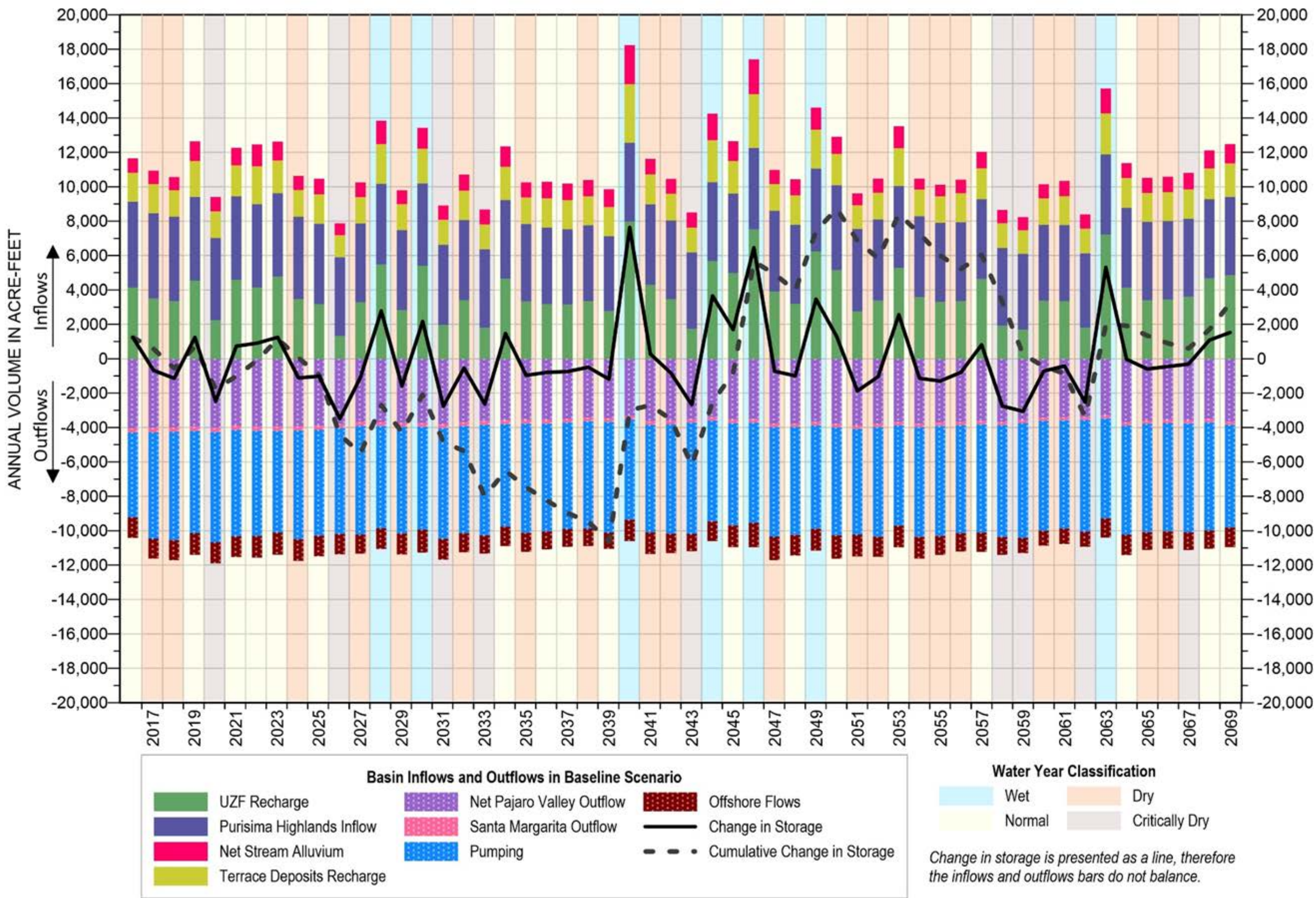

Figure 2-73. Santa Cruz Mid-County Basin Projected Baseline Annual Groundwater Budget (2016 – 2069)

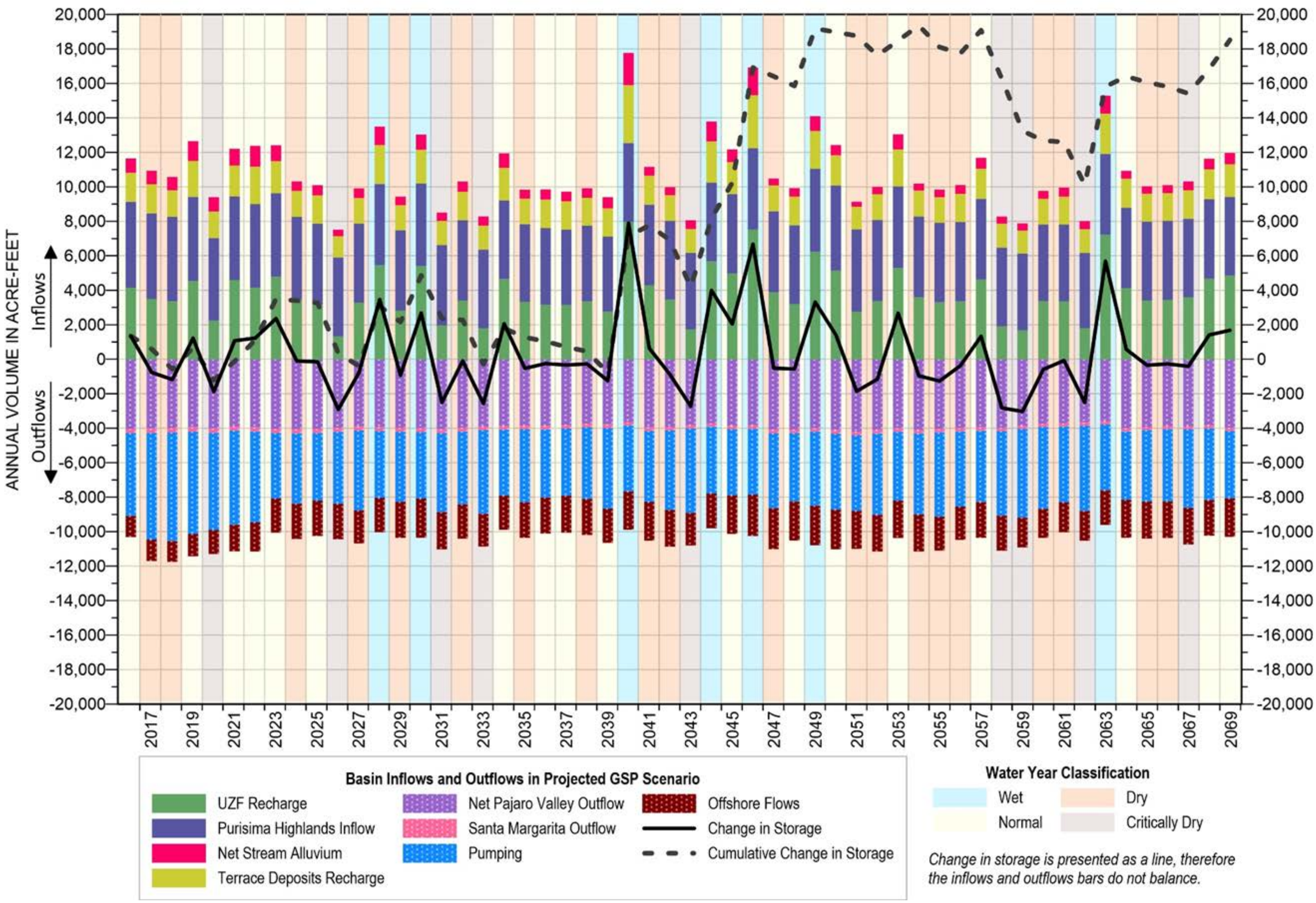

Figure 2-74. Santa Cruz Mid-County Basin Projected GSP Implementation Annual Groundwater Budget (2016 – 2069)

2.2.5.6.4 North of Aptos Area Faulting Projected Groundwater Budget

In both the projected groundwater budgets for the area north of the Aptos area faulting, the inflow and outflow components occur in relatively similar proportions to the historical period (Table 2-14). Both inflows (UZF recharge and inflow from Purisima Highlands) decrease due to the drier climate, amounting to 970 acre-feet less in average annual inflow. Similarly, outflows also decrease by about 970 acre-feet when compared to the historical average. While all groundwater outflows decrease slightly, subsurface outflow to Pajaro Valley decreases by almost 660 acre-feet annually (Table 2-14).

In the Baseline projection, an average loss of groundwater in storage of 20 acre-feet annually culminates in a total loss of nearly 1,140 acre-feet over the 54-year projected period. With projects and management actions, the area North of the Aptos area faulting experiences an average increase in groundwater in storage of 30 acre-feet annually, culminating in a total gain of 1,710 acre-feet by 2069. The difference may be attributable to overall increases in groundwater elevations in the area south of the Aptos area faulting where GSP projects are implemented. The increase groundwater elevations may reduce the hydraulic gradient across the Aptos area faulting thereby resulting in less outflow to the area south of the fault (Table 2-14).

Table 2-25. North of Aptos Area Faulting Projected Groundwater Water Budget Summary (2016 – 2069)

Groundwater Budget Component	Projected Baseline		Projected GSP Implementation		Difference between GSP Implementation and Baseline
	Annual Average	Average % (rounded)	Annual Average	Average % (rounded)	
Inflows (acre-feet per year)					
UZF Recharge	2,380	33%	2,380	33%	0
Subsurface Inflow from Purisima Highlands	4,650	67%	4,650	67%	0
Total Inflow	**7,030**	**100%**	**7,030**	**100%**	**0**
Outflows (acre-feet per year)					
Pumping	610	9%	610	9%	0
Discharge to Streams	360	5%	350	5%	-10
Subsurface Outflow to Santa Margarita Subbasin	190	3%	190	3%	0
Net Subsurface Outflow to Pajaro Valley Subbasin	4,450	63%	4,450	63%	2
Subsurface Outflow to South of Aptos Area Faulting	1,440	20%	1,400	20%	-40
Total Outflow	**7,050**	**100%**	**7,000**	**100%**	**-30**
	Average	**Cumulative**	**Average**	**Cumulative**	**Average**
Change in Storage (acre-feet per year)	-20	-1,140 acre-feet	30	+1,710 acre-feet	+50

Note: all values are rounded to the nearest foot. This causes slight discrepancies between average and cumulative change in groundwater in storage

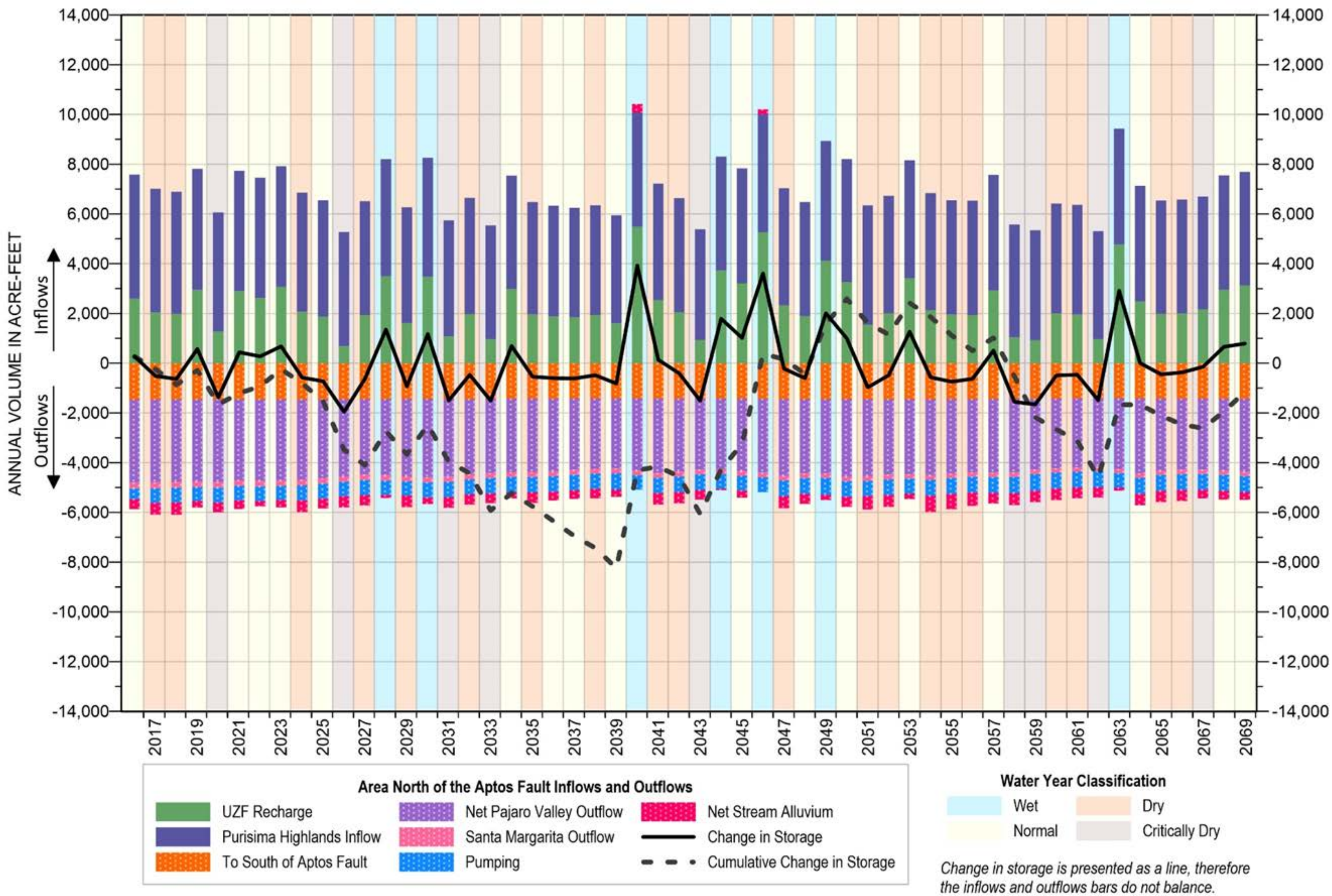

Figure 2-75. North of Aptos Area Faulting Projected Baseline Annual Groundwater Budget (2016 – 2069)

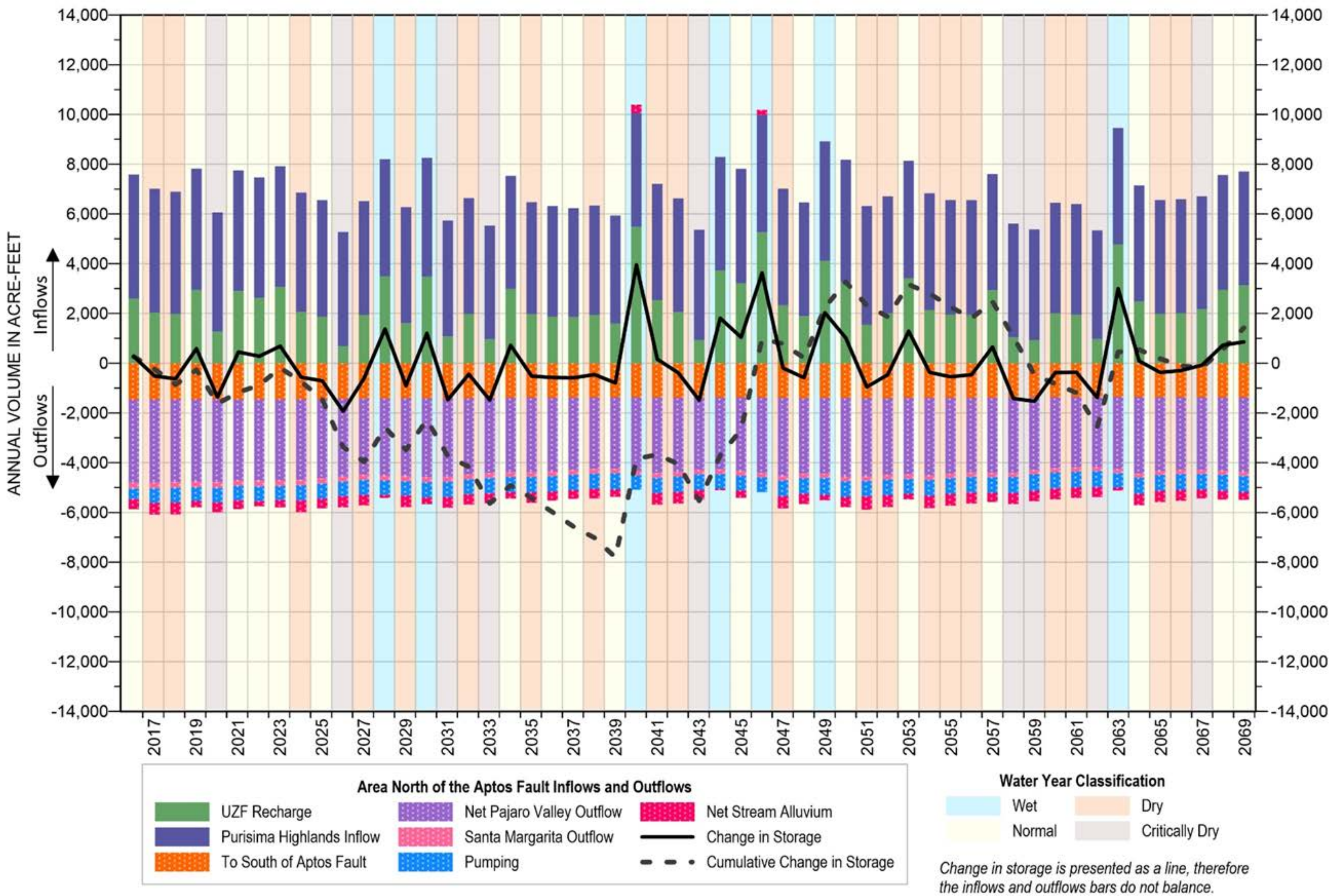

Figure 2-76. North of Aptos Area Faulting Projected GSP Implementation Annual Groundwater Budget (2016 – 2069)

2.2.5.6.5 South of Aptos Area Faulting Projected Groundwater Budget

The relative proportions of projected groundwater inflow and outflow components for the area south of the Aptos area faulting are very similar to the historical and current periods. All inflows decrease slightly due to the drier and warmer climate (Table 2-15 and Table 2-26). Groundwater pumping is decreased by about 1,130 acre-feet annually in the Baseline projection when compared to the historical time period because of improved groundwater management practices and water conservation.

In the projected GSP Implementation scenario, pumping is further decreased by 1,740 acre-feet per year from Baseline pumping because of projects that provide supplemental water as a supply source (Table 2-26). With GSP Implementation, offshore flows are increased when compared to the historical, current, and Baseline budgets. These increased offshore flows reflects higher groundwater elevations within the Basin as a result of projects and management actions.

Under both Baseline and GSP Implementation projections, the area south of the Aptos area faulting is simulated to have increases in groundwater in storage (Table 2-26). In the Baseline scenario, an average annual gain in storage of 70 acre-feet per year creates 4,380 acre-feet of cumulative storage by 2069. In the projected GSP Implementation scenario, an average annual gain in storage of 320 acre-feet per year creates about 17,100 acre-feet of cumulative storage by 2069.

Table 2-26. South of Aptos Area Faulting Projected Groundwater Water Budget Summary (2016 – 2069)

Groundwater Budget Component	Projected Baseline		Projected GSP Implementation		Difference between GSP Implementation and Baseline
	Annual Average	Average % (rounded)	Annual Average	Average % (rounded)	
Inflows (acre-feet per year)					
UZF Recharge	1,480	22%	1,480	24%	0
Net Recharge from Stream Alluvium	1,360	20%	1,030	17%	-330
Recharge from Terrace Deposits	1,780	25%	1,740	27%	-40
Subsurface Inflow from Pajaro Valley Subbasin	780	11%	530	9%	-250
Subsurface Flow from North of Aptos Area Faulting	1,430	22%	1,390	23%	-40
Total Inflow	**6,830**	**100%**	**6,170**	**100%**	**-660**
Outflows (acre-feet per year)					
Pumping	5,580	83%	3,840	66%	-1,740
Net Subsurface Outflow to Pajaro Valley Subbasin	10	<1%	10	<1%	0
Net Outflow Offshore	1,150	17%	2,000	34%	850
Total Outflow	**6,740**	**100%**	**5,850**	**100%**	**-890**
	Average	**Cumulative**	**Average**	**Cumulative**	**Average**
Change in Storage (acre-feet per year)	+70	+4,380 acre-feet	+320	+17,100 acre-feet	+390

Note: all values are rounded to the nearest foot. This causes slight discrepancies between average and cumulative change in groundwater in storage

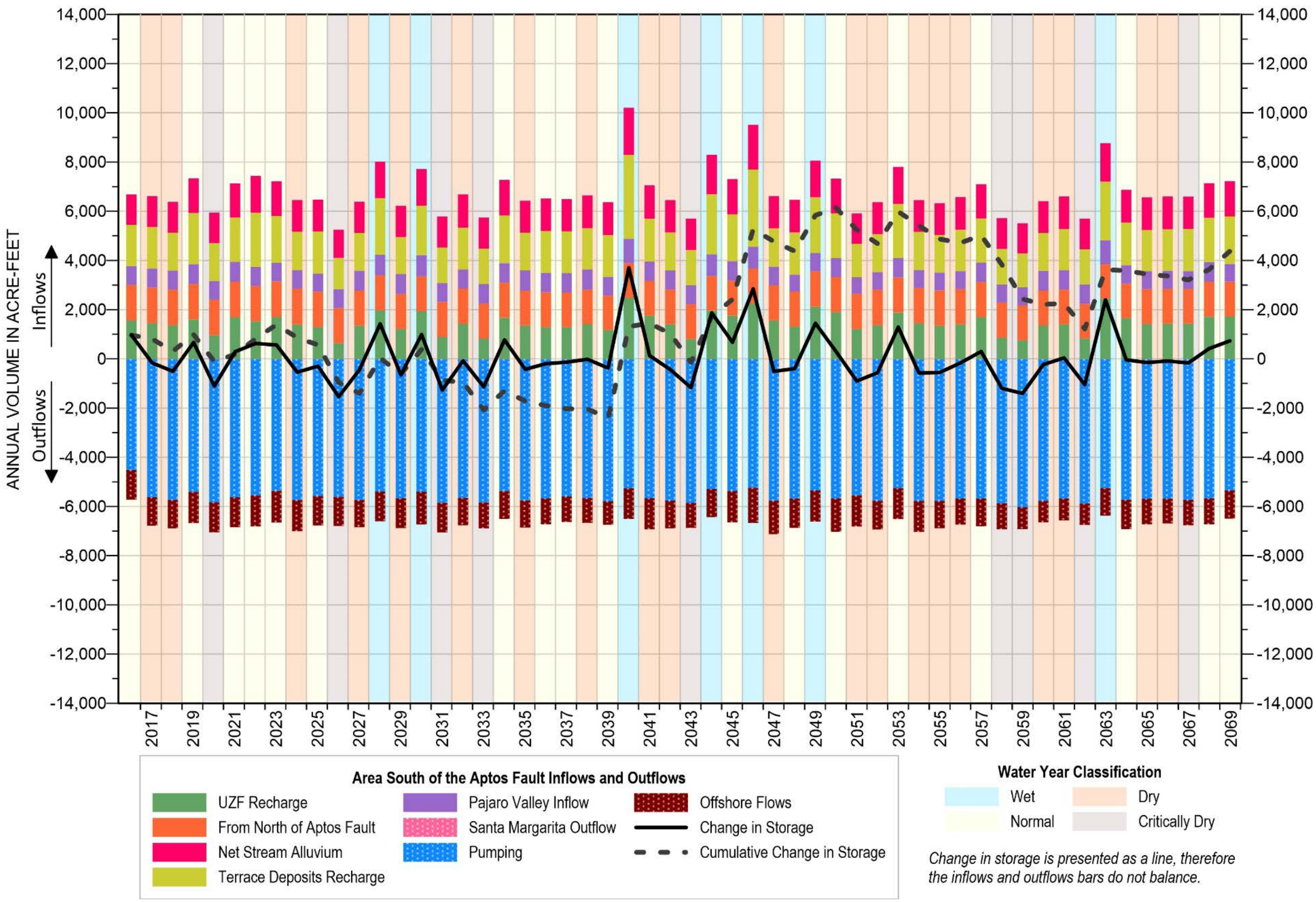

Figure 2-77. South of Aptos Area Faulting Projected Baseline Annual Groundwater Budget (2016 – 2069)

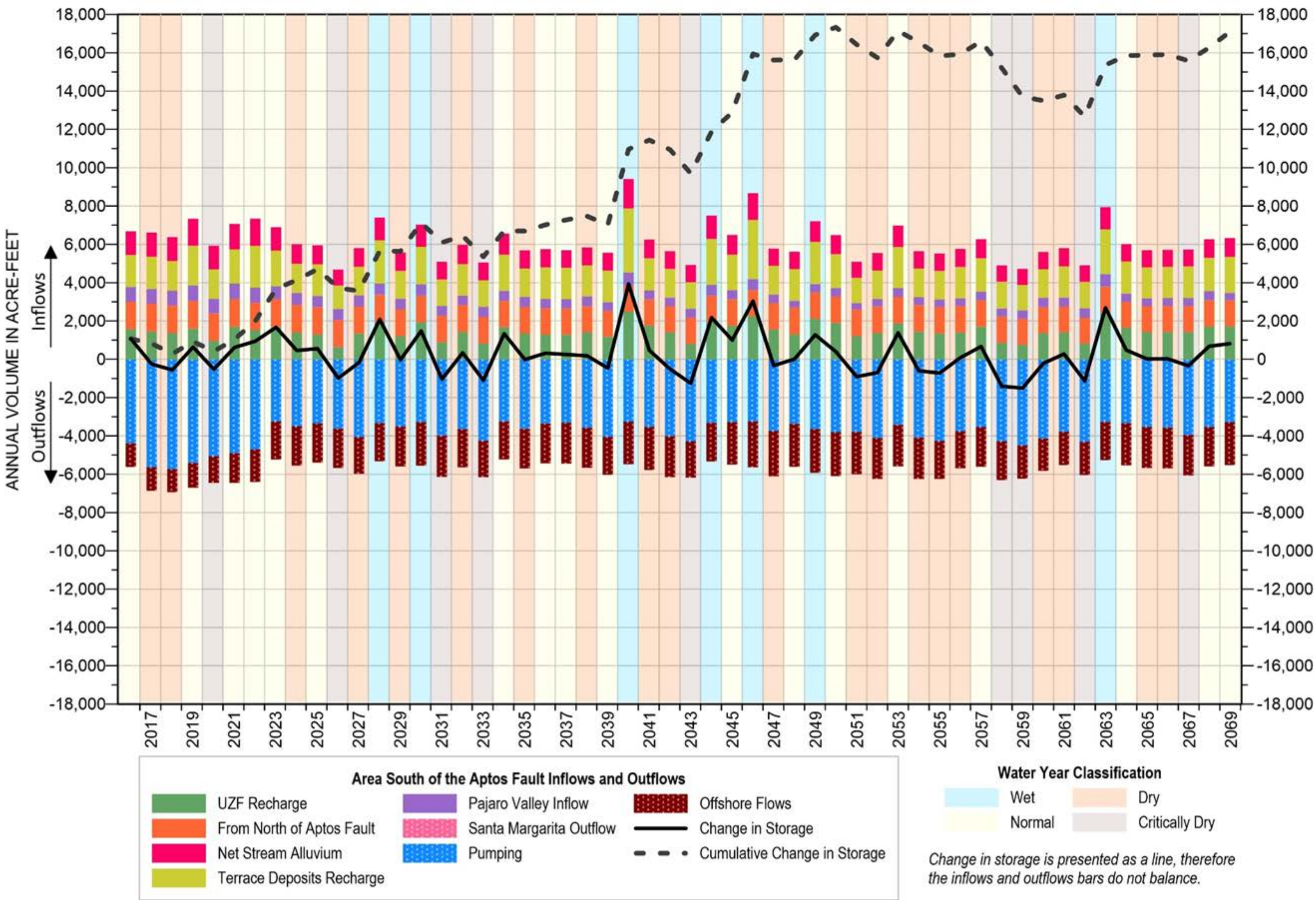

Figure 2-78. South of Aptos Area Faulting Projected GSP Implementation Annual Groundwater Budget (2016 – 2069)

2.2.5.7 Projected Sustainable Yield

The projected sustainable yield is the amount of net Basin pumping that can occur while being able to avoid undesirable results for the applicable sustainability indicators described in Section 3. Section 4 describes the expected benefits of Soquel Creek Water District's Pure Water Soquel project and the City of Santa Cruz's Aquifer Storage and Recovery project as preventing undesirable results in the Basin. Therefore, once the projects are implemented, net Basin pumping is planned to be within the sustainable yield.

The sustainable yield is higher than the net Basin pumping planned with project implementation because the projects have goals beyond achieving minimum thresholds that define undesirable results. Section 4 shows that the projects have expected benefits of achieving or approaching measurable objectives beyond the minimum thresholds that define undesirable results.

To estimate the sustainable yield that is higher than planned net Basin pumping but still avoids undesirable results, sensitivity model runs were conducted to test whether undesirable results would still be avoided if injection was reduced and/or pumping increased at municipal wells. The following summarizes the conclusions of the sensitivity model runs that inform the estimated sustainable yield.

- Long term net injection by City ASR develops a drought supply, but is not necessary for avoiding undesirable results. Reducing pumping at the City's Beltz wells can avoid undesirable results.

- Pumping reductions at Soquel Creek Water District's Garnet and O'Neill Ranch wells planned as part of the Pure Water Soquel project to meet measurable objectives are not necessary to meet minimum thresholds and avoid undesirable results.

- Planned injection at Pure Water Soquel seawater intrusion prevention wells help meet measurable objectives, but lower injection amounts can raise groundwater levels to avoid undesirable results.

Based on the sensitivity model runs, average pumping and injection at municipal pumping that avoid undesirable results is estimated and combined with projected non-municipal pumping to estimate sustainable yield for each of the following aquifer groups:

- Aromas Red Sands aquifer and Purisima F aquifer units,
- Purisima DEF, BC, A, and AA aquifer units, and
- Tu aquifer.

The aquifer groupings are based on how production wells are typically screened through multiple aquifers. The full rationale for the aquifer grouping is provided in Section 3.5.1: Undesirable Results - Reduction of Groundwater Storage.

There may be other combinations of injection and pumping using planned infrastructure or other combinations of projects that can avoid undesirable results. Other combinations would likely result in different estimates of sustainable yield for the aquifer groupings. The estimates of sustainable yield presented here are appropriate for use as minimum thresholds for the reduction in groundwater storage indicator in this GSP because they are estimated to avoid undesirable results and are achievable with the planned projects.

The sustainable yield for each of the aquifer groups and the entire Basin is presented in Table 2-27. The overall projected Basin sustainable yield is 4,870 acre-feet per year, which is just over 1,000 acre-feet less than what was pumped from 2010 to 2015.

Table 2-27. Projected Sustainable Yield

Aquifer Group	Sustainable Yield (acre-feet per year)
Aromas Red Sands and Purisima F	1,650
Purisima DEF, D, BC, A and AA	2,290
Tu	930
Total	**4,870**

2.2.6 Management Areas

SGMA allows groundwater sustainability agencies to define one or more management areas within a groundwater basin if the agency determines that the creation of management areas will facilitate implementation of its GSP. Management areas may define different minimum thresholds and be operated to different measurable objectives than the basin at large, provided that undesirable results are defined consistently throughout the basin.

The GSP Advisory Committee and MGA technical staff considered whether or not to recommend the creation of management areas within the Basin during its meeting #12 on December 12, 2018. MGA technical staff outlined four potential management areas for the committee to consider within the Basin and the reasoning associated with each potential management area.

The GSP Advisory Committee considered the following management areas, and chose to recommend against management areas at this time.

1. **Inland Private Well Area**: Management area could be warranted in inland areas where less frequent monitoring is required because non-municipal domestic groundwater use has less influence on Basin sustainability, most notably seawater intrusion. The Committee discussed the potential impacts of non-municipal domestic groundwater use impacting nearby inland surface waters. Additional monitoring of sustainable management criteria for interconnected surface-water depletion specified in Section 3.9

will likely indicate if further management actions are needed, thus creation of a management area is not required at this time.

2. **Aromas Red Sands Area**: Management area could be warranted where seawater intrusion currently occurs and different sustainable management criteria are set for this area. The Committee discussed that the Aromas Red Sands Area is hydraulically linked to the Pajaro Valley Subbasin and the MGA does not have sole influence over groundwater levels through its management actions. Ongoing monitoring in this area may require additional management actions and inter-basin coordination to address seawater intrusion in this area, but the Committee agreed that creation of a management area is not required at this time.

3. **Area of Municipal Groundwater Production**: Management area could extend one to two miles inland along the majority of the coastline of the Basin where all municipal wells are located that influence coastal groundwater levels. This area also includes larger institutional groundwater users: Cabrillo College and Seascape Golf Course. The Committee was asked to consider extending a management area inland to 50 feet above mean sea level groundwater elevation because this area is the most vulnerable to seawater intrusion and pumping in this area has the greatest impact on coastal groundwater levels. It is also the area where supplemental water supply projects are most likely to be implemented. While the Committee agreed that ongoing groundwater monitoring was necessary the Committee agreed that creation of a management area is not required at this time.

4. **Alluvial Channels of Major Creeks**: Management area could be warranted if pumping wells connected to shallow alluvium require the future installation of meters to monitor groundwater extractions that may influence creek baseflows. While the Committee agreed that this is an example of how a certain area may require a specific management approach, the Committee agreed that creation of a management area is not required at this time.

Management areas were not recommended because the overall sustainability goals (minimum thresholds and measurable objectives) apply to the entire MGA Basin. These goals are specifically defined for each sustainability indicator and each representative monitoring location. Because representative monitoring locations and monitoring requirements are set specifically for each sustainability indicator, the technical staff and the GSP Advisory Committee found no additional benefit to establishing separate management areas within the Basin.

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3 SUSTAINABILITY MANAGEMENT CRITERIA

This section defines the conditions that direct sustainable groundwater management in the Santa Cruz Mid-County Basin, discusses the process by which the MGA characterizes undesirable results, and establishes minimum thresholds and measurable objectives for each sustainability indicator. The undesirable results, minimum thresholds, and measurable objectives define the Basin's future conditions and commits the MGA to meet these objectives. Defining Sustainable Management Criteria (SMC) requires a significant level of analysis and scrutiny, and this section includes explanation of how SMC were developed and how they influence all beneficial uses and users of groundwater.

3.1 Sustainability Goal

As required by the SGMA regulations, the MGA developed a sustainability goal for the Basin, which is to:

> Manage the groundwater Basin to ensure beneficial uses and users have access to a safe and reliable groundwater supply that meets current and future Basin demand without causing undesirable results to:

- Ensure groundwater is available for beneficial uses and a diverse population of beneficial users;
- Protect groundwater supply against seawater intrusion;
- Prevent groundwater overdraft within the Basin and resolves problems resulting from prior overdraft;
- Maintain or enhance groundwater levels where groundwater dependent ecosystems exist;
- Maintain or enhance groundwater contributions to streamflow;
- Ensure operational flexibility within the Basin by maintaining a drought reserve;
- Support reliable groundwater supply and quality to promote public health and welfare;
- Account for changing groundwater conditions related to projected climate change and sea level rise in Basin planning and management;
- Do no harm to neighboring groundwater basins in regional efforts to achieve groundwater sustainability.

3.2 Sustainable Management Criteria

This section defines the groundwater conditions that constitute sustainable groundwater management, discusses the process by which the MGA characterizes undesirable results, and establishes minimum thresholds and measurable objectives for each applicable sustainability indicator. Undesirable results, minimum thresholds, and measurable objectives together define sustainable conditions in the Basin and commit the MGA to actions that will achieve those conditions. These SGMA specific terms and others are defined in the Glossary.

Defining Sustainable Management Criteria (SMC) requires significant analysis and scrutiny. This section presents the data and methods used to develop SMC and demonstrates how they influence beneficial uses and users. The SMC are based on currently available data and the application of best available science. As noted in this GSP, data gaps exist in the hydrogeologic conceptual model related to the interconnection of surface water and groundwater. Uncertainty caused by these data gaps was considered when developing the SMC. Due to uncertainty in the hydrogeologic conceptual model, the SMC are considered initial criteria that will be reevaluated and potentially modified in the future as new data becomes available.

This section is organized to address all of the SGMA regulations regarding SMC. To retain an organized approach that focuses on SMC for each individual sustainability indicators, the SMC are grouped by sustainability indicator. Each subsection follows a consistent format that contains the information required by Section §354.22 *et. seq* of the SGMA regulations and outlined in the Sustainable Management Criteria BMP (DWR, 2017). Each Sustainable Management Criteria section includes a description of:

- How locally defined significant and unreasonable conditions were developed.
- How undesirable results were developed, including:
    - The criteria defining when and where the effects of the groundwater conditions cause undesirable results based on a quantitative description of the combination of minimum threshold exceedances (§354.26 (b)(2)).
    - The potential causes of undesirable results (§354.26 (b)(1)).
    - The effects of these undesirable results on the beneficial users and uses (§354.26 (b)(3)).
- How minimum thresholds were developed, including:
    - The information and methodology used to develop minimum thresholds (§354.28 (b)(1)).
    - The relationship between minimum thresholds and the relationship of these minimum thresholds to other sustainability indicators (§354.28 (b)(2)).
    - The effect of minimum thresholds on neighboring basins (§354.28 (b)(3)).
    - The effect of minimum thresholds on beneficial uses and users (§354.28 (b)(4))
    - How minimum thresholds relate to relevant Federal, State, or local standards (§354.28 (b)(5)).
    - The method for quantitatively measuring minimum thresholds (§354.28 (b)(6)).
- How measurable objectives were developed, including:
    - The methodology for setting measurable objectives (§354.30).
    - Interim milestones (§354.30 (a), §354.30 (e), §354.34 (g)(3)).

3.2.1 Process of Developing Sustainable Management Criteria

Development of SMC involved initial proposals by staff, followed by discussion and refinement by the GSP Advisory Committee over multiple meetings. Prior to discussing SMCs for a particular sustainability indicator with the GSP Advisory Committee, the members were provided background information on the status of the indicator in the Basin and a brief on the groundwater conditions pertaining to the indicator. This information was provided both in written materials included in the meeting agenda packet and a presentation that was made during the meeting. Discussion during the meeting facilitated additional information sharing and clarity. Once there was comfort in understanding Basin conditions related to the sustainability indicator, the technical consultant described possible options or proposals for indicator specific significant and unreasonable groundwater conditions that indicate the Basin was unsustainable.

Based on the qualitative statement of significant and unreasonable conditions that was formed by the Committee, the same approach of providing several options for the quantitative criteria: undesirable results and minimum thresholds, were provided to the GSP Advisory Committee for consideration. This approach was taken so that it could be understood that within the various options, there are relative levels of protectiveness. Meeting summaries posted on the MGA website reflect the discussions that took place for each sustainability indicator.

Farther along in the SMC development process when minimum thresholds were generally agreed upon, options for measurable objectives were presented and discussed by the Committee. Several iterations of providing options were afforded each sustainability indicator which allowed for continual improvements to the criteria. Additionally, opportunities for public comment on the topics being discussed at the GSP Advisory Committee meetings were provided and taken into consideration during development of the SMCs.

Interim milestones were developed based on current conditions and modeled groundwater levels and did not have direct GSP Advisory Committee input.

3.3 Monitoring Network

This subsection describes the monitoring networks that currently exist in the Basin to monitor Basin conditions and that will continue to be used during GSP implementation, Representative Monitoring Points (RMPs) for which sustainable management criteria are set, and improvements to the monitoring networks that will be made as part of GSP implementation. It also includes a description of monitoring objectives, monitoring protocols, and data requirements. The monitoring network subsection is before the sustainability management criteria (SMC) subsection because it is important to describe the representative monitoring networks that measure Basin sustainability before SMC associated with the RMPs in the networks are provided.

The monitoring networks included in this subsection are based on existing monitoring networks described generally in Section 2.1.2: Water Resources Monitoring and Management Programs. To be able to relate monitoring features to sustainability indicators, monitoring networks are described below for each of the information types that are needed to evaluate the applicable sustainability indicators.

3.3.1 Description of Monitoring Networks

The SGMA regulations require monitoring networks be developed to promote the collection of data of sufficient quality, frequency, and spatial distribution to characterize groundwater and related surface water conditions in the Basin, and to evaluate changing conditions that occur during implementation of the GSP. Monitoring networks should accomplish the following:

- Demonstrate progress toward achieving measurable objectives described in the GSP.
- Monitor impacts to the beneficial uses and users of groundwater.
- Monitor changes in groundwater conditions relative to measurable objectives and minimum thresholds.
- Quantify annual changes in water budget components.

The Santa Cruz Mid-County Basin's existing monitoring networks have been used for several decades to collect information to demonstrate short-term, seasonal, and long-term trends in groundwater and related surface conditions. The monitoring networks include features for the collection of data to monitor the five groundwater sustainability indicators that are applicable to the Basin: chronic lowering of groundwater levels, seawater intrusion, depletion of interconnected surface water, reduction of groundwater in storage, and degraded groundwater quality (Table 3-1). As discussed in Section 2: Basin Setting, land subsidence is not an applicable sustainability indictor in the Basin and therefore monitoring of land surface elevations is not included in the current monitoring network. Section 3.3.1.5 does however include a source of monitoring data for land surface elevations in the Basin that is provided by public agencies not part of the MGA.

Table 3-1. Applicable Sustainability Indicators in the Santa Cruz Mid-County Basin

Sustainability Indicator	Metric	Proxy
Chronic Lowering of Groundwater Levels	Groundwater elevation	-
Reduction of Groundwater in Storage	Volume of groundwater extracted	-
Seawater Intrusion	Chloride concentration	Groundwater elevation
Degraded Groundwater Quality	Concentration	-
Depletion of Interconnected Surface Water	Volume or rate of streamflow	Groundwater elevation

3.3.1.1 Groundwater Level Monitoring Network

Each MGA member agency has its own network of dedicated monitoring wells and production wells that monitor groundwater elevations in its own service area or area of jurisdiction. Many of these monitoring sites have been used to manage the Basin since the 1980's which was prior to completion of the 1995 Groundwater Management Plan (GMP) that covered the Soquel-Aptos area. These individual networks are combined into the GMP monitoring network, as described in Section 2.1.2: Water Resources Monitoring and Management Programs. The GMP monitoring network has been added to and maintenance of the network has included replacing monitoring wells when they are damaged. Almost all monitoring wells and all production wells have data loggers to continuously monitor groundwater levels. Shallow monitoring wells used to monitor surface water / groundwater interactions are also included in this extensive GMP monitoring network.

Table 3-2 summarizes the number of wells included in the existing GMP monitoring network across the Basin to monitor groundwater levels. Figure 3-1 is a map showing the basin-wide distribution of groundwater level monitoring wells. The aquifers monitored by each well with their frequency of monitoring are listed in Table 3-3. With 170 wells in the Basin monitored at least twice a year, the network is demonstrably extensive and sufficient to evaluate short-term, seasonal, and long-term trends in groundwater for groundwater management purposes. Groundwater level data from many of the wells have been used since 2006 to generate fall and spring groundwater elevation contours for all of the Basin's aquifers. As there are multiple well clusters with monitoring wells completed in different aquifers at the same location included throughout the Basin, these are used to understand changes in vertical gradients between aquifers.

Table 3-2. Summary of MGA Member Agency Monitoring Well Network for Groundwater Levels

Member Agency	Number of Wells			
	Monitoring Wells	Production Wells	Total in Network	Representative Monitoring Wells
City of Santa Cruz	34	4	38	7
Soquel Creek Water District	78	17	95	26
Central Water District	6	3	9	2
Santa Cruz County	0	27	27	2
Total	*118*	*51*	*169*	*37*

Note: each well in a cluster of multi-depth wells is counted as a separate well

The groundwater level monitoring network accomplishes the following for each sustainability indicator that relies on groundwater levels either directly or using groundwater levels as a proxy to determine Basin sustainability:

- Chronic Lowering of Groundwater Levels: Monitoring wells are distributed throughout the Basin in all the aquifers used for groundwater production, and the distribution of wells is sufficient to develop groundwater elevation contours for each aquifer.

- Seawater Intrusion: The monitoring network includes coastal monitoring wells that are used to monitor seawater intrusion through groundwater quality and groundwater levels as a proxy. Each location has multiple monitoring wells completed at different depths within the productive aquifers. Protective groundwater elevations are established at each of these locations to prevent seawater intrusion. Two additional monitoring wells, one in the Tu-unit and one in the Purisima AA-unit, are needed to complete the monitoring network as described in Section 3.3.4.1: Groundwater Level Monitoring Data Gaps.

- Depletion of Interconnected Surface Water: The current shallow monitoring wells used to monitor and evaluate interactions between surface water and groundwater are focused on the lower stretch of Soquel Creek where there are several municipal production wells. In addition, there are multiple depth monitoring well clusters near Soquel Creek that are included in the evaluation of surface water and groundwater interactions. Eight new shallow monitoring wells will be added to complete the monitoring network to better evaluate the effects of groundwater extractions on streamflow in interconnected surface waters (see Section 3.3.4.1: Groundwater Level Monitoring Data Gaps.)

Each agency will use its own resources to continue to monitor these wells as the GSP is implemented. Groundwater level data collected, both hand soundings and recorded by data loggers, for each well will be stored in the WISKI DMS.

The only data gaps that exist for the groundwater level monitoring network are two deep coastal monitoring wells to monitor seawater intrusion in the Tu and Purisima AA aquifers, and eight shallow monitoring wells to monitor depletion of interconnected surface water. These are discussed in more detail in Section 3.3.4.1: Groundwater Level Monitoring Data Gaps.

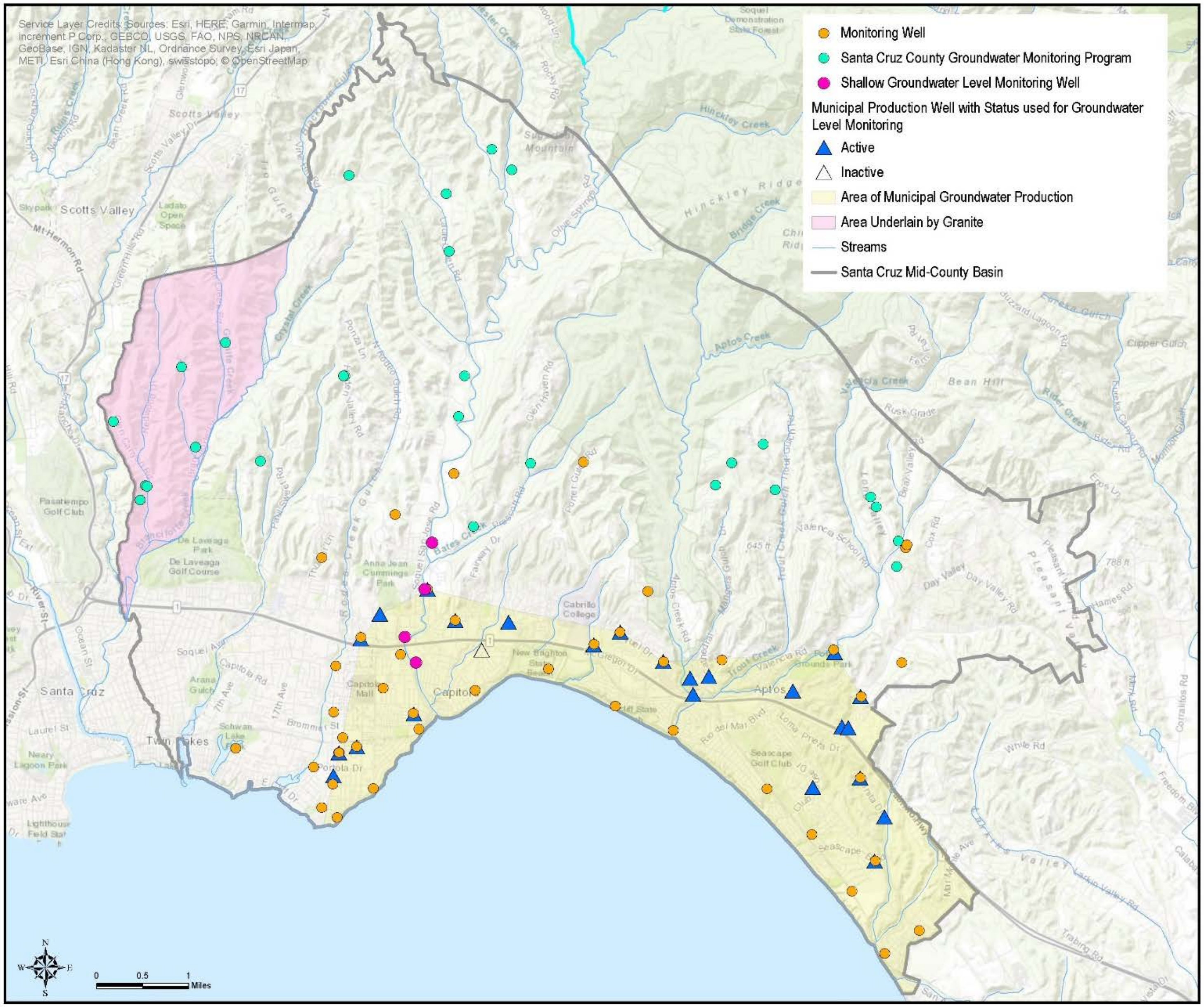

Figure 3-1. Location of Existing Basin-Wide Wells Used for Groundwater Level Monitoring

Table 3-3. Monitoring Wells for Groundwater Levels in the Santa Cruz Mid-County Basin

Aquifer Unit	Well Name	Monitoring Agency	Sounding Frequency	Data Logger
Shallow Well for Surface Water Interactions	**Balogh [1]**	SqCWD	Quarterly	y
	Main St SW 1 [1]	SqCWD	Quarterly	y
	Wharf Road SW [1]	SqCWD	Quarterly	y
	Nob Hill SW 2[1]	SqCWD	Quarterly	y
Various	27 Private Domestic Wells Unnamed for Privacy Reasons **(2 wells used as RMPs) [3]**	Santa Cruz County	Semi- Annually	n
Aromas	SC-A1C	SqCWD	Quarterly	y
	SC-A1D	SqCWD	Quarterly	y
	SC-A2RC	SqCWD	Quarterly	y
	SC-A3A [2]	**SqCWD**	**Quarterly**	**y**
	SC-A3B	SqCWD	Quarterly	y
	SC-A3C	SqCWD	Quarterly	y
	SC-A5C	SqCWD	Quarterly	y
	SC-A5D	SqCWD	Quarterly	y
	SC-A6C	SqCWD	Monthly	n
	SC-A7C [3]	**SqCWD**	**Monthly**	**n**
	SC-A7D	SqCWD	Monthly	n
	SC-A8B	SqCWD	Quarterly	y
	SC-A8C	SqCWD	Quarterly	y
	CWD-12A	CWD	Quarterly	n
	CWD-12B	CWD	Quarterly	n
	CWD-10 PW	CWD	Monthly	n
Aromas/ Purisima F	Polo Grounds PW	SqCWD	Annually	y
	Aptos Jr. High 2 PW	SqCWD	Annually	y
	Country Club PW	SqCWD	Annually	y
	Bonita PW	SqCWD	Annually	y
	San Andreas PW	SqCWD	Annually	y
	Seascape PW	SqCWD	Annually	y
	CWD-4 PW	CWD	Monthly	y
	CWD-12 PW	CWD	Monthly	y
Purisima F	SC-20A	SqCWD	Quarterly	y
	SC-20B	SqCWD	Quarterly	y
	SC-20C	SqCWD	Quarterly	y

Aquifer Unit	Well Name	Monitoring Agency	Sounding Frequency	Data Logger
	SC-23C [3]	**SqCWD**	**Quarterly**	**y**
	SC-8RF	SqCWD	Quarterly	y
	SC-A1B [2]	**SqCWD**	**Quarterly**	**y**
	SC-A2RA [2]	**SqCWD**	**Quarterly**	**y**
	SC-A2RB	SqCWD	Quarterly	y
	SC-A5A	SqCWD	Quarterly	y
	SC-A5B	SqCWD	Quarterly	y
	SC-A6A	SqCWD	Quarterly	n
	SC-A6B	SqCWD	Quarterly	n
	SC-A7A	SqCWD	Monthly	n
	SC-A7B	SqCWD	Monthly	n
	SC-A8A [2]	**SqCWD**	**Quarterly**	**y**
	CWD-12C	CWD	Quarterly	n
	Black [3]	**CWD**	**Monthly**	**n**
	CWD-3	CWD	Monthly	n
	CWD-5 [3]	**CWD**	**Monthly**	**y**
Purisima DEF	**SC-8RD** [2]	**SqCWD**	**Quarterly**	**y**
	SC-8RE	SqCWD	Quarterly	y
	SC-9RE	SqCWD	Quarterly	y
	SC-11RD [3]	**SqCWD**	**Quarterly**	**y**
	SC-17C	SqCWD	Monthly	n
	SC-17D	SqCWD	Monthly	n
	SC-23B [3]	**SqCWD**	**Quarterly**	**y**
	SC-A1A	SqCWD	Quarterly	y
	T. Hopkins PW	SqCWD	Annually	y
	Granite Way PW	SqCWD	Annually	y
Purisima BC	SC-1B	SqCWD	Monthly April – Nov, otherwise Quarterly	y
	SC-3RC	SqCWD	Quarterly	y
	SC-5RC	SqCWD	Quarterly	y
	SC-8RB [2]	**SqCWD**	**Quarterly**	**y**
	SC-8RC	SqCWD	Quarterly	y
	SC-9RC [2]	**SqCWD**	**Quarterly**	**y**
	SC-11RB [3]	**SqCWD**	**Quarterly**	**y**
	SC-14B	SqCWD	Monthly	n

Aquifer Unit	Well Name	Monitoring Agency	Sounding Frequency	Data Logger
	SC-14C	SqCWD	Monthly	n
	SC-16B	SqCWD	Monthly	n
	SC-17B	SqCWD	Monthly	n
	SC-19 [3]	**SqCWD**	**Monthly**	**n**
	SC-23A [3]	**SqCWD**	**Quarterly**	**y**
	Madeline 2 PW	SqCWD	Annually	y
	Ledyard PW	SqCWD	Twice monthly	n
	Aptos Creek PW	SqCWD	Annually	y
Purisima B	SC-3RB	SqCWD	Quarterly	y
	SC-5RB	SqCWD	Quarterly	y
Purisima A	**SC-1A** [2]	**SqCWD**	**Monthly April – Nov, otherwise Quarterly**	**y**
	SC-5RA [2]	**SqCWD**	**Quarterly**	**y**
	SC-8RA	SqCWD	Quarterly	y
	SC-9RA	SqCWD	Quarterly	y
	SC-10RA [1]	SqCWD	Quarterly	y
	SC-15B	SqCWD	Quarterly	y
	SC-17A	SqCWD	Monthly	n
	SC-21A	SqCWD	Quarterly	y
	SC-22A [3]	**SqCWD**	**Monthly April – Nov, otherwise Quarterly**	**y**
	Tannery 2 PW	SqCWD	Annually	y
	Estates PW	SqCWD	Annually	y
	Garnet PW	SqCWD	Annually	y
	Main St. PW	SqCWD	Annually	y
	Rosedale PW	SqCWD	Annually	y
	Corcoran Lagoon Med.	City	Monthly	y
	Corcoran Lagoon S.	City	Monthly	n
	Moran Lake Medium [2]	**City**	**Monthly**	**y**
	Moran Lake Shallow	City	Monthly	n
	Beltz #2	City	Monthly	y
	Beltz #4 Deep	City	Monthly	y
	Beltz #4 Shallow	City	Monthly	n
	Soquel Point Shallow	City	Monthly	n
	Soquel Point Medium [2]	**City**	**Monthly**	**y**

Aquifer Unit	Well Name	Monitoring Agency	Sounding Frequency	Data Logger
	Pleasure Point Medium [2]	**City**	**Monthly**	**y**
	Pleasure Point Shallow	City	Monthly	n
	Coffee Lane Shallow [3]	**City**	**Monthly**	**y**
	Auto Plaza Med	City	Monthly	y
	Auto Plaza Shallow	City	Monthly	n
	Cory Street Medium	City	Monthly	y
	Cory Street Shallow	City	Monthly	n
	30th Ave Shallow (3)	City	Monthly	y
	Beltz #8 PW	City	Annually	y
	Beltz #9 PW	City	Annually	y
	Beltz #7 Shallow	City	Monthly	n
	Beltz #6	City	Monthly	n
Purisima A/AA	SC-11RA	SqCWD	Quarterly	y
	SC-14A	SqCWD	Monthly	n
	SC-16A	SqCWD	Quarterly	y
	SC-3RA [2]	**SqCWD**	**Quarterly**	**y**
	Beltz #10 PW	City	Annually	y
	Beltz #7 Deep	City	Monthly	n
Purisima AA	**SC-10RAA [3]**	**SqCWD**	**Quarterly**	**y**
	SC-15A	SqCWD	Quarterly	y
	SC-18RA	SqCWD	Quarterly	y
	SC-21AA	SqCWD	Quarterly	y
	SC-21AAA	SqCWD	Quarterly	y
	SC-22AA [3]	**SqCWD**	**Monthly April – Nov, otherwise Quarterly**	**y**
	SC-22AAA	SqCWD	Quarterly, with Monthly visits April - Nov	y
	Corcoran Lagoon Deep	City	Monthly	y
	Moran Lake Deep [2]	**City**	**Monthly**	**y**
	Soquel Point Deep [2]	**City**	**Monthly**	**y**
	Pleasure Point Deep [2]	**City**	**Monthly**	**y**
	Schwan Lake	City	Monthly	y
	Coffee Lane Deep	City	Monthly	y
	Auto Plaza Deep	City	Monthly	y
	Cory Street Deep	City	Monthly	y

Aquifer Unit	Well Name	Monitoring Agency	Sounding Frequency	Data Logger
	30th Ave Medium (2)	City	Monthly	y
	Thurber Lane Shallow	City	Monthly	y
Purisima AA/Tu	Beltz #12 PW	City	Annually	y
	O'Neill Ranch PW	SqCWD	Annually	y
Tu	SC-10AAA	SqCWD	Quarterly	y
	SC-13A [2]	**SqCWD**	**Quarterly**	**y**
	SC-18RAA	SqCWD	Quarterly	y
	Cory Street-4	City	Monthly	y
	30th Ave Deep (1)	City	Monthly	y
	Beltz #7 SM Test	City	Monthly	y
	Thurber Lane Deep	City	Monthly	y

PW = production well; City = City of Santa Cruz, SqCWD = Soquel Creek Water District; CWD = Central Water District; monitoring wells in bold are representative monitoring points (RMP) for groundwater elevations; [1] = RMP for depletion of interconnected surface water; [2 =] RMP for seawater intrusion; [3 =] RMP for chronic lowering of groundwater levels

3.3.1.2 Groundwater Quality Monitoring Network

Each MGA member agency monitors a network of dedicated monitoring wells and production wells for groundwater quality in its service area or area of jurisdiction. These monitoring sites have been used to manage the Basin and added to since the 1980's which was prior to completion of the 1995 Groundwater Management Plan that covered the Soquel-Aptos area. Table 3-4 summarizes the wells included in the existing monitoring network across the Basin. A map showing the distribution of monitoring wells used to sample groundwater quality is shown on Figure 3-2, and the aquifers monitored by each well with their frequency of sampling are listed in Table 3-5. There is no established inland groundwater quality monitoring network within the areas outside of the MGA member water supply agency sphere of influence where predominantly private domestic and agricultural extractions take place. As described in Section 2: Basin Setting, groundwater quality in the inland Purisima aquifer areas of the Basin is very good, with the exception of occasional low concentrations of native arsenic, and elevated naturally occurring iron and manganese. The Aromas area of the Basin is more susceptible to surface sources of contamination because the underlying aquifers are unconfined and highly permeable. The distribution and sampling frequency of monitoring and production wells used for sampling groundwater quality reflects locational and aquifer depth susceptibility to contamination, including from seawater. Iron and manganese are sampled more frequently in municipal production wells as a necessary step in the iron and manganese treatment process.

Table 3-4. Summary of MGA Member Agency Monitoring Well Network for Groundwater Quality

Member Agency	Number of Wells			
	Monitoring Wells	Production Wells	Total in Network	Representative Monitoring Wells
City of Santa Cruz	28	4	32	18
Soquel Creek Water District	51	17	68	47
Central Water District	0	3	3	3
Total	*79*	*24*	*103*	*68*

Note: each well in a cluster of multi-depth wells is counted as a separate well

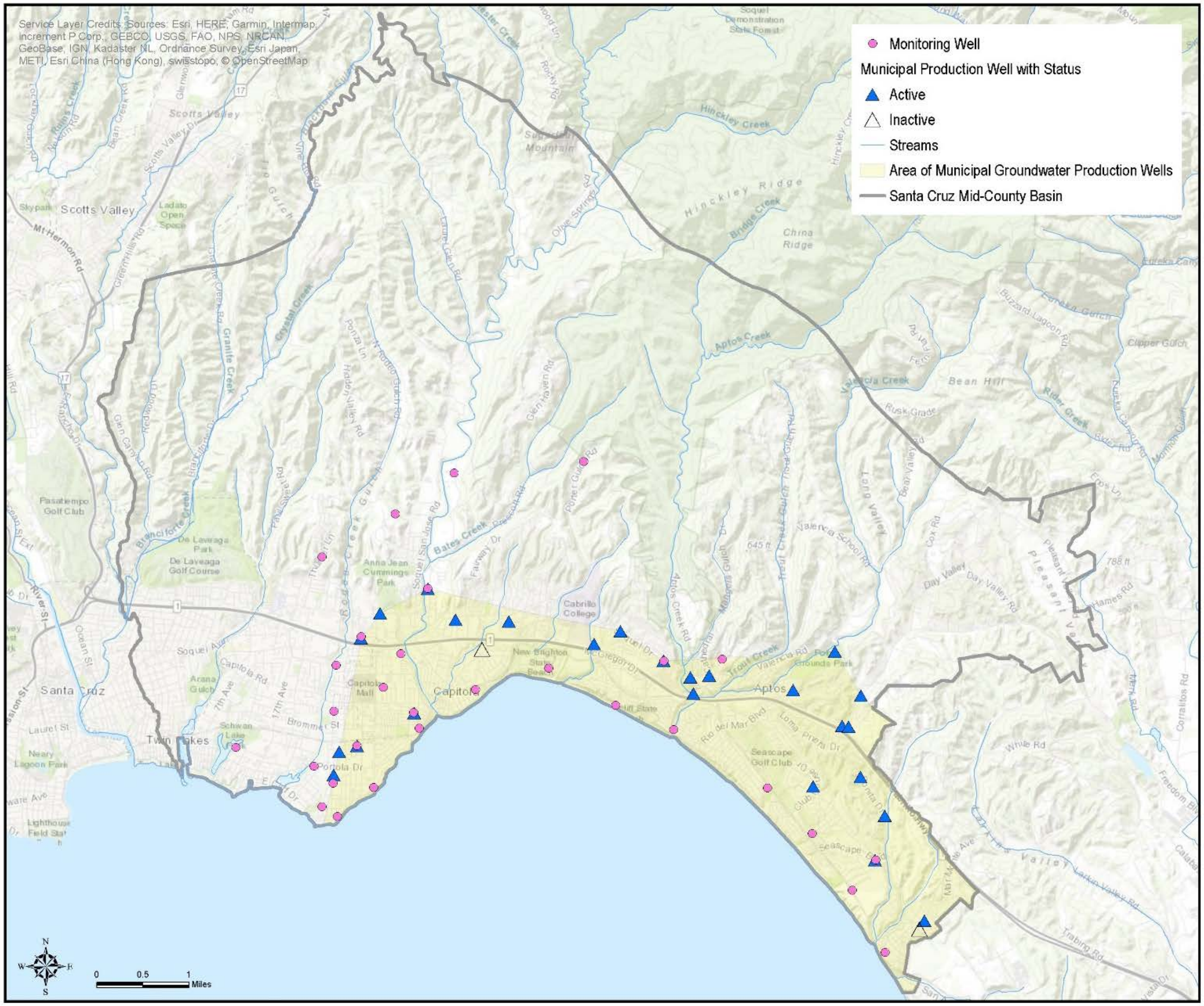

Figure 3-2. Location of Basin-Wide Wells Used for Groundwater Quality Monitoring

Table 3-5. Monitoring Wells for Groundwater Quality in the Santa Cruz Mid-County Basin

Aquifer Unit	Well Name	General Mineral Sampling Frequency	Chloride and TDS Sampling Frequency
Aromas	Altivo PW	Semi-Annually	Quarterly
	CWD-10 PW [1]	**Triennial, nitrate as (N) Annually**	**Triennial**
	SC-A1C [1]	**Annually**	**Quarterly**
	SC-A1D	Semi-Annually	Quarterly
	SC-A2RC [1]	**Semi-Annually**	**Quarterly**
	SC-A3A [1 2]	**Annually**	**Quarterly**
	SC-A3B [2]	**Annually**	**Quarterly**
	SC-A3C [1]	**Annually**	**Quarterly**
	SC-A5C	Semi-Annually	Quarterly
	SC-A5D	Annually	Quarterly
	SC-A8B [1 2]	**Semi-Annually**	**Quarterly**
	SC-A8C [1]	**Annually**	**Quarterly**
Aromas/ Purisima F	**Polo Grounds PW [1]**	**Semi-Annually, nitrate (as N) Annually**	**Quarterly**
	Aptos Jr. High 2 PW [1]	**Semi-Annually, nitrate (as N) Annually**	**Quarterly**
	Country Club PW [1]	**Semi-Annually, nitrate (as N) Annually**	**Quarterly**
	Bonita PW [1]	**Semi-Annually, nitrate (as N) Annually**	**Quarterly**
	San Andreas PW [1 2]	**Semi-Annually, nitrate (as N) Annually**	**Quarterly**
	Seascape PW [1 2]	**Semi-Annually, nitrate (as N) Annually**	**Quarterly**
Purisima F	**CWD-4 PW [1]**	**Triennial, nitrate as (N) Annually**	**Triennial**
	CWD-12 PW [1]	**Triennial, nitrate as (N) Annually**	**Triennial**
	SC-23C	Annually	Semi-Annually
	SC-8RF	Annually	Semi-Annually
	SC-A1B [2]	**Annually**	**Semi-Annually**
	SC-A2RA [1 2]	**Annually**	**Quarterly**
	SC-A2RB [2]	**Semi-Annually**	**Quarterly**
	SC-A5A [2]	**Annually**	**Quarterly**
	SC-A5B [2]	**Annually**	**Quarterly**
	SC-A8A [1 2]	**Annually**	**Quarterly**
Purisima DEF	**T-Hopkins PW [1 2]**	**Annually**	**Annually**
	Granite Way PW [1]	**Annually**	**Annually**

Aquifer Unit	Well Name	General Mineral Sampling Frequency	Chloride and TDS Sampling Frequency
	SC-8RD [1] [2]	**Annually**	**Semi-Annually**
	SC-8RE	Annually	Semi-Annually
	SC-9RE [1]	**Annually**	**Semi-Annually**
	SC-11RD	Semi-Annually	Semi-Annually
	SC-23B	Annually	Annually
	SC-A1A [1] [2]	**Semi-Annually**	**Quarterly**
Purisima BC	**Ledyard PW [1] [2]**	**Annually**	**Annually**
	Madeline 2 PW [1]	**Annually**	**Annually**
	Aptos Creek PW [1]	**Annually**	**Annually**
	SC-3RC [1]	**Annually**	**Semi-Annually**
	SC-23A [1]	**Annually**	**Annually**
	SC-8RB [1] [2]	**Semi-Annually**	**Semi-Annually**
	SC-8RC	Semi-Annually	Semi-Annually
	SC-9RC [1] [2]	**Annually**	**Semi-Annually**
	SC-11RB	Annually	Semi-Annually
	SC-17B	Annually	Semi-Annually
Purisima B (Aquitard)	SC-3RB	Annually	Annually
	SC-5RB	Annually	Annually
Purisima A	**30th Ave Shallow (3) [1]**	**Semi-Annually**	**Semi-Annually**
	Auto Plaza Medium	Semi-Annually	Semi-Annually
	Auto Plaza Shallow	Semi-Annually	Semi-Annually
	Corcoran Lagoon Med.	Semi-Annually	Semi-Annually
	Corcoran Lagoon S.	Semi-Annually	Semi-Annually
	Cory Street Medium	Semi-Annually	Semi-Annually
	Cory Street Shallow	Semi-Annually	Semi-Annually
	Pleasure Point Medium [2]	**Quarterly**	**Quarterly**
	Pleasure Point Shallow [1]	**Quarterly**	**Quarterly**
	Beltz #2 [2]	**Semi-Annually**	**Semi-Annually**
	Moran Lake Medium [2]	**Quarterly**	**Quarterly**
	Moran Lake Shallow	Quarterly	Quarterly
	Soquel Point Medium [2]	**Quarterly**	**Quarterly**
	Soquel Point Shallow	Quarterly	Quarterly
	Tannery II PW [1]	**Annually**	**Annually**
	Estates PW [1] [2]	**Annually**	**Annually**

Aquifer Unit	Well Name	General Mineral Sampling Frequency	Chloride and TDS Sampling Frequency
	Main Street PW [1]	**Annually**	**Annually**
	Rosedale 2 PW [1]	**Annually**	**Annually**
	Garnet PW [1,2]	**Annually**	**Annually**
	Beltz #6	Semi-Annually	Semi-Annually
	Beltz #8 PW [1,2]	**Triennial, iron & manganese quarterly, nitrate (as N) Annually**	**Triennial**
	Beltz #9 PW [1]	**Triennial, iron & manganese quarterly, nitrate (as N) Annually**	**Triennial**
	SC-1A [2]	**Annually**	**Annually**
	SC-3RA [2]	**Annually**	**Annually**
	SC-5RA [1,2]	**Semi-Annually**	**Semi-Annually**
	SC-8RA	Quarterly	Quarterly
	SC-9RA [1]	**Quarterly**	**Quarterly**
	SC-10RA [1]	**Annually**	**Annually**
	SC-21A	Annually	Annually
	SC-22A [1]	**Annually**	**Annually**
Purisima A/AA	**Beltz #10 PW [1]**	**Triennial, iron & manganese quarterly, nitrate (as N) Annually**	**Triennial**
	SC-11RA	Annually	Annually
Purisima AA	**SC-10RAA [1]**	**Annually**	**Annually**
	SC-18RA	Annually	Annually
	SC-21AA	Annually	Annually
	SC-21AAA	Quarterly	Quarterly
	SC-22AA [2]	**Semi-Annually**	**Quarterly**
	SC-22AAA [1]	**Semi-Annually**	**Quarterly**
	30th Ave Medium (2)	Semi-Annually	Semi-Annually
	Auto Plaza Deep	Semi-Annually	Semi-Annually
	Coffee Lane Deep [1]	**Semi-Annually**	**Semi-Annually**
	Corcoran Lagoon Deep [2]	**Semi-Annually**	**Semi-Annually**
	Cory Street Deep	Semi-Annually	Semi-Annually
	Pleasure Point Deep [1,2]	**Quarterly**	**Quarterly**
	Moran Lake Deep [2]	**Quarterly**	**Quarterly**
	Soquel Point Deep [2]	**Quarterly**	**Quarterly**
	Thurber Lane Shallow [1]	**Annually**	**Annually**

Aquifer Unit	Well Name	General Mineral Sampling Frequency	Chloride and TDS Sampling Frequency
	Schwan Lake [1] [2]	**Semi-Annually**	**Semi-Annually**
Purisima AA/Tu	**O'Neill Ranch PW [1]**	**Annually**	**Annually**
	Beltz #12 PW [1]	**Triennial, iron & manganese quarterly, nitrate (as N) Annually**	**Triennial**
Tu	30th Ave Deep (1)	Semi-Annually	Semi-Annually
	Cory Street-4	Semi-Annually	Semi-Annually
	Thurber Lane Deep [1]	**Annually**	**Annually**
	SC-10RAAA	Semi-Annually	Semi-Annually
	SC-13A [2]	**Quarterly**	**Quarterly**
	SC-18RAA [1]	**Semi-Annually**	**Quarterly**

PW = production well; monitoring wells in bold are representative monitoring points (RMP) for groundwater quality; [1] = RMP for degraded groundwater quality; [2] = RMP for seawater intrusion

The groundwater quality monitoring network accomplishes the following for the sustainability indicators relying on groundwater quality to determine Basin sustainability:

- Degraded Groundwater Quality: Monitoring wells are distributed throughout the Basin in all the aquifers used for groundwater production, and the distribution of wells and their sampling frequency is sufficient to determine groundwater quality trends over time for each aquifer. No additional monitoring wells for degraded groundwater quality are needed until projects are implemented.

- Seawater Intrusion: The monitoring network includes coastal monitoring wells that are used to monitor groundwater quality related to seawater intrusion. Most locations have multiple monitoring wells completed at different depths within the productive aquifers. All coastal monitoring wells are sampled for chloride and TDS quarterly to ensure increases in salinity are identified quickly. The two deep monitoring wells to be added for monitoring groundwater levels as a proxy for seawater intrusion will also be part of the network to monitor groundwater quality related to seawater intrusion. Like other coastal monitoring wells, these two deep monitoring wells will be monitored quarterly once constructed and equipped.

Each agency will use its own resources to continue to sample these wells as the GSP is implemented. Groundwater quality data collected for each well will be stored in the WISKI DMS.

3.3.1.3 Groundwater Extraction Monitoring

3.3.1.3.1 Metered Groundwater Extraction

Each MGA member agency that supplies water meters its own groundwater extraction in its service area by individual well. All municipal production wells have SCADA systems to automatically record groundwater extraction. Manual meter readings are also recorded. Monthly extraction data by well is stored in the WISKI DMS.

Small water systems (SWS) having between 5 and 199 connections are required to meter their groundwater production with monthly meter readings that are reported annually to Santa Cruz County. Monthly metered production is also required by the State Water Resources Control Board Division of Drinking Water (DDW) under California Code of Regulations §64561. This requirement also includes businesses or other operations that extract groundwater and that serve more than 25 people for more than 60 days a year. Annual extractions for reporting SWSs will be stored in the WISKI DMS.

3.3.1.3.2 Unmetered Groundwater Extraction

In areas outside of the municipal service areas, there are over one thousand private wells that each extract less than 2 acre-feet per year of groundwater for domestic purposes. These are called *de minimis* users and their wells are typically unmetered. Estimates of pumping for private domestic use are made based on the number of parcels with a residence and typical water use factor per connection derived from metered SWS water use per connection. To keep a current estimate of *de minimis* pumping, records of the number of rural parcels with residences and estimates of water use per connection from SWSs need to be updated annually.

Groundwater extraction for agricultural use (irrigation and livestock) is currently unmetered in the Basin. Annual agricultural demand is estimated based on the crop irrigated, monthly reference evapotranspiration that is measured at a nearby CIMIS station, and irrigated crop acreage. The MGA will need to monitor the acreage of irrigated lands in the Basin annually, and include cannabis which was not included in the agricultural use estimates in the historical groundwater model. As part of GPS implementation, the MGA will be implementing a metering plan that will require some of the larger agricultural and other non-de minimis users to meter their wells and provide the MGA with extraction data.

Estimated groundwater extractions will not be included in the WISKI DMS as the data are not measured. Spreadsheets and GIS containing the data used to estimate groundwater extractions for unmetered wells will be used to store estimated extraction data. These data will be included in annual reporting and to update the model periodically.

3.3.1.4 Streamflow Monitoring

The USGS streamflow gauge No. 11160000 (Soquel Creek at Soquel) is one of five streamflow gauges currently active in the Basin. The USGS gauge has been operational since 1951 and is part of the USGS's National Water Information System.

Other streamflow monitoring in the Basin is focused on Soquel Creek (Figure 3-3 and Table 3-6). This is because SqCWD recognized the potential of stream impacts from pumping their municipal supply wells close to Soquel Creek. As part of SqCWD's Soquel Creek Monitoring and Adaptive Management Plan (MAMP) described in Section 2.1.2.1: Description of Water Resources Monitoring and Management Programs, SqCWD has stream water level loggers in Soquel Creek alongside the shallow monitoring wells shown on Figure 3-3. Since changes in stream levels from groundwater pumping of nearby municipal wells have not been measurable at the monitoring locations since monitoring started, stream water level monitoring may be terminated after five years of monitoring (after 2019).

Trout Unlimited is working in conjunction with the Resource Conservation District of Santa Cruz County (RCD) to monitor dry season flows at four locations on Soquel Creek (Figure 3-3) to help measure the impact of stream diversions and evaluate opportunities for streamflow enhancement. The current effort is funded through 2019 under a Proposition 1 Grant from the Wildlife Conservation Board for streamflow enhancement. After 2019, ongoing monitoring of the streamflow gauges will be continued by the MGA.

All streamflow data will be stored in the WISKI DMS.

Table 3-6. Streamflow Gauges in the Santa Cruz Mid-County Basin

Monitoring Entity	Streamflow Gauge Name
USGS	USGS 11160000 Soquel Creek at Soquel
Trout Unlimited / Santa Cruz Resource Conservation District	Soquel Creek West Branch
	Soquel Creek near Olive Springs
	Soquel Creek above West Branch Confluence
	Soquel Creek above Bates Creek

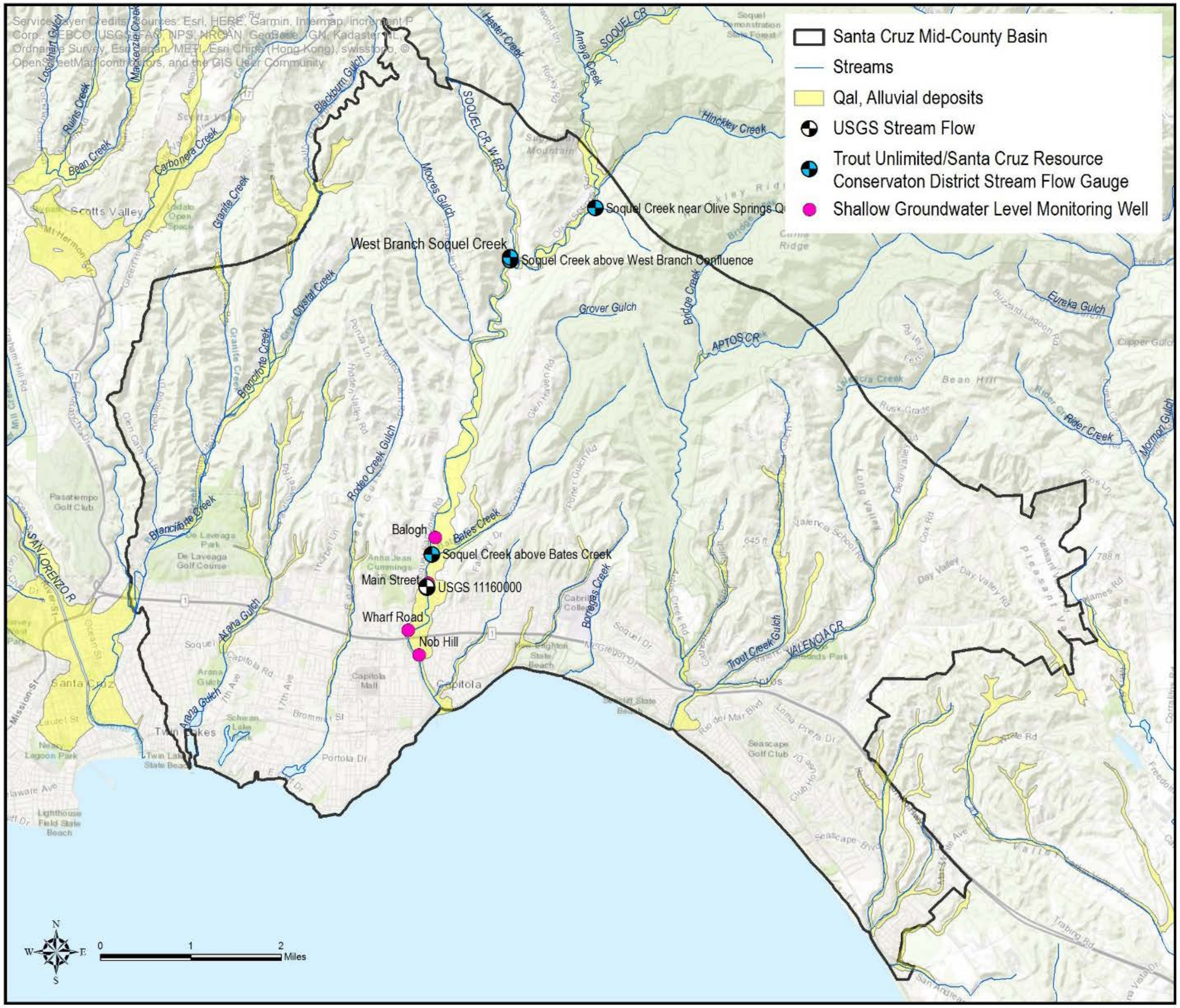

Figure 3-3. Location of Basin Streamflow Gauges

3.3.1.5 Land Elevation Monitoring

Land subsidence is not an applicable indicator of sustainability in the Basin and land surface elevations within the Basin have not been monitored historically, nor are there plans to monitor it in the future. There are however two land subsidence monitoring networks that are publicly available: (1) Continuous Global Positioning System (CGPS) stations in the vicinity of the Basin that are part of the UNAVCO Plate Boundary Observatory network of CGPS stations, and (2) Interferometric Synthetic Aperture Radar (InSAR) data that are collected by the European Space Agency (ESA) Sentinel-1A satellite and processed by TRE ALTAMIRA Inc. (TRE).

1. The CGPS data are a subset of Plate Boundary Observatory GPS with near real-time data streams made available by UNAVCO. The data is provided as elevation (Z) and longitude (X) and latitude (Y). There is one CGPS stations (Larkin Valley CGPS station (P212)) just outside of the Aromas area of the Basin that can be used to assess subsidence at the basin boundary (Figure 3-4).

2. Through a contract with TRE ALTAMIRA Inc. (TRE) and as part of DWR's SGMA technical assistance for GSP development and implementation, DWR has made available measurements of vertical ground surface displacement in more than 200 of the high-use and populated groundwater basins across California, including for the Santa Cruz Mid-County Basin. Vertical displacement estimates are derived from Interferometric Synthetic Aperture Radar (InSAR) data that are collected by the European Space Agency (ESA) Sentinel-1A satellite and processed by TRE. The InSAR dataset has also been ground-truthed to best available independent data. The current data covers the months between January 2015 and June 2018, and DWR is planning on supporting updating the dataset on an annual basis through 2022.

The CGPS data and TRE ALTAMIRA InSAR subsidence dataset can be used by the MGA annually to compare against groundwater elevations to confirm that subsidence is not occurring in the Basin.

3.3.1.6 Climate Monitoring

Climate conditions are collected by MGA member agencies and partners at various locations in the Basin. Monitored information includes precipitation and temperature to help provide information on recharge, soil moisture, and evapotranspiration. This information is also important to consider influences on streamflow. Consideration will be given to expanding this network and providing for more direct measurement of evapotranspiration and occurrence of fog cover.

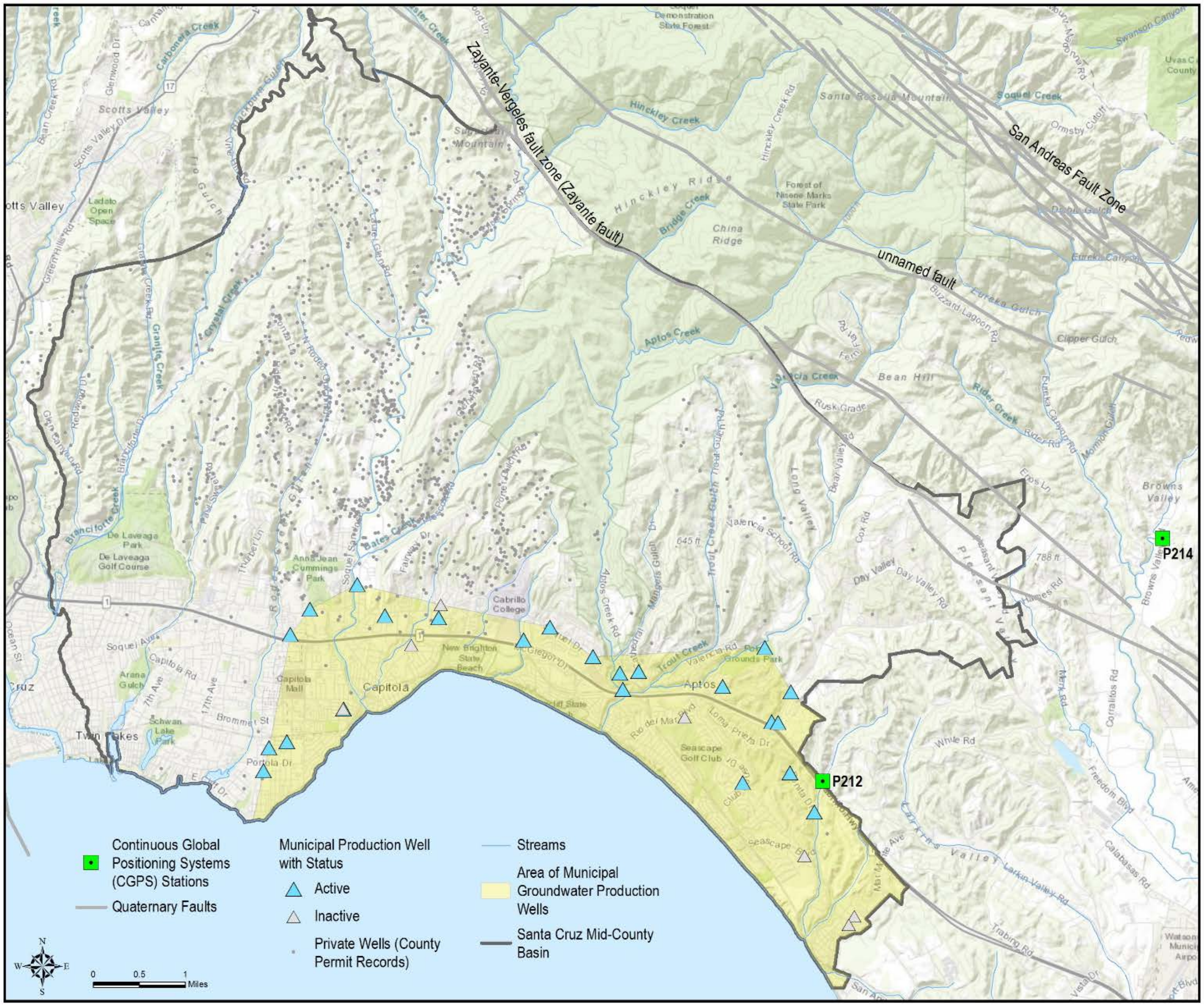

Figure 3-4. Location of Continuous GPS Stations near the Santa Cruz Mid-County Basin

3.3.2 Monitoring Protocols for Data Collection and Monitoring

Pursuant to the goals of SGMA, MGA member agencies use robust and reliable data collection protocols to monitor groundwater conditions in the Basin. Use of the monitoring protocols contained within this GSP ensure data is consistently collected by all member agencies, thereby increasing the reliability of data used to evaluate GSP implementation. Overall there are five types of data collected by MGA member agencies: groundwater elevations, groundwater quality, streamflow, volume of groundwater extracted, and climate conditions.

3.3.2.1 Groundwater Elevation Monitoring Protocols

Groundwater elevation monitoring is conducted to evaluate Basin conditions relative to the sustainable management criteria for chronic lowering of groundwater levels, seawater intrusion (proxy), and depletion of interconnected surface water (proxy), as shown in Table 3-1. Most groundwater levels in the Basin are measured and recorded at least daily using data loggers and measurements at most wells without loggers occur at least monthly. This allows the evaluation of a ‘snapshot’ of groundwater conditions for any given month.

All groundwater elevation measurements are referenced to a consistent elevation datum, known as the Reference Point (RP). For monitoring wells, the RP consists of a mark on the top of the well casing. For most production wells, the RP is the top of the well’s concrete pedestal. The elevation of the (RP) of each well is surveyed to the National Geodetic Vertical Datum of 1929 (NGVD 29). The elevation of the RP is accurate to at least 0.5 foot, and most MGA well RPs are accurate to 0.1 foot or less.

Groundwater level measurements are taken to the nearest 0.01 foot relative to the RP using procedures appropriate for the measuring device. Equipment is operated and maintained in accordance with manufacturer’s instructions, and all measurements are in consistent units of feet, tenths of feet, and hundredths of feet.

Groundwater elevation is calculated using the following equation:

$$GWE = RPE - DTW$$

where:

GWE = groundwater elevation

RPE = reference point elevation

DTW = depth to water

In cases where the official RPE is a concrete pedestal but the hand soundings are referenced off the top of a sounding tube, the measured DTW is adjusted by subtracting the sounding tube offset from the top of the pedestal.

All groundwater level measurements include a record of the date, well identifier, time (in 24-hour format), RPE, DTW, GWE, and comments regarding factors which may influence the recorded measurement such as nearby production wells pumping, weather, flooding, or well condition.

3.3.2.1.1 Manual Groundwater Level Measurement

Manual groundwater level measurements are made with electronic sounders or steel tape. All manual groundwater level measurements taken by MGA member agencies abide by the following protocols:

- Equipment usage follows manufacturer specifications for procedure and maintenance.
- Measurements are taken in wells that have not been subject to recent pumping. At least two hours of recovery must be allowed before a hand sounding is taken.
- For each well, multiple measurements are collected to ensure the well has reached equilibrium such that no significant changes in groundwater level are observed.
- Equipment is sanitized between well locations in order to prevent contamination and maintain the accuracy of concurrent groundwater quality sampling.

The majority of manual groundwater level measurements taken by MGA member agency utilize electric sounders. These consist of a long, graduated wire equipped with a weighted electric sensor. When the sensor is lowered into water, a circuit is completed and an audible beep is produced, at which point the sampler will record the depth to water. Some production wells may have lubricating oil floating on the top of the water column, in which case electric sounders will be ineffective. In this circumstance steel tape may be used. Steel tape instruments consist of simple graduated lines where the end of the line is chalked so as to indicate depth to water without interference from floating oil.

3.3.2.1.2 Groundwater Level Measurement with Continuous Recording Devices

In addition to manual groundwater level measurements, most municipal production wells, most monitoring wells, and the full subset of monitoring wells used as representative monitoring points are equipped with pressure transducers to collect more frequent data than manual measurements. Installation and use of pressure transducers abide by the following protocols:

- Prior to installation the sampler uses an electronic sounder or steel tape to measure and calculate the current groundwater level in order to properly install and calibrate the transducer. This is done following the protocols listed above.
- All transducer installations follow manufacturer specifications for installation, calibration, data logging intervals, battery life, and anticipated life expectancy.
- Transducers are set to record only measured groundwater level in order to conserve data capacity; groundwater elevation is calculated later after downloading.

- In any log or recorded datasheet, the well ID, transducer ID, transducer range, transducer accuracy, and cable serial number are all recorded.

- The sampler notes whether the pressure transducer uses a vented or non-vented cable for barometric compensation. If non-vented units are used, data are properly corrected for natural barometric pressure changes.

- All transducer cables are secured to the well head with a well dock or another reliable method. This cable is marked at the elevation of the reference point to allow estimates of future cable slippage.

- Transducer data is periodically checked against hand measured groundwater levels to monitor electronic drift, highlight cable movement, and ensure the transducer is operating correctly. This check occurs at least annually, typically during routine site visits.

- For wells not connected to SCADA, transducer data is downloaded as necessary to ensure no data is overwritten or lost. Data is entered into the data management system as soon as possible. When the transducer data is successfully downloaded and stored, the data is deleted or overwritten to ensure adequate data logger memory.

3.3.2.2 Groundwater Quality Monitoring Protocols

Groundwater quality samples are required to monitor the effect of GSP implementation on the degraded groundwater quality and seawater intrusion sustainability indicators (Table 3-1). All groundwater quality analyses are performed by laboratories certified under the State Environmental Laboratory Accreditation Program.

While specific groundwater sampling protocols vary depending on the constituent and the hydrogeologic context, the protocols contained here provide guidance which is applied to all groundwater quality sampling. Prior to sampling, the sampler contacts the laboratory to schedule laboratory time, obtain appropriate sample containers, and clarify any sample holding times or sample preservation requirements. Laboratories must be able to provide a calibration curve for the desired analyte and are instructed to use reporting limits that are equal to or less than the applicable data quality objectives, regional water quality objectives/screening levels, or state Detection Limit for Purposes of Reporting.

- Each well used for groundwater quality monitoring has a unique identifier (ID). This ID is written on the well housing or the well casing to avoid confusion.

- Sample containers are labeled prior to sample collection. The sample label includes: sample ID, sample date and time, sample personnel, sample location, preservative used, analyte, and analytical method.

- In the case of wells with dedicated pumps, samples are collected at or near the wellhead. Samples are not collected from storage tanks, at the end of long pipe runs, or after any water treatment.
- Prior to any sampling, the sampler cleans the sampling port and/or sampling equipment so that it is free of any contaminants, and also decontaminates sampling equipment between sampling locations to avoid cross-contamination between samples.
- At the time of sampling, groundwater elevation in the well is also measured following appropriate protocols described above in the groundwater level measuring protocols.
- For any well not equipped with low-flow or passive sampling equipment, at least three well casing volumes are purged from the well to ensure that the groundwater sample is representative of ambient groundwater and not stagnant water in the well casing. If pumping causes a well to be go dry, the condition is documented and the well is allowed to recover to within 90% of original level prior to sampling.
- In addition to the constituent of interest, field parameters of dissolved oxygen, electrical conductivity, temperature, oxidation reduction potential and pH are collected for each sample during well purging, with dissolved oxygen and conductivity being the most critical parameters. Samples are not collected until these parameters stabilize. Parameters are considered stabilized at the following ranges: dissolved oxygen and oxidation reduction potential, ±10%; temperature and electrical conductivity, ±3%; and pH ±0.2%.
- All field instruments are calibrated each day of use, cleaned between samples, evaluated for drift throughout the day of use.
- Samples are collected exclusively under laminar flow conditions. This may require reducing pumping rates prior to sample collection.
- Samples are collected according to the appropriate standards listed in the Standard Methods for the Examination of Water and Wastewater and the USGS National Field Manual for the Collection of Water Quality Data. The specific sample collection procedures reflect the type of analysis to be performed and characteristics of the constituent.
- All samples requiring preservation are preserved as soon as practically possible and filtered appropriately as recommended for the specific constituent.
- Samples are chilled and maintained at 4 °C to prevent degradation of the sample.
- Samples must be shipped under chain of custody documentation to the appropriate laboratory promptly to avoid violating holding time restrictions.

3.3.2.3 Streamflow Monitoring Protocols

Streamflow discharge measurements are collected by MGA member agencies and partners to monitor streamflow interaction related to groundwater extractions, monitor stream conditions related to fish habitat, and help preserve other beneficial uses of surface water. There is one USGS gauge that is operated and monitored by the USGS according to procedures outlined by USGS (1982).

Surface water is most easily measured using a stream gauge and stilling well system, which requires development of rating curves between stream stage and total discharge. Several measurements of discharge at a variety of stream stages are taken to develop an accurate ratings curve.

3.3.2.4 Measuring Groundwater Extraction Protocols

Groundwater extraction volumes are collected to provide data for well field management and for assessment of the Basin's water budget. Additionally, the volume of groundwater extraction is the metric for the reduction of groundwater in storage sustainability indicator. Municipal MGA member agencies measure discharge from all their production wells with calibrated flow meters. Supervisory Control and Data Acquisition (SCADA) for individual wells are used to monitor and control production in close to real-time.

Small water systems (SWS) report their annual extractions to Santa Cruz County. Meters are typically read monthly.

3.3.3 Representative Monitoring Points

Representative Monitoring Points (RMPs) are a subset of the Basin's overall monitoring network. Designation of an RMP is supported by adequate evidence demonstrating that the site reflects general conditions in the area. Representative monitoring points are where numeric values for minimum thresholds, measurable objectives, and interim milestones are defined. Avoiding undesirable results based on data collected at RMPs demonstrates the Basin's sustainability.

Groundwater levels may be used as a proxy for sustainability indicators whose metric is not groundwater levels if the following can be demonstrated:

1. Significant correlation exists between groundwater elevations and the sustainability indicators for which groundwater elevation measurements serve as a proxy.

2. Measurable objectives established for groundwater elevation include a reasonable margin of operational flexibility taking into consideration the basin setting to avoid undesirable results for the sustainability indicators for which groundwater elevation measurements serve as a proxy.

Table 3-1 lists the metrics for each of the Basin's applicable sustainability indicators. The sustainability indicators for *seawater intrusion* and *depletion of interconnected surface water* use groundwater levels as a proxy.

3.3.3.1 Chronic Lowering of Groundwater Level Representative Monitoring Points

The objective of the chronic lowering of groundwater levels representative monitoring network is to monitor areas where there is a concentration of groundwater extraction, but not immediately adjacent to municipal production wells. This is to avoid the dynamic drawdown caused by high-capacity wells. Use of dedicated monitoring wells in the network is preferable over wells actively used for groundwater extraction. Clustered multi-depth monitoring wells are included to evaluate groundwater elevations in different aquifers at the same location and to evaluate vertical gradients between aquifers. Because groundwater elevations to protect against seawater intrusion are higher (or more stringent) than groundwater elevations to prevent chronic lowering of groundwater levels, RMPs along the coast are not included in the chronic lowering of groundwater levels monitoring network. Groundwater elevations along the coast are instead controlled by the seawater intrusion sustainable management criteria in coastal monitoring wells. Figure 3-5 includes all wells in the representative monitoring network used for monitoring chronic lowering of groundwater levels.

Table 3-7. Representative Monitoring Points for Chronic Lowering of Groundwater Levels

Aquifer Unit	Well Name	Rationale
Aromas	SC-A7C	Located near boundary with Pajaro Valley Subbasin
Purisima F	Private Well 2	Located in an inland area with a high concentration of private domestic wells
	Black	Located near boundary with Pajaro Valley Subbasin in an area with a high concentration of private domestic wells, and is a dedicated monitoring well
	CWD-5	Located in an area with a high concentration of private domestic wells and is a dedicated monitoring well
	SC-23C	Just inside the area of municipal production but close to municipal production wells pumping from the Purisima F-unit and a high concentration of private domestic wells
Purisima DEF	SC-11RD	Located in an area with a high concentration of private domestic wells
	SC-23B	Just inside the area of municipal production but close to municipal production wells pumping from the Purisima DEF-unit and a high concentration of private domestic wells
Purisima BC	SC-11RB	Located in an area with a high concentration of private domestic wells
	SC-19	Outside the area of municipal production but close to municipal production wells pumping from the Purisima BC-unit and in an area between private domestic well pumping centers
	SC-23A	Just inside the area of municipal production but close to municipal production wells pumping from the Purisima BC-unit and a high concentration of private domestic wells
Purisima A	Coffee Lane Shallow	Outside the area of municipal production but close to municipal production wells pumping from the Purisima A-unit
	SC-22A	Inside the area of municipal production but close to municipal production wells pumping from the Purisima A-unit
Purisima AA	SC-22AA	Inside the area of municipal production but close to municipal production wells pumping from the Purisima AA-unit
	SC-10RAA	Located in an area with a high concentration of private domestic wells
Purisima AA/Tu	Private Well 1	Located in an inland area with a high concentration of private domestic wells
Tu	30^{th} Ave Deep (1)	One of the few monitoring wells screened in the Tu aquifer located outside of the area of municipal production
	Thurber Lane Deep	One of the few monitoring wells screened in the Tu aquifer located outside of the area of municipal production

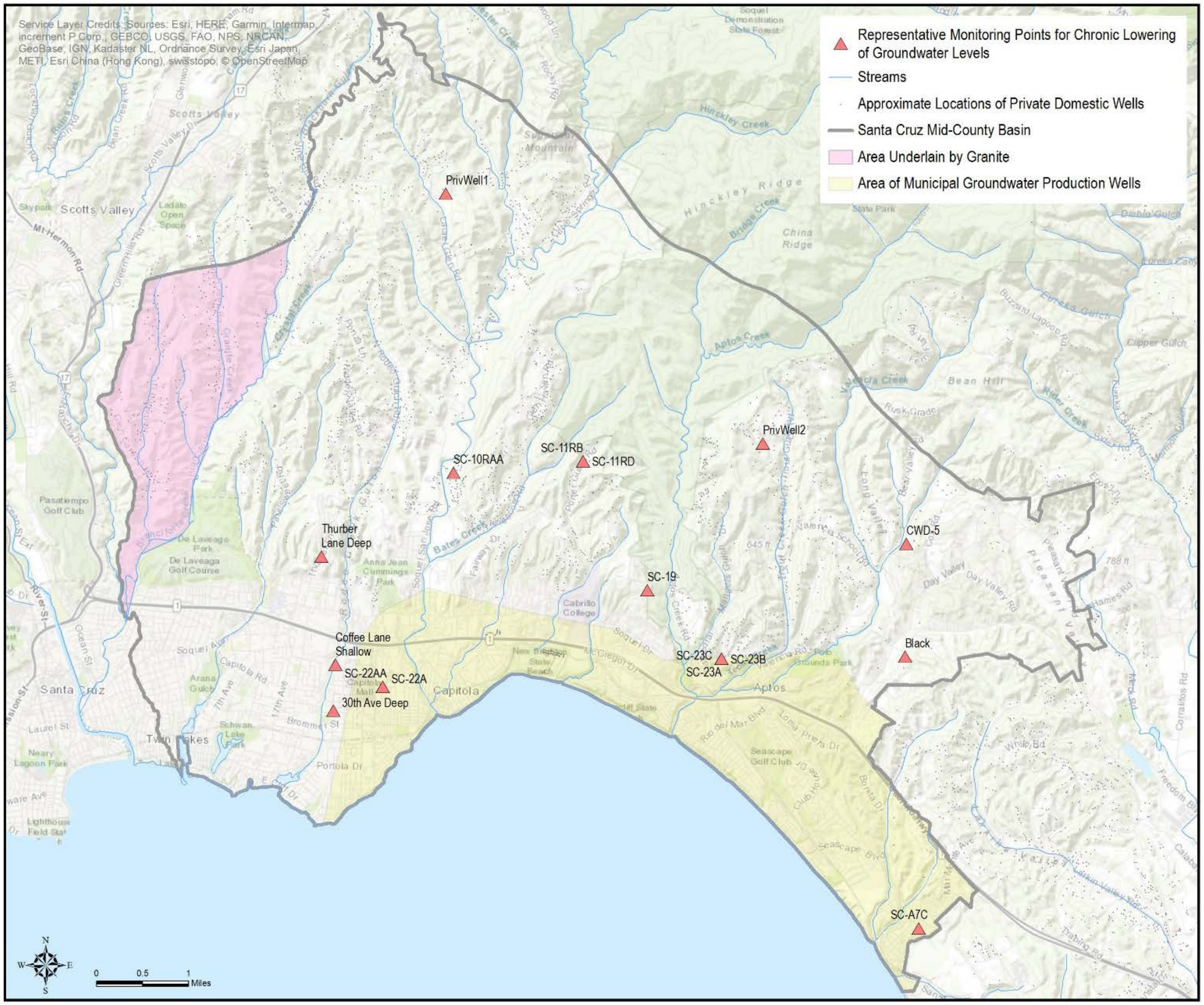

Figure 3-5. Chronic Lowering of Groundwater Level Representative Monitoring Network

3.3.3.2 Reduction of Groundwater in Storage Representative Monitoring Points

The physical well locations for the reduction of groundwater in storage representative monitoring network are all metered wells in the Basin (Figure 3-6). These are the only points where measured extraction data are available to evaluate the sustainability of the Basin with respect to reduction of groundwater in storage. All other groundwater extraction in the Basin will be estimated. Section 3.3.1.3 (Groundwater Extraction Monitoring) describes how small water systems, de minimis private pumping, and agricultural irrigation pumping will be estimated.

Wells that are metered as part of GSP implementation will be added as RMPs to the reduction of groundwater in storage representative monitoring network.

3.3.3.3 Seawater Intrusion Representative Monitoring Points

The seawater intrusion monitoring network monitors both chloride concentration and groundwater elevations as a proxy for seawater intrusion. Chloride concentrations are monitored in wells which are at least 0.5 mile away from the coast and either side of the chloride isocontour representing a minimum threshold for seawater intrusion. The City of Santa Cruz and SqCWD have been using protective groundwater elevations in coastal monitoring wells since 2009 to monitor and manage seawater intrusion in the Basin, and these same wells plus some additional wells to monitor the very deepest aquifers will be included in the representative monitoring network for proxy monitoring of seawater intrusion. Groundwater levels are continuously monitored with data loggers in all coastal monitoring wells where protective elevations are set. Hand soundings are taken at least quarterly in these RMP coastal monitoring wells.

In the event of data logger failure, monthly soundings measured during the data gap should be used to replace missing data in calculating averages used to determine if undesirable results have occurred. If no sounding measurement occurred during the data gap, the average of available hourly readings in the 7 days before and the 7 days after the data gap (up to 336 total hourly readings) should be used to replace the missing data in calculating averages. If data logger groundwater level data are shown to be inconsistent with a sounding measurement, the sounding measurement should be used to replace the inconsistent logger data in the calculation of averages. Inconsistent logger data is considered a variation of 0.5-feet between data logger and manual well soundings.

Figure 3-7 shows the locations of all RMPs in the seawater intrusion monitoring network used for both chloride concentrations and groundwater elevation proxies. The wells used to measure chloride concentrations have a different symbol than those used to monitor protective groundwater elevations. Table 3-8 lists the wells in the representative monitoring network and provides a brief rationale why each well was selected as an RMP.

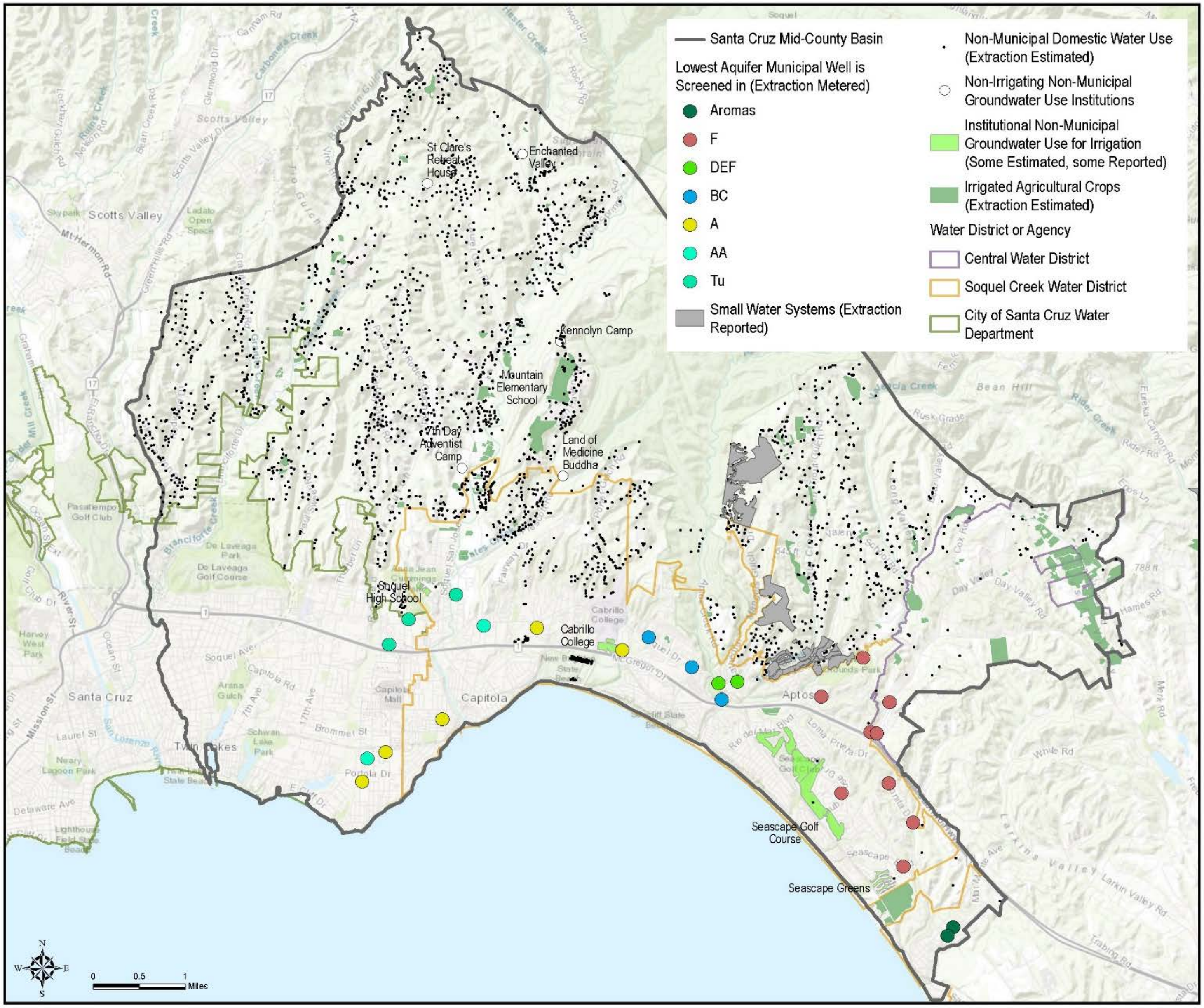

Figure 3-6. Reduction of Groundwater in Storage Representative Monitoring Network

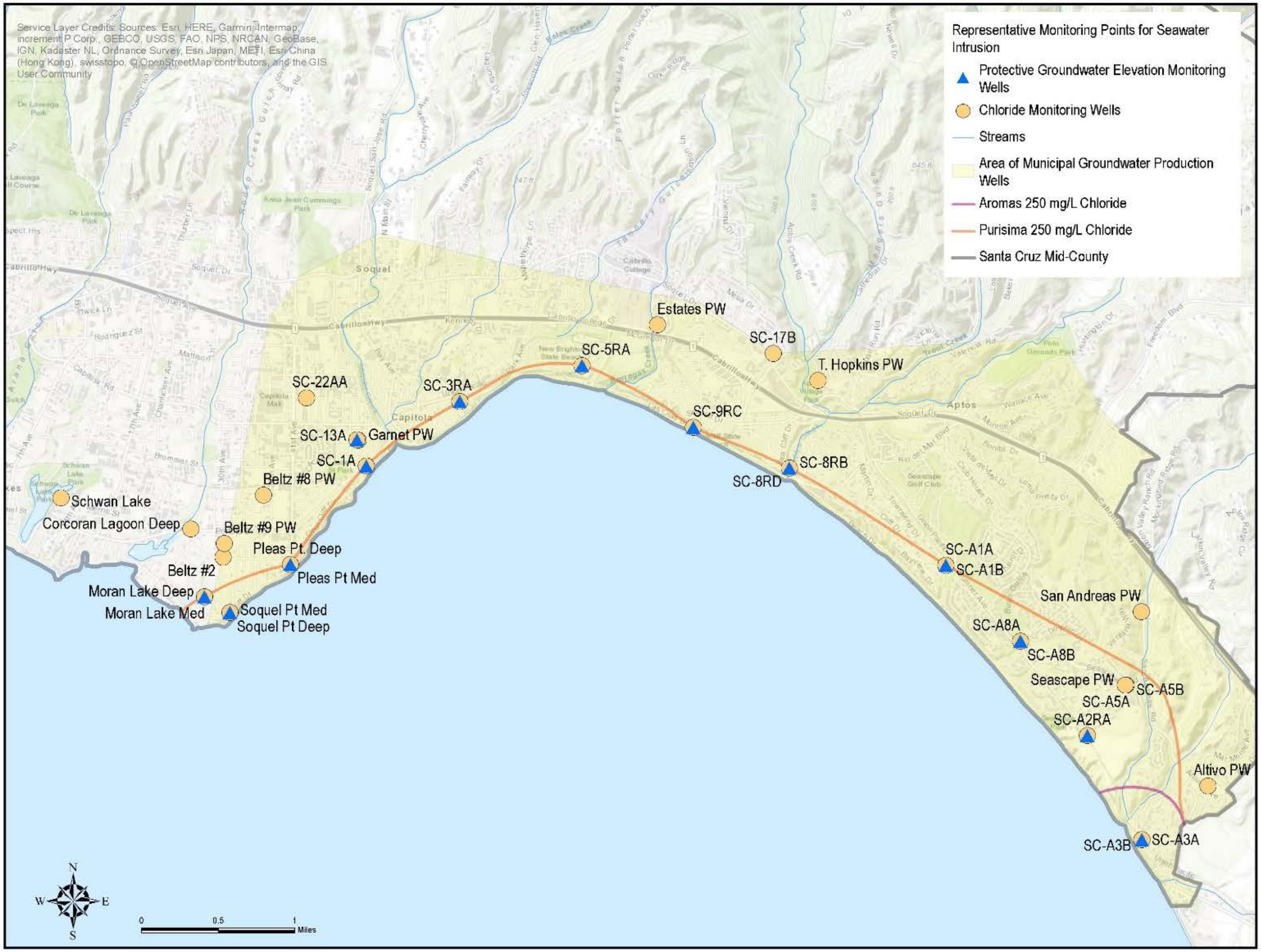

Figure 3-7. Seawater Intrusion Representative Monitoring Network

Table 3-8. Representative Monitoring Points for Seawater Intrusion

Aquifer Unit	Well Name	Rationale	Metric
Aromas	SC-A3B	Coastal monitoring well within the area intruded by seawater	Chloride
	SC-A3A	Coastal monitoring well within the area intruded by seawater	Chloride and GWL
	SC-A8B	Coastal monitoring well within the area intruded by seawater but at a depth above saltwater interface	Chloride
Aromas / Purisima F	Seascape PW	Municipal production well within the area intruded by seawater but at a depth above saltwater interface	Chloride
	San Andreas PW	Municipal production well closest inland of the chloride isocontour	Chloride
Purisima F	SC-A1B	Coastal monitoring well through which the 250 mg/L chloride isocontour runs through	Chloride and GWL
	SC-A2RA	Coastal monitoring well within the area intruded by seawater	Chloride and GWL
	SC-A2RB	Coastal monitoring well within the area intruded by seawater	Chloride and GWL
	SC-A8A	Coastal monitoring well within the area intruded by seawater	Chloride and GWL
	SC-A5A	Inland monitoring well with seawater intrusion; screened ~100 ft below Seascape PW	Chloride
	SC-A5B	Inland monitoring well at a depth above saltwater interface; screened ~20 ft below Seascape PW	Chloride
Purisima DEF	SC-8RD	Coastal monitoring well through which the 250 mg/L chloride isocontour runs through	Chloride and GWL
	SC-A1A	Coastal monitoring well through which the 250 mg/L chloride isocontour runs through	Chloride
	T. Hopkins PW	Municipal production well closest inland of the chloride isocontour	Chloride
Purisima BC	SC-9RC	Coastal monitoring well through which the 250 mg/L chloride isocontour runs through	Chloride and GWL
	SC-8RB	Coastal monitoring well through which the 250 mg/L chloride isocontour runs through	Chloride and GWL

Aquifer Unit	Well Name	Rationale	Metric
	Ledyard PW	Municipal production well between the Estates and T-Hopkins production wells	Chloride
Purisima A/BC	Estates PW	Municipal production well closest inland of the chloride isocontour	Chloride
Purisima A	Moran Lake Medium	Coastal monitoring well through which the 250 mg/L chloride isocontour runs through	Chloride and GWL
	Soquel Point Medium	Coastal monitoring well within the area intruded by seawater	Chloride and GWL
	Pleasure Point Medium	Coastal monitoring well through which the 250 mg/L chloride isocontour runs through	Chloride and GWL
	SC-1A	Coastal monitoring well through which the 250 mg/L chloride isocontour runs through	Chloride and GWL
	SC-3RA	Coastal monitoring well through which the 250 mg/L chloride isocontour runs through	Chloride and GWL
	SC-5RA	Coastal monitoring well through which the 250 mg/L chloride isocontour runs through	Chloride and GWL
	Beltz #2	Inland monitoring well that monitors inland of the chloride isocontour	Chloride
	Beltz #8 PW	Municipal production well closest inland of the chloride isocontour	Chloride
	Garnet PW	Municipal production well closest inland of the chloride isocontour	Chloride
Purisima AA	Moran Lake Deep	Coastal monitoring well through which the 250 mg/L chloride isocontour runs through	Chloride and GWL
	Pleasure Point Deep	Coastal monitoring well through which the 250 mg/L chloride isocontour runs through	Chloride and GWL
	Soquel Point Deep	Coastal monitoring well within the area intruded by seawater but at a depth below intrusion	Chloride and GWL
	SC-22AA	Inland monitoring well that monitors inland of the chloride isocontour	Chloride
	Corcoran Lagoon Deep	Inland monitoring well that monitors inland of the chloride isocontour	Chloride

Aquifer Unit	Well Name	Rationale	Metric
	Schwan Lake	Westernmost monitoring well	Chloride
Tu	SC-13A	Coastal monitoring well	Chloride and GWL

PW = production well; GWL = groundwater level

3.3.3.4 Degraded Groundwater Quality Representative Monitoring Points

Figure 3-8 shows the distribution of wells selected as RMPs for the degraded groundwater quality monitoring network. Since the sustainability of the degraded groundwater quality indicator is related to quality impacts caused by projects and management actions implemented as part of the GSP, its RMPs are located in areas where projects and management actions are most likely to be located in the future, i.e., within the water districts' and City service areas.

The majority of municipal production wells in the Basin are included as RMPs for degraded groundwater quality since they are the wells that provide groundwater to the largest beneficial user group. Municipal production wells are only excluded as RMPs if there is another nearby municipal production well screened in the same aquifer that is an RMP. In the area of municipal production (yellow shaded area on Figure 3-8), monitoring wells are added as RMPs in areas where there are no municipal production wells.

Future projects implemented as part of the GSP to achieve sustainability will have designated monitoring wells, some existing and some new, as part of their permit conditions. Additional monitoring wells not currently identified as RMPs for degraded groundwater quality will be included as needed to monitor future projects under the GSP. The constituents monitored for each new RMP will comply with permit conditions for these future projects, will become constituents of concern for these new RMPs, and will be incorporated into monitoring and reporting requirements under this GSP.

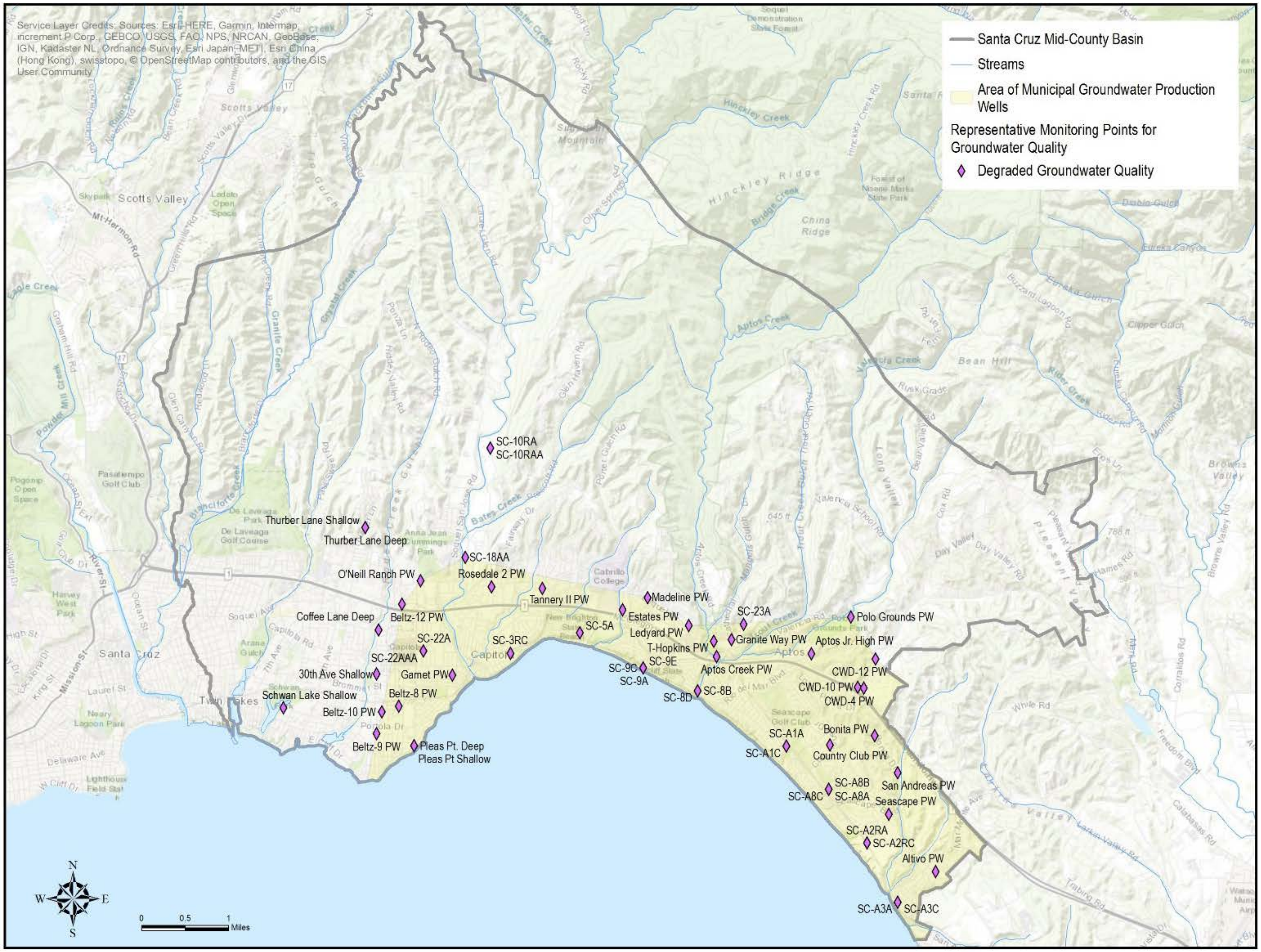

Figure 3-8. Degraded Groundwater Quality Representative Monitoring Network

Table 3-9. Representative Monitoring Points for Degraded Groundwater Quality

Aquifer Unit	Well Name	General Water Quality Sampling Frequency	Rationale
Aromas	Altivo PW*	Semi-Annual	Production well and area impacted by nitrate
	CWD-10 PW	Triennial, nitrate as (N) annual	Production well
	SC-A1C	Annual	Coastal monitoring well in area with spare monitoring wells
	SC-A2RC	Semi-Annual	Coastal monitoring well, and located between an area of private well domestic and agricultural users
	SC-A3A	Annual	Southernmost coastal monitoring well
	SC-A3C	Semi-Annual	Southernmost coastal monitoring well
	SC-A8B	Semi-Annual	Coastal monitoring well
	SC-A8C	Annual	Coastal monitoring well
Aromas/ Purisima F	Polo Grounds PW	Semi-Annual, nitrate (as N) annual	Production well
	Country Club PW*	Semi-Annual, nitrate (as N) annual	Production well
	Bonita PW	Semi-Annual, nitrate (as N) annual	Production well
	San Andreas PW	Semi-Annual, nitrate (as N) annual	Production well
	Seascape PW	Semi-Annual, nitrate (as N) annual	Production well
Purisima F	CWD-4 PW	Triennial, nitrate as (N) annual	Production well
	CWD-12 PW	Triennial, nitrate as (N) annual	Production well, inland
	Aptos Jr. High 2 PW	Semi-Annual, nitrate (as N) annual	Production well
	SC-A2RA	Annual	Coastal monitoring well, and located between an area of private well domestic and agricultural users
	SC-A8A	Annual	Coastal monitoring well
Purisima DEF	SC-8RD	Annual	Coastal monitoring well
	SC-9RE	Annual	Coastal monitoring well
	SC-A1A	Semi-Annual	Coastal monitoring well in area with few monitoring wells
	Granite Way PW	Annual	Production well
	T-Hopkins PW	Annual	Production well
Purisima BC	Ledyard PW	Annual	Production well
	Madeline 2 PW	Annual	Production well

Aquifer Unit	Well Name	General Water Quality Sampling Frequency	Rationale
	Aptos Creek PW	Annual	Production well
	SC-23A	Annual	Inland of a production wellfield
	SC-3RC	Annual	Coastal monitoring well
	SC-8RB	Annual	Coastal monitoring well
	SC-9RC	Annual	Coastal monitoring well
Purisima A	30th Ave Shallow (3)	Semi-Annual	Just outside of area of municipal production
	Pleasure Point Shallow	Quarterly	Coastal monitoring well
	Estates PW	Annual	Production well
	Garnet PW	Annual	Production well
	Tannery II PW	Annual	Production well
	Rosedale 2 PW	Annual	Production well
	Beltz #8 PW	Triennial, iron & manganese quarterly, nitrate (as N) annual	Production well
	Beltz #9 PW	Triennial, iron & manganese quarterly, nitrate (as N) annual	Production well
	SC-5RA	Annual	Coastal monitoring well
	SC-9RA	Annual	Coastal monitoring well
	SC-10RA	Annual	Inland monitoring well
	SC-22A	Quarterly	Between several municipal production wells
Purisima A/AA	Beltz #10 PW	Triennial, iron & manganese quarterly, nitrate (as N) annual	Production well
Purisima AA	SC-10RAA	Annual	Inland monitoring well
	SC-22AAA	Semi-Annual	Between several municipal production wells
	Coffee Lane Deep	Semi-Annual	Just outside of area of municipal production
	Pleasure Point Deep	Quarterly	Coastal monitoring well
	Thurber Lane Shallow	Semi-Annual	Inland monitoring well
	Schwan Lake	Semi-Annual	Westernmost monitoring well
Purisima AA/Tu	O'Neill Ranch PW	Annual	Production well
	Beltz #12 PW	Triennial, iron & manganese quarterly, nitrate (as N) annual	Production well
Tu	SC-18RAA	Semi-Annual	Next to production well
	Thurber Lane Deep	Semi-Annual	Inland monitoring well and one of the few Tu unit wells

3.3.3.5 Depletion of Interconnected Surface Water Monitoring Representative Monitoring Points

The depletion of interconnected surface water representative monitoring network monitors shallow groundwater elevations adjacent to creeks that both support priority species and are interconnected with groundwater. Groundwater elevations as a proxy for surface water depletion are needed as a measure of sustainability because no direct measurable change in streamflow from deep groundwater extraction has been detected in over 18 years of monitoring shallow groundwater levels adjacent to lower Soquel Creek. Even though there is no measurable direct change in streamflow from groundwater extraction, there is a demonstrable indirect influence on shallow groundwater connected to the creek from deeper aquifers pumped by municipal and private wells. This is discussed in Section 2.2.4.6: Identification of Interconnected Surface Water Systems.

Figure 3-9 shows the location of four shallow monitoring wells currently used to monitor depletion of interconnected surface water. These four wells are designated as RMPs for groundwater level proxy measurements. One other monitoring well, SC-10RA, is also included as an RMP because it is located within 730 feet of Soquel Creek, is screened from 110-170 feet below ground in the Purisima A-unit aquifer underlying alluvium, and has groundwater levels that correspond to changes in creek flows. Table 3-10 lists the RMPs and summarizes rationale for selection.

Since these wells only monitor the lower reach of Soquel Creek, the MGA recognizes that other shallow wells are needed to better characterize the surface water / groundwater interaction for other reaches of Soquel Creek and for other creeks that are connected to groundwater. Section 3.3.4 discusses the monitoring data gaps for this sustainability indicator.

Table 3-10. Representative Monitoring Points for Depletion of Interconnected Surface Water

Monitoring Type	Well Name	Rationale
Shallow Groundwater Levels	Balogh	Dedicated shallow groundwater / surface water monitoring well
	Main St. SW 1	Dedicated shallow groundwater / surface water monitoring well
	Wharf Road SW	Dedicated shallow groundwater / surface water monitoring well
	Nob Hill SW 2	Dedicated shallow groundwater / surface water monitoring well
Purisima A	SC-10RA	Shallow monitoring well 730 feet from Soquel Creek, screened in Purisima A-unit below alluvium. Groundwater levels show response to creek flows and rainfall

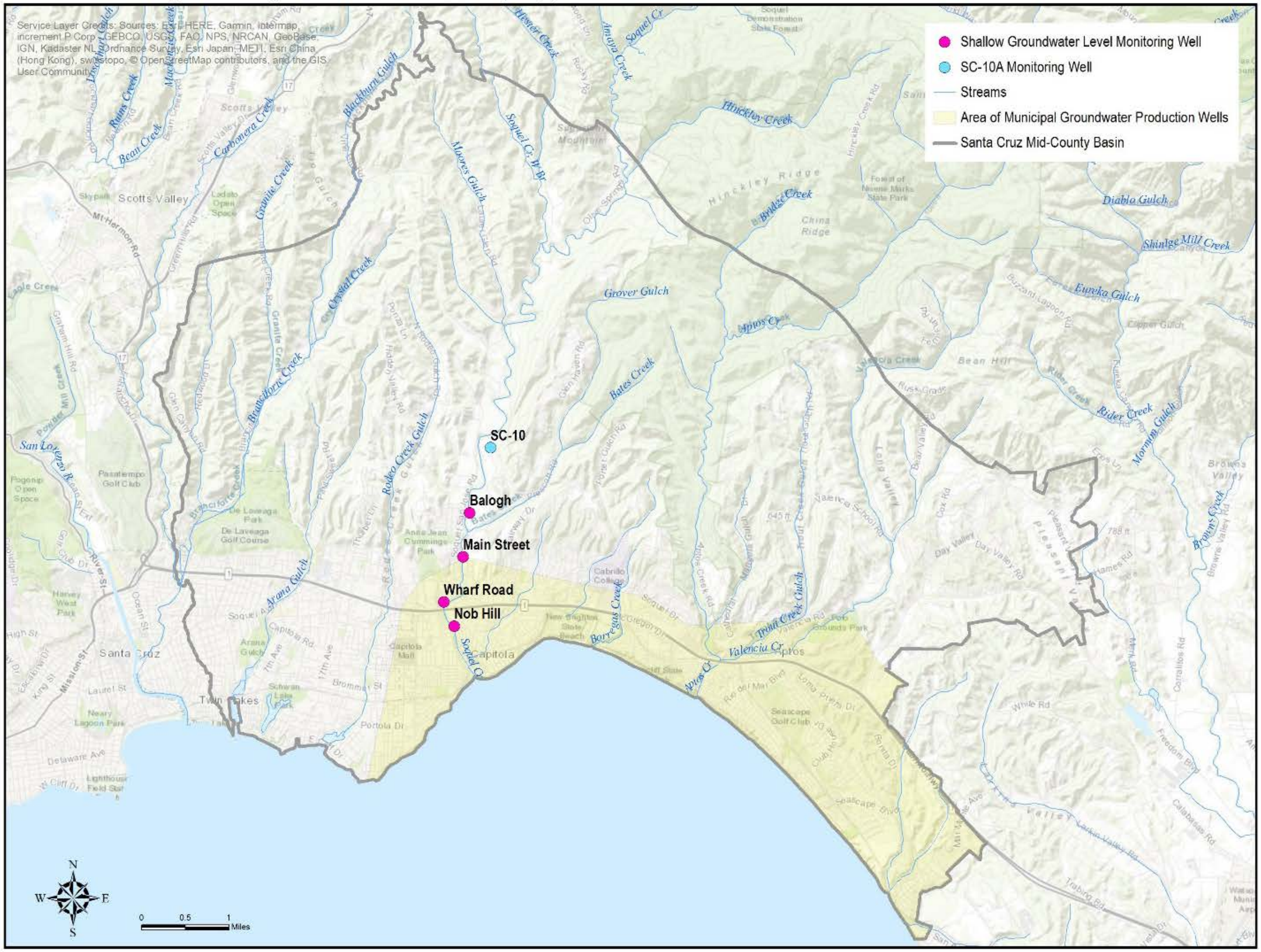

Figure 3-9. Depletion of Interconnected Surface Water Existing Representative Monitoring Network

3.3.4 Assessment and Improvement of Monitoring Network

3.3.4.1 Groundwater Level Monitoring Data Gaps

The existing groundwater level monitoring network described in Section 3.3.1.1 is extensive laterally both across the Basin and vertically through all of the Basin's aquifers. There are however some locations where new monitoring wells are required to evaluate groundwater levels for improved Basin characterization and to potentially include as RMPs once they have been constructed.

Seawater Intrusion monitoring: Additional deeper wells are needed in two locations along the coast. Existing monitoring wells at these locations do not extend down far enough to establish protective groundwater elevations for the deepest producing aquifers that are being used for production and in the near future potentially used for storage. Figure 3-10 shows the locations of the two proposed deep monitoring wells. One of the locations, SC-3 (AA), will involve adding a deeper monitoring well adjacent to an existing SqCWD monitoring well screened in the Purisima A-unit. The second location, will be a deep Tu monitoring well located between the City of Santa Cruz's Soquel Point and Pleasure Point monitoring cluster. The exact location is still to be determined.

Depletion of interconnected surface water monitoring: To more fully characterize interconnections between surface water and groundwater, additional monitoring of shallow groundwater levels is needed in the upper reaches of Soquel Creek and on other creeks that both support priority species and have a connection to groundwater. The locations for additional shallow wells are selected based on whether groundwater is connected to surface water, it is in an area of concentrated groundwater extraction, has a suitable nearby location for a streamflow gauge, and has potential site access. There is a fair degree of uncertainty regarding access at some of the proposed locations. The actual locations of future shallow wells will be determined based on a site suitability study that will include the ability to obtain easements or an access agreement. Figure 3-10 shows the locations of eight proposed shallow monitoring wells that fill monitoring gaps in the Basin. To indicate areas of concentrated groundwater extraction, Figure 3-10 shows the area of municipal pumping and the small dots are approximate locations of private domestic wells. The proposed shallow well on Lower Aptos is an example of a well site that may be moved, based on findings from the site suitability study, to a better location that may be on Valencia Creek above Aptos Creek. The shallow well on Rodeo Gulch is a lower priority site which may require synoptic measurements to establish where it is gaining and losing before finalizing a new shallow monitoring well site. Section 5 on Plan Implementation outlines how the MGA plans to finance and construct the eight shallow monitoring wells.

Table 3-11. Summary of Additional Monitoring Wells to Fill Groundwater Level Data Gaps

Sustainability Indicator being Monitored	General Location	Rationale
Seawater Intrusion	Deep well near Soquel Point	No existing coastal monitoring in the Tu unit in the SCWD area
	Deep well at the SC-3 well site	No existing coastal monitoring exclusively in the AA unit in the SqCWD area
Depletion of interconnected surface water	Shallow well on lower Aptos Creek	The majority of Aptos Creek flows through The Forest of Nisene Marks State Park and has no groundwater extractions. The lower reach of Aptos Creek is where private domestic and municipal extraction occurs
	Shallow well on Aptos Creel above Valencia Creek	
	Shallow well on the East Branch of Soquel Creek	In areas of concentrated private domestic pumping
	Shallow well on Soquel Creek below Moores Gulch	
	Shallow well near the existing SC-10 well cluster	Add a shallow well to the cluster of monitoring wells at SC-10 which already monitor the Purisima A and AA-units, and Tu Unit
	Shallow well near the Balogh stream gauge	Add two wells to supplement the existing shallow well. If feasible, wells are to be completed perpendicular to the creek to determine groundwater gradient
	Shallow well near the Balogh stream gauge	
	Shallow well on Rodeo Gulch	Near concentrated private domestic pumping

The locations of additional monitoring wells, and additional streamflow gauges discussed below in Section 3.3.4.2, have been selected to identify the location, quantity, and timing of surface water depletion caused specifically by groundwater use in areas where no monitoring features currently exist. Section 5.2 describes the timeline for completing installation of these new monitoring features.

Data obtained from these monitoring features will inform the validity of groundwater levels as a proxy for depletion of interconnected surface water, and better inform if changes are needed to minimum thresholds to avoid undesirable results. Groundwater level data collected will be evaluated annually with respect to streamflow, climate, groundwater usage, and noted biological responses. Biological responses will include information obtained from The Nature Conservancy's GDE Pulse application that monitors the health of vegetation and available fish count data from the Santa Cruz County Juvenile Steelhead and Stream Habitat Monitoring Program described in Section 2.1.2.1.

It is expected that based on all the different types of data collected over the first five years of GSP implementation, wherein some of the projects described in Section 4 will be operational, groundwater level proxies for depletion of interconnected surface water will be re-evaluated to determine if they are still needed as the sustainability metric in place of direct measurements of streamflow. At the first five-year review, data collected will also be evaluated to determine whether adjustments to minimum thresholds and measurable objectives are needed, or whether additional monitoring features are needed. It is expected that the participants of the Surface Water Working Group (see Section 2.2.4.7) established as part of GSP development will be involved in this re-evaluation process.

3.3.4.2 Streamflow Monitoring Data Gaps

Associated with the shallow groundwater level monitoring wells identified above, streamflow gauges to monitor changes in streamflow are needed to correlate changes in streamflow from groundwater extraction. The shallow monitoring wells and streamflow gauges need to be located adjacent to each other for the data to be meaningful. Figure 3-10 shows the locations of five proposed streamflow gauges that would be associated with shallow monitoring wells.

Section 5 on Plan Implementation outlines how the MGA plans to finance and construct the streamflow gauges.

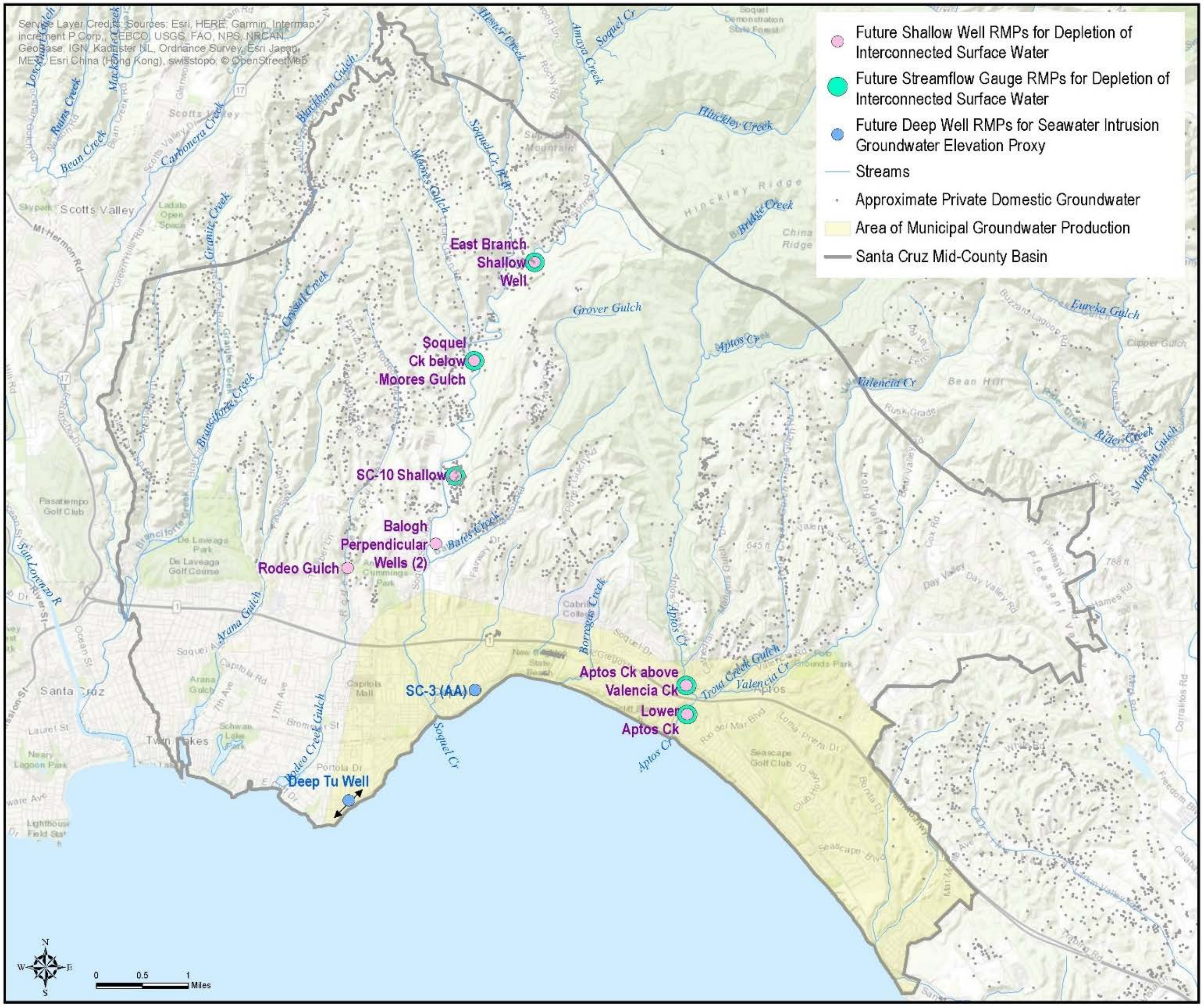

Figure 3-10. Groundwater Level and Streamflow Monitoring Data Gaps

3.3.4.3 Groundwater Extraction Monitoring Data Gaps

As part of GSP implementation, the MGA will initiate a new well metering program on all private non-de minimis wells that meet the following criteria:

- Pump more than two (2) acre-feet per year within priority management zones to be defined by the County of Santa Cruz. These will be related to seawater intrusion and depletion of interconnected surface water.
- Wells outside of priority management zones that pump more than 5 acre-feet per year.

Implementation of a planned metering program is described in more detail in Section 5 on Plan Implementation.

3.4 Chronic Lowering of Groundwater Levels Sustainable Management Criteria

3.4.1 Undesirable Results - Chronic Lowering of Groundwater Levels

Chronic lowering of groundwater levels is considered significant and unreasonable when:

> *A significant number of private, agricultural, industrial, and municipal production wells can no longer provide enough groundwater to supply beneficial uses.*

In the late 1980's, groundwater levels in parts of the Basin were between 35 and 140 feet lower than they are currently. Even at these lower levels, production wells were still able to extract groundwater to supply beneficial uses. Based on what is considered significant and unreasonable described above, chronic lowering of groundwater levels has not historically occurred and is not currently occurring in the Basin. Although groundwater users did not lose significant capacity historically during periods of lowered groundwater levels, those lower groundwater levels caused seawater intrusion which is the reason why the Basin is classified as critically overdrafted by DWR.

3.4.1.1 Criteria for Defining Chronic Lowering of Groundwater Levels Undesirable Results

Specific groundwater level conditions that constitute undesirable results for chronic lowering of groundwater levels are:

> *Any average monthly representative monitoring point's groundwater elevation falls below its minimum threshold.*

The definition of undesirable results is based on MGA sentiment that groundwater levels in the Basin should be managed to support all existing and/or proposed overlying land uses and environmental water user's beneficial needs. Using the criteria of monthly average groundwater levels adequately monitors and identifies seasonal low groundwater elevations that could be much lower than average annual groundwater levels

3.4.1.2 Potential Causes of Undesirable Results

The possible causes of undesirable chronic lowering of groundwater level results are:

- a significant change in Basin pumping distribution and volumes, or
- a significant reduction in natural recharge as a result of climate change.

If the location and volumes of groundwater pumping change as a result of unforeseen rural residential, agricultural, and urban growth that depend on groundwater as a water supply without supplemental supplies, these increased demands might lower groundwater to undesirable levels. Reduction in recharge or changes in rainfall patterns could also lead to more prolonged periods of lowered groundwater levels than have occurred historically.

3.4.1.3 Effects on Beneficial Users and Land Use

Undesirable results will prevent a significant number of private, agricultural, industrial, and municipal production wells from supplying groundwater to meet their water demands. Lowered groundwater levels will reduce the thickness of saturated aquifer from which wells can pump. Some wells may even go dry and new much deeper wells will need to be drilled. This would effectively increase the cost of using groundwater as a water source for all users.

3.4.2 Minimum Thresholds - Chronic Lowering of Groundwater Levels

3.4.2.1 Information and Methodology Used to Establish Minimum Thresholds and Measurable Objectives

Information used for establishing the chronic lowering of groundwater levels minimum thresholds and measurable objectives include:

- Definitions of significant and unreasonable conditions and desired groundwater elevations discussed during GSP Advisory Committee meetings.
- Depths, locations, and logged lithology of existing wells used to monitor groundwater levels.
- Historical groundwater elevation data from wells monitored by the MGA agencies.
- Maps of current and historical groundwater elevation data.
- Department of Water Resources well drillers' logs of domestic and agricultural wells for determining aquifers pumped, well depths and diameters, screened intervals, and estimated yield in the vicinity of RMPs.

Minimum thresholds at RMPs for chronic lowering of groundwater levels are based on the groundwater elevation required to meet the typical overlying water demand in the shallowest well in the vicinity of the RMP. The methodology used to estimate the groundwater elevation is based on water demand for overlying land uses and is documented in Appendix 3-A. If the minimum threshold elevation methodology is greater than 30 feet below historic low groundwater elevations, the minimum threshold elevation is increased, even if overlying water demand can be met at these lower levels. Groundwater levels 30 feet below historic low groundwater elevations may conflict with other sustainability indicator minimum thresholds. The 30-foot limit rationale is explained more fully in Appendix 3-A.

3.4.2.2 Chronic Lowering of Groundwater Level Minimum Thresholds

Figure 3-5 shows the location of RMPs with chronic lowering of groundwater levels minimum thresholds. Table 3-12 lists minimum thresholds for all RMPs. Historical hydrographs for RMPs showing historical groundwater elevations versus minimum thresholds and measurable objectives are provided in Appendix 3-B.

Table 3-12. Minimum Thresholds and Measurable Objectives for Chronic Lowering of Groundwater Level Representative Monitoring Points

Representative Monitoring Point	Well Type	Aquifer	Minimum Threshold	Measurable Objective
			Groundwater Elevation, feet above mean sea level	
SC-A7C	Monitoring	Aromas	0	8
Private Well #2	Production	Purisima F	562	596
Black	Monitoring		10	41
CWD-5	Monitoring		140	194
SC-23C	Monitoring		15	49
SC-11RD	Monitoring	Purisima DEF	295	318
SC-23B	Monitoring		50	85
SC-11RB	Monitoring	Purisima BC	120	157
SC-19	Monitoring		56	95
SC-23A	Monitoring		0	44
Coffee Lane Shallow	Monitoring	Purisima A	27	47
SC-22A	Monitoring		2	44
SC-22AA	Monitoring	Purisima AA	0	22
SC-10RAA	Monitoring		35	76
Private Well #1	Production	Purisima AA/Tu	362	387
30th Ave Deep (1)	Monitoring	Tu	0	30
Thurber Lane Deep	Monitoring		-10	33

3.4.2.3 Relationship between Individual Minimum Thresholds and Relationship to Other Sustainability Indicators

Section §354.28 of the SGMA regulations requires that a description of all minimum thresholds include a discussion about the relationship between the minimum thresholds for each sustainability indicator. In the Sustainable Management Criteria Best Management Practice Guide (DWR, 2017), DWR has clarified this requirement:

1. The GSP must describe the relationship between each sustainability indicator's minimum threshold (e.g., describe why or how a water level minimum threshold set at a particular representative monitoring site is similar to or different to groundwater level thresholds in nearby RMP).
2. The GSP must describe the relationship between the selected minimum threshold and minimum thresholds for other sustainability indicators (e.g., describe how a groundwater level minimum threshold would not trigger an undesirable result for seawater intrusion).

Minimum thresholds are selected to avoid undesirable results for other sustainability indicators. If the same RMP was selected for chronic lowering of groundwater levels as another sustainability indicator's RMP that uses groundwater elevation as a metric, the shallowest groundwater elevation minimum threshold of the two sustainability indicators is set at that RMP and assigned to the sustainability indicator that has the shallowest elevation. The relationship between chronic lowering of groundwater level minimum thresholds and minimum thresholds for other sustainability indicators are discussed below.

- **Reduction of groundwater in storage**. The metrics for chronic lowering of groundwater level minimum thresholds (groundwater elevations) and reduction of groundwater in storage (volume of groundwater extracted) are different. However, since the reduction of groundwater in storage minimum thresholds are dependent on avoiding undesirable results for the Basin's other sustainability indicators, maintaining the chronic lowering of groundwater level minimum thresholds does not result in an undesirable reduction of groundwater in storage.
- **Seawater intrusion**. All near-coastal minimum thresholds for chronic lowering of groundwater levels are set at elevations no deeper than sea level so as to not interfere with seawater intrusion minimum thresholds (Figure 3-11). Where groundwater levels close to the coast determined from an estimated minimum saturated thickness are deeper than seawater intrusion's groundwater level proxy minimum thresholds, the chronic lowering of groundwater level minimum threshold is increased to ensure that it does not restrict the ability to meet or exceed protective elevations for seawater intrusion. One of the chronic lowering of groundwater levels RMPs, Thurber Lane Deep, is inland and far enough away from RMPs for seawater intrusion that groundwater levels in the Tu unit are allowed to fall below sea level without causing undesirable seawater intrusion.
- **Degraded groundwater quality**. Protecting groundwater quality is critically important to all who depend upon the groundwater resource. A significant and unreasonable condition for

degraded water quality is exceeding drinking water standards for constituents of concern in supply wells due to projects and management actions proposed in the GSP. Although chronic lowering of groundwater level minimum thresholds does not directly affect degraded quality, groundwater quality could potentially be affected by projects and management action induced changes in groundwater elevations and gradients. These changes could potentially cause poor quality groundwater to flow towards supply wells that would not have otherwise been impacted. Currently, apart from one location with 1,2,3-TCP and more widespread nitrate in parts of the Aromas Red Sands aquifers, and saline water associated with seawater intrusion in two areas along the coast, the Basin's groundwater quality is good with no non-native poor groundwater quality present within productive aquifers.

- **Subsidence**. This sustainability indicator is not applicable in the Basin.
- **Depletion of interconnected surface water**. Minimum thresholds for depletion of interconnected surface water are mostly set in shallow alluvial sediments and are based on shallow groundwater levels between 2001 and 2015. Chronic lowering of groundwater level minimum thresholds are set in the deeper Purisima aquifers where the majority of production occurs and are set substantially lower than groundwater levels observed between 2001-2015. As described in more detail in Section 2, there is no immediate measurable influence on surface water flow from extraction in the deeper Purisima aquifers, but there is likely some long-term indirect connection between the deeper Purisima aquifers and shallow groundwater. In the unlikely event that groundwater levels drop to minimum thresholds for chronic lowering of groundwater levels, the vertical gradient between shallow and deep aquifers will increase and may cause undesirable results in the shallow aquifers and interconnected surface waters.

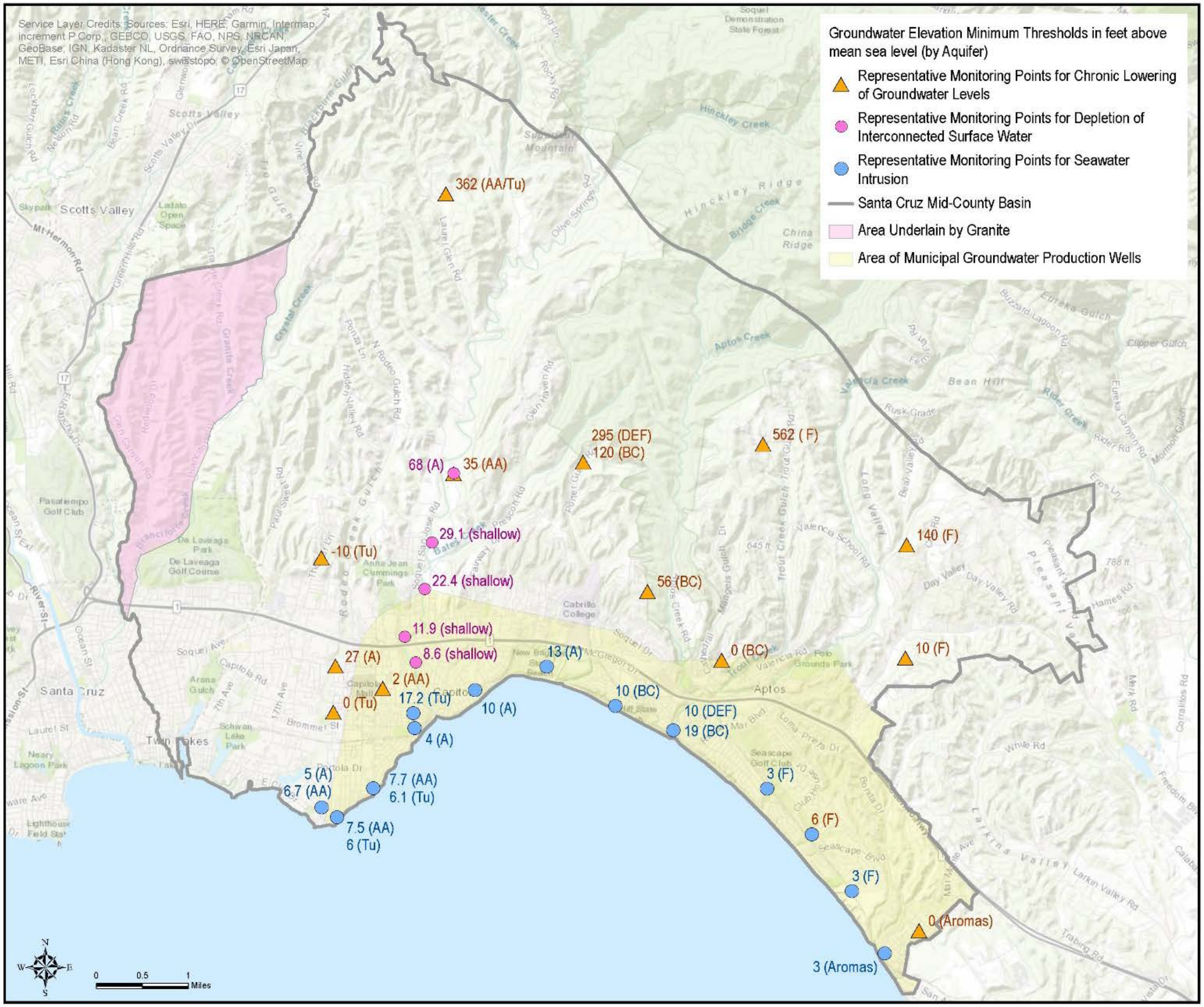

Figure 3-11. Minumum Thresholds for All Sustainability Indicators with Groundwater Elevation Minimum Thresholds

3.4.2.4 Effect of Minimum Thresholds on Neighboring Basins

Two neighboring groundwater basins are required to develop and adopt GSPs or have submitted an alternative: the medium-priority Santa Margarita Basin (to the northwest) and the critically-overdrafted Pajaro Valley Subbasin of the Corralitos Basin (to the east). There are two additional groundwater basins prioritized as very low and do not require GSPs: the Purisima Highlands Subbasin of the Corralitos Basin (to the north) and the West Santa Cruz Terrace Basin (to the west). Since the West Santa Cruz Terrace Basin is not significantly connected to the Santa Cruz Mid-County Basin due to the Purisima aquifers not extending westwards into that basin, effects of minimum thresholds on that basin are not discussed further. Anticipated effects of chronic lowering of groundwater levels minimum thresholds on the other three neighboring basins are addressed below and for subsequent sustainability indicators.

Pajaro Valley Subbasin of the Corralitos Basin (critically-overdrafted). The Pajaro Valley Subbasin is hydrogeological down- to cross-gradient of the Santa Cruz Mid-County Basin. Because of lower groundwater elevations in the Pajaro Valley Subbasin, groundwater along the coastal portion of the boundary generally flows from the Santa Cruz Mid-County Basin into the Pajaro Valley Subbasin. Purisima aquifers are not a major source of groundwater in the Pajaro Valley and are only pumped by a few deeper wells (Carollo Engineers, 2014). The Aromas Red Sands aquifer is the major producing aquifer within the Pajaro Valley Subbasin (Carollo Engineers, 2014). The Aromas Red Sands aquifer RMP (SC-A7A) in the Santa Cruz Mid-County Basin near the boundary with Pajaro Valley Subbasin has a minimum threshold that is a few feet lower than current levels. In the unlikely event that groundwater levels in this area fall to minimum thresholds, it may slightly reduce the amount of subsurface outflow to the Pajaro Valley Subbasin but would not be expected to hinder it from achieving sustainability.

Santa Margarita Basin (medium-priority). The Santa Margarita Basin is required to develop a GSP by 2022. Santa Margarita Basin is hydrogeologically downgradient of the Santa Cruz Mid-County Basin and based on the water budget, less than 400 acre-feet of groundwater flows from the Santa Cruz Mid-County Basin into the Santa Margarita Basin annually. The boundary where subsurface flows occur between the two basins is north of the Aptos Fault and four miles inland of the area where GSP projects and management actions would take place. Current groundwater levels are already well above the minimum thresholds for all RMPs and no GSP induced changes in elevations are expected as GSP activities are some distance away so it is not expected that Santa Margarita Basin will be adversely affected by activities under this GSP. However, if groundwater levels near the Santa Margarita basin drop to the minimum thresholds, flow from the Santa Cruz Mid-County Basin to Santa Margarita Basin could be reduced and could affect Santa Margarita Basin's ability to achieve sustainability.

Purisima Highlands Subbasin of the Corralitos Basin (very low-priority). The Purisima Highlands Subbasin is hydrogeological up-gradient of the Santa Cruz Mid-County Basin. Groundwater flow, historically and projected in the future, will continue to be from the higher elevation Purisima Highlands Subbasin into the Santa Cruz Mid-County Basin. If groundwater levels in the northern portion of the Basin declined to minimum thresholds, the rate of subsurface outflow may increase slightly from the Purisima Highlands Subbasin.

3.4.2.5 Effects of Minimum Thresholds on Beneficial Users and Land Uses

Chronic lowering of groundwater elevation minimum thresholds may have several effects on beneficial users and land uses in the Basin.

Rural residential land uses and users. The chronic lowering of groundwater level minimum thresholds protects most domestic users of groundwater by protecting their ability to pump from domestic wells. However, if groundwater elevations fall to minimum thresholds, there may be limited water in some of the shallowest domestic wells (less than 100 feet deep) that may require well owners to drill deeper wells.

Agricultural land uses and users. Similar to rural residential uses and users, chronic lowering of groundwater level minimum thresholds protects agricultural users of groundwater by protecting their ability to meet their typical demands. Minimum thresholds for chronic lowering of groundwater level will not limit use of land for agricultural purposes.

Urban land uses and users. The chronic lowering of groundwater level minimum thresholds are set so that all users, including municipal groundwater pumpers can still meet their typical water demands. As most of the RMPs for the chronic lowering of groundwater levels are located inland of the area of municipal pumping which covers the majority of the Basin's urban area, it is the groundwater level proxy minimum thresholds for seawater that have a bigger influence on urban/municipal users of groundwater.

Ecological land uses and users. As described in Section 3.2.3.2, chronic lowering of groundwater level minimum thresholds are not set to protect the groundwater resource including those existing ecological habitats that rely upon it. In the unlikely event that groundwater levels drop to minimum thresholds for chronic lowering of groundwater levels, it could lead to a significant and unreasonable reduction of flow of groundwater toward streams, which could adversely affect ecological habitats.

3.4.2.6 Relevant Federal, State, or Local Standards

No federal, state, or local standards exist for chronic lowering of groundwater elevations.

3.4.2.7 Method for Quantitative Measurement of Minimum Thresholds

Groundwater elevations in RMPs will be directly measured to determine where groundwater levels are in relation to minimum thresholds. Groundwater level monitoring will be conducted in accordance with the monitoring plan outlined in Section 3.3. All RMPs will be equipped with continuous data loggers.

There are two privately-owned wells that do not currently have data loggers. Section 5 on Plan Implementation includes planned implementation budget to purchase, install and monitor those additional RMPs. All other agency monitoring wells assigned as RMPs already have data loggers installed.

3.4.3 Measurable Objectives - Chronic Lowering of Groundwater Levels

3.4.3.1 Measurable Objectives

Measurable objectives for RMPs are the 75th percentile of historical groundwater elevations for the period of record of each monitoring point. The 75th percentile is higher than median or average groundwater elevations and reflects where the MGA would like groundwater elevations to be in the future whilst allowing for operational flexibility.

Representative monitoring point hydrographs in Appendix 3-B include measurable objectives for chronic lowering of groundwater levels compared to minimum thresholds.

3.4.3.2 Interim Milestones

Groundwater levels in the Basin are currently above minimum thresholds for all RMPs with no significant changes in levels expected from projects and management actions implemented to achieve sustainability. Since the measurable objectives effectively represent current conditions, interim milestones are set at the same elevations as measurable objectives shown in Table 3-12.

3.5 Reduction of Groundwater in Storage Sustainable Management Criteria

3.5.1 Undesirable Results - Reduction of Groundwater in Storage

The reduction in storage sustainability indicator is not measured by a change in groundwater in storage. Rather, the reduction in groundwater in storage sustainability indicator is measured by “a total volume of groundwater that can be withdrawn from the basin without causing conditions that may lead to undesirable results.” (§354.28 (c)(2)).

Locally defined significant and unreasonable conditions for a reduction of groundwater in storage in the Basin are defined as:

> *A net volume of groundwater extracted (pumping minus annual volume of managed aquifer recharge) that will likely cause other sustainability indicators to have undesirable results.*

3.5.1.1 Criteria for Defining Reduction of Groundwater in Storage Undesirable Results

The net volume of groundwater extracted that constitutes undesirable results for reduction of groundwater storage is:

> *Five-year average net extraction exceeding the sustainable yield (minimum threshold) for any one of the groups of aquifers:*
>
> - *Aromas Red Sands aquifer and Purisima F aquifer units,*
> - *Purisima DEF, BC, A, and AA aquifer units, and*
> - *Tu aquifer.*

Although only a total volume for the whole basin is required as a metric for the reduction of groundwater in storage sustainability indicator per the SGMA regulations, this GSP has separate SMC for three aquifer groups in the Basin: (1) Aromas Red Sands and Purisima F, (2) Purisima DEF, BC, A, and AA aquifers, and (3) the Tu aquifer. The SMC metrics for this indicator are based on the sustainable yields for each of the three aquifer groups estimated in Section 2.2.3.7: Projected Sustainable Yield.

Developing reduction of groundwater storage SMC for separate aquifer units reflects the stacked aquifer units of the Basin where groundwater supply in different areas of the Basin are provided by different aquifer units. To maximize capacity, municipal wells are often screened across multiple aquifers: The aquifer groupings are based on how municipal wells are typically screened. Most municipal wells screened in the Aromas Red Sands aquifer are also screened in the deeper Purisima F-unit aquifer. Other typical multiple aquifer screened wells include: the Purisima DEF and BC-units; the Purisima BC and A-units; and the Purisima A and AA-units. Although municipal wells screened in the Tu unit are also screened in the Purisima AA-unit, a high percentage of the flow in these wells is observed to be from the Tu unit. Additionally, the vertical separation of flow between the Purisima AA and Tu units is observed to be greater than the vertical separation between the Purisima A and AA-units, which further supports the Tu unit being in a group on its own.

Although sustainable yield can be estimated for individual aquifers, monitoring how much is pumped from each aquifer is not possible because of production wells being screened through multiple aquifers. Therefore, the aquifer groupings account for the extraction from the aquifers production wells are typically screened in.

The purpose of this sustainability indicator is to prevent undesirable results for other sustainability indicators. Each of these sustainability indicators are monitored by individual aquifer units. If undesirable results are observed in any aquifer unit or related to pumping from a specific aquifer unit, the most likely management action to eliminate the undesirable result is to change net pumping from the aquifer unit. The change in net pumping will be determined by what is necessary to eliminate the undesirable result, not based on the reduction of groundwater in storage criteria. Recognizing this, developing reduction of storage SMC for each aquifer unit is not necessary for planning groundwater management and may restrict operational flexibility.

3.5.1.2 Potential Causes of Undesirable Results

Future increased well density and pumping amounts can contribute to reduction of groundwater in storage undesirable results. Since the locations of groundwater extraction and MAR are not static, new private or municipal wells, or changed operations could cause localized undesirable results. To optimize operations or locations of new high-capacity wells and MAR, groundwater modeling can be used to predict if undesirable results may occur.

3.5.1.3 Effects on Beneficial Users and Land Use

Undesirable reduced groundwater in storage caused by over-pumping may cause undesirable results in any of the other four applicable sustainability indicators that potentially impact beneficial users and land uses. Groundwater levels that are too low as a result of implementing the GSP may:

1. Prevent a significant number of private, agricultural, industrial, and municipal production wells from supplying groundwater to meet their water demands.

2. Induce seawater intrusion that will render impacted portions of the Basin's aquifers unusable to its beneficial users. Land uses completely overlying seawater intrusion, such as agriculture, will need alternative sources of water if their wells are located in the affected areas.

3. Cause more surface water depletion in interconnected streams that support priority species than has occurred over the past 18 years.

4. Degrade groundwater quality if by implementation of the GSP there are changes in groundwater elevations and gradients that cause non-native poor-quality groundwater to flow towards extraction wells that were previously not impacted. Groundwater quality that does not meet state drinking water standards will need to be treated, which is a significant cost to users. For municipal pumpers, impacted wells can be taken offline until a solution is found. This will add stress on their water system by having to make up pumping in other unimpacted wells and increase the potential for further declines in groundwater levels.

3.5.2 Minimum Thresholds - Reduction of Groundwater in Storage

3.5.2.1 Information and Methodology Used to Establish Minimum Thresholds and Measurable Objectives

Information used for establishing the reduction of groundwater in storage minimum thresholds and measurable objectives include:

- Definitions of significant and unreasonable conditions discussed during GSP Advisory Committee meetings.
- Projected municipal agency, private domestic, institutional, and agricultural pumping at specific well locations.
- Projected injection for Pure Water Soquel and City of Santa Cruz ASR at assumed locations.
- Projected hydrographs comparing simulated groundwater levels compared to minimum thresholds for seawater intrusion and depletion of interconnected surface water.
- Sustainable yield estimates from Section 2.2.3.7.

The Basin's sustainable yields for three aquifer groups used as minimum thresholds for the reduction of groundwater in storage sustainability indicator rely on projected net pumping with GSP implementation, as described in Section 2.2.3.7: Projected Sustainable Yield. Net projected pumping for Water Years 2016 – 2069 is pumping that has been adjusted to avoid undesirable results. Adjustments to achieve minimum thresholds include redistributing pumping and the operation of City of Santa Cruz ASR and SqCWD's Pure Water Soquel.

3.5.2.2 Reduction of Groundwater in Storage Minimum Thresholds

Minimum thresholds for reduction of groundwater storage are the sustainable yields representing net annual volume of groundwater extracted (pumping minus volume of managed aquifer recharge) for each of the three groups of aquifers, as summarized in Table 3-13.

Table 3-13. Minimum Thresholds and Measurable Objectives for Reduction of Groundwater of Storage

Aquifer Unit Group	Minimum Threshold	Measurable Objective
	Groundwater Extracted, acre-feet per year	
Aromas Red Sands and Purisima F	1,740	1,680
Purisima DEF, BC, A and AA	2,280	960
Tu	930	620

3.5.2.3 Relationship between Individual Minimum Thresholds and Relationship to Other Sustainability Indicators

As the sustainable yields for the three aquifer groups are based on avoiding undesirable results for all the other applicable sustainability indicators, net pumping at or below the sustainable yield should not conflict with minimum thresholds for the other sustainability indicators.

However, there could be discrepancies observed between the sustainable yields used as minimum thresholds and undesirable results observed for other sustainability indicators. Undesirable results in the other applicable sustainability indicators could still occur if net pumping is below minimum thresholds and undesirable results in the other applicable sustainability indicators might not occur if net pumping exceeds minimum thresholds. In addition to hydrologic uncertainty of the estimates for sustainable yield used for minimum thresholds, the sustainable yield estimates are highly dependent on the location of groundwater extraction and managed aquifer recharge (MAR) used to derive the estimates. Depending on the location of these activities, pumping within the sustainable yield may still cause seawater intrusion at the coast, such as if new production wells are located close to existing wells and close to the coastline.

If discrepancies with other sustainability indicators occur, the estimate for sustainable yields and the minimum thresholds should be revised to be consistent with whether or not there are undesirable results for the other sustainability indicators.

3.5.2.4 Effect of Minimum Thresholds on Neighboring Basins

Anticipated effects of the reduction of groundwater in storage minimum thresholds on neighboring basins are addressed below.

Pajaro Valley Subbasin of the Corralitos Basin (critically-overdrafted). To avoid undesirable seawater intrusion results in the Aromas area near the Basin's boundary with the Pajaro Valley, municipal extraction is currently and projected to be in the future very limited, unless a recharge project can provide supplemental water supplies. As a result of almost eliminating municipal extraction, groundwater levels in the Aromas area near the boundary with Pajaro Valley Subbasin are close to seawater intrusion proxy minimum thresholds. With GSP implementation, groundwater levels are expected to increase slightly higher and closer to measurable objectives at the Basin boundary. Decreased pumping in the Aromas, included in the reduction of groundwater in storage minimum threshold for the Aromas and Purisima F-unit aquifer group, is beneficial to both basins for controlling seawater intrusion. Therefore, it is unlikely that the reduction of groundwater storage minimum thresholds established for the Basin will prevent the Pajaro Valley Subbasin from achieving sustainability.

Santa Margarita Basin (medium-priority). The area of the Basin with potential to influence the Santa Margarita Basin is the western area north of the Aptos Fault where unsustainable conditions have not historically nor currently occurred. Groundwater use in this area is all for private use: mostly for *de minimis* private domestic purposes with two retreats that are non-*de minimis* users of groundwater. Groundwater use in this part of the Basin, as part of the sustainable yield, is projected to remain similar to historic use and therefore minimum thresholds for reduction of groundwater in storage will not negatively impact groundwater conditions in the Santa Margarita Basin.

Purisima Highlands Subbasin of the Corralitos Basin (very low-priority). Similar to the Basin's relationship with the Santa Margarita Basin, the area of the Basin that is closest to the Purisima Highlands Subbasin is mainly pumped by private *de minimis* groundwater users. Pumping in this area is projected to remain similar to historic use and therefore minimum thresholds for reduction of groundwater in storage will not negatively impact groundwater conditions in the Santa Margarita Basin.

3.5.2.5 Effects of Minimum Thresholds on Beneficial Users and Land Uses

The reduction of groundwater in storage (sustainable yield) minimum thresholds may have several effects on beneficial users and land uses in the Basin.

Rural residential land uses and users. Twenty-one percent of the projected sustainable yield comprises estimated pumping from *de-minimis* domestic wells. As changes in pumping in the Basin are focused on municipal wells closer to the coast to avoid undesirable seawater intrusion conditions, rural residential users are not impacted by required reductions in pumping. The model indicated that impacts of inland rural residential pumping on seawater intrusion is minimal and therefore reductions to their pumping would not help achieve protective groundwater elevations. There are therefore no effects on rural residential land uses and users from the reduction of groundwater in storage minimum thresholds.

Agricultural land uses and users. Nine percent of the projected sustainable yield comprises estimated pumping for agricultural purposes. At this time, reductions in agricultural pumping for irrigation purposes are not included in meeting the projected sustainable yield. Therefore, there are no effects on agricultural land uses and users from reduction of groundwater in storage minimum thresholds.

Urban land uses and users. Urban users and land uses are concentrated in a corridor along the coast. Municipal wells that supply water to these users are also located in this area and are therefore also close to the coast. Reductions in municipal pumping needed to increase coastal groundwater levels to control seawater intrusion need to be offset by other water sources. Reducing the amount of municipal groundwater pumping increases the cost of water for municipal users in the Basin because water agencies need to find other, more expensive water sources.

Ecological land uses and users. Groundwater dependent ecosystems would generally benefit from the reduction of groundwater in storage minimum threshold in the area of municipal pumping. Increasing groundwater levels above current levels will generally improve conditions for groundwater dependent ecosystems.

3.5.2.6 Relevant Federal, State, or Local Standards

No federal, state, or local standards exist for reduction of groundwater in storage related groundwater extraction.

3.5.2.7 Method for Quantitative Measurement of Minimum Thresholds

Groundwater extractions in municipal and small water systems RMPs will be directly measured with water meters to determine the volume of groundwater produced in relation to minimum thresholds. Groundwater extraction monitoring will be conducted in accordance with the monitoring plan outlined in Section 3.3.2.4. For *de minimis* domestic and agricultural users that are unmetered, the groundwater extracted by these users will be estimated as described in Section 0.

Annual Basin extractions from each the three aquifer groups will be used in a five-year running average to compare against minimum thresholds to determine if undesirable results have occurred in any of the aquifer groups.

3.5.3 Measurable Objectives - Reduction of Groundwater Storage

3.5.3.1 Measurable Objectives

The reduction of groundwater in storage measurable objectives for each of the three aquifer groups are the maximum net annual amount of groundwater that can be extracted while ensuring 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 any one of the three aquifer groups. Table 3-13 lists the measurable objectives for the three aquifer groups.

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 the maximum that can be pumped if the next four years all had maximum projected pumping for undesirable results to be avoided.

It is not expected that the planned projects will achieve the measurable objective for the Purisima DEF, BC, A, and AA aquifer group; i.e., the planned projects will not provide for four consecutive years of maximum net pumping without avoiding undesirable results.

3.5.3.2 Interim Milestones

Interim milestones for this sustainability indicator track implementation of projects planned to meet sustainability described in Section 4. Section 4 describes the expected benefits of Soquel Creek Water District’s Pure Water Soquel project and the City of Santa Cruz’s Aquifer Storage and Recovery project as preventing undesirable results in the Basin and meeting measurable objectives in much of the Basin. The interim milestones are therefore the projected net pumping for the Basin as the projects get implemented. The interim milestones for 2025, 2030, and 2035 are the five-year averages for net pumping covering Water Years 2021-2025, Water Years 2026-2030, and Water Years 2031-2035, respectively.

Interim milestones for Water Year 2025 do not meet all of the sustainable yields because the operation of Pure Water Soquel with approximately 1,500 acre-feet per year of injection is not scheduled to begin operation until Water Year 2023. The interim milestones for 2030 and 2035 are lower than sustainable yield (minimum threshold) with planned operation of both projects occurring simultaneously by 2026. There will be no undesirable results for reduction of groundwater in storage by 2030.

Although below sustainable yield (minimum threshold), interim milestones are higher in 2035 than 2030 due to projected climate. Evaluations of net pumping versus interim milestones should consider effect of climate on injection and pumping volumes for the previous five years.

Table 3-14. Interim Milestones for Reduction of Groundwater of Storage

Aquifer Unit Group	Interim Milestone 1 2025	Interim Milestone 2 2030	Interim Milestone 3 2035
	Trailing 5 Year Average of Groundwater Extracted, acre-feet per year		
Aromas Red Sands and Purisima F	1,930	1,630	1,670
Purisima DEF, BC, A and AA	2,110	1,970	2,120
Tu	720	710	760

3.6 Seawater Intrusion Sustainable Management Criteria

3.6.1 Undesirable Results - Seawater Intrusion

Locally defined significant and unreasonable seawater intrusion in the Basin is:

Seawater moving farther inland than has been observed from 2013 through 2017.

This statement reflects that the MGA does not want seawater intrusion to advance further into the Basin. The period from 2013 through 2017 is included in the statement because although there has not been much recent change in the distribution of seawater intrusion, there has been one seawater intruded monitoring well (Moran Lake Medium) that has experienced decreased chloride concentrations which are now below 250 mg/L. By specifying the years 2013-2017, we ensure that intrusion is not allowed back into this area, whereas if the historical maximum chloride concentration was used, Moran Lake Medium chloride concentrations could be allowed to increase back to 700 mg/L. Table 3-15 summarizes 2013-2017 average and maximum chloride concentrations for all coastal monitoring wells.

Table 3-15. Summary of Chloride Concentrations in Monitoring and Production Wells at the Coast

Well	Aquifer Unit	Historical Maximum Year	Historical Maximum	2013-2017 Average	2018 / 2017*
			Chloride Concentrations, mg/L		
Coastal Monitoring Wells - Intruded					
SC-A3A	Aromas	2010	22,000	17,955	18,000
SC-A3B	Aromas	2005	4,330	676	1,100
SC-A8A	Purisima F	2015	8,000	7,258	7,500
SC-A2RA	Purisima F	2001	18,480	14,259	15,000
SC-A2RB	Purisima F	2015 & 2018	470	355	470
Moran Lake Medium	Purisima A	2005	700	147	78
Soquel Point Medium	Purisima A	2005	1,300	1,104	1,100
Coastal Monitoring Wells - Unintruded					
SC-A8B	Aromas	2014	38	33	33
SC-A1B	Purisima F	2009	38	26	22
SC-A1A	Purisima DEF	2009	37	28	26
SC-8RD	Purisima DEF	2016	65	28	66
SC-9RC	Purisima BC	1984	63	28	31
SC-8RB	Purisima BC	2003	32	14	13
Pleasure Point Medium	Purisima A	2012	38	34	36
SC-1A	Purisima A	2013	51	41	38
SC-5RA	Purisima A	2001	94	55	58

Well	Aquifer Unit	Historical Maximum Year	Historical Maximum	2013-2017 Average	2018 / 2017*
			Chloride Concentrations, mg/L		
SC-3RA	Purisima A	1984	66	39	38
Moran Lake Deep	Purisima AA	2012	66	64	62*
Pleasure Point Deep	Purisima AA	2006	87	22	21*
Soquel Point Deep	Purisima AA	2016	144	137	140*
SC-13A	Tu	1986	114	NA	NA
Inland Monitoring and Production Wells - Unintruded					
SC-A5A	Purisima F	2015	9,800	8,575	53
SC-A5B	Purisima F	2018	130	95	83
San Andreas PW	Purisima F	2011	79	21	21
Seascape PW	Purisima F	1996	29	20	16
T. Hopkins PW	Purisima DEF	2011	71	46	42
Estates PW	Purisima BC & A	1990	63	45	45
Ledyard PW	Purisima BC	1986	87	35	33
Garnet PW	Purisima A	2009	90	81	84
Beltz #2	Purisima A	2008	97	63	61*
Beltz #8 PW	Purisima A	2012	56	51	52*
SC-22AA	Purisima AA	2018	45	39	36
Corcoran Lagoon Deep	Purisima AA	2011	120	20	21
Schwan Lake	Purisima AA	2008	97	91	94*

PW = production well; NA = not available

3.6.1.1 Criteria for Defining Seawater Intrusion Undesirable Results

Undesirable results for seawater intrusion listed below are related to the inland movement of the chloride isocontour which would be considered significant and unreasonable seawater intrusion. To be able to monitor the location of the isocontour, chloride concentrations in monitoring and production wells either side of the chloride isocontours are used in the definition of undesirable results. In addition to the chloride isocontour minimum threshold, protective groundwater elevations at coastal monitoring wells are used as a proxy for seawater intrusion minimum thresholds. For a decade, seawater intrusion in the Basin has been managed using protective groundwater elevations. Experience has shown that protective groundwater elevations are easier to measure and manage with respect to controlling seawater intrusion, compared to relying purely on chloride concentrations.

The Basin's seawater intrusion undesirable results are split into three categories as defined below.

1. Undesirable results for intruded coastal monitoring wells.

2. Undesirable results for unintruded coastal monitoring wells, and inland monitoring and production wells.
3. Undesirable results for protective groundwater elevations.

If any of these occur, undesirable results from seawater intrusion are occurring.

Undesirable Results for Intruded Coastal Monitoring Wells

Undesirable results for coastal wells hat already have experienced seawater intrusion are:

> *Any coastal monitoring well with current intrusion has a chloride concentration above the 2013–2017 maximum chloride concentration. This concentration must be exceeded in 2 or more of the last 4 consecutive quarterly samples.*

The rationale for this statement is that 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 to that level again is low. Using a five-year (2013 – 2017) historical maximum chloride concentration provides greater flexibility in avoiding undesirable results than using a five-year average concentration and is more protective than using the historical maximum, which is mostly higher than the 2013–2017 maximum concentration.

The number of chloride concentration exceedances should be set at two per year to account for occasional fluctuations not related to seawater intrusion. Two to four samples exceeding the recent historical maximum indicates that seawater intrusion has advanced farther inland, which would be considered significant and unreasonable. Table 3-15 includes a list of historical maximum chloride values versus 2013–2017 average and 2013–2017 maximum chloride concentrations for monitoring and production wells that have had or have seawater intrusion. Note that Moran Lake was previously impacted by seawater (700 mg/L) and its chloride concentration has decreased to below 250 mg/L.

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

Undesirable results for wells unintruded by seawater are broken down by general proximity to the coast:

A. Unintruded coastal monitoring wells

B. Unintruded inland wells (which includes municipal production wells closest to the coast and other non-coastal monitoring wells).

Undesirable results for unintruded coastal monitoring wells (A) are:

> *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 samples (quarterly sampled wells).*

Coastal monitoring wells have been constructed to be 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 father onshore than it is currently. There are seven coastal monitoring well sites (each site contains several multi-depth monitoring wells) that currently do not show seawater intrusion. These wells' chloride concentrations are summarized in Table 3-15. Groundwater 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 increase confidence that tested groundwater concentrations are not anomalies, the exceedance of 250 mg/L must be repeated within a year (quarterly sampled wells) to be undesirable.

Undesirable Results for unintruded inland monitoring wells (B) are:

> *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 unintruded wells used as data points to develop the chloride isocontour will have TDS and chloride tested on at least a semi-annual schedule until an exceedance occurs, which triggers quarterly testing. Additionally, for an undesirable result to occur, seawater must be the cause of the chloride increase and not another source, such as a localized chemical spill. These wells' chloride concentrations are summarized in Table 3-15.

Undesirable Results for Protective Groundwater Elevations

For coastal representative monitoring wells which have protective elevations:

> *Five-year average groundwater elevations below protective groundwater elevations for any Coastal representative monitoring well.*

A five-year averaging period is selected based on the reasoning that follows:

> Cross-sectional models used to develop most of the protective elevations are quasi-steady state models (HydroMetrics LLC, 2009). Therefore, the protective elevations estimated by the models represent long-term averages that need to be achieved to maintain the freshwater-seawater interface at the desired location. The Basin is currently considered in critical overdraft because groundwater levels are below protective elevations in a number of coastal monitoring wells. Therefore, seawater intrusion groundwater level proxies for minimum thresholds that define sustainability are based on a multi-year average to ensure that critical overdraft is considered eliminated only when groundwater levels achieve the long-term average estimated to maintain the freshwater-seawater interface at the desired location. Achieving protective elevations in a single year should not represent elimination of the Basin's critical overdraft condition.
>
> However, the multi-year averaging period cannot be too long because once protective elevations are achieved with a multi-year average, an overly long averaging period would allow for long periods of groundwater levels being below protective elevations and seawater to advance inland during those periods. A five-year period also corresponds with SGMA requirements for five-year updates of the GSP.

Currently, undesirable results are occurring within the Basin for seawater intrusion because five-year average groundwater elevations do not meet protective elevations at all 13 representative monitoring points. Eliminating undesirable results for seawater intrusion is essential to achieve Basin sustainability.

3.6.1.2 Potential Causes of Undesirable Results

Seawater intrusion is a direct result of groundwater levels falling below elevations that would keep seawater offshore. Water supply wells pumping close to the coast have the potential to cause seawater intrusion if the volumes extracted cause groundwater elevations to fall close to or below sea level. The effects on groundwater levels are increased when multiple wells pump cumulative in close proximity to each other.

3.6.1.3 Effects on Beneficial Users and Land Use

The primary detrimental effect on beneficial users and land users from seawater intrusion is that the groundwater supply will become saltier and thus impact the use of groundwater for domestic/municipal and agricultural purposes. Although groundwater with greater than 250 mg/L chloride has a salty taste, it is still drinkable. The state's upper maximum contaminant level is set at 500 mg/L, when it becomes undrinkable by humans.

Regarding effects on agriculture, 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 (Grattan, 2002).

Seawater intrusion renders impacted groundwater essentially unusable to its beneficial users without treatment. Desalinization would significantly increase the cost of water for all users. Land uses completely overlying seawater intrusion, such as agriculture, will need alternative sources of water if their wells are located in the affected areas. For municipal pumpers, impacted wells can be taken offline until a solution is found. This will add stress on their water system by having to make up pumping in other unimpacted wells and increase the potential for further declines in groundwater levels and possibly more seawater intrusion.

3.6.2 Minimum Thresholds - Seawater Intrusion

Contrary to the general rule for setting minimum thresholds for other sustainability indicators, seawater intrusion minimum thresholds do 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, for practical purposes of monitoring the isocontour, minimum thresholds are set at selected monitoring and production wells used to define the isocontour. Groundwater elevation minimum thresholds are also included as a proxy for seawater intrusion.

3.6.2.1 Information Used and Methodology for Establishing Seawater Intrusion Minimum Thresholds

3.6.2.1.1 Chloride Isocontours

Information used for establishing the chloride isocontour seawater intrusion minimum thresholds and measurable objectives include:

- Definitions of significant and unreasonable conditions and desired groundwater quality discussed during GSP Advisory Committee meetings.
- Depths, locations, and logged lithology of existing wells used to monitor groundwater quality.
- Historical and current chloride concentrations in monitoring and production wells near the coast as summarized in Table 3-15.

To provide for more spatial certainty of the chloride isocontour, the isocontour is anchored, where possible, to coastal monitoring wells which are mostly located within 1,000 feet of the coastline. Anchoring the isocontour at coastal monitoring wells provides a consistent point to ascertain if concentrations at a data point on the isocontour (coastal monitoring well) have increased beyond the minimum threshold concentration set for the isocontour. There are 12 points on the isocontour represented by a monitoring well from which concentration data can be obtained and no interpolation is necessary. Additionally, because the 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 because there are no data points on the coast from which to obtain concentration data to know if that concentration has been exceeded or not.

3.6.2.1.2 Groundwater Elevations as a Proxy

The information used for establishing the seawater intrusion groundwater level proxy minimum thresholds and measurable objectives include:

- Information about local definitions of significant and unreasonable conditions and desired groundwater elevations discussed during GSP Advisory Committee meetings.
- Depths and locations of existing coastal monitoring wells used to monitor groundwater levels and seawater intrusion.
- Historical groundwater elevation data from wells monitored by the MGA agencies.
- Maps of current and historical groundwater elevation data.
- Model output from a variable density (SEAWAT 2000) cross-sectional groundwater models.
- SkyTEM geophysical resistivity data.

Cross-sectional models were used to develop both protective and target groundwater levels at coastal monitoring well clusters (HydroMetrics LLC, 2009). Using Monte Carlo uncertainty analysis, a range of protective groundwater levels were developed for each coastal monitoring well cluster (HydroMetrics LLC, 2009). This range represents the uncertainty in the aquifer characteristics. Protective groundwater elevations developed using the cross-sectional models have successfully been used by SqCWD to manage seawater intrusion in the Basin.

Protective groundwater elevations for the Basin are established using two different methods dependent on availability of cross-sectional models:

1. Cross-sectional model data available: minimum thresholds are groundwater elevations that represents at least 70% of cross-sectional model simulations being protective against seawater intrusion for each monitoring well with a protective elevation[1]. 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.

[1] The cross-sectional modeling to develop protective groundwater elevations could not use specific hydrogeologic properties (properties that influence how groundwater flows) with any certainty because there are insufficient data to calibrate the models to groundwater level or concentration data. Additionally, there are limited data for hydrogeologic parameter values offshore, adding further uncertainty. To develop reliable protective groundwater levels, it was necessary to perform an uncertainty analysis that evaluates the range of reasonable outcomes given the lack of precise hydrogeologic property/parameter data.

Each coastal monitoring well location where protective groundwater elevations were developed included 99 randomized parameters model simulations Parameters varied are horizontal hydraulic conductivities of the production unit and underlying unit, and vertical conductivities of the aquitards above the production unit.

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

3.6.2.1.3 Consideration of Sea-Level Rise

The chloride isocontour and associated well chloride concentrations established as seawater intrusion minimum thresholds are based on the description of significant and unreasonable conditions for the sustainability indicator. This describes seawater moving farther inland than has been observed in the past five years as significant and unreasonable conditions. Undesirable results that occur when chloride concentrations exceed minimum thresholds represent significant and unreasonable conditions even when the intrusion is a result of sea level rise. By defining chloride concentrations as minimum thresholds, the MGA is required to prevent significant and unreasonable seawater intrusion in the Basin resulting from sea level rise.

Groundwater level proxies for the seawater intrusion minimum thresholds also take into account current and rising sea levels. The seawater intrusion groundwater level proxies are established as groundwater elevations above mean sea level. The current datum is therefore current sea levels but the datum will rise in the future as sea levels rise. Although the elevation relative to sea level is set by the groundwater level proxy, the absolute elevations that define undesirable results will increase with rising sea levels.

This consideration of the effect of sea level rise is incorporated into the model evaluation of whether projects can raise and maintain groundwater elevations to meet and exceed the groundwater level proxies for minimum thresholds. The model incorporates projected sea level rise in the offshore boundary condition for simulations of future conditions. The boundary condition head for sea level is increased over time to 2.3 feet in 2070 over current sea level rise based on state of California projections for Monterey representing 5% probability under a High Emissions scenario (California Natural Resources Agency, 2018). Since the datum in the model is set at current sea level, simulated future groundwater levels were compared to the groundwater level proxies plus the total sea level rise of 2.3 feet. This allows evaluation of whether projects and management actions will raise and maintain groundwater elevations to meet groundwater level proxies relative to projections of higher sea levels.

3.6.2.2 Chloride Isocontour Minimum Threshold

The current extent of seawater intrusion is indicated by the circle symbols on Figure 3-12. The larger the symbol the greater the chloride concentration. The symbols are also colored by aquifer to indicate depth. Figure 3-12 shows that in the Basin, the Aromas Red Sands aquifer has seawater intrusion only in the La Selva Beach area. However, the SC-A4 monitoring well outside of the Basin in the Pajaro Valley is also intruded thus it is assumed that seawater intrusion in the Aromas Red Sands aquifer extends southwards across the Basin boundary. Current seawater intrusion in the Purisima aquifers is found in one Purisima A-unit monitoring well in the Soquel Point area with a chloride concentration of 1,100 mg/L, and in the Seascape area where chloride concentrations up to 15,000 mg/L occur in three Purisima F-unit monitoring wells (Figure 3-12).

Considering the extent of current seawater intrusion, the chloride isocontours on Figure 3-12 represents seawater intrusion minimum thresholds in both the Aromas and Purisima aquifers. A chloride concentration of 250 mg/L is selected for the minimum threshold for the Basin because native chloride concentrations in groundwater are generally below 100 mg/L. Thus, an increase up to the basin water quality objective and state drinking water standard of 250 mg/L is considered significant and unreasonable. A chloride concentration of 250 mg/L is relatively low and likely represents some seawater mixed with native groundwater. Full strength seawater has a chloride concentration of 19,000 mg/L.

Since the location of the chloride isocontour is defined by concentrations in wells, wells either side of the contour are assigned minimum threshold concentrations that determine if the isocontour is moving inland. It is not required in the SGMA regulations but as discussed in the measurable objectives subsection, chloride concentration in these wells are also used to trigger early management actions if concentrations increase above measurable objectives but are still below minimum thresholds.

If chloride concentrations inland of the isocontour increase to above the minimum threshold concentration of 250 mg/L, this indicates 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 the minimum threshold of 250 mg/L.

Table 3-16 summarizes the minimum thresholds for each of the wells used to define the chloride isocontour.

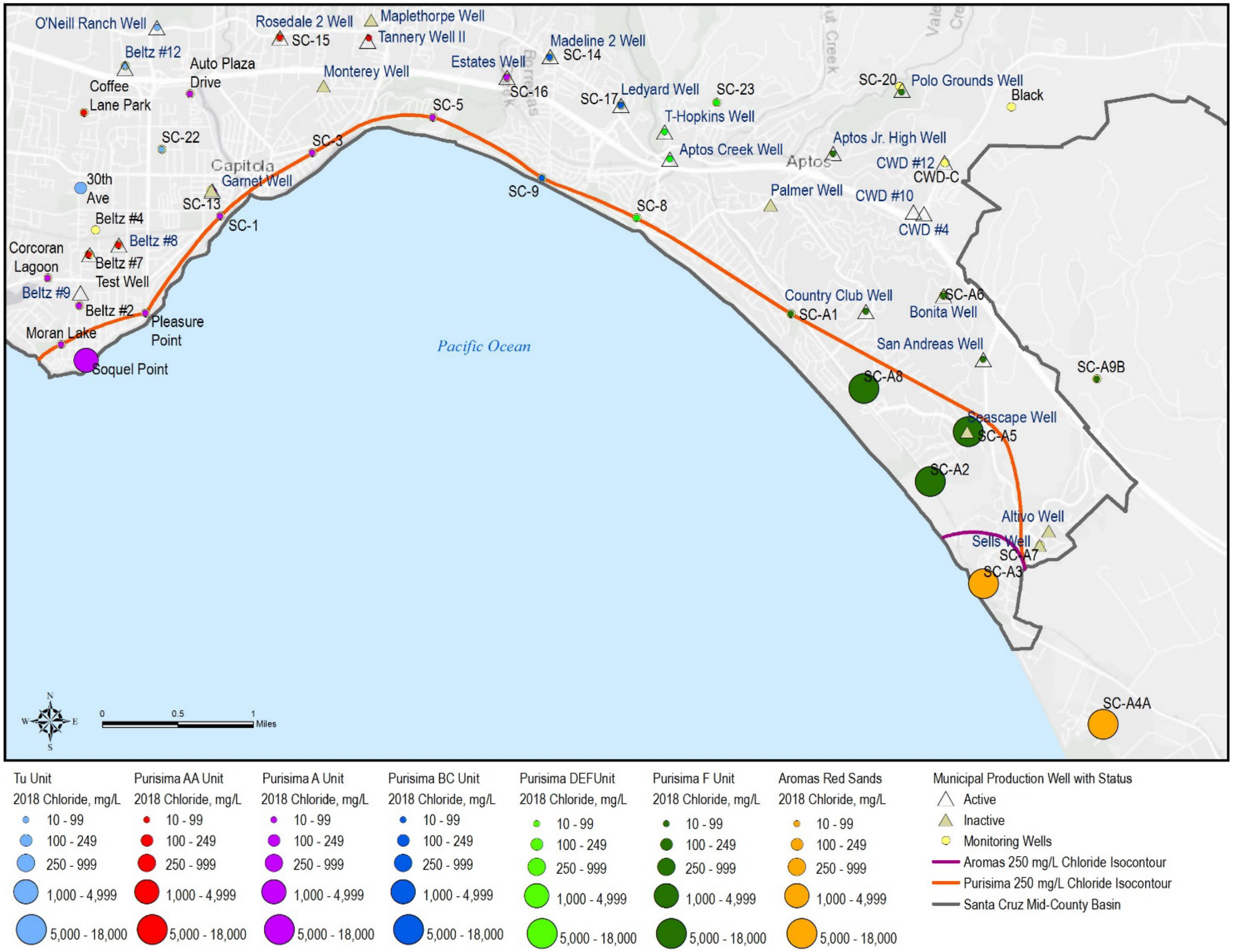

Figure 3-12. 250 mg/L Chloride Isocontour for the Aromas and Pursima Aquifers

Table 3-16. Chloride Minimum Thresholds and Measurable Objectives for Coastal and Inland Wells

Monitoring Well	Aquifer	Minimum Threshold	Measurable Objective
		Chloride Concentration, mg/L	
Coastal Monitoring Wells - Intruded			
SC-A3A	Aromas	22,000	17,955
SC-A3B	Aromas	4,330	676
SC-A8A	Purisima F	8,000	7,258
SC-A2RA	Purisima F	18,480	14,259
SC-A2RB	Purisima F	470	355
Moran Lake Med	Purisima A	700	147
Soquel Point Med	Purisima A	1,300	1,104
Coastal Monitoring Wells - Unintruded			
SC-A8B	Aromas	250	100
SC-A1B	Purisima F	250	100
SC-A1A	Purisima DEF	250	100
SC-8RD	Purisima DEF	250	100
SC-9RC	Purisima BC	250	100
SC-8RB	Purisima BC	250	100
Pleasure Point Medium	Purisima A	250	100
SC-1A	Purisima A	250	100
SC-5RA	Purisima A	250	100
SC-3RA	Purisima A	250	100
Moran Lake Deep	Purisima AA	250	100
Pleasure Point Deep	Purisima AA	250	100
Soquel Point Deep	Purisima AA	250	100
SC-13A	Tu	250	100
Inland Production and Monitoring Wells - Unintruded			
SC-A5A	Purisima F	150	100
SC-A5B	Purisima F	150	100
San Andreas PW	Purisima F	150	100
Seascape PW	Purisima F	150	100
T. Hopkins PW	Purisima DEF	150	100
Estates PW	Purisima BC & A	150	100
Ledyard PW	Purisima BC	150	100
Garnet PW	Purisima A	150	100

Monitoring Well	Aquifer	Minimum Threshold	Measurable Objective
		Chloride Concentration, mg/L	
Beltz #2	Purisima A	150	100
Beltz #8 PW	Purisima A	150	100
SC-22AA	Purisima AA	150	100
Corcoran Lagoon Deep	Purisima AA	150	100
Schwan Lake	Purisima AA	150	100

PW = production well

3.6.2.3 Groundwater Elevations as a Proxy for Seawater Intrusion Minimum Thresholds

As indicated in the SGMA Regulations Section §354.36(b) "*groundwater elevations may be used as a proxy for monitoring other sustainability indicators*." For seawater intrusion, protective groundwater elevations are used as proxies for additional minimum thresholds. Use of a proxy is appropriate because there is significant correlation between groundwater elevations and seawater intrusion. When coastal groundwater levels in aquifers connected to the ocean fall to near or below sea level, flows across the ocean/land boundary become predominantly onshore flows. As higher density seawater flows inland, a wedge forms under the less dense fresh groundwater until the water table achieves equilibrium. The lower groundwater levels are, the less pressure there is from freshwater within the aquifer to resist the intruding seawater.

Minimum thresholds for seawater intrusion using groundwater elevation proxies are the current protective groundwater elevations set at coastal monitoring wells and used for groundwater management over the past 10 years. Current protective elevations for coastal monitoring wells are listed in Table 3-17 and shown on a map as Figure 3-13. New deep monitoring wells need to be constructed in the early part of GSP implementation and protective elevations will be established when the construction details of those wells are available. Table 3-17 and Figure 3-13 identify the two new deep Tu-unit monitoring wells.

Table 3-17. Minimum Thresholds and Measurable Objectives for Groundwater Elevations Used as Proxies at Seawater Intrusion Representative Monitoring Points

Coastal Monitoring Well with Aquifer Unit in Parenthesis	Minimum Threshold (feet mean sea level)	Basis for Minimum Threshold	Measurable Objective (feet mean sea level)	Basis for Measurable Objective	Trigger for Early Management Action (feet mean sea level)
SC-A3A (Aromas)	3	XS 70th	4	XS >99th	1
SC-A1B (F)	3	XS 70th	5	XS >99th	1
SC-A8RA (F)	6	XS 70th	7	XS >99th	2
SC-A2RA (F)	3	XS 70th	4	XS >99th	1
SC-8RD (DEF)	10	XS 70th	11	XS >99th	2
SC-9RC (BC)	10	XS 70th	11	XS >99th	2
SC-8RB (BC)	19	XS 70th	20	SC-8RD + GH	2
SC-5RA (A)	13	XS 70th	15	XS >99th	2
SC-3RA (A)	10	XS 70th	12	XS >99th	2
SC-1A (A)	4	XS 70th	6	XS >99th	2
Moran Lake Medium (A)	5	GH BS	6.8	GH BU	2
Soquel Point Medium (A)	6	GH BS	7.1	GH BU	2
Pleasure Point Medium (A)	6.1	GH BS	6.5	GH BU	2
Moran Lake Deep (AA)	6.7	GH BS	16	GH BU	2
Soquel Point Deep (AA)	7.5	GH BS	16	GH BU	2
Pleasure Point Deep (AA)	7.7	GH BS	16	GH BU	2
SC-13A (Tu)	17.2	GH BS	19	GH BU	2

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

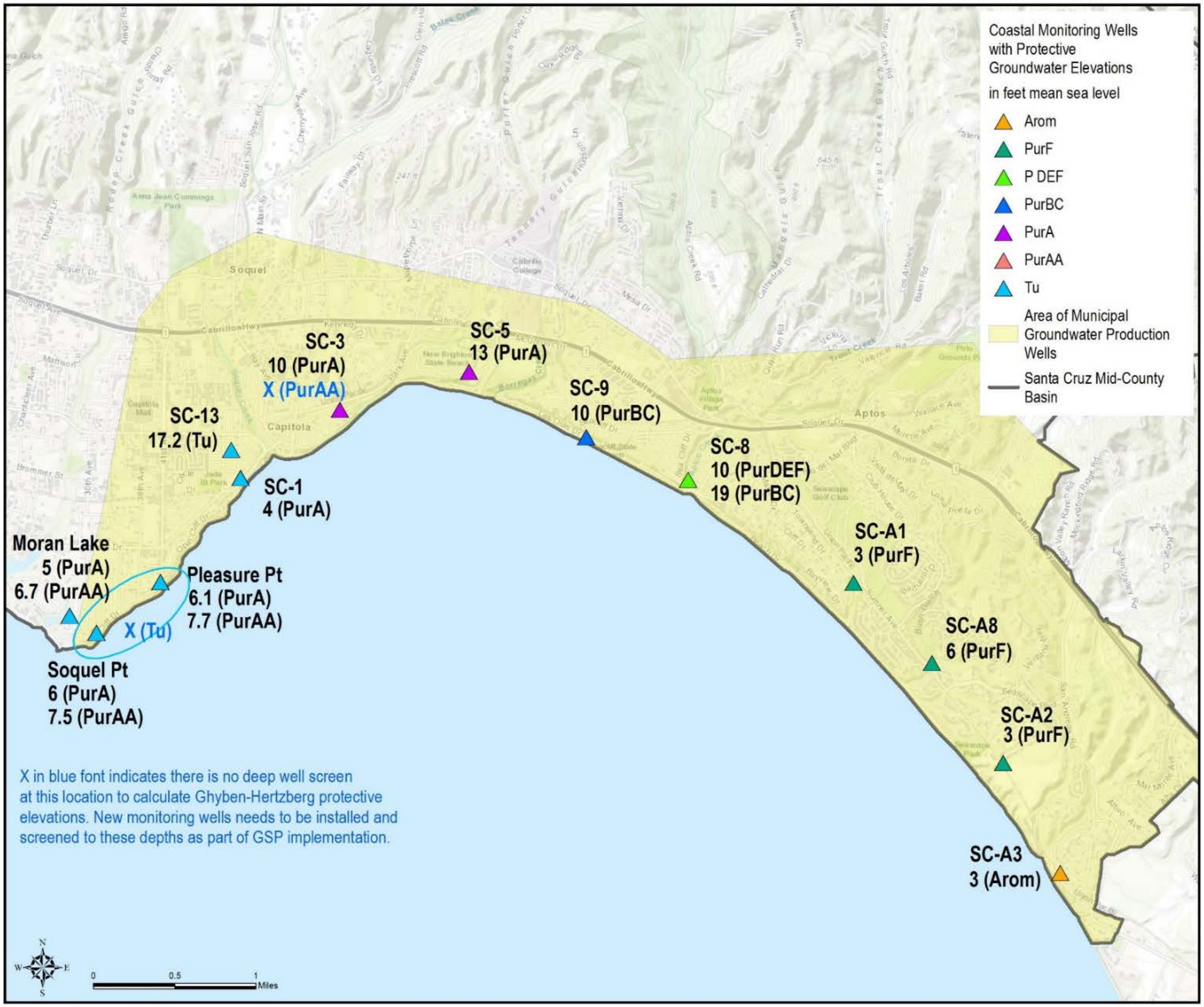

Figure 3-13. Protective Groundwater Elevations at Coastal Monitoring Wells

3.6.2.4 Relationship between Individual Minimum Thresholds and Relationship to Other Sustainability Indicators

Considering the minimum thresholds for seawater intrusion are both groundwater quality and groundwater elevation metrics, the bullets below address the relationship between the seawater intrusion minimum thresholds and other sustainability indicator minimum thresholds.

- **Chronic lowering of groundwater levels.** Groundwater elevations associated with proxy minimum thresholds for seawater intrusion are more stringent than groundwater elevations that represent chronic lowering of groundwater levels. Minimum threshold groundwater elevations for chronic lowering of groundwater levels are raised from the level that would meet overlying demands so that they do not interfere with attaining minimum threshold elevations for seawater intrusion.

- **Reduction of groundwater in storage.** Minimum thresholds for reduction of groundwater in storage and seawater intrusion are dependent on each other. Minimum thresholds for reduction of groundwater in storage are volumes of groundwater, for each of the three aquifer groups that do not cause undesirable results in the other applicable sustainability indicators such as seawater intrusion.

- **Degraded groundwater quality.** The chloride isocontour minimum threshold for seawater intrusion is the same minimum threshold concentration assigned to chloride for degradation of groundwater quality. For the unintruded inland wells, a seawater intrusion chloride minimum threshold of 150 mg/L, although less than the degraded groundwater quality minimum threshold of 250 mg/L, is only used to represent if the chloride isocontour has moved inland and does not signify degraded quality.

- **Subsidence.** This sustainability indicator is not applicable to the Basin.

- **Depletion of interconnected surface water**. Minimum thresholds for interconnected surface water are shallow groundwater levels (as a proxy) that have been set in existing RMPs. Groundwater elevations used as a proxy minimum threshold shown on Figure 3-11 are above sea level and do not interfere with the ability to attain proxy seawater intrusion groundwater elevation thresholds. Since shallow groundwater level proxies set as minimum thresholds for depletion of interconnected surface water are based on observations from 2001-2015, proxy seawater intrusion groundwater elevation minimum thresholds that are generally higher than groundwater elevations from 2001-2015 should not interfere with the ability to avoid undesirable results for depletion of interconnected surface water.

3.6.2.5 Effect of Minimum Thresholds on Neighboring Basins

The anticipated effect of the degraded groundwater quality minimum thresholds on each of the neighboring basins/subbasins are addressed below.

Pajaro Valley Subbasin of the Corralitos Basin (critically-overdrafted). The Pajaro Valley Subbasin is hydrogeological down- to cross-gradient of the Santa Cruz Mid-County Basin. Because of lower groundwater elevations in the Pajaro Valley Subbasin, groundwater along the coastal portion of the boundary flows from the Santa Cruz Mid-County Basin into the Pajaro Valley Subbasin. Chloride concentrations in the La Selva area of the Basin are similar to those in the Pajaro Valley Subbasin, which has more extensive seawater intrusion along its entire length of coastline (Figure 3-12 and Figure 3-14). The goal for seawater intrusion conditions in Pajaro Valley is to halt intrusion by reducing the rate of intrusion (Carollo Engineers, 2014). Since the groundwater level proxy minimum thresholds in the Santa Cruz Mid-County Basin in the Aromas area are intended to keep seawater intrusion where it is currently, the seawater intrusion minimum thresholds assist Pajaro Valley achieve its sustainability goals for seawater intrusion by causing increased subsurface flow into Pajaro Valley thus helping to reduce the rate of intrusion. The increase in outflows to Pajaro Valley when minimum thresholds are achieved is supported by the projected groundwater budget in Section 2.

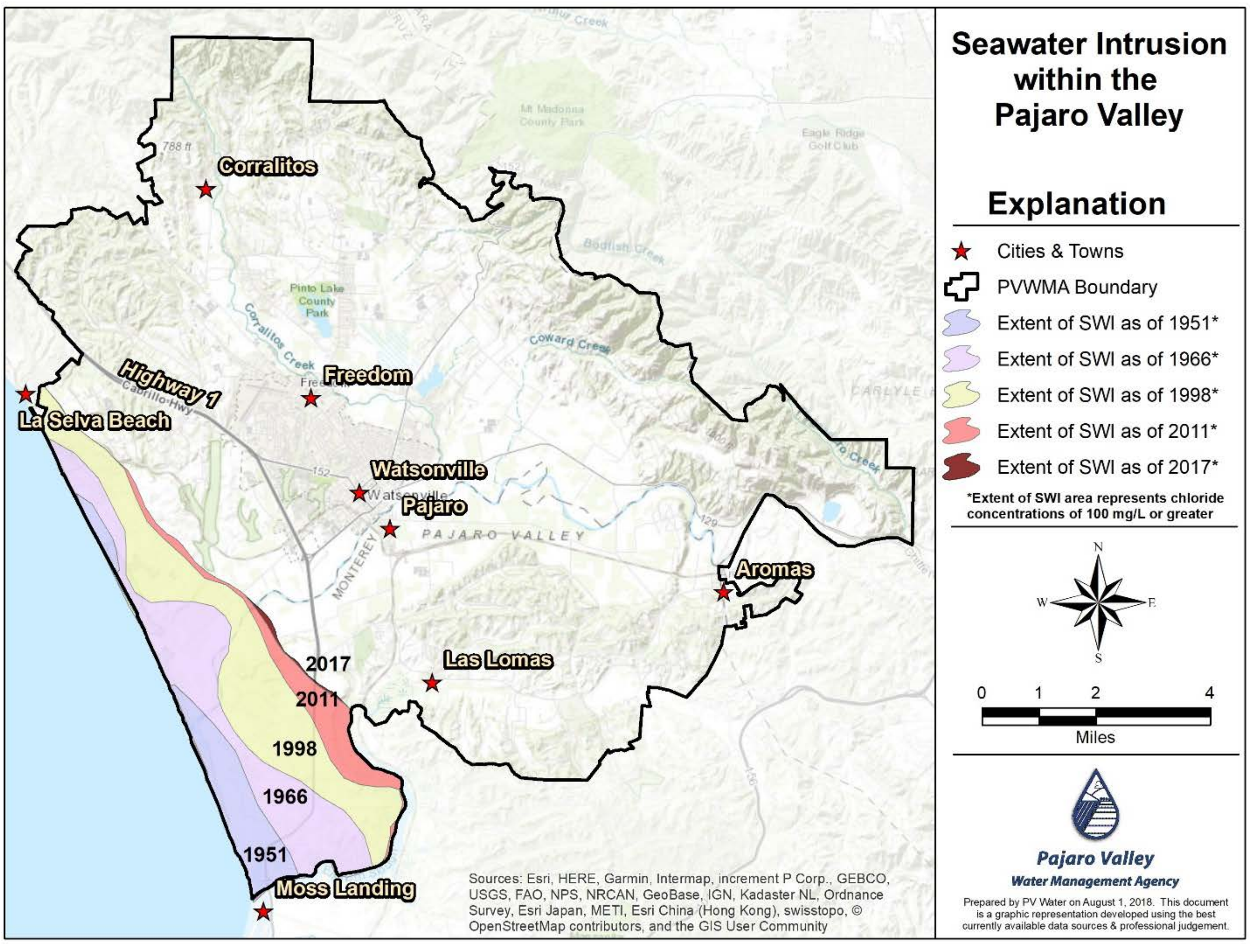

Figure 3-14. Seawater Intrusion within the Pajaro Valley (Source: PV Water)

Santa Margarita Basin (medium-priority). The Santa Margarita Basin is an inland basin being at least 5.8 miles from the coast. Because of this distance and the fact that groundwater elevations at the chloride isocontour near the coast are roughly 550 feet lower than groundwater elevations at the boundary between the two basins, there is no potential for seawater intrusion minimum thresholds established for the Santa Cruz Mid-County Basin to affect the Santa Margarita Basin from achieving sustainability.

Purisima Highlands Subbasin of the Corralitos Basin (very low-priority). Similar to the Santa Margarita Basin, the Purisima Highlands Subbasin is an inland basin that is at an elevation of at least 340 feet above sea level and will not be impacted by seawater intrusion minimum thresholds at the coast.

3.6.2.6 Effects of Minimum Thresholds on Beneficial Users and Land Uses

Between the ocean and the chloride isocontour, land use is predominantly recreational, open space, agricultural, and residential. Private and agricultural users have their own wells while residential users of groundwater are supplied municipal water pumped in other parts of the Basin. Restricting the advancement of seawater intrusion to where it is currently will not impact more wells and an area greater than already impacted. Also, wells inland of the chloride isocontour will not be impacted by the seawater minimum thresholds.

3.6.2.7 Relevant Federal, State, or Local Standards

No federal or state standards exist for seawater intrusion. Locally, the City of Santa Cruz and Soquel Creek Water District have a cooperative monitoring / adaptive groundwater management agreement to: (1) ensure protection of the shared groundwater resource from seawater intrusion, (2) allow for the redistribution of pumping inland away from the Purisima A-unit offshore outcrop area, (3) maintain inland groundwater levels that promote continued groundwater flow toward coastal wells and the Purisima A offshore outcrop area while maintaining coastal groundwater levels that will abate seawater intrusion, and (4) provide both agencies adequate flexibility to respond to changing water demands, changing water supply availability, and infrastructure limitations. Protective groundwater elevations used as proxy measurements for seawater intrusion are aligned with the cooperative agreement's target groundwater elevations.

3.6.2.8 Method for Quantitative Measurement of Minimum Thresholds

Chloride concentrations used to define the chloride isocontour in production and monitoring well RMPs will be directly measured to determine where chloride concentrations are in relation to minimum thresholds. Groundwater quality samples will be collected and tested in accordance with the monitoring plan outlined in Section 3.3. Sampling for all coastal monitoring wells is quarterly and unintruded inland wells are sampled semi-annually, unless an exceedance of a minimum threshold is measured, whereupon the sampling frequency will be increased to quarterly.

Groundwater elevations in RMPs will be directly measured to determine where groundwater levels are in relation to minimum thresholds used a proxy metric for seawater intrusion.

Groundwater level monitoring will be conducted in accordance with the monitoring plan outlined in Section 3.3. All RMPs will be equipped with continuous data loggers.

3.6.3 Measurable Objectives - Seawater Intrusion

3.6.3.1 Chloride Isocontour Measurable Objective

3.6.3.1.1 Measurable Objectives

The measurable objective chloride isocontour has the same location as the minimum threshold isocontour shown on Figure 3-12. Since all historical unintruded coastal monitoring well concentrations are below 100 mg/L (Table 3-16), the isocontour concentration for measurable objectives is 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 allows the same monitoring wells along that isocontour to be used to define its location. The measurable objectives for intruded wells are their 2013 – 2017 average concentration and is 100 mg/L for all unintruded wells. Table 3-16 lists the minimum threshold and measurable objective concentrations for all wells used to define the isocontour.

3.6.3.1.2 Chloride Concentration Triggers

Although not required by the SGMA regulations, the MGA will use chloride concentration exceedances of measurable objectives as a trigger for preemptive actions to prevent significant and unreasonable conditions from occurring. This approach is being taken for this specific sustainability indicator because it is the indicator for which the Basin is in critical overdraft. If chloride concentrations exceed measurable objectives and have a continuing increasing trend, it indicates that concentrations are moving toward minimum thresholds that define undesirable results. Such a trend will be addressed immediately.

For unintruded monitoring wells where chloride concentrations are below 250 mg/L, the measurable objective for chloride concentration is 100 mg/L. Variation of chloride concentrations below 100 mg/L is not necessarily indicative of seawater intrusion. Chloride concentrations above 100 mg/L in two of four quarterly samples are more likely indicative of seawater intrusion and warrant early management action.

For intruded monitoring wells where chloride concentrations are currently above 250 mg/L, the measurable objective for chloride concentrations is the 2013-2017average concentration. As this average concentration includes seasonal and measurement variation, an annual average of four quarterly chloride samples above the measurable objective is indicative of seawater intrusion moving inland and warrants early management action.

The recommended management action for exceedances of chloride measurable objectives is for pumping to be reduced at the municipal well nearest to the monitoring well with the exceedance. The objective of this action is to raise groundwater levels in the monitoring well and prevent further increases of chloride concentrations that could result in significant and unreasonable conditions.

If the groundwater level proxy minimum threshold is being met but chloride measurable objective is exceeded at any monitoring well, this indicates that the groundwater level proxy is not protective for preventing further seawater intrusion than observed over 2013-2017. In this case, the groundwater level proxy should be revised. The groundwater level proxy may not be sufficient because the level is too low or because the multi-year averaging period is too long. Based on an evaluation of groundwater levels and chloride concentrations for what appears insufficient, the level should be raised and/or the averaging period should be shortened.

3.6.3.1.3 Interim Milestones for Chloride

The measurable objective chloride isocontour of 100 mg/L is defined in part by RMPs that currently have chloride concentrations below their measurable objective of 100 mg/L (Figure 3-12). Inland of the isocontour, RMPs are also below their measurable objectives (Table 3-15). Projects and management actions included in the GSP are designed so that current seawater intrusion does not advance inland. Therefore, interim milestones are set at the same concentration as measurable objectives (100 mg/L) as no change in inland chloride concentrations are expected as the GSP is implemented.

For RMPs currently impacted by seawater intrusion and located on the coast-side of the chloride isocontour, current concentrations represented by average 2013 – 2017 chloride concentrations are their measurable objectives. Interim milestones for these wells are set at the same concentrations as measurable objectives shown in Table 3-16, effectively representing conditions that do not allow seawater intrusion to get worse than it is currently.

3.6.3.2 Groundwater Elevations as a Proxy Measurable Objectives

3.6.3.2.1 Measurable Objectives

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

1. Cross-sectional model available: measurable objectives are groundwater elevations that represents >99% of 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 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.

Measurable objectives established based on the approaches above are provided in Table 3-17.

3.6.3.2.2 Protective Groundwater Elevation Triggers

Similar to the chloride concentration triggers described in Section 3.6.3.1 that initiate action based on exceeding chloride concentration measurable objectives in monitoring and production wells near the chloride isocontour, groundwater level proxy triggers at coastal monitoring wells will also initiate early management actions. As with the chloride concentration triggers, these triggers are not required by SGMA regulations but are included in the GSP as a preemptive action to prevent significant and unreasonable conditions from occurring. This approach is being taken for this specific sustainability indicator because seawater intrusion is the indicator for which the Basin is in critical overdraft. Groundwater elevations dropping below these triggers over the short-term indicate an increased risk of seawater intrusion that may not be fully addressed by minimum thresholds and measurable objectives based on five-year average elevations.

The groundwater level proxy trigger is based on the minimum groundwater elevation at coastal monitoring wells included in the existing cooperative monitoring/adaptive management groundwater management agreement between the City of Santa Cruz and Soquel Creek Water District that has been in effect since 2015. The agreement lists a minimum groundwater elevation as 2 feet above mean sea level applied to a 30 day running average at the coastal monitoring wells Moran Lake Medium, Soquel Point Medium, Pleasure Point Medium, and SC-1A. In order to maintain consistency with the cooperative agreement, the following groundwater level proxy triggers are set for other coastal monitoring wells:

- 2 feet above mean sea level is set as the groundwater elevation trigger for wells with minimum threshold groundwater level proxies for seawater intrusion of 4 feet or higher: SC-A8RA, SC-A8RD, SC-9RC, SC-8RB, SC-5RA, SC-3RA, SC-1A, Moran Lake Medium, Soquel Point Medium, Pleasure Point Medium, Moran Lake Deep, Soquel Point Deep, Pleasure Point Deep, and SC-13A.

- In order to provide operational flexibility, 1 foot above mean sea level is set as the groundwater elevation trigger for wells with minimum threshold groundwater level proxies of less than 4 feet: SC-A3A, SC-A1B, and SC-A2RA.

Table 3-17 lists the groundwater elevation triggers for early management action compared to minimum thresholds and measurable objectives for RMPs that use proxy groundwater elevations for SMC.

If data show that a 30-day running average groundwater elevation has dropped below the groundwater elevation trigger at a coastal monitoring well, MGA member agencies that pump from the aquifer unit of the monitoring well will evaluate how municipal pumping quantities and distribution may have caused the decline in groundwater levels. The MGA member agencies will then adjust municipal pumping based on the evaluation to avoid future groundwater elevations below the triggers. If municipal pumping does not appear to have caused the groundwater elevations falling below triggers, the MGA will investigate the cause of the drop.

3.6.3.2.3 Interim Milestones for Groundwater Elevation Proxies

Groundwater elevations as proxy interim milestones are based on model simulations of projects showing how projects will raise coastal groundwater levels over time to prevent undesirable results related to seawater intrusion. Section 4 contains the model results which are used to describe the expected benefits of the projects.

Interim milestones are established at each of the coastal RMPs with proxy groundwater elevations for seawater intrusion. Interim milestones are based on the five year average of model simulated groundwater elevations in Water Years 2025, 2030, and 2035.

Interim milestones at Soquel Creek Water District's coastal monitoring wells (with names beginning in SC) are based on model simulation of Pure Water Soquel because the expected benefits of that project are to raise groundwater levels above or approaching measurable objectives at the District's wells as described in Section 4. The interim milestones at City of Santa Cruz's coastal monitoring wells (Moran Lake, Soquel Point, and Pleasure Point) are based on model simulation of Pure Water Soquel and City of Santa Cruz ASR in combination because the expected benefits of the City of Santa Cruz project are to raise groundwater levels above minimum thresholds at the City's wells as described in Section 4. Table 3-18 summarizes the interim milestones for coastal RMPs.

If simulated groundwater elevations in 2025 are above minimum thresholds, the minimum thresholds are used as the interim milestone because there is some uncertainty about when projects would begin. This GSP sets as an interim milestone the elimination of undesirable results by 2025 at locations where model results show it is achievable with project implementation. If modeled groundwater levels in 2030 and 2035 are above measurable objectives, the measurable objectives are used as the interim milestones.

The model does not reliably simulate groundwater elevations in the Purisima DEF unit where SC-8RD is located. The interim milestone for this well are set at the minimum threshold so that the MGA will evaluate whether Purisima DEF unit pumping is sustainable at each five year interval (Table 3-18).

Interim milestones at Moran Lake Deep well drop slightly between 2030 and 2035. This is a result of reduced surface water supply for City ASR during this time based on projected climate variability. Evaluation of groundwater elevations against these interim milestones should account for actual surface water supply used to recharge the Basin and climate variability.

Table 3-18. Interim MIlestones for Seawater Intrusion Groundwater Elevation Proxies

Representative Monitoring Well with Aquifer Unit in Parenthesis	Minimum Threshold (feet mean seal level)	Measurable Objective (feet mean sea level)	Interim Milestone 2025 (feet mean sea level)	Interim Milestone 2030 (feet mean sea level)	Interim Milestone 2035 (feet mean sea level)
SC-A3A (Aromas)	3	7	3	3.7	3.7
SC-A1B (F)	3	5	3	5	5
SC-A8RA (F)	6	7	4.5	6.0	6.9
SC-A2RA (F)	3	4	3	4	4
SC-8RD (DEF)	10	11	10	10	10
SC-9RC (BC)	10	11	4.6	11	11
SC-8RB (BC)	19	20	8.4	16.6	18.1
SC-5RA (A)	13	15	13	15	15
SC-3RA (A)	10	12	10	12	12
SC-1A (A)	4	6	4	6	6
Moran Lake Medium (A)	5	6.8	5	6.8	6.8
Soquel Point Medium (A)	6	7.1	6	7.1	7.1
Pleasure Point Medium (A)	6.1	6.5	6.1	6.5	6.5
Moran Lake Deep (AA)	6.7	16	6.7	8.1	7.8
Soquel Point Deep (AA)	7.5	16	7.5	8.3	8.3
Pleasure Point Deep (AA)	7.7	16	7.7	11.8	11.9
SC-13A (Tu)	17.2	19	8.3	16.7	18.1

3.7 Degraded Groundwater Quality Sustainable Management Criteria

3.7.1 Undesirable Results - Degraded Groundwater Quality

Locally defined significant and unreasonable groundwater quality degradation in the Basin is:

> *Groundwater quality, attributable to groundwater pumping or managed aquifer recharge, that fails to meet state drinking water standards.*

Recognizing there are naturally occurring groundwater quality issues in the Basin, this statement reflects that any project implemented or management actions taken by the MGA to achieve sustainability must not cause groundwater quality degradation that results in groundwater quality to be worse than drinking water standards.

3.7.1.1 Criteria for Defining Degraded Groundwater Quality Undesirable Results

For the Santa Cruz Mid-County Basin, groundwater quality degradation is unacceptable as a direct result of GSP implementation. Therefore, the degradation of groundwater quality undesirable result is:

> *Groundwater quality undesirable results in the Basin occur when as a result of groundwater pumping or managed aquifer recharge, any representative monitoring well exceeds any state drinking water standard.*

Because degraded groundwater quality undesirable results can only occur due to projects and management actions implemented to achieve sustainability in the GSP, it is important to correlate groundwater quality impacts to RMPs with quality and hydraulic gradient changes caused by projects implemented or management actions taken to achieve sustainability.

3.7.1.2 Potential Causes of Undesirable Results

Conditions that may lead to undesirable results for degraded groundwater quality include the following:

- **Changes to Basin Pumping**. If the location and rates of groundwater pumping change as a result of projects implemented or management actions taken under the GSP, these changes could alter hydraulic gradients and cause movement of poor-quality groundwater towards a supply well at concentrations that exceed state drinking water standards.
- **Groundwater Recharge.** Active recharge of water or captured runoff could modify groundwater gradients and move poor-quality groundwater towards a supply well in concentrations that exceed state drinking water standards.
- **Recharge of Poor-Quality Water.** Recharging the Basin with water that exceeds state drinking water standards may lead to an undesirable result. Since the State Water Control Board who is responsible for regulating recharge activities enforces an anti-degradation policy, there is minimal likelihood of poor-quality water being recharged into the Basin.

3.7.1.3 Effects on Beneficial Users and Land Use

The undesirable result for degradation of groundwater quality is groundwater degradation due to actions directly resulting from GSP implementation. Degradation for this sustainability indicator only occurs if two conditions occur together: (1) there are induced changes in groundwater elevations and gradients, and (2) there is non-native poor-quality groundwater. If both these conditions occur together, the changed hydraulic gradients may move poor-quality groundwater flows towards supply wells that would not have otherwise been impacted.

Currently, apart from one location with 1,2,3-TCP and more widespread nitrate in parts of the Aromas Red Sands aquifers and saline water associated with seawater intrusion in two areas along the coast, the Basin's groundwater quality is good with no non-native poor-quality groundwater present within productive aquifers.

If undesirable results are allowed to take place, groundwater quality that does not meet state drinking water standards needs to be treated, which is a significant cost to users. For municipal suppliers, impacted wells can be taken offline until a solution is found. This will add stress on their water system by having to make up pumping in other unimpacted wells and increase the potential for further declines in groundwater levels.

This undesirable result does not apply to groundwater quality changes that occur due to other causes not in the control of the MGA. There are a number of federal, state, and local regulatory policies related to the protection of groundwater quality that will continue to be enforced by relevant federal, state, and local agencies. A summary of these regulations is included in Appendix 3-C.

3.7.2 Minimum Thresholds - Degraded Groundwater Quality

3.7.2.1 Information and Methodology Used to Establish Minimum Thresholds and Measurable Objectives

The information used for establishing the degraded groundwater quality minimum thresholds included:

- Feedback about significant and unreasonable conditions from the GSP Advisory Committee and the public.
- Historical and current groundwater quality data from production and monitoring wells in the Basin.
- Federal and state drinking water quality standards.
- Depths, locations, and logged lithology of existing wells used to monitor groundwater quality.

The historical and current groundwater quality used to establish groundwater quality minimum thresholds are discussed in Section 2.2.2.4: Groundwater Quality. Based on review of historical and current groundwater quality data, federal and state drinking water standards, and irrigation water quality needs, the MGA agreed that state drinking water standards are appropriate to define degraded groundwater quality minimum thresholds.

3.7.2.2 Degraded Groundwater Quality Minimum Thresholds

Minimum thresholds are state drinking water standards for constituents of concern monitored in RMPs for degraded groundwater quality. Table 3-19 lists the constituents of concern in the Basin together with why it is of concern and their state drinking water standards that represent minimum thresholds.

Table 3-19. Constituents of Concern with Minimum Thresholds

Constituent of Concern	Reason for Concern	Minimum Threshold/ Drinking Water Standard
Total dissolved solids	basic health of basin	1,000 mg/L
Chloride	basic health of basin	250 mg/L
Iron	naturally elevated	300 µg/L
Manganese	naturally elevated	50 µg/L
Arsenic	naturally elevated	10 µg/L
Chromium (Total)	naturally elevated	50 µg/L
Chromium VI	naturally elevated	none set yet
Nitrate as Nitrogen	septic systems & agriculture	10 mg/L
Perchlorate	agriculture related	6 µg/L
Organic compounds	human introduced	various

Each project implemented as part of the GSP will have its own unique constituents of concern that will apply to monitoring and production wells included in their use permits granted by the State Water Resources Control Board Division (SWRCB) of Drinking Water (DDW). For example, projects injecting purified recycled water into the Basin are classified as groundwater replenishment reuse projects (GRRP) and permits from SWRCB DDW are required. A compendium of groundwater replenishment reuse regulations (GRRR) (Title 22, Division 4, Chapter 3) were issued by the SWRCB in 2014 (SWRCB, 2018). Specific monitoring wells and a list of constituents to monitor are part of specific permit conditions. The GRRR Section 60320.200 (c) requires at least four quarters of background groundwater quality data to characterize groundwater quality in each aquifer that will be receiving recycled water before injection of purified recycled water starts.

For Aquifer Storage & Recovery (ASR) projects, the SWRCB has adopted general waste discharge requirements for ASR projects that inject water of drinking water quality into groundwater (Order No. 2012-0010-DWQ or ASR General Order). The ASR General Order provides a consistent statewide regulatory framework for authorizing both pilot ASR testing and permanent ASR projects. Oversight of these regulations is through the Regional Water Quality Control Board (RWQCB) and obtaining coverage under the General ASR Order requires the preparation and submission of a Notice of Intent (NOI) application package. The NOI includes a technical report that, amongst other things, identifies and describes target aquifers, delineates the Areas of Hydrologic Influence, identifies all land uses within the delineated Areas of Hydrologic Influence, identifies known areas of contamination within the Areas of Hydrologic Influence, identifies project-specific constituents of concern, and groundwater degradation assessment.

3.7.2.3 Relationship between Individual Minimum Thresholds and Relationship to Other Sustainability Indicators

As SGMA regulations do not require projects or management actions to improve existing groundwater quality, there are no direct actions under the GSP associated with achieving groundwater quality minimum thresholds. Therefore, there are no actions that directly influence other sustainability indicators. However, preventing migration of poor-quality groundwater may limit activities needed to achieve minimum thresholds for other sustainability indicators.

- **Chronic lowering of groundwater levels.** Degraded groundwater quality minimum thresholds could influence groundwater level minimum thresholds by limiting the types of water that can be used for recharge to raise groundwater levels in the unlikely event that levels started to approach minimum thresholds.
- **Change in groundwater storage**. Degraded groundwater quality minimum thresholds do not promote pumping in excess of the sustainable yield. Therefore, the degraded groundwater quality minimum thresholds will not result in an exceedance of the groundwater storage minimum threshold.
- **Seawater intrusion**. Degraded groundwater quality minimum thresholds could influence groundwater level proxy minimum thresholds for seawater intrusion by limiting the types of water that can be used for recharge to raise groundwater levels.
- **Subsidence**. This sustainability indicator is not applicable to this Subbasin
- **Depletion of interconnected surface waters.** Degraded groundwater quality minimum thresholds do not promote additional pumping or lower groundwater elevations adjacent to interconnected surface waters. Therefore, the degraded groundwater quality minimum thresholds will not result in a significant or unreasonable depletion of interconnected surface waters.

Minimum thresholds for all constituents of concern and RMPs are uniform throughout the Basin, thus there is no conflict between individual minimum thresholds.

3.7.2.4 Effect of Minimum Thresholds on Neighboring Basins

The anticipated effect of the degraded groundwater quality minimum thresholds on each of the neighboring basins is addressed below.

Pajaro Valley Subbasin of the Corralitos Basin (critically-overdrafted). The Pajaro Valley Subbasin is hydrogeological down- to cross-gradient of the Santa Cruz Mid-County Basin. Because of lower groundwater elevations in the Pajaro Valley Subbasin, groundwater along the coastal portion of the boundary generally flows from the Santa Cruz Mid-County Basin into the Pajaro Valley Subbasin (Figure 2-50. Groundwater Budget Subareas). The groundwater quality on either side of the Basin boundary with the Pajaro Valley Subbasin is similar; having overall good quality with the exception of elevated nitrates and salinity associated with seawater intrusion at the coast. The quality of groundwater in Pajaro Valley is documented in its Salt and Nutrient Management Plan (PVWMA, 2016). The degraded groundwater quality minimum threshold is set to maintain the good-quality groundwater in the Basin that flows into the Pajaro Valley Subbasin. Therefore, it is unlikely that the groundwater quality minimum thresholds established for the Basin will prevent the Pajaro Valley Subbasin from achieving sustainability with regards to groundwater quality.

Santa Margarita Basin (medium-priority). Limited groundwater currently flows from the Santa Cruz Mid-County Basin into the Santa Margarita Basin. Groundwater quality in the vicinity of the basins' boundary is generally good with the exception of naturally occurring elevated iron, manganese, and occasionally arsenic. No GSP projects or management actions are likely in this area as it is far from the coast where projects and management actions to raise coastal groundwater levels preventing seawater intrusion will take place. Therefore, it is unlikely that the groundwater quality minimum thresholds established for the Basin will prevent the Santa Margarita Basin from achieving sustainability.

Purisima Highlands Subbasin of the Corralitos Basin (very low-priority). The Purisima Highlands Subbasin is hydrogeological up-gradient of the Santa Cruz Mid-County Basin. Groundwater flow, historically and projected in the future, is from the Purisima Highlands Subbasin into the Santa Cruz Mid-County Basin. For this reason, there is no possibility of groundwater quality in the Basin impacting the Purisima Highlands Subbasin. Furthermore, minimum thresholds for groundwater quality are set to maintain the good groundwater quality in both basins.

3.7.2.5 Effects of Minimum Thresholds on Beneficial Users and Land Uses

In general, degraded groundwater quality minimum thresholds will not have any negative effects on beneficial users and land uses in the Basin.

Rural residential land uses and users. The degraded groundwater quality minimum thresholds benefit domestic water users in the Basin. Ensuring constituents of concern in additional drinking water supply wells remain below state drinking water standard protects groundwater for domestic use.

Agricultural land uses and users. The degraded groundwater quality minimum thresholds generally benefit agricultural water users in the Basin. Drinking water standards are more stringent than some agricultural water quality standards, with the exception of strawberries which are very sensitive to salt in irrigation water.

Urban land uses and users. The degraded groundwater quality minimum thresholds benefit the urban water users in the Basin. Preventing groundwater for drinking water supply from exceeding state drinking water standards ensures an adequate supply of groundwater for municipal use.

Ecological land uses and users. Although the groundwater quality minimum thresholds do not directly benefit ecological uses, it can be inferred that the degraded groundwater quality minimum thresholds generally benefit the ecological water uses in the Basin. Preventing poor-quality groundwater from migrating will prevent unwanted contaminants from impacting groundwater dependent ecosystems.

3.7.2.6 Relevant Federal, State, or Local Standards

The degraded groundwater quality minimum thresholds specifically incorporate state drinking water standards.

3.7.2.7 Method for Quantitative Measurement of Minimum Thresholds

Groundwater quality in production and monitoring well RMPs will be directly measured to determine where groundwater quality concentrations are in relation to minimum thresholds. Groundwater quality samples will be collected and tested in accordance with the monitoring plan outlined in Section 3.3.

3.7.3 Measurable Objectives - Degraded Groundwater Quality

3.7.3.1 Measurable Objectives

Measurable objectives for each RMP are the 2013 – 2017 average concentrations for each constituent of concern for each RMP. Table 3-20 summarizes the measurable objectives for each RMP. If a representative monitoring well does not have groundwater quality data during this period, the most recent concentrations are used.

3.7.3.2 Interim Milestones

Groundwater quality in the Basin is currently above minimum thresholds for all RMPs with no changes in quality expected from projects and management actions implemented to achieve sustainability. Since the measurable objectives effectively represent current conditions (average of 2013 – 2017 concentrations), interim milestones are set at the same concentration as measurable objectives shown in Table 3-20.

Table 3-20. Measurable Objectives for Degradation of Groundwater Quality

Aquifer Unit	Well Name	Total Dissolved Solids, mg/L	Chloride, mg/L	Iron, µg/L	Manganese, µg/L	Arsenic, µg/L	Chromium (Total), µg/L	Chromium VI, µg/L	Nitrate as Nitrogen, mg/L	Perchlorate, µg/L	Organic compounds
	Minimum Threshold	**1,000**	**250**	**300**	**50**	**10**	**50**	**NA**	**10**	**6**	**various**
Aromas	Altivo PW	209	18.9	41	4	0.2	26.5	22	1	0.2	ND
	CWD-10 PW	340	26	ND	ND	ND	11	ND	25	ND	ND
	SC-A1C	348	29	232	1378	ND	ND	ND	1	ND	ND
	SC-A2RC	355	41	114	11	ND	6	ND	4	ND	ND
	SC-A3A*	33,000	17,995	478	258	ND	1	ND	ND	ND	ND
	SC-A3C	390	62	251	17	ND	8	ND	7	ND	ND
	SC-A8B	321	33	20	188	ND	ND	ND	ND	ND	ND
	SC-A8C	298	35	23	8	ND	12	ND	4	ND	ND
Aromas/ Purisima F	Polo Grounds PW	265	21	18	181	0.4	ND	ND	ND	0.3	ND
	Aptos Jr. High 2 PW	301	31	28	181	0.9	0.9	ND	ND	ND	ND
	Country Club PW	311	34	18	6	0.4	7.5	6	4	ND	ND
	Bonita PW	287	27	21	4	0.4	9.3	11	3	ND	ND
	San Andreas PW	242	21	10	5	0.7	17.5	16	2	ND	ND
	Seascape PW	288	20	34	6	0.3	15	16	1	ND	ND
Purisima F	CWD-4 PW	30	30	0	0	ND	12	ND	25	ND	ND
	CWD-12 PW	310	24	0	0	ND	ND	ND	1.2	ND	ND

Aquifer Unit	Well Name	Total Dissolved Solids, mg/L	Chloride, mg/L	Iron, µg/L	Manganese, µg/L	Arsenic, µg/L	Chromium (Total), µg/L	Chromium VI, µg/L	Nitrate as Nitrogen, mg/L	Perchlorate, µg/L	Organic compounds
	Minimum Threshold	**1,000**	**250**	**300**	**50**	**10**	**50**	**NA**	**10**	**6**	**various**
	SC-A2RA*	28,947	14,259	1,019	1,608	ND	ND	ND	ND	ND	ND
	SC-A8A*	15,174	7,258	380	3,633	ND	6	ND	1	ND	ND
Purisima DEF	SC-8RD	319	28	5	9	ND	ND	ND	2	ND	ND
	SC-9RE	507	28	46	57	ND	ND	ND	ND	ND	ND
	SC-A1A	224	28	1842	57	ND	ND	ND	ND	ND	ND
	T. Hopkins PW	355	46	33	106	2.3	2.4	ND	ND	ND	ND
Purisima BC	Ledyard PW	363	35	98	12	0.2	0.2	ND	ND	ND	ND
	Madeline 2 PW	408	34	187	10	ND	ND	ND	ND	ND	ND
	Aptos Creek PW	463	40	405	412	4	ND	ND	ND	ND	ND
	SC-23A	272	20	530	12	ND	ND	ND	ND	ND	ND
	SC-8RB	433	14	87	10	ND	ND	ND	2	ND	ND
	SC-9RC	381	27	16	9	ND	ND	ND	ND	ND	ND
Purisima A	30th Ave Shallow (3)	822	56	107	1,231	NT	NT	NT	ND	NT	NT
	Pleasure Point Shallow	288	37	106	119	NT	NT	NT	ND	NT	NT
	Estates PW	465	45	212	99	0.2	0.2	ND	ND	ND	ND
	Garnet PW	619	81	1,400	416	ND	ND	ND	ND	ND	ND
	Tannery 2 PW	574	60	224	140	0.18	ND	ND	ND	ND	ND

Aquifer Unit	Well Name	Total Dissolved Solids, mg/L	Chloride, mg/L	Iron, µg/L	Manganese, µg/L	Arsenic, µg/L	Chromium (Total), µg/L	Chromium VI, µg/L	Nitrate as Nitrogen, mg/L	Perchlorate, µg/L	Organic compounds
	Minimum Threshold	**1,000**	**250**	**300**	**50**	**10**	**50**	**NA**	**10**	**6**	**various**
	Rosedale 2 PW	496	44	715	255	0.18	ND	ND	ND	ND	ND
	Beltz #8 PW	448	51	1478	178	2	ND	ND	ND	ND	ND
	Beltz #9 PW	447	50	47	747	200	ND	ND	ND	ND	ND
	SC-3RC	461	46	63	36	ND	ND	ND	ND	ND	ND
	SC-5RA	534	55	2,778	180	ND	ND	ND	ND	ND	ND
	SC-9RA	390	15	14,424	19	ND	ND	ND	ND	ND	ND
	SC-10RA	349	29	223	522	ND	ND	ND	ND	ND	ND
	SC-22A	419	20	502	540	ND	ND	ND	ND	ND	ND
Purisima A/AA	Beltz #10 PW	621	58	836	277	2	ND	ND	ND	ND	ND
Purisima AA	SC-10RAA	231	10	93	72	ND	ND	ND	ND	ND	ND
	SC-22AAA	579	57	21	36	ND	ND	ND	ND	ND	ND
	Coffee Lane Deep	928	41	8	134	NT	NT	NT	ND	NT	NT
	Pleasure Point Deep	610	22	553	208	NT	NT	NT	ND	NT	NT
	Thurber Lane Shallow	No samples collected since 2006									
	Schwan Lake	400	91	316	113	NT	NT	NT	ND	NT	ND
Purisima	O’Neill Ranch PW	402	34	651	281	0.18	ND	ND	ND	3	ND

Aquifer Unit	Well Name	Total Dissolved Solids, mg/L	Chloride, mg/L	Iron, µg/L	Manganese, µg/L	Arsenic, µg/L	Chromium (Total), µg/L	Chromium VI, µg/L	Nitrate as Nitrogen, mg/L	Perchlorate, µg/L	Organic compounds
	Minimum Threshold	**1,000**	**250**	**300**	**50**	**10**	**50**	**NA**	**10**	**6**	**various**
AA/Tu	Beltz #12 PW	472	33	1,021	354	ND	ND	ND	ND	ND	ND
Tu	SC-18RAA	243	18	64	77	ND	ND	ND	ND	ND	ND
	Thurber Lane Deep	No samples collected since 2006									

NA = State Water Resources Control Board is still developing the maximum contaminant level for Chromium VI
ND = non-detect; NT = not tested
* well impacted by seawater intrusion therefore measurable objective is the same as the seawater intrusion measurable objective.

3.8 Land Subsidence Sustainable Management Criteria

3.8.1 Undesirable Results - Land Subsidence

The sustainability indicator is not applicable in the Santa Cruz Mid-County Basin as an indicator of groundwater sustainability and therefore no SMC are set. Section 2.2.2.5: Land Subsidence provides the evidence for subsidence's inapplicability as an indicator of groundwater sustainability. Even though the indicator is not applicable, a statement of significant and unreasonable subsidence caused by lowering of groundwater levels was discussed by the GSP Advisory Committee and is included below:

> *Any land subsidence caused by lowering of groundwater levels occurring in the basin would be considered significant and unreasonable.*

3.8.2 Minimum Thresholds - Land Subsidence

Subsidence is not applicable in the Santa Cruz Mid-County Basin as an indicator of groundwater sustainability and therefore no minimum thresholds are set.

3.8.3 Measurable Objectives - Land Subsidence

Land subsidence is not applicable in the Santa Cruz Mid-County Basin as an indicator of groundwater sustainability and therefore no measurable objectives or interim milestones are set.

3.9 Depletion of Interconnected Surface Water Sustainable Management Criteria

Development of sustainable management criteria for depletion of interconnected surface water is based on the only shallow well and associated streamflow data available in the Basin. Figure 3-3 shows the monitoring features concentrated along the lower Soquel Creek where the closest municipal pumping center occurs to surface water. From these data and other studies, it is understood that late summer streamflow in the mainstem of Soquel Creek between its forks and the USGS streamflow gauge is influenced by many other factors in addition to contributions by groundwater. Annual rainfall, flows from the upper Soquel Creek watershed outside of the Basin, temperature and evapotranspiration individually have a much greater measurable influence on streamflow than groundwater pumping. For this reach of Soquel Creek, it has been concluded over several years of monitoring that there is not a direct measurable depletion of surface water flow correlated with municipal pumping. There are, however, indications that there is an indirect influence where shallow groundwater levels mimic deeper regional groundwater level trends, which have been influenced by municipal pumping. As these observations are made from a few wells on the lower Soquel Creek only, further study as part of GSP implementation will revise the current understanding. This might necessitate a future change in the sustainable management criteria for this sustainability indicator.

3.9.1 Undesirable Results - Depletion of Interconnected Surface Water

Significant and unreasonable depletion of surface water due to groundwater extraction, in interconnected streams supporting priority species, would be undesirable if there is more depletion than experienced since the start of shallow groundwater level monitoring through 2015.

3.9.1.1 Groundwater Elevations as a Proxy for Depletion of Interconnected Surface Water Minimum Thresholds

The metric for depletion of interconnected surface water is a volume or rate of surface water depletion. This is a very difficult metric to quantify in the Basin since the depletion of interconnected surface water by municipal groundwater extraction is so small that it is not possible to directly measure through changes in streamflow. The SGMA regulations allow for the use of groundwater elevations as a proxy for volume or rate of surface water depletion. To use a groundwater elevation proxy there must be significant correlation between groundwater elevations and the sustainability indicator for which groundwater elevation measurements are to serve as a proxy. Significant correlation is difficult to prove because depletion of surface water by groundwater extractions is so small compared to the other streamflow factors mentioned in Section 3.9 above, and is not directly measurable in the streamflow. Even though changes in streamflow from groundwater extractions cannot be directly measured, those changes can be simulated by a model.

An example of the complexities of showing significant correlation can be seen at the Main Street SW 1 shallow well. Data collected at the well site show precipitation and creek stage to have much greater impact on shallow groundwater levels than nearby municipal pumping. Since undesirable results are related to significant and unreasonable depletion of surface water due to groundwater extraction, future monitoring and analysis efforts need to specifically identify groundwater level changes resulting from groundwater extractions. If groundwater levels are responding to factors other than groundwater extractions, it will be challenging to determine whether minimum thresholds are not being met due to just groundwater extractions or because of these other factors.

If groundwater elevations connected to streams are kept at or above current elevations, which are close to record high levels, there will be no more depletion in surface water than experienced over the past 18 years. Essentially, the minimum thresholds seek to maintain a groundwater gradient toward the stream by controlling groundwater levels near the stream. Lower minimum thresholds than those included in this GSP may also prevent increased surface water depletion. However, as there is uncertainty around this relationship, higher minimum thresholds have initially been selected to be more conservative for habitat and sensitive species.

In an effort to show correlation between volume or rate of streamflow and groundwater level proxies for minimum thresholds, groundwater model output is used to estimate the relationship. The groundwater model is used to estimate streamflow depletion from pumping during the 2001-2015 period, which is the period where shallow groundwater level data are available and from which minimum thresholds are derived. The streamflow depletion estimate is derived by testing the sensitivity of simulated groundwater contribution of streamflow to pumping within the Basin. It is important to acknowledge that data quantifying flows between the stream and shallow groundwater are not available for calibration so there is high uncertainty of the magnitude of simulated flows between stream and aquifer calculated by the model. Adding to the uncertainty of the estimate, this sensitivity test is outside the bounds of real world conditions (i.e., removing all Basin pumping) under which the model is calibrated to shallow groundwater elevation and streamflow data. Due to this uncertainty, the model results represent an estimate of historical streamflow depletion, but the model result value should not be used as quantitative criteria.

Figure 3-15 shows the sensitivity results of groundwater contribution to streamflow from changes in Basin pumping. This analysis is for the entire Soquel Creek watershed during minimum flow months. Removing all modeled private domestic, agricultural, and municipal pumping within the Basin, while continuing pumping outside of the Basin, results in an increased groundwater contribution to Soquel Creek of up to 1.4 cubic-feet per second (cfs) for the 2001-2015 modeled period. This is an estimate of the relationship between the groundwater level proxies for minimum thresholds and streamflow depletion, but it is too uncertain to represent a value to specify as a minimum threshold. For this reason and due to the difficulty measuring streamflow depletion from pumping, it is appropriate to use a groundwater level proxy to prevent the undesirable result of increases in streamflow depletion above what occurred from 2001-2015.

The estimate of historical streamflow depletion may be revised in the future as more information becomes available as a result of more refined modeling, collection of additional monitoring data, or future testing of aquifer and stream properties. In addition, future methods or use of new information may be able to better quantify current depletion from pumping. In order to assess whether undesirable results have occurred, values estimated by different methods or new estimates should be compared to streamflow depletion for 2001-2015 estimated in a consistent manner as opposed to the 1.4 cfs estimated above.

Sections 3.3.4.1 and 3.3.4.2 discuss data gaps associated with establishment of minimum thresholds for depletion of interconnected surface water and the plan to address them.

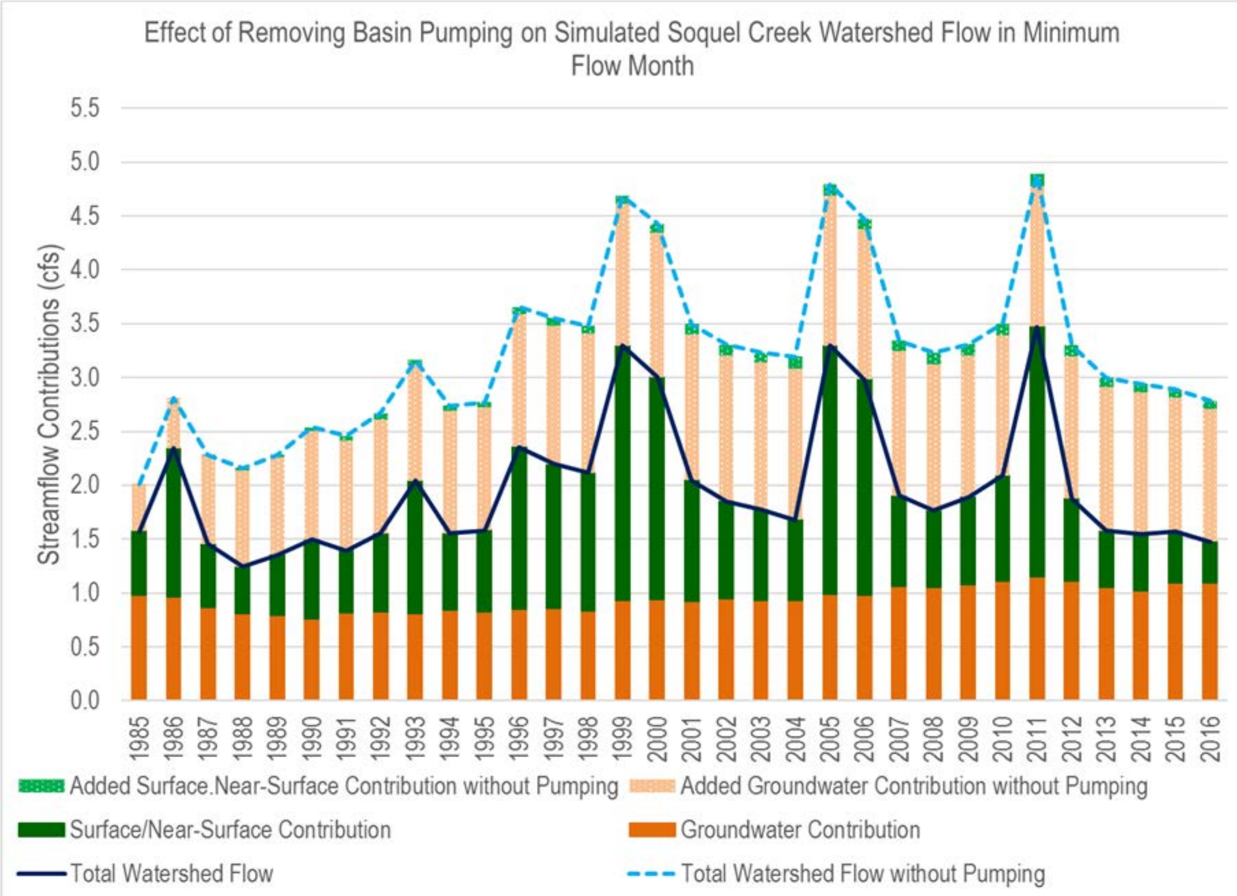

Figure 3-15. Simulated Contributions to Streamflow for Soquel Creek Watershed with and without Historical Pumping

3.9.1.2 Criteria for Defining Depletion of Interconnected Surface Water Undesirable Results

There was support in the Surface Water Working Group to move towards managing shallow groundwater so that interconnected streams have gaining flow from groundwater and are not losing flow to groundwater. Additionally, ensuring that streams do not experience more depletion than has occurred since the start of shallow groundwater level monitoring was another key condition. The Surface Water Working Group elected to take a conservative approach to defining undesirable results where any shallow RMP's groundwater elevation falling below its minimum threshold would be an undesirable result.

It should be noted that since the direct relationship between impacts on sensitive species or habitat and shallow groundwater levels has not been established, current observations do not indicate shallow well groundwater levels below minimum thresholds have a significant and unreasonable impact on sensitive species or habitat. Separate from the GSP, MGA member agencies are monitoring streams within the Basin for fish abundance and habitat conditions. Where feasible, these observations will be compared to groundwater levels and streamflow to attempt to establish a better understanding of the relationships between them.

3.9.1.3 Potential Causes of Undesirable Results

As mentioned previously, there are many factors aside from groundwater that effect streamflow in Soquel Creek and likely other streams in the Basin. Undesirable results for depletion of interconnected surface water in the context of the GSP are related purely to the extraction of groundwater from the Basin. Increased pumping is a potential cause of undesirable results that may manifest itself in reduced groundwater levels in both the shallow and deeper underlying Purisima aquifers. Shallow groundwater data show a relationship with long-term trends in groundwater levels of deeper underlying Purisima aquifers resulting from changes in pumping. However, deep aquifer pumping by municipal wells near Soquel Creek has not found any direct measurable impact on creek flows in studies done to date (HydroMetrics, 2015; HydroMetrics, 2016; HydroMetrics, 2017). Long-term impacts from this pumping on streamflow are being studied as part of the monitoring program outlined in Section 3,4,1,1 of this GSP.

From well permit records it is known there are private domestic wells screened in shallow alluvial sediments and upper Purisima units that are directly connected to surface water. It is possible these wells may have a larger impact on shallow groundwater levels than municipal pumping from the deeper Purisima aquifers. A sensitivity run documented in the model calibration report in Appendix 2-F assumes that non-municipal pumping occurs in the stream alluvium as opposed to the underlying aquifer unit and shows there would be impacts on shallow groundwater levels of pumping the shallow aquifer as opposed to the deeper aquifer.

3.9.1.4 Effects on Beneficial Users and Land Use

Undesirable results for the depletion of interconnected surface water from groundwater extraction will affect aquatic systems mainly during the late summer. Under low flow conditions, there is a direct linear relationship between streamflow and the amount of suitable habitat. Reduction of flow directly reduces the amount of suitable rearing habitat for steelhead, by reducing the amount of wetted area, stream depth, flow velocity, cover, and dissolved oxygen. Reduced flow can also result in increased temperature. In extreme conditions, dewatering of channel segments eliminates the ability of the fish to move to more suitable areas and can cause outright mortality. In even more extreme conditions lowering of groundwater levels below the root zone of riparian vegetation can result in the loss of that vegetation.

3.9.2 Minimum Thresholds - Depletion of Interconnected Surface Water

Using shallow groundwater levels adjacent to streams as a proxy for surface water depletion, undesirable results will occur if the average monthly groundwater levels fall below the minimum threshold, which is established as the highest seasonal low elevation during below- average rainfall years from the start of monitoring through 2015.

3.9.2.1 Information and Methodology Used to Establish Minimum Thresholds and Measurable Objectives

Information used to establish the depletion of interconnected surface water minimum thresholds and measurable objectives include:

- Definitions of significant and unreasonable conditions and desired groundwater elevations discussed during Surface Water Working Group and GSP Advisory Committee meetings.
- Depths, locations, and logged lithology of existing wells used to monitor shallow groundwater levels near creeks.
- Historical groundwater elevation data from shallow wells monitored by SqCWD.
- Streamflow and stream stage data collected by the USGS, SqCWD, County of Santa Cruz, and Trout Unlimited.
- Past hydrologic reports, including annual reports for SqCWD's Soquel Creek Monitoring and Adaptive Management Plan.

The approach for developing minimum thresholds for the depletion of interconnected surface water sustainability indicator is to select groundwater elevations in shallow RMPs below which significant and unreasonable depletion of surface water due to groundwater extractions would occur.

Initially, minimum thresholds were proposed as the lowest groundwater level measured in the shallow wells over the period of record since those years did not appear to have significant or unreasonable conditions. The Surface Water Working Group, however, selected a more conservative minimum threshold due to uncertainty in the relationship between shallow groundwater levels and groundwater contributions to creek flow. It should be noted that there was not consensus around use of specific minimum thresholds, and that these thresholds may need to be adjusted in future updates to the GSP as better monitoring data or more refined modeling results become available.

Based on Surface Water Working Group input, minimum thresholds for shallow groundwater elevations in the vicinity of interconnected streams are the highest seasonal-low groundwater elevation during below-average rainfall years, over the period from the start of shallow groundwater level monitoring through 2015. The years after 2015 are not included because 2016 was an average rainfall year and 2017 was extremely wet, which increased overall Basin shallow groundwater elevations above all previous levels.

3.9.2.2 Depletion of Interconnected Surface Water Minimum Thresholds

Table 3-21 lists the minimum thresholds for RMPs currently available to monitor depletion of interconnected surface water. Hydrographs showing historical groundwater elevation data compared to the minimum threshold are provided in Appendix 3-D. An example of one of the RMP hydrographs with its minimum threshold is shown on Figure 3-16.

Table 3-21. Minimum Thresholds and Measurable Objectives for Representative Monitoring Points for Depletion of Interconnected Surface Water

Aquifer Unit	Well Name	Minimum Threshold	Measurable Objective
		Groundwater Elevation, feet above mean sea level	
Shallow Groundwater	Balogh	29.1	30.6
	Main St. SW 1	22.4	25.3
	Wharf Road SW	11.9	12.1
	Nob Hill SW 2	8.6	10.3
Purisima A	SC-10RA	68	70

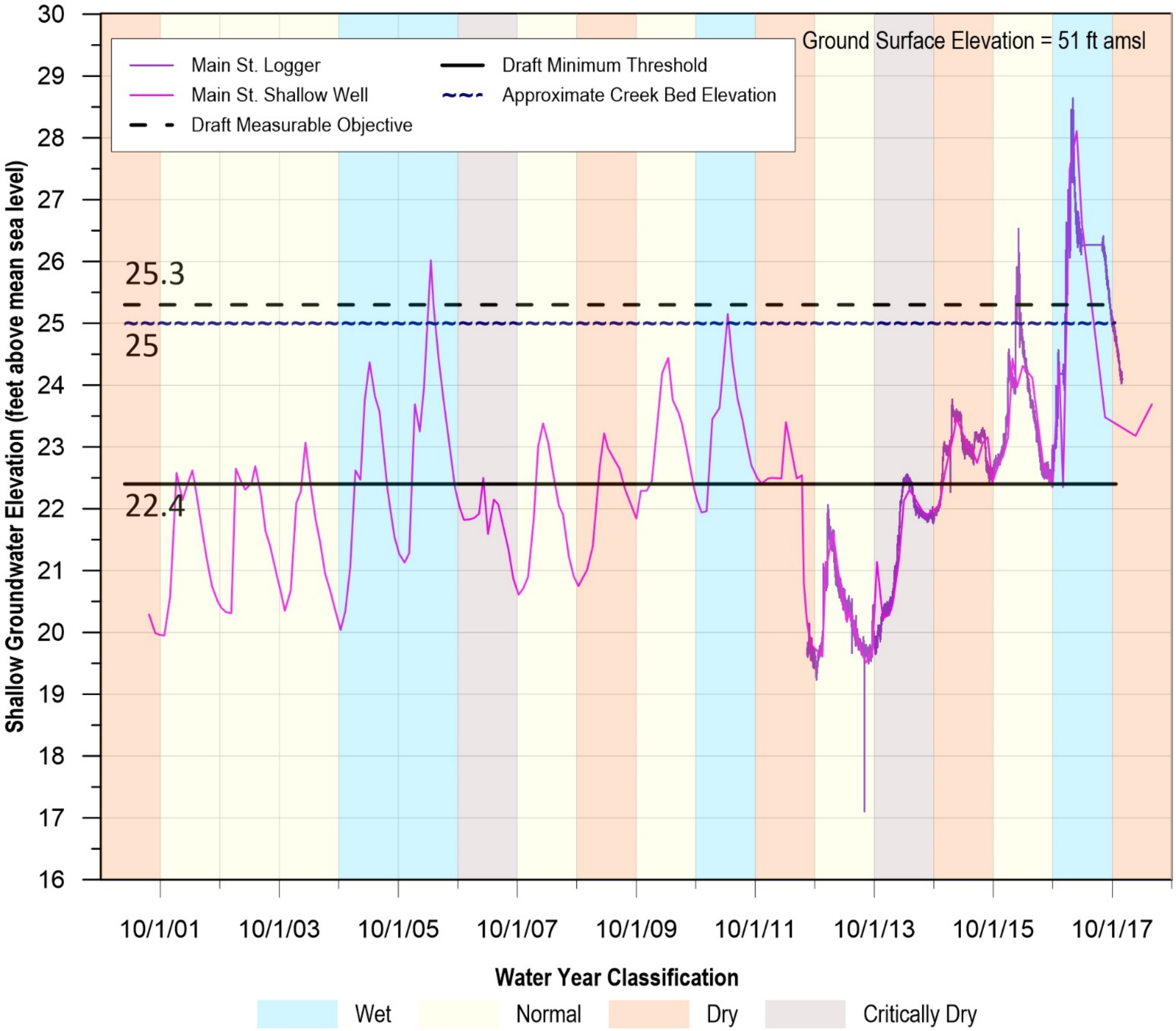

Figure 3-16. Main Street SW 1 Shallow Monitoring Well Hydrograph with Minimum Threshold and Measureable Objective

3.9.2.3 Relationship between Individual Minimum Thresholds and Relationship to Other Sustainability Indicators

Figure 3-11 shows proxy shallow groundwater elevations in relation to both individual minimum thresholds and other sustainability indicator minimum thresholds that use groundwater levels as a metric. Proxy groundwater elevation minimum thresholds decline in elevation downstream thereby following the surface elevation and avoiding unnatural groundwater elevations that would not be physically attainable. There are also no conflicts with other sustainability indicator minimum thresholds as upper Purisima unit RMPs for other indicators close to the creek were purposely avoided because the groundwater elevations for the depletion of interconnected surface water are much more stringent than for other indicators.

3.9.2.4 Effect of Minimum Thresholds on Neighboring Basins

None of the creeks in the Basin are upstream of any of the neighboring basins. Therefore, there will be no effects on those basins from depletion of interconnected surface water minimum thresholds.

3.9.2.5 Effects of Minimum Thresholds on Beneficial Users and Land Uses

Maintenance of interconnected surface water minimum thresholds will not have any negative effects on beneficial users and land uses in the Basin.

Rural residential and agricultural land uses and users. With the minimum thresholds for depletion of interconnected surface water being similar to shallow groundwater levels over the past few years, there will be no declines in shallow groundwater which is a general benefit for private domestic and agricultural well groundwater users. There is a possibility that when additional studies are conducted to improve understanding of this sustainability indicator, restrictions on pumping of wells close to streams may be instituted for wells screened in shallow alluvium that have a direct connection to the stream. The few existing older shallow wells could be replaced by deeper wells screened in the deeper units to minimize any direct impact on flow. There are no other anticipated effects on rural residential or agricultural land uses from the minimum thresholds.

Urban land uses and users. Where streams and creeks flow through urban areas of the Basin, there will be a small increase to no change in shallow groundwater levels. Since there are no major changes in shallow groundwater levels expected in urban areas, the depletion of interconnected surface water minimum thresholds will not negatively impact urban land uses. Urban users of groundwater, the City of Santa Cruz and SqCWD, may be negatively impacted since some of the municipal production wells that are part of their water supply are located near Soquel Creek and potential restrictions on pumping to meet minimum thresholds in RMP shallow wells may impact their ability to provide drinking water to their customers. For example, SqCWD groundwater extractions from the Purisima A and AA-units, and Tu aquifer that occur below Soquel Creek are approximately 2,000 acre-feet per year and account for about 50% of the water served to its customers.

Ecological land uses and users. The main benefit of these minimum thresholds is to protected species and GDEs in streams connected to groundwater. Meeting minimum thresholds effectively increases overall hydraulic gradients from the shallow groundwater to the streams allowing for more groundwater to flow into the stream.

3.9.2.6 Relevant Federal, State, or Local Standards

No explicit federal, state, or local standards exist for depletion of interconnected surface water. However, both state and federal endangered species provisions call for the protection and restoration of conditions necessary for steelhead and coho salmon habitat in Soquel and Aptos Creeks.

3.9.2.7 Method for Quantitative Measurement of Minimum Thresholds

Groundwater elevations in RMPs will be directly measured to determine where groundwater levels are in relation to minimum thresholds. Groundwater level monitoring will be conducted in accordance with the monitoring plan outlined in Section 3.3. All RMPs will be equipped with continuous data loggers.

In the future, as the MGA increases its understanding of groundwater and surface water interconnections along other reaches of Soquel Creek and other streams, areas where measurable depletion from groundwater extraction may be identified. Where these conditions exist, RMPs to monitor streamflow will be added to the representative monitoring network.

3.9.3 Measurable Objectives - Depletion of Interconnected Surface Water

3.9.3.1 Measurable Objectives

Measurable objectives at RMPs are groundwater elevations greater than the minimum thresholds by the range in seasonal-low shallow elevations over the period of record through 2015. In all cases, this results in groundwater elevations that are higher than the creek bed elevation at each RMP. Increased hydraulic gradient increases groundwater contributions to streamflow.

The range in seasonal-low elevations represents known change in seasonal-low elevations that can occur and includes the years when overall groundwater elevations in the Basin have increased. The range effectively provides the operational flexibility that measurable objectives are intended to provide.

3.9.3.2 Interim Milestones

Groundwater elevations as proxy interim milestones are based on model simulations of projects and management actions to prevent undesirable results related to seawater intrusion will also raise shallow groundwater levels along Soquel Creek over time. These model results are shown in Section 4 describing the expected benefits of the projects.

Interim milestones are established at each of the shallow RMPs with proxy groundwater elevations for surface water depletion. Since the groundwater elevation proxies for surface water depletion are compared to minimum groundwater elevations each year and the minimums vary from year to year due to climate, the interim milestones are based on minimum simulated groundwater elevations at the wells over five-year periods in order to be less dependent on climate simulated for a specific year. The interim milestones for Water Years 2025, 2030, and 2035 are based on the minimum model simulated groundwater elevations over Water Years 2021-2025, Water Years 2026-2030, and 2031-2035, respectively.

Interim milestones are based on model simulation of Pure Water Soquel because the expected benefits of that project are to raise groundwater levels above or approaching measurable objectives at shallow wells, as described in Section 4.

If modeled groundwater levels for 2021- 2025 are above minimum thresholds, the minimum thresholds are used as the interim milestone because there is some uncertainty about when projects would begin. This GSP sets as an interim milestone the elimination of undesirable results by 2025 at locations where model results show it is achievable with project implementation. If modeled groundwater levels in 2030 and 2035 are above measurable objectives, the measurable objectives are used as the interim milestones. Table 3-22 summarizes the interim milestone for each RMP.

Table 3-22. Interim Milestones for Depletion of Interconnected Surface Water Groundwater Elevation Proxies

Representative Monitoring Point	Minimum Threshold (feet mean seal level)	Measurable Objective (feet mean sea level)	Interim Milestone 2025 (feet mean sea level)	Interim Milestone 2030 (feet mean sea level)	Interim Milestone 2035 (feet mean sea level)
Balogh	29.1	30.6	29.1	30.6	30.6
Main St. SW 1	22.4	25.3	20.7	22.9	23.2
Wharf Road SW	11.9	12.1	11.3	12.1	12.1
Nob Hill SW 2	8.6	10.3	7.3	9.5	9.9
SC-10RA	68	70	68	70	70

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4 PROJECTS AND MANAGEMENT ACTIONS

DWR regulations require each GSP to include a description of projects and management actions necessary to achieve the basin sustainability goal. This must include projects and management actions to respond to changing conditions in the Basin.

In November 2018, the MGA Board discussed the MGA's role in implementing projects and management actions and agreed that the most efficient approach to project and management action implementation was to have the MGA member agencies perform this function. A major rationale for this decision was the long-standing engagement of MGA member agencies in groundwater management and water supply reliability planning work. In particular, both the City of Santa Cruz Water Department (SCWD) and the Soquel Creek Water District (SqCWD) have evaluated a number of supplemental supply options over the last five years, and in several cases work has proceeded far enough to make it significantly more efficient for these agencies to continue their efforts rather than switching project implementation actions to the MGA.

Projects and management actions discussed in this section are in the process of being developed to address sustainability goals, measurable objectives, and undesirable results identified for the Basin in Section 3. The primary applicable undesirable result that must be avoided is seawater intrusion. In addition, surface water depletions and impacts to groundwater dependent ecosystems (GDEs) were separately evaluated. The GSP's approach to address seawater intrusion is anticipated to provide ancillary benefits to interconnected surface waters and GDEs. Because the SCWD water system relies heavily on surface water, an additional focus of several of the management actions discussed in this section is creation of a supplemental drought supply to improve the reliability of the Santa Cruz water supply. SCWD is pursuing several alternative approaches for storing available wet season surface water flows in regional aquifers for eventual use in augmenting supply during dry conditions. SCWD acknowledges that the operation of its existing groundwater system in the Basin and the design and operation of any new facilities for groundwater storage and recovery would need to function in a manner that supports Basin sustainability.

Each MGA member agency will manage the permitting and other specific implementation oversite for its own projects. Inclusion in this GSP does not forego any obligations under local, state, or federal regulatory programs. While the MGA does have an obligation to oversee progress towards groundwater sustainability, it is not the primary regulator of land use, water quality, or environmental project compliance. It is the responsibility of the implementing agency to ensure that it is working with outside regulatory agencies to keep its projects and management actions in compliance with all applicable laws. That said, the MGA may choose to collaborate with regulatory agencies on specific overlapping interests such as water quality monitoring and oversight of projects developed within the Basin.

Section 4 is presented in three groups to provide the clearest description of how and when projects and management actions will be taken to reach sustainability.

Baseline Projects and Management Actions (Group 1)

Activities in Group 1 are considered existing commitments by MGA member agencies. These include projects and management actions that are currently being implemented and are expected to continue to be implemented, as needed, to assist in achieving the sustainability goal throughout the GSP implementation period. In the groundwater modeling scenarios, the Group 1 projects and management actions are incorporated into baseline conditions. As shown in modeling results of the baseline condition for seawater intrusion presented later in this section, Group 1 projects and management actions, by themselves, are not sufficient to achieve groundwater sustainability (see Table 4-1).

Projects and Management Actions Evaluated Against the Sustainable Management Criteria (Group 2)

Activities in Group 2 have been developed and thoroughly vetted by MGA member agencies and are planned for near-term implementation by individual member agencies. The MGA used an integrated groundwater/surface water model (model) to evaluate the Group 2 projects against the Sustainable Management Criteria to determine if they contribute to achieving sustainability. The expected benefits of each of the projects presented in Section 4.2 as informed by the groundwater modeling simulations and documented in the model simulations report (Appendix 2-I), show that the implementation of a combination of these projects will be sufficient to achieve and maintain sustainability even under climate change scenarios. Therefore, ongoing implementation of Group 1 activities, coupled with the implementation of Group 2 projects and management actions, are required to reach sustainability to comply with SGMA (see Table 4-1).

Identified Projects and Management Actions That May Be Evaluated in the Future (Group 3)

The MGA's analysis indicates that the ongoing implementation of Group 1 and the added implementation of Group 2 projects and management actions will bring the Basin into sustainability. However, if one of the projects and management actions required for sustainability in Group 2 either fails to be implemented or does not have the expected results, further actions will be required to achieve sustainability. In that case, appropriate projects and/or management actions will be chosen from those listed under Group 3. As work on supplemental water supply and resource management efforts is ongoing, it may be the case that additional projects will be identified and added to the list in future GSP updates (see Table 4-2).

The specific Group 3 activity selected would be based on factors such as size of the water shortage, speed of implementation, scale of regulatory and political hurdles, and the metrics of success achieved in basin sustainability. The level of detail provided for Group 3 is significantly less detailed than Groups 1 and 2 because the activities listed are not currently planned for implementation.

Table 4-1. Projects and Management Actions (Groups 1 and 2)

Description	Agency	Category	Status	Anticipated Timeframe[1]
Group 1 – Baseline Projects and Management Actions				
Water Conservation and Demand Management	All	Mgmt. Actions	Ongoing	2020-2070 adaptive management
Installation and Redistribution of Municipal Groundwater Pumping	SCWD; SqCWD	Mgmt. Actions & Projects	Ongoing	2020-2070 adaptive management

Description	Agency	Category	Status	Anticipated Timeframe[2]
Group 2 – Projects and Management Actions Planned to Reach Sustainability				
Pure Water Soquel	SqCWD	Project	Permitting	2020-2022 development 2023-2070 operations & adaptive management
Aquifer Storage and Recovery (ASR)	SCWD	Project	Pilot Testing	2021-2027 development 2021-2070 operations & adaptive management
Water Transfers / In Lieu Groundwater Recharge	SCWD ; SqCWD	Project	Pilot Testing	2020-2025 development 2025-2070 operations & adaptive management
Distributed Storm Water Managed Aquifer Recharge (DSWMAR)	SCCo; SqCWD	Project	Few current facilities; ongoing assessment	Timing is project specific; ongoing operations & adaptive management

1. SGMA's required planning implementation horizon is 50 years.
2. Phased projects may include overlapping periods of development and operations. Adaptive management is ongoing during implementation.

Table 4-2. Identified Potential Future Projects and Management Actions (Group 3)

Group 3 - Identified Projects and Management Actions That May Be Evaluated in the Future		
Description	Category	Comment
Recycled Water – Groundwater Replenishment and Reuse (GRR)	Project	A new or expanded centralized GRR project could be developed by SCWD, the Soquel Creek Water District or as a joint project of these agencies. SCWD Recycled Water Facilities Planning Study (2018) identifies a GRR project as a future (mid-term) possibility requiring additional studies to confirm feasibility to meet drought shortfall needs and/or support basin sustainability goals in either or both the Mid-County and Santa Margarita groundwater basins. In addition, the Soquel Creek Water District Feasibility Study (2017) and the Pure Water Soquel EIR (2018) also identify expansion opportunities, if needed. Future need anticipated to be assessed as GSP Implementation proceeds.
Recycled Water – Surface Water (Reservoir) Water Augmentation	Project	Reservoir Augmentation would use advanced treated Santa Cruz WWTF effluent, to replenish Santa Cruz's Loch Lomond Reservoir. SCWD evaluated this option in its 2018 Recycled Water Facilities Planning Study and did not identify it as a preferred alternative. Conceptually this approach could serve to augment supply to the Basin as well as improve the reliability of Santa Cruz's water supply. Future need anticipated to be assessed as GSP Implementation proceeds.
Recycled Water – Direct Potable Reuse	Project	Current state regulations do not allow the introduction of advanced treated recycled water directly into a public water system. State drinking water and public health regulatory agencies continue to assess the possible framework for the regulation of potable reuse projects. As state regulations develop, the feasibility and potential future need for this option will continue to be evaluated.
Groundwater Pumping Curtailment and/or Restrictions	Mgmt. Action	Potential policy to curtail and/or restrict groundwater extractions from areas at high risk of seawater intrusion or surface water depletions would be considered if the planned Projects and Management Actions are insufficient to reach and/or maintain sustainability and one or more sustainability indicator is likely to dip below the minimum threshold by 2040.
Local Desalination	Project	Previously considered by SCWD in partnership with SqCWD. This is no longer being actively pursued, but given the Basin's proximity to the Pacific Ocean this option will continue to be a potential option.
Regional Desalination	Project	DeepWater Desal LLC., is a private company seeking to establish a regional supply facility in Moss Landing. It would produce an estimated 25,000 acre-fee per year (22 million gallons per day) of treated desalinated water available for purchase by local agencies.

4.1 Baseline Projects and Management Actions (Group 1)

4.1.1 Water Conservation and Demand Management

As described in Section 2, the MGA's member water agencies have a full range of water conservation programs in place and have actively and successfully implemented policies and programs promoting and incentivizing water conservation and efficient water use. SCWD's and SqCWD's residential water usage (gallons capita per day) are among the lowest in the state. All MGA member agencies participate in the Water Conservation Coalition of Santa Cruz County (watersavingtips.org). The Coalition serves as a regional information source for county-wide water reduction measures, rebates, and resources.

Soquel Creek Water District's Water Demand Offset (WDO) program is a targeted water conservation program developed to mitigate the water demand of new and expanded development in Soquel Creek Water District's service area. This management action originally required new development to be "net neutral" to ensure that each new project contributed toward conservation projects proportional to their expected new water demand. Development project applicants have met this requirement through direct replacement of inefficient water fixtures for SqCWD customers or through payment into a SqCWD conservation fund that supports similar demand management projects and programs. Since 2013, WDO requires new development to offset 200% of their project's expected water demand so that new development will actually reduce water use in the Basin. Participation in this program is required to be eligible for SqCWD will-serve approval and installation of the new water service. Will-serve letters are also required to obtain building permits from land use jurisdictions where the new development is located.

The City of Santa Cruz Water Department (SCWD) uses fees paid by developers to support a robust rebate program that, along with its "retrofit on resale" program has resulted in a significant reduction in water demand from current customers and a long term demand forecast that is flat rather than increasing. The County of Santa Cruz (County), in order to promote more efficient water use in rural areas, adopted code requirements that all small water systems meter and report monthly water production beginning in October 2015. Additionally, by October 2017, all small water systems with 15 or more connections were required to install individual meters on each connection to be able to track individual water use and potentially excessive usage.

4.1.1.1 Project Implementation Discussion

Water Conservation and Demand Management strategies use a variety of management actions to reduce water demand that then results in reduced groundwater pumping. Depending on where pumping reductions occur, groundwater levels near the coast may increase, which results in reducing the threat of seawater intrusion, and surface water depletions may also be reduced, which supports maintaining or enhancing groundwater levels where groundwater dependent ecosystems exist. These management actions are implemented, planned to continue, and will continue to evolve with technological advances and future legislative requirements to reduce regional water demand.

Management actions to reduce water demand were initially implemented in the 1990s and there is no plan to end these successful water use reduction strategies. Benefits are monitored with the Basin-wide groundwater monitoring network by comparing groundwater levels and groundwater quality against past observations. Costs of conservation and demand management programs are built into MGA member agency ongoing budgetary commitments and are not anticipated to be passed on to the MGA.

As water conservation and demand management projects and management actions within the Basin continue to evolve over time, any significant changes will be publicly noticed as necessary by MGA member's governing bodies. Existing California state law gives water districts the authority to implement water conservation programs. Local land use jurisdictions have police powers to develop similar permitting programs to conserve water. The Sustainable Groundwater Management Act of 2014 grants the MGA legal authority to pass regulations necessary to achieve sustainability. MGA member agencies are committed to successful implementation of their conservation programs and have among the lowest water consumption rates in California.

4.1.2 Planning and Redistribution of Municipal Groundwater Pumping

Municipal water agencies serve the majority of the population within the Basin. Although surface water from the Santa Cruz water system serves some customers in the Basin, all municipal groundwater supplies that are produced within the Basin come solely from groundwater pumped by MGA member agencies within their respective service areas.

Prior to SGMA, regional groundwater management planning identified the need to move groundwater production further from the coast to reduce the threat of seawater intrusion related to pumping impacts from municipal wells. MGA member agencies developed and have already begun implementing plans to move municipal groundwater production further inland to reduce these pumping impacts. The SCWD has completed its planning and well development project with the installation of its Beltz 12 well and supporting infrastructure at its Research Park facility (SCWD 2012). Soquel Creek Water District's Well Master Plan (ESA 2010), identified moving pumping further inland by developing four new groundwater production well locations and the conversion of an existing irrigation well at a fifth location. The Polo Grounds irrigation well conversion in Aptos was completed in 2012. Two of the four new well sites, O'Neill Ranch in Soquel (completed in 2015) and Granite Way in Aptos (anticipated completion in 2019) have been constructed. Two remaining production well sites at Cunnison Lane in Soquel and Austrian Way in Aptos have yet to be constructed.

MGA member agencies have also adjusted the timing, and pumping amounts from existing wells to redistribute pumping both vertically and horizontally within Basin aquifers. These efforts have been used to achieve more uniform drawdown of the Basin, to minimize localized pumping depressions, and reduce the Basin's susceptibility to seawater intrusion. In addition, in 2015 the

City of Santa Cruz and Soquel Creek Water District signed the Cooperative Monitoring and Adaptive Groundwater Management Agreement to more conservatively manage groundwater pumping in the shared aquifer units of the Basin. Redistribution of municipal pumping is designed to be paired with projects (such as Pure Water Soquel, In-Lieu Recharge, and ASR) as a way to rest and reduce pumping of coastal wells and be consistent with Basin sustainability goals to protect the groundwater supply against seawater intrusion; prevent overdraft within the Basin, and resolve problems resulting from prior overdraft; support reliable groundwater supply and quality to promote public health and welfare; maintain or enhance groundwater levels where groundwater dependent ecosystems exist; and maintain or enhance groundwater contributions to streamflow.

4.1.2.1 Implementation Discussion

Planning, municipal well construction at locations further from the coast, and redistribution of municipal groundwater pumping is used to reduce the ongoing threat of seawater intrusion within the Basin. These projects and management actions are implemented, planned to continue, and will continue to evolve as we learn more about Basin groundwater management and climate change. Additional well construction within the Basin will be publicly noticed and permitted as necessary by MGA member agencies. Redistribution of municipal groundwater pumping was initially implemented in 1995 and has improved with careful expansion of municipal production wells further from the coast. There is no plan to end these successful water production strategies which have made significant progress to reduce groundwater pumping depressions and improve groundwater levels at the coast. Benefits are monitored using municipal production well meters, the Basin-wide groundwater monitoring network, and data management systems to compare production impacts with groundwater levels and groundwater quality over time.

Redistribution of groundwater pumping is direct management of groundwater extraction. While these management actions don't reduce overall Basin groundwater production, they do allow municipal groundwater production to consider and respond to changes in groundwater levels across the portions of the Basin within municipal service areas. These groundwater production management strategies do not require an additional water source. Costs of planning, new municipal well construction, and redistribution of municipal groundwater pumping are or are anticipated to be built into the City of Santa Cruz's, Central Water District's, and Soquel Creek Water District's operational budgetary commitments that would be paid for through water rates and/or grant funds. These costs are not anticipated to be passed on to the MGA. Redistributed groundwater pumping has contributed to increased Basin groundwater levels and supports the additional GSP elements outlined in section 2.1.4 and the Basin's sustainability goals to protect groundwater supplies against seawater intrusion and maintain or enhance groundwater levels where groundwater dependent ecosystems exist.

4.2 Projects and Management Actions Planned to Reach Sustainability (Group 2)

4.2.1 Pure Water Soquel

4.2.1.1 Project Description

Pure Water Soquel (PWS) would provide advanced water purification to existing secondary-treated wastewater that is currently disposed of in the Monterey Bay National Marine Sanctuary. The project would replenish the Basin with approximately 1,500 acre-feet per year of advanced purified water that meets or exceeds drinking water standards into aquifers within the Basin. Replenishment is currently planned at three locations in the central portion of Soquel Creek Water District's service area to mix with native groundwater. Purified water would contribute to the restoration of the groundwater basin, provide a barrier against seawater intrusion, and provide a drought proof and sustainable source of water supply. The conveyance infrastructure of PWS is being sized to accommodate the potential for future expansion of the Project's treatment system (if desired at a later time) and to convey up to approximately 3,000 AFY of purified water (ESA 2018).

4.2.1.2 Measurable Objective

Use of advanced purified water made from highly treated wastewater as a source has a proven track record and is already widely used in California and elsewhere throughout the world as a water supply. Model results indicate that consistent and ongoing recharge of advanced purified water into the groundwater basin would create a barrier against further seawater intrusion and could be leveraged to shift groundwater production to improve sustainability throughout the entire Basin.

4.2.1.3 Circumstances for Implementation

Groundwater management policies that predate this GSP established protective groundwater elevations at 13 coastal monitoring well locations necessary to prevent seawater intrusion. Protective elevations have been included in this GSP as a sustainability indicator for seawater intrusion. Currently, protective elevations have been met at eight of the 13 coastal monitoring locations, which is an increase since these wells were installed in the mid-1980s. Projects identified by the MGA and its member agencies to improve Basin sustainability will be implemented to achieve and maintain protective elevations at all 13 well locations. Pure Water Soquel is included in Group 2 projects, along with Aquifer Storage and Recovery (ASR), Water Transfer/In Lieu Groundwater Recharge, and Distributed Storm Water Managed Aquifer Recharge as projects planned for near-term implementation by MGA partner agencies to reach Basin sustainability.

4.2.1.4 Public Noticing

PWS was developed from public input received during Soquel Creek Water District's Community Water Plan (CWP) to develop a timely solution to seawater intrusion. The PWS project was developed by staff and refined during Soquel Creek Water District's publicly noticed

Board of Director's meetings as well as community meetings, workshops during the development of the CWP and the evaluation of the PWS project. The project is also discussed at publicly noticed meetings of Soquel Creek Water District's Water Resources Management and Infrastructure Committee. CEQA environmental review of PWS was first publicly noticed through the State Clearinghouse in November 2016 and review completed in December 2018. Applicable PWS project permits will be publicly noticed for meetings of the issuing agencies, as required.

4.2.1.5 Overdraft Mitigation and Management Actions

The Santa Cruz Mid-County Basin (Basin 3-001 (DWR 2016)) is identified by the State of California as a high priority basin in critical overdraft (DWR 2019). Groundwater levels have recovered from critically low levels identified in the 1980s. However, seawater intrusion exists in several Basin locations and remains a significant threat to regional groundwater supplies as groundwater levels at five of the Basin's 13 key coastal monitoring wells remain below protective elevations. In 2018, groundwater levels declined between 0.4 feet to 4.0 feet at various Basin locations from all-time highs recorded in Water Year 2017. As the first line of defense along the coastline, the replenishment with advanced purified water will increase Basin groundwater levels and create a fresh water barrier to reduce the threat of further seawater intrusion into the Basin.

4.2.1.6 Permitting and Regulatory Process

Soquel Creek Water District completed the California Environmental Quality Act (CEQA) review for Pure Water Soquel in December 2018 and is undergoing the permitting phase of project implementation. Implementation could require several permits for construction and operations as described in the Pure Water Soquel Environmental Impact Report (EIR) (ESA 2018).

4.2.1.7 Time-table for Implementation

The Pure Water Soquel EIR and project were approved by the lead agency in December 2018. The project is currently in the design and permitting phase and construction is anticipated to be complete in late 2022 with the project to come online in early 2023.

4.2.1.8 Expected Benefits

The Pure Water Soquel project is designed to replenish the Basin with approximately 1,500 acre-feet per year of advanced purified water into three locations in the Basin to increase groundwater elevations and create a seawater intrusion barrier (ESA 2018). The tertiary treatment portion of the project is also designed to produce an additional 300 acre-feet per year tertiary treated wastewater supply for reuse by the City of Santa Cruz suitable for non-potable landscape and other uses. PWS also supports in-lieu recharge in aquifer units and areas where water is not injected. In the simulation of PWS for the GSP, in-lieu recharge is facilitated by increasing pumping from the Purisima A and BC aquifer units that benefit from PWS injection to allow for pumping reductions in the Tu, Purisima F, and Aromas Red Sands aquifer units. Therefore, project benefits are expected to raise groundwater elevations at all of Soquel Creek Water District's coastal monitoring wells to prevent seawater intrusion and improve groundwater levels at shallow wells along Soquel Creek to prevent additional surface water depletions. Expected benefits will be evaluated using the existing monitoring well network and data management systems to compare groundwater levels over time.

A simulation of the PWS project under projected future climate conditions using the model (Appendix 2-I) demonstrates expected Basin sustainability benefits including raising average groundwater levels at coastal monitoring wells throughout Soquel Creek Water District's service area to reduce the risk of seawater intrusion (Figure 4-1 and Figure 4-2). The figures below show running five-year averages of simulated groundwater levels at representative monitoring points for seawater intrusion (section 3.3.3.3) in the SqCWD's service area. The simulated groundwater levels are compared to groundwater level proxies (section 3.6) for minimum thresholds (black dots) and measurable objectives (black dashes) adjusted for sea level rise.[1]

Without the project (yellow line labeled Baseline), five-year averages of simulated groundwater levels are projected to be below the minimum threshold in the aquifer units pumped by Soquel Creek Water District. In the Purisima A and BC aquifer units where PWS injection occurs, groundwater levels are projected to rise to or above measurable objectives (blue dashes labeled PWS) even as pumping is increased from these aquifer units. In the Purisima F and Aromas Red Sands aquifer units where pumping is reduced under PWS, groundwater levels (blue dashes labeled PWS overlying green line labeled PWS+ASR) are projected to rise above or near measurable objectives by 2040 and to be maintained above minimum thresholds thereafter so that undesirable results for seawater intrusion do not occur. Figure 4-5 in Section 4.2.3.8 below shows how pumping reduction from the AA and Tu units under PWS (blue dashes) also is projected to raise groundwater levels above minimum thresholds to prevent undesirable results for seawater intrusion.

[1] Projected sea level rise of 2.3 feet is added to the groundwater level proxies (see Section 3.6.2.1.1).

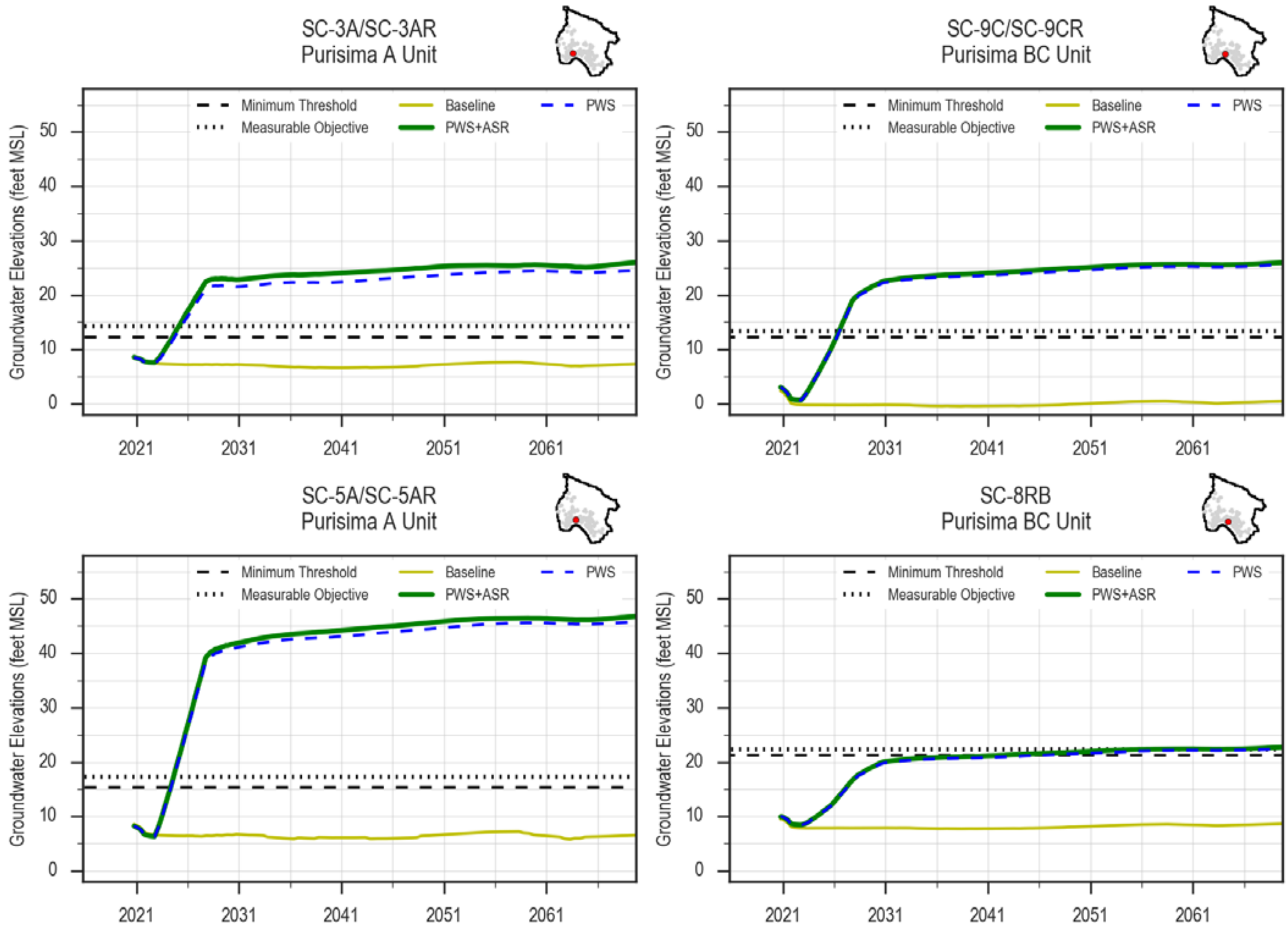

Figure 4-1. Five Year Averages of Model Simulated Groundwater Elevations at Coastal Monitoring Wells in Purisima A and BC Units

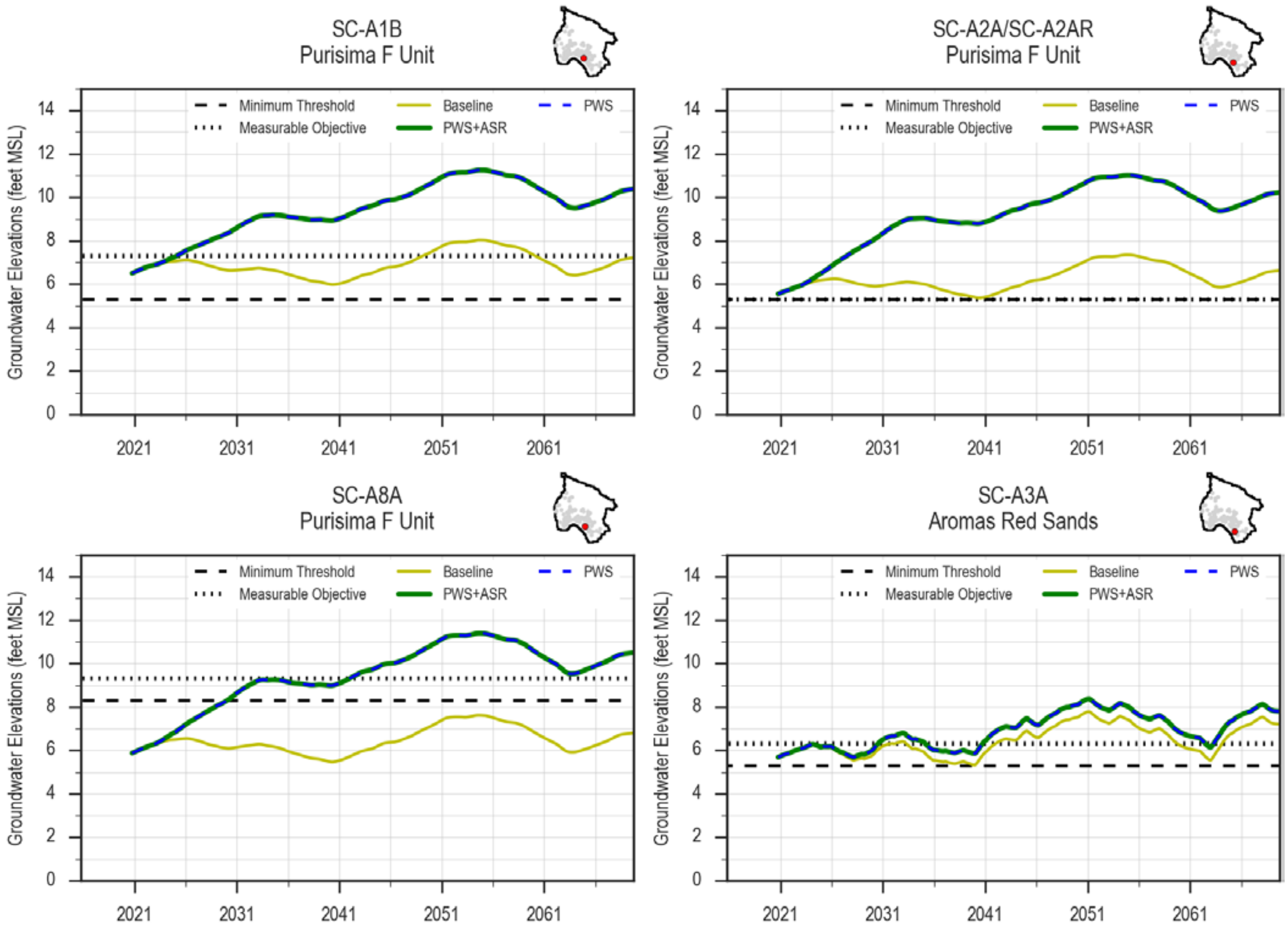

Figure 4-2. Five Year Averages of Model Simulated Groundwater Elevations at Coastal Monitoring Wells in Purisima F and Aromas Red Sands Units

Pure Water Soquel replenishment into the Purisima A unit also is expected to benefit the streamflow depletions indicator by raising shallow groundwater levels along Soquel Creek. Without the project (yellow line labeled Baseline), simulated monthly groundwater levels are projected to be below the minimum threshold at most of the shallow wells. With the PWS project, shallow groundwater levels (blue dashes labeled PWS) are projected to rise to measurable objectives and be maintained above minimum thresholds to prevent undesirable results for surface water depletions (Figure 4-3).

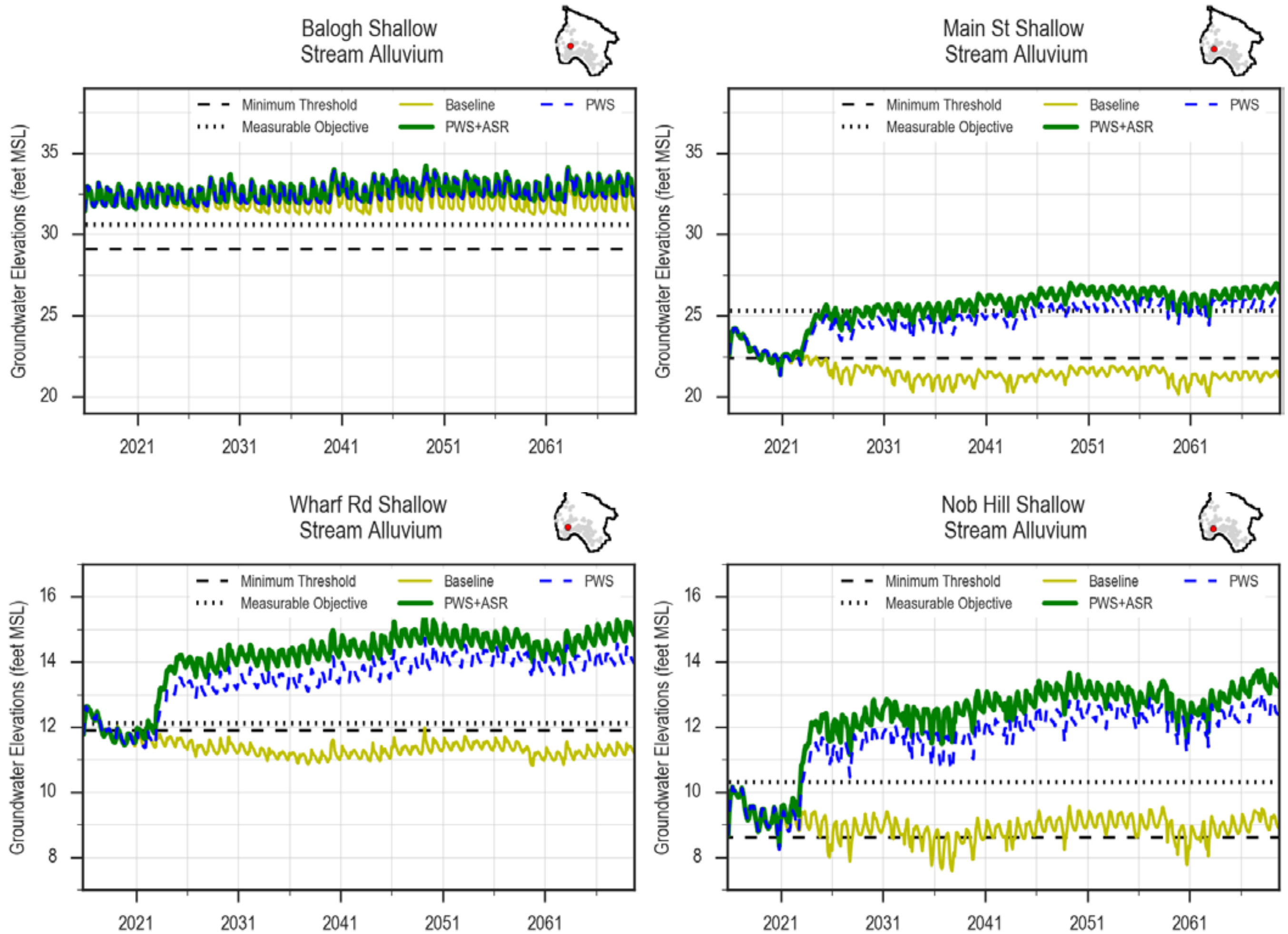

Figure 4-3. Monthly Model Simulated Groundwater Elevations in Shallow Wells along Soquel Creek

The hydrographs also show that the expected benefits are maintained when combining SCWD's ASR project to Pure Water Soquel (green line labeled PWS+ASR).

4.2.1.9 How the Project will be Accomplished

Pure Water Soquel would use advanced water treatment technology to reuse locally available treated secondary effluent for advanced purified water that meets or exceeds drinking water standards. Advanced purified water would then be replenished into the groundwater aquifer to ultimately mix with native groundwater and contribute to the restoration of the groundwater basin, provide a barrier to seawater intrusion, and contribute to a sustainable water supply. The source of supply is secondary treated wastewater from the City of Santa Cruz Wastewater Treatment Plant. In 2019, Soquel Creek Water District and the City of Santa Cruz approved a 35 year contractual project agreement to supply Soquel Creek Water District with enough secondary effluent to produce 1,500 acre-feet per year of advanced treated water for replenishment and an additional amount of secondary effluent for PWS to provide the City with 300 acre-feet per year of tertiary treated water for non-potable reuse by the City for irrigation and other purposes. At the end of the 35 year wastewater agreement, the project agreement contractual terms for source water automatically renews for consecutive 5 year periods. The proposed amount of secondary effluent to be provided is approximately 25% of the annual wastewater treated by the City Wastewater Treatment Plant.

If needed, the project has potential to be expanded if Basin sustainability goals have not been achieved.

4.2.1.10 Legal authority

California state law gives Water Districts the authority to take actions necessary to supply sufficient water for present or future beneficial use. Land use jurisdictions have regulatory authority to develop similar programs.

4.2.1.11 Estimated Costs and Funding Plan

Pure Water Soquel is projected to cost $90 million to permit and construct to deliver the 1,500 AFY of purified water to the Basin and ~300 AFY of tertiary treated water for City uses. The project will be funded entirely through SqCWD's water rates and/or low interest loans or grant funds; no direct costs are anticipated to the MGA. Soquel Creek Water District has received over $2M in planning grants from the State Water Resources Control Board and a $150,000 planning grant from the US Bureau of Reclamation to evaluate the PWS project. The project is eligible to compete for implementation money ($50M under Prop 1 Groundwater and $20M under Title XVI). Both grant applications were submitted in early 2019. SqCWD is also pursuing low-interest loans through USEPA's Water Infrastructure Finance and Innovation Act (WIFIA) program and State Revolving Funds (SFR).

4.2.1.12 Management of groundwater extractions and recharge

Monitoring wells and data management systems are used to record and compare groundwater elevations in the Basin to evaluate pumping impacts and ongoing sustainability. Municipal groundwater extraction is monitored by metering municipal production wells operated by SCWD and Soquel Creek Water District in the areas where the Pure Water Soquel project would be located. Project recharge wells to recharge the aquifer would be metered to control the amount and rate of water injected into the regional aquifer.

4.2.1.13 Relationship to Additional GSP Elements

Soquel Creek Water District's Pure Water Soquel project will be managed to ensure no negative impacts to any of the additional GSP elements outlined in GSP Section 2.1.4. The project will recharge the groundwater with purified recycled water to support groundwater replenishment. Increased groundwater levels will improve progress toward the Basin's sustainability goals to protect groundwater supplies against seawater intrusion and to maintain or enhance groundwater levels where groundwater dependent ecosystems exist.

4.2.2 Aquifer Storage and Recovery

4.2.2.1 Project Description

Aquifer Storage and Recovery (ASR) would inject excess surface water, treated to drinking water standards, into the natural structure of Basin aquifers for use as an underground storage reservoir. The ASR project modeled for this GSP optimizes existing SCWD infrastructure as a more efficient use of available resources to inject excess drinking water into Basin aquifers. However, since SCWD is in the process of developing its plans for the ASR project, eventual implementation of the ASR project may include new infrastructure. SCWD can produce excess surface water by improving the treatment process at its Graham Hill Water Treatment Plant to improve its ability to treat available surface water (within its water rights, above the amount of water required for City operations, and respecting water for fish flows). Drinking water stored in the Basin as a result of an ASR project would provide a drought supply for the SCWD service area and any ASR project would need to be designed with additional capacity to contribute to the restoration of the Basin. (Note: A SCWD ASR project to store treated drinking water in the Santa Margarita Groundwater Basin is also being evaluated.)

SCWD is actively evaluating the feasibility of injecting treated drinking water from its surface water sources into regional groundwater aquifers and is currently conducting pilot tests of ASR in the Basin. Pilot testing involves injecting potable drinking water into the Basin's aquifers and recovering it to assess injection and recovery capacities and monitor water quality impacts to native groundwater resources. Information generated by pilot test evaluations will help inform the degree to which ASR is a feasible part of SCWD's strategy to improve the reliability of its water supply, along with helping to evaluate whether or not an ASR project can be developed and operated in a manner that will achieve both supply reliability and groundwater sustainability benefits.

4.2.2.2 Measurable Objective

A well designed and operated ASR project has the potential to raise groundwater levels in the Basin, thus reducing the threat of seawater intrusion, and store available surface water in regional aquifers for use as drought supply. However, any ASR project would need to manage groundwater extractions to prevent adverse impacts.

4.2.2.3 Circumstances for Implementation

SCWD water system simulation model analyses of projected water availability from SCWD surface water sources indicates that surface water from SCWD's water system, as a sole source, is insufficient to meet both drought supply demands and restore the Basin within the 20-year planning horizon. This result is based on an assessment of the availability of surface water to either offset existing pumping or create a reliable supply for a seawater barrier after the SCWD meets its own needs to provide instream flows, meet daily municipal and industrial demand and store water for its drought supply. Availability of surface water for possible use to achieve both Basin sustainability and SCWD drought supply objectives is constrained by a number of factors, including drinking water treatment capacity, water rights, fish flows, and potential climate change impacts on the availability of surface water resources. To determine the feasibility of an ASR project, the SCWD will be looking at:

- Basin hydrogeologic characteristics (well efficiency, specific capacity and injectivity)
- Loses of injected water due to off-shore movement
- Injection well plugging rates (both active and residual)
- Long-term sustainable injection rates
- Local aquifer response to injection and extraction, particularly to ensure that protective groundwater elevations are maintained at the coast.
- Water-quality changes during aquifer storage and recovery pumping

If any of these issues yields unfavorable results or information, it may result in a project that doesn't meet the SCWD's Basin sustainability and drought supply objectives.

4.2.2.4 Public Noticing

Public notice for aspects of the ASR pilot project was carried out by SCWD and the Santa Cruz City Council prior to initiating of the ASR project pilot tests (SCWD 2018). For the full-scale ASR project, public noticing is anticipated to occur through compliance with the California Environmental Quality Act (CEQA) for any facilities or plans associated with the project, as part of development of a Groundwater Storage Supplement to permit the storage of water from the City's water rights in the Basin that is required by the State Water Resources Control Board and through publically noticed discussions of the proposed project at City Water Commission and City Council meetings.

4.2.2.5 Overdraft Mitigation and Management Actions

The Department of Water Resources designates the Santa Cruz Mid-County Basin (Basin 3-001 (DWR 2016)) as a high priority basin in critical overdraft (DWR 2019). To respond both to the state's designation and to the Basin's condition, which has been a high priority focus of local agencies for decades, in 2015 the City and the Soquel Creek Water District entered into the Cooperative Monitoring/Adaptive Groundwater Management Agreement. This agreement sets limits for each agency's use of groundwater under normal and drought conditions. Basin pumping limits in this agreement were specifically intended to support stabilizing basin drawdown and restoring and maintaining protective groundwater levels at the coast. Work done as part of that agreement, along with work done as part of ongoing groundwater management for the Basin indicates that groundwater levels have improved. However, seawater intrusion exists in some locations throughout the basin and remains a significant threat to regional groundwater supplies as groundwater levels at five of the Basin's 13 key coastal monitoring wells remain below protective elevations including the Soquel Point Medium well in the SCWD area. In 2018, groundwater levels declined between 0.4 feet to 4.0 feet from all-time highs recorded in Water Year 2017. ASR, if withdrawals are carefully managed, may help to increase groundwater levels and reduce the threat of further seawater intrusion into the Basin.

4.2.2.6 Permitting and Regulatory Process

As part of its efforts to update and align its water rights on the San Lorenzo River to incorporate fish flow requirements and provide additional operational flexibility, the SCWD has initiated a water rights change process with the State Water Resources Control Board (State Water Board). No additional water rights are being requested. SCWD is also working with the State Water Board to obtain the necessary Groundwater Storage Supplement for an ASR project in the Basin. An Environmental Impact Report is being developed to comply with CEQA and updated water rights and petitions are expected to be noticed for public comment before the end of calendar year 2019. Upon completion of the CEQA water rights process, and any necessary ASR CEQA process for a full-scale project, the Santa Cruz Water Commission and the City Council take actions to certify the CEQA work and approve projects.

The State Water Resources Control Board (SWRCB) has recently recognized that it in the best interest of the state to develop a comprehensive regulatory approach for ASR projects and has adopted general waste discharge requirements for ASR projects that inject drinking water into groundwater (Order No. 2012-0010-DWQ or ASR General Order). The ASR General Order provides a consistent statewide regulatory framework for authorizing both pilot ASR testing and permanent ASR projects. The City's ASR Pilot Tests and any future permanent ASR facility will be permitted under the ASR General Order. Oversight of these regulations is done through the

Regional Water Quality Control Boards (RWQCBs) and will require SCWD to comply with the monitoring and reporting requirements of the ASR General Order. Any additional permits required for the construction and operation of an ASR facility would be obtained as needed.

4.2.2.7 Time-table for Implementation

ASR pilot tests began in early 2019 at SCWD's Beltz 12 well. Additional pilot testing at an additional Beltz well is slated to occur this coming winter. Assuming results from the initial pilot testing conducted at SCWD's Beltz 12 well during 2019 continues to be favorable, full scale implementation of ASR at that facility would occur on a phased basis beginning in 2021. The current plan for developing ASR in the Basin would utilize to the greatest extent possible existing infrastructure, meaning that new infrastructure would be greatly limited and allowing for both incremental drought supply and groundwater sustainability benefits to begin accruing as early as 2022.

4.2.2.8 Expected Benefits

Basin groundwater elevations are expected to increase with ASR's injection of excess surface water, treated to drinking water standards, and continued basin management. ASR withdrawals would be managed to ensure they do not impact the attainment of or ongoing Basin sustainability. Benefits are evaluated using the existing groundwater monitoring well network and data management systems to compare groundwater levels over time. Potential impacts of recovering water from the Basin through ASR would be monitored to ensure ongoing groundwater sustainability is maintained.

Expected benefits for sustainability are evaluated based on a simulation of a potential ASR project, in combination with the Pure Water Soquel project, under projected future climate conditions using the model (Appendix 2-I). The potential ASR project simulated for evaluation of expected benefits is based on using existing SCWD Beltz wells for injection and recovery pumping. SCWD is in the process of evaluating different configurations of the project so the ASR project simulated for the GSP likely does not represent the ASR project that will be implemented.

The model simulation shows that expected benefits for sustainability are to raise average groundwater levels at coastal monitoring in SCWD's service area and reduce the risk of seawater intrusion. The figure below (Figure 4-4) shows running five-year averages of simulated groundwater levels at representative monitoring points for seawater intrusion (section 3.3.3.3) in SCWD's service area. The simulated groundwater levels are compared to groundwater level proxies (section 3.6) for minimum thresholds (black dots) and measurable objectives (black dashes) adjusted for sea level rise. Projected sea level rise of 2.3 feet is added to the groundwater level proxies (see Section 3.6.2.1.1).

Without a SCWD ASR project, five-year averages of simulated groundwater levels are not projected to achieve and maintain measurable objectives at the representative monitoring points and are below the minimum threshold in the AA unit. This is the case whether or not the Pure Water Soquel project is implemented (yellow line labeled Baseline without Pure Water Soquel and blue dashes labeled PWS with Pure Water Soquel but no ASR) as the simulated Pure Water Soquel project does not substantially raise groundwater levels in much of the SCWD service area. With a simulated project that injects water at the existing SCWD Beltz wells and reduces overall pumping at the Beltz wells (green line labeled PWS+ASR), it is projected that measurable objectives will be achieved and maintained in the A unit that is the main source of groundwater supply for SCWD and minimum thresholds will be achieved and maintained in the AA unit such that undesirable results for seawater intrusion do not occur. The project is projected to raise groundwater levels sufficiently such that sustainability is maintained even as SCWD increases recovery pumping to meet drought demand from the 2050s into the early 2060s.

The model simulation also shows that an ASR project can help prevent undesirable results for the interconnected surface water depletion indicator. Figure 4-3 shows that adding an ASR project to Pure Water Soquel (green line labeled PWS+ASR) is projected to raise groundwater levels in shallow wells along Soquel Creek in almost all times and groundwater levels are maintained above the groundwater elevation proxies set as minimum thresholds.

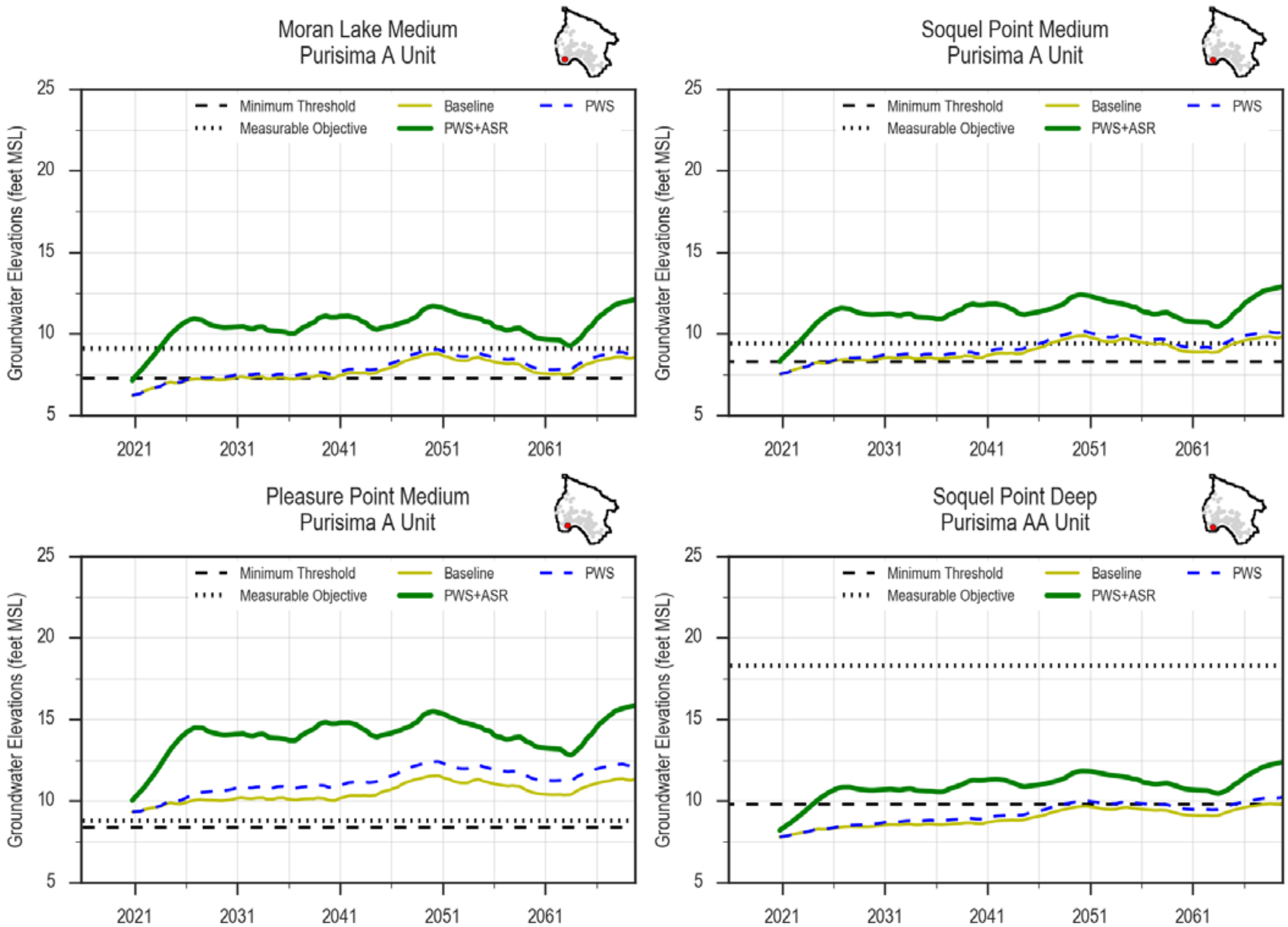

Figure 4-4. Five Year Averages of Groundwater Elevations at Purisima AA and A Units

4.2.2.9 How the Project will be Accomplished

Following the successful completion of additional ASR pilot testing, SCWD would develop a phased implementation plan for ASR in the Basin. The initial phases would emphasize leveraging existing water system infrastructure to the greatest extent possible, with new infrastructure being mostly limited to retrofitting existing wells in the Beltz system to function as both injection and extraction wells rather than just extraction wells. Available wet season surface water within the City's existing water rights quantities and diversion rates and after fish flow commitments are met would be treated to meet both primary and secondary federal and state drinking water standards at the Graham Hill Water Treatment Plant and distributed to the Beltz wells using existing water system infrastructure. During the dry season or drought periods, ASR water and native groundwater would be withdrawn from the Basin, treated as needed at existing groundwater treatment facilities and delivered to water system customers using existing water system infrastructure. Operation of an ASR system would be conducted in such a way that it avoids negative impacts on protective groundwater elevations and chloride concentrations at coastal monitoring wells. Over time, and depending on the availability of both additional surface water and aquifer storage space, additional ASR system facilities in the western part of the Basin could be developed and operated to protect groundwater resources and provide additional drought supply.

4.2.2.10 Legal Authority

The City of Santa Cruz is a land use jurisdiction with police powers necessary to take actions to supply sufficient water for present and future beneficial uses. The City also has the authority to work with the State Water Resources Control Board as needed to pursue necessary updates to its water rights and authorization to store surface water in regional aquifers for both water supply benefits and to provide groundwater sustainability benefits.

4.2.2.11 Estimated Costs and Funding Plan

As described above, the current plan for development of ASR in the basin is intended to leverage the use of existing infrastructure to the greatest extent feasible. As proposed, this approach is substantially less expensive than an ASR project that was discussed by the Water Supply Advisory Committee during its work between April of 2014 and October of 2015. SCWD hasn't necessarily abandoned a potentially larger and significantly more expensive ASR project that might involve storing water and supporting groundwater sustainability objectives in both the Mid-County and Santa Margarita groundwater basins but, rather is pursuing a project in the Mid-County Basin first. This direction provides the opportunity to make near-term incremental improvements in the reliability of SCWD's water supply and also to take near term action to address and mitigate the threat of further seawater intrusion in the Basin.

SCWD staff have estimated that a more limited ASR project using existing Beltz well infrastructure as simulated for the GSP would cost roughly $21,000,000 in 2019 dollars. These funds would be used to support ongoing pilot testing of ASR at Beltz system wells, necessary design for permanent retrofitting of existing wells, any needed improvements or modifications to SCWD's groundwater treatment facilities, and planning for additional ASR facilities in the western portion of the Basin if and as needed. The SCWD will continue to develop and fund the ASR project planning and implementation through its individual agency budget at no cost to the MGA. Project funding is expected to come from the SCWD water rate payers generated funds and from grant programs if such funds are available and can be successfully obtained.

4.2.2.12 Management of Groundwater Extractions and Recharge

Monitoring wells and data management systems are in use in the Basin to record and compare groundwater elevations to evaluate pumping impacts and for monitoring the performance of the basin relative to the various Sustainable Management Criteria. SCWD's ASR project would inject potable drinking water into the Basin during the wet season, storing injected water for use during the dry season and during droughts, along with allowing the stored water to recover the Basin. Groundwater levels exceeding minimum thresholds may allow SCWD to also extract additional groundwater when needed.

4.2.2.13 Relationship to Additional GSP Elements

SCWD's ASR project is a conjunctive use project that will be managed to ensure no negative impacts to any of the additional GSP elements outlined in GSP Section 2.1.4. Injection of surface water, treated to potable drinking water standards, is expected to support groundwater replenishment and improve progress toward the Basin's sustainability goals. An ASR project will help protect groundwater supplies against seawater intrusion and maintain or enhance groundwater levels where groundwater dependent ecosystems exist, as well as provide drought supply to City water system customers.

4.2.3 Water Transfers / In Lieu Groundwater Recharge

4.2.3.1 Project Description

Water Transfers/In Lieu Groundwater Recharge would deliver excess SCWD surface water, treated to drinking water standards, to SqCWD to reduce groundwater pumping and allow an increase in groundwater in storage in order to help prevent seawater intrusion. If water transfers benefit groundwater levels, is sustainable over time, and the Basin's performance consistently reaches sustainability targets, then SCWD could recover some of the increase in groundwater in storage as a supplemental supply during droughts.

In the summer of 2016, SCWD and SqCWD signed an agreement to work together to conduct a five-year pilot water transfer project. Prior to initiating the pilot, evaluations of the potential for unintended consequences due to differing chemical characteristics of surface and groundwater resources were completed.

A water transfer pilot test was conducted between December 2018 and April 2019 in which SCWD delivered treated drinking water to SqCWD to serve a portion of SqCWD's service area. The pilot test used an existing intertie between the two water agencies, providing on average 400,000 gallons per day to SqCWD. During the pilot test, SqCWD reduced or eliminated pumping in its O'Neill Ranch, Garnet, and Main Street wells. It also tracked water quality as concerns about the potential incompatibility of surface and groundwater sources, particularly related to elevated levels of lead, copper, or colored water from exposing public and private plumbing used to less corrosive groundwater to more corrosive surface water. Additional pilot testing is expected to begin in late 2019 with a larger pilot area within SqCWD's service area to continue evaluating operational and water quality conditions to help inform the feasibility for a long-term transfer. For a long term project, additional surface water could be provided from the City's North Coast sources and the San Lorenzo River (if water rights allow) to meet more of Soquel Creek Water District's wet season demand, rebuild groundwater storage by eliminating or reducing pumping during some part of the year within the SqCWD's western area of its service area.

4.2.3.2 Measurable Objective

Water Transfers/In Lieu Groundwater Recharge is a project to passively recharge groundwater by resting SqCWD's groundwater wells using treated drinking water from SCWD as a source of supply. In Lieu Groundwater Recharge has the potential to reduce the threat of seawater intrusion and possibly create additional groundwater in storage if adequate amounts of treated surface water are consistently and reliably available when SqCWD customers have the demand needed to use SCWD excess surface water.

4.2.3.3 Circumstances for Implementation

Water Transfers/In Lieu Groundwater Recharge is in pilot testing. Availability of excess surface water is constrained by a number of factors, including drinking water treatment capacity, water rights place of use restrictions, required minimum fish flows, and availability of adequate surface water supplies to serve SCWD's customers prior to selling excess drinking water outside the SCWD's service area. Climate change factors could also impact water availability. The amount of in lieu groundwater recharge that can be achieved is also limited by the relatively low water demand in SqCWD's service area during the winter months when SCWD has excess surface water available.

4.2.3.4 Public Noticing

In Lieu Groundwater Recharge pilot testing began in the winter of 2018-2019. Public Notice for all aspects of the project was carried out by SCWD and SqCWD prior to the start of pilot tests, including a CEQA Negative Declaration adopted for the pilot project (SCWD 2016). Future notification of the public for any additional pilot testing or long-term implementation would be done prior to initiation of the transfer.

4.2.3.5 Overdraft Mitigation and Management Actions

The Department of Water Resources designates the Basin 3-001 as in a state of critical overdraft. To respond both to the state's designation and to the Basin's condition, which has been a high priority focus of local agencies for decades, in 2015 SCWD and SqCWD entered into the Cooperative Monitoring/Adaptive Groundwater Management Agreement. This agreement sets limits for each agency's use of groundwater under normal and drought conditions. Basin pumping limits in this agreement were specifically intended to support stabilizing basin drawdown and restoring and maintaining protective groundwater levels at the coast. Work done as part of the development of the GSP indicates that groundwater levels have recovered from critically low levels identified in the 1980s. However, seawater intrusion exists in several locations and remains a significant threat to regional groundwater supplies as groundwater levels at five of the Basin's 13 key coastal monitoring wells remain below protective elevations. In 2018, groundwater levels declined between 0.4 feet to 4.0 feet from all-time highs recorded during Water Year 2017. Water Transfer/In Lieu Groundwater Recharge would reduce groundwater pumping and is likely to increase Basin groundwater levels and reduce the threat of further seawater intrusion into the Basin. Surface water transfers from SCWD would be expected to reduce regional groundwater dependence.

4.2.3.6 Permitting and Regulatory Process

SCWD completed a CEQA analysis, including opportunity for public comment, for the Pilot Water Transfer project (SCWD 2016). That CEQA analysis was completed in 2016 and focused on water from the City's North Coast Sources pre-1914 water rights, which are not constrained by formalized places of use. The City has initiated a process with the State Water Resources Control Board to update its San Lorenzo River water rights, and one of its requests to the State Board is to expand the places of use for all its San Lorenzo River water rights (Newell Creek License, Felton Permits, and Tait Diversion Licenses) to cover the boundaries of the municipal water providers and the general basin boundaries for the Santa Cruz Mid-County and Santa Margarita groundwater basins. No new water rights are being requested in this effort. An Environmental Impact Report (EIR) on the City's water rights changes is underdevelopment and is expected to be released for public review in the fall of 2019. A final EIR and State Board action on the requests is anticipated during calendar year 2020.

Prior to initiating the Pilot Water Transfer, SqCWD was required work with the State Division of Drinking Water (DDW) to modify its Operating Permit to allow it to take surface water during the pilot testing efforts. Any long-term water transfer would also need to be reflected in its Operating Permit from DDW.

4.2.3.7 Time-table for Implementation

Water Transfer/In Lieu Groundwater Recharge projects have been in the planning and engineering process for four years. In Lieu Groundwater Recharge is in pilot tested now and pilot testing will continue through at least the winter of 2019/2020. Longer term implementation of water transfers will require a new agreement, including compliance with Proposition 218 requirements to set the cost of service for water delivered and, depending on the annual quantity transferred, waiting for resolution of the places of use changes of the City's San Lorenzo River water rights. Given these factors, a likely timeline for implementation of a longer-term water transfer project is a minimum of two years.

The Basin is expected to see groundwater elevations continue to improve but model analysis of projected water availability from all surface water sources and groundwater recharge projections appear insufficient to restore the Basin within the 20-year planning horizon without additional water augmentation projects. The Basin is required to be sustainable by 2040, even during times of drought, which could limit large scale water transfers back to SCWD.

4.2.3.8 Expected Benefits

Groundwater elevations are expected to continue to increase with continued basin management and implementation of In Lieu Groundwater Recharge. Benefits are evaluated using the existing groundwater monitoring well network and data management systems to compare groundwater levels over time. The potential expected benefits of in-lieu recharge is demonstrated by model simulations of the Pure Water Soquel project (Appendix 2-I), which similarly implements in-lieu recharge by reducing pumping in the three westernmost SqCWD production wells. It is most feasible for operation of a surface water transfer from SCWD to facilitate reduction of pumping at these wells closest to the interchange between SCWD and SqCWD. Reduction of pumping at these wells can raise groundwater levels at nearby representative monitoring points for seawater intrusion as shown by plots of five-year average simulated groundwater levels at the wells under Pure Water Soquel (blue dashes labeled PWS) compared to the baseline (yellow line labeled Baseline) in Figure 4-5. The simulation of Pure Water Soquel shows the concept of benefits of in-lieu recharge in this area, but does not simulate expected volumes of surface water transfer, the seasonality of the transfer, or any additional pumping to transfer water to SCWD to meet its drought shortage needs.

The MGA will continue to evaluate the amount and timing of water transferred between SCWD and SqCWD as part of the pilot and permanent In Lieu Groundwater Recharge projects. Use of this collected data and any changes to groundwater elevations will be used to better analyze the effect of project implementation on groundwater sustainability over time.

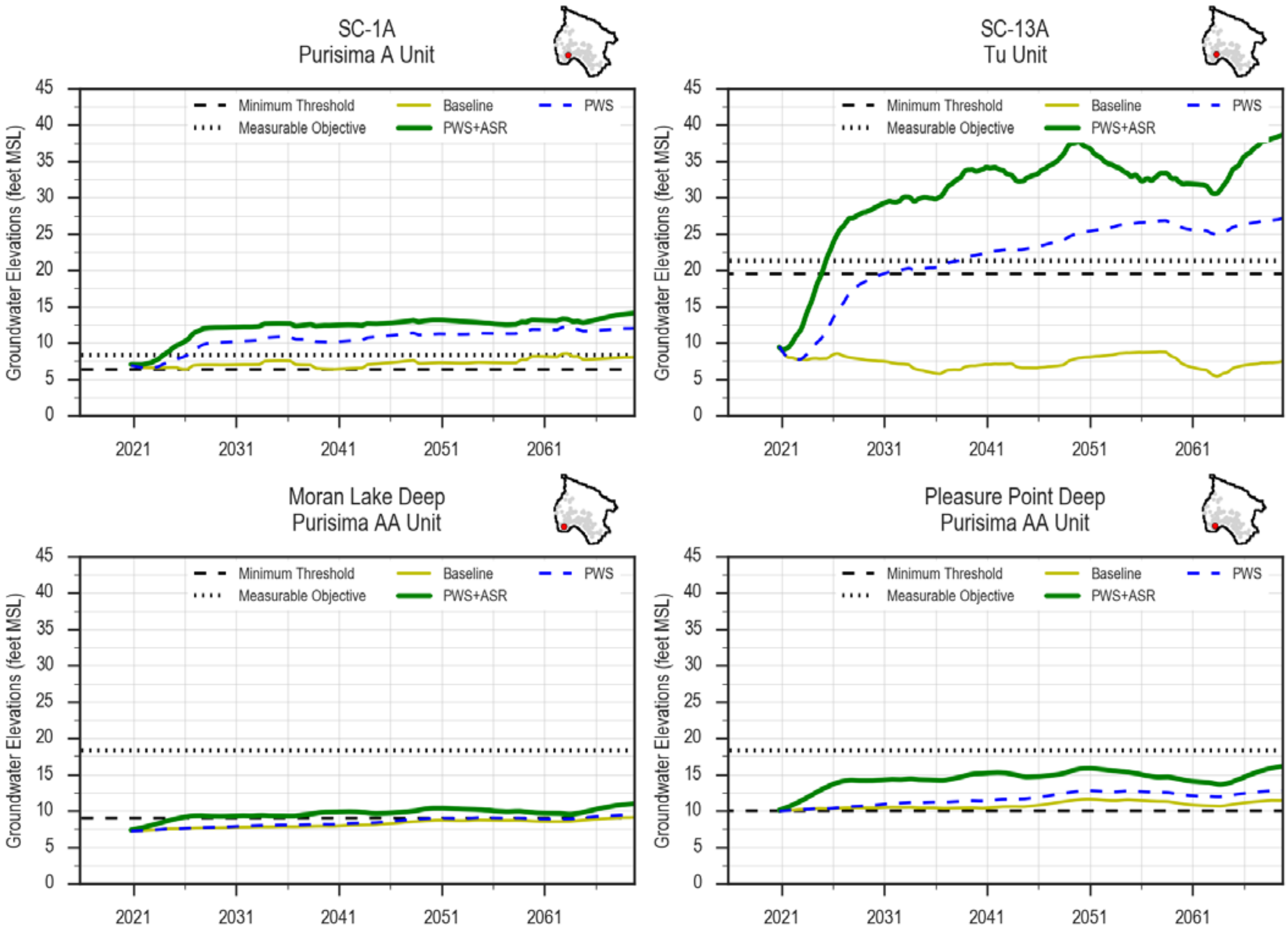

Figure 4-5. Five Year Averages of Groundwater Elevations at Coastal Monitoring Wells in Tu and Purisima AA and A Units (includes in-lieu recharge from Group 2 projects)

4.2.3.9 How the Project will be Accomplished

Water Transfers/In Lieu Groundwater Recharge projects can be implemented when SCWD has available excess surface water to provide to SqCWD. When available, water would come from SCWD's surface water sources and treated at the Graham Hill Water Treatment Plant, then delivered to the SqCWD via existing infrastructure at the O'Neill Ranch intertie. Excess surface water transferred by SCWD to SqCWD is treated at SCWD's Graham Hill Water Treatment Plant to meet both primary and secondary federal and state drinking water standards. Treated water delivered to customers is sampled by SqCWD, as required by the State Water Resource Control Board (SWRCB) regulators and tested to ensure the water delivered to its customers meets safe drinking water standards, these water quality sampling results will be reported monthly to SWRCB. If any water quality samples fail to meet safe drinking water standards, then notification of customers will be directed by the SWRCB staff.

Because of San Lorenzo surface water place of use restrictions, the volume of water available could be limited until place of use issues with the San Lorenzo River water rights are resolved. Volumes of water in the range of 300 to 500 acre feet per year (≈100 to 165 million gallons per year) are consistently available from the City's North Coast Sources. Larger volumes may be available in some years, but likely require use of water from San Lorenzo River sources. Analysis by SCWD shows that there is insufficient water available via Water Transfers to meet SCWD's drought supply requirements. In addition, Water transfers are constrained by both, the availability of water in the SCWD system and the demands of SqCWD's customers. There is no evidence to date that indicates an In Lieu Groundwater Recharge project by itself would achieve Basin sustainability.

4.2.3.10 Legal authority

California state law gives water districts the authority to take actions necessary to supply sufficient water for present or future beneficial use. Land use jurisdictions have police powers to develop similar programs. The Sustainable Groundwater Management Act of 2014 grants MGA legal authority to pass regulations necessary to achieve sustainability. San Lorenzo River water rights are restricted to place of use areas within SCWD water service areas. The City is applying to the State Water Board to expand the places of use for its San Lorenzo River water rights to allow for the expansion of the In Lieu Groundwater Recharge project.

4.2.3.11 Estimated Costs and Funding Plan

Water Transfer/In Lieu Groundwater Recharge projects utilize a significant amount of existing infrastructure. Costs for additional infrastructure to optimize In Lieu/Water Transfers are largely in the form of increased operating costs and could include increased water quality monitoring, increased public notification, and the cost of purchased water. Cost of water purchases between SCWD and SqCWD must comply with the legal requirements of Proposition 218, which sets the cost of service for water delivered.

4.2.3.12 Management of groundwater extractions and recharge

Water Transfer/In Lieu Groundwater Recharge projects are conjunctive use projects. In Lieu Groundwater Recharge reduces groundwater pumping to allow passive recharge that can contribute to groundwater level increases. Monitoring wells and data management systems are used to record and compare groundwater elevations in the Basin to evaluate pumping impacts and ongoing sustainability. Relationship to Additional GSP Elements

4.2.3.13 Relationship to Additional GSP Elements

SCWD and SqCWD's joint Water Transfer/In Lieu Groundwater Recharge projects are conjunctive use projects that will be managed to ensure no negative impacts to any of the additional GSP elements outlined in GSP Section 2.1.4. Passive recharge through resting groundwater wells by delivering excess surface water treated to drinking water standards to SqCWD customers is expected to support groundwater replenishment. Increased groundwater levels will improve progress toward the Basin's sustainability goals to protect groundwater supplies against seawater intrusion and to maintain or enhance groundwater levels where groundwater dependent ecosystems exist.

4.2.4 Distributed Storm Water Managed Aquifer Recharge (DSWMAR)

4.2.4.1 Project Description

Distributed Storm Water Managed Aquifer Recharge (DSWMAR) redirects storm water flows for use as a groundwater recharge supply to increase groundwater storage (RCD 2014). Where feasible, small to medium scale facilities (up to 10 acre-feet/year/site) are installed to capture and treat storm water for shallow groundwater recharge zones in Basin groundwater aquifers. Projects would be accomplished through surface spreading and/or the construction of dry wells.

4.2.4.2 Measurable Objective

DSWMAR is a groundwater recharge project to increase groundwater storage in the shallow aquifer layers in the Basin for increased groundwater storage and added protection against seawater intrusion and improved surface water quality.

4.2.4.3 Circumstances for Implementation

The County has installed DSWMAR projects in the Live Oak and Aptos areas of the Basin. Bioswale filtration systems and dry wells were installed at Brommer Street County Park with a capacity to recharge 1 acre-foot per year from the parking lot runoff. Bioswales and dry wells were also installed to capture runoff from two parking lots at Polo Grounds County Park with a capacity to recharge 19 acre-feet per year. Eight more DSWMAR sites were evaluated in 2018. Three of these sites were identified for further site investigation. One of these sites was recently eliminated because depth to groundwater was too shallow for recharge to be effective at that site. The availability of suitable sites and the limited scale of DSWMAR projects may be a constraint to project implementation.

Topography, ground cover, local vegetation, and surface and sub-surface geology/hydrogeology can provide significant constraints for siting DSWMAR projects. DSWMAR introduces water to the upper levels of aquifers and most drinking water production draws from deeper levels. Depending on the configuration of aquifers, DSWMAR may never reach the aquifers from which drinking water is produced. DSWMAR projects vary in size and benefit to the Basin and are likely to be prioritized according to recharge efficiency/needs and implemented when funding is available.

4.2.4.4 Public Noticing

Installed DSWMAR projects were publicly noticed and approved by the Santa Cruz County Board of Supervisors during its regularly scheduled board meetings. This process included statewide notice of the submission of Negative Declarations under CEQA to the state clearing house. Future DSWMAR projects would be noticed by the lead agency when a DSWMAR project is proposed.

4.2.4.5 Overdraft Mitigation and Management Actions

Groundwater levels have recovered from critically low levels identified in the 1980s. However, seawater intrusion exists in several Basin locations and remains a significant threat to regional groundwater supplies as groundwater levels at five of the Basin's 13 key coastal monitoring wells remain below protective elevations. In 2018, groundwater levels declined between 0.4 feet to 4.0 feet at various Basin locations from all-time highs recorded in Water Year 2017. The introduction of storm water into shallow Basin aquifers may increase groundwater levels in localized areas where DSWMAR projects are installed.

4.2.4.6 Permitting and Regulatory Process

Installed DSWMAR projects required permits from or notice to the following agencies:

- CEQA documentation
- Santa Cruz County grading permit
- USEPA - Class 7 dry well notice

Future projects may also require:

- Regional Water Quality Control Board - may require notice/permit

4.2.4.7 Time-table for Implementation

The County has developed and installed two DSWMAR projects to date, one in Aptos and another in Live Oak. The County installed dry wells in Aptos at Polo Grounds County Park became operational in 2012 and are estimated to add 19 acre-feet per year to the local shallow groundwater aquifer. In Live Oak, dry wells were installed and became operational at Brommer Street County Park in 2015 to add an estimated one acre-foot per year to the local shallow groundwater aquifer. The Polo Grounds project was accomplished with planning and funding through the Integrated Regional Water Management (IRWM) program and the Live Oak project was completed with IRWM and storm water grant funding.

Eight potential future sites were screened in 2018. Three of these eight potential sites were identified for further investigation, and one was eliminated after borings showed depth to groundwater too shallow to provide adequate conditions for recharge at that location. The two remaining sites are still under investigation. Time-table for development and expected benefits to groundwater recharge at these or any other potential future DSWMAR project sites are not available and would be speculative at this time

4.2.4.8 Expected Benefits

DSWMAR projects are expected to recharge shallow groundwater aquifers. Future projects of small to medium scale would be installed where feasible to capture storm water and recharge more shallow zones of aquifers through surface spreading or construction of dry wells. Existing projects in Live Oak and Aptos use recorded local rainfall observations and project design parameters to estimate project recharge rates. Future DSWMAR projects would likely be designed to more accurately measure recharge rates to the groundwater aquifer. The expected benefit from each project would vary based on both project design parameters and the amount/timing of storm water runoff. Benefits are evaluated using the existing monitoring well network and data management systems to compare groundwater levels over time. Time-table for accrual of expected benefits to groundwater recharge for potential future DSWMAR projects is not currently available and would be speculative at this time.

Although a specific DSWMAR project was not specifically modeled, a theoretical project in Aptos was modelled and was shown to raise groundwater levels in the Aromas Red Sands aquifer and allow for pumping from the aquifer unit more than what simulations of Pure Water Soquel show is necessary to achieve measurable objectives to prevent seawater intrusion into the aquifer.

4.2.4.9 How the Project will be Accomplished

Future DSWMAR projects would be developed by identifying sites receptive to groundwater recharge in areas where shallow groundwater recharge would be beneficial to the Basin. The Resource Conservation District of Santa Cruz County (RCD) is working with land owners in the neighboring Pajaro Valley Sub-basin on surface spreading projects and has developed data to show project effectiveness with the right surface and subsurface hydrogeologic conditions. The County has installed dry wells to capture and recharge storm water in Live Oak and Aptos. MGA member agencies will leverage existing project information from members and regional partner agencies, like the RCD, to identify sites and design future DSWMAR projects within the Basin. DSWMAR water supply would come from redirecting local storm water runoff to areas suitable for shallow groundwater recharge.

4.2.4.10 Legal authority

California state law gives Water Districts the authority to take actions necessary to supply sufficient water for present or future beneficial use. Land Use Jurisdictions have police powers to develop similar programs. The Sustainable Groundwater Management Act of 2014 grants MGA legal authority to pass regulations necessary to achieve sustainability.

4.2.4.11 Estimated Costs and Funding Plan

Existing DSWMAR projects were developed with local and grant funding sources. Future DSWMAR projects sites are under investigation. Two of the three potential storm water recharge sites evaluated in a report prepared for the County (MME, June 2019) were found suitable for project development. Both suitable sites are at different locations on Seascape Golf Course. The MME report estimates costs per unit of water infiltrated over a 20 year project lifespan. These costs were developed per acre-foot of storm water recharge and varied between $1,649 and $2,786 per acre-foot. Project development costs for initial project installation were estimated at $450,000 at the Los Altos site and $650,000 at the 14th Fairway site. MGA policy developed to date indicates project funding would come from member agencies and grants.

4.2.4.12 Management of groundwater extractions and recharge

Groundwater extraction is monitored by metering municipal production wells, small water systems, and the model estimates production by non-municipal private wells. DSWMAR projects recharge shallow groundwater. Basin recharge attributable to DWSMAR projects is estimated according to project design parameters and recorded precipitation. Basin groundwater recharge is monitored through a basin wide monitoring well network and data management system.

4.2.4.13 Relationship to Additional GSP Elements

Environmental impacts of future DSWMAR projects will be reviewed under the California Environmental Quality Act (CEQA). If implemented, future projects would avoid significant impacts to the environment including to the additional GSP elements outlined in GSP Section 2.1.4. Groundwater recharge related to DSWMAR is expected to support shallow groundwater replenishment and improve progress toward the Basin’s sustainability goals to maintain or enhance groundwater levels where groundwater dependent ecosystems exist.

4.3 Identified Projects and Management Actions That May Be Evaluated in the Future (Group 3)

4.3.1 Recycled Water - Groundwater Replenishment and Reuse

Soquel Creek Water District: The Soquel Creek Water District Feasibility Study (Carollo 2017) and the Pure Water Soquel EIR (ESA 2018) both identify expansion opportunities for the Pure Water Soquel Project. The conveyance infrastructure of the Pure Water Soquel Project is currently sized to accommodate the potential for future expansion of the Project’s treatment system (if desired at a later time) which is centrally-located and could convey up to approximately 3,000 AFY of purified water. This could be developed should SCWD need supplemental water supplies to meet drought needs or the Basin needs additional supplies to meet MGA sustainability goals based on project performance and monitoring of the GSP’s implementation measures.

City of Santa Cruz: SCWD conducted planning and assessments of the potential use of recycled water to supplement SCWD’s water supply. The City’s Water Supply Advisory Committee’s (WSAC) 2015 recommendations were to pursue a strategy of water conservation and enhanced groundwater storage, with a back-up option of advanced treated recycled water or desalinated water. WSAC recommended further evaluation of these water supply alternatives (SCWD 2015). The WSAC’s charge, as represented in its final recommendations, was focused on addressing SCWD’s water supply gap of 3,700 acre-feet (or 1.2 billion gallons) per year during times of extended drought. However, the potential recycled water strategies to augment

SCWD's water supply could also potentially benefit the Basin if implemented in a manner that targeted groundwater storage or seawater intrusion prevention.

In 2018, in response to WSAC's recommendations, SCWD concluded a Recycled Water Facilities Planning Study (RWFPS) that evaluated recycled water alternatives (Kennedy/Jenks 2018). This included a high-level feasibility study and conceptual level design of alternatives for recycled water. In addition to evaluating water supply benefit to SCWD, the RWFPS also provided a broader range of potential beneficial uses of the treated effluent from the regional Santa Cruz Wastewater Treatment Facility (WWTF). The RWFPS evaluated eight project alternatives, which included:

1) Centralized Non-Potable Reuse
2) Decentralized Non-Potable Reuse
3) SqCWD Led Groundwater Replenishment Reuse Project (Includes Pure Water Soquel)
4) Santa Cruz Led Groundwater Replenishment Reuse Project
5) Surface Water Augmentation
6) Streamflow Augmentation
7) Direct Potable Reuse
8) Regional Groundwater Replenishment Reuse Project (GRRP)

The evaluation of the project alternatives consisted of a conceptual-level engineering analysis to evaluate each project and to score and rank projects based on screening criteria for engineering and operational considerations, economic factors, environmental, and social considerations.

The RWFPS identified the near-term preferred alternative as strategies/projects under Alternative 1 Centralized Non-Potable Reuse; this consists of two separate projects (1. SCPWD Title 22 Upgrade (Alternative 1A) and 2. BayCycle (Alternative 1B Phase 4)) to increase production and recycled water reuse. Both would benefit SCWD but they are located outside of the Basin and would not assist in achieving sustainability within the Basin and therefore are not under consideration by the MGA.

The RWFPS identified a mid-term opportunity for a centralized Groundwater Replenishment Reuse Project (GRRP) led by the SCWD (Alternative 4). This alternative evaluated a GRRP (independent of Pure Water Soquel) in the Santa Cruz service area with a centralized Advanced Water Treatment Facility (AWTF) at or near the Santa Cruz Wastewater Treatment Facility (WWTF) to send advanced treated water for injection in the Beltz wellfield area and also deliver advanced treated water for non-potable reuse (NPR) along the way.

The Beltz wellfield is located in the Basin, so this potential project to assist with replenishing the Purisima aquifer and protecting against seawater intrusion. Santa Cruz WWTF secondary effluent would serve as the source of the water. The effluent would receive advanced water treatment at or near Santa Cruz WWTF employing full advanced treatment with microfiltration, reverse osmosis (RO) and ultra-violet (UV)/Peroxide for advanced oxidation. It is estimated the project would provide up to 2.0 MGD (2,240 AFY) advanced treated water for groundwater replenishment at the Beltz Wellfield. In addition, it would provide an estimated 0.11 MGD (120 AFY) for NPR irrigation at approximately 35 customer sites in City along the pipeline alignment from the AWTF to SCWD's GRR injection sites. The RWFPS summarizes the other infrastructure required to implement the project including: advanced treated water pump station; approximately 43,000 linear feet (LF) of new advanced treated water pipeline (6 to 12-inch) to distribute water to the Beltz wellfield; 5 injection wells and 5 monitoring wells and associated buildings. The study's summary of probable costs estimated the total capital costs at $70.5 million (includes treatment, pipelines, pump station, site retrofit costs, wells) and presents a summary of loaded capital costs, by facility component, as well an annual unit life cycle costs.

The RWFPS summarizes the significant limitations and challenges of the project as:

1. Operational complexity and energy for treatment and injection;

2. Additional studies to confirm the groundwater basin capacity, ability to capture recharged flow and meet all regulatory requirements;

3. The produced water quality exceeds the needs for non-potable reuse.

Based upon the identified limitations and challenges, this project is included in Group 3 because there is insufficient information at this stage to fully evaluate its feasibility and merits. Pending the potential implementation of Group 2 projects and management actions and the Basin's hydrologic response as indicated in the assessments of the sustainable management criteria during the GSP implementation, the MGA may reevaluate the need and further evaluate a centralized Groundwater Replenishment Reuse Project (GRRP) led by SCWD.

4.3.2 Recycled Water – Surface Water (Reservoir) Augmentation

As discussed in Section 4.3.1 above, SCWD's Recycled Water Facilities Planning Study (RWFPS) evaluated recycled water alternatives (Kennedy/Jenks 2018). This included an evaluation of recycled water use for a Surface Water Augmentation (SWA) project (Alternative 5) to convey advanced treated water from the Santa Cruz WWTF to blend with raw water and store in Loch Lomond Reservoir, a source of municipal drinking water supply for the SCWD service area. Water from Loch Lomond would be conveyed to and treated at SCWD's Graham Hill Water Treatment Plan (GHWTP) before entering SCWD's potable water distribution system.

The study found that a SWA project at Loch Lomond would maximize the beneficial reuse of wastewater in summer months, and potentially provide more operational flexibility for reservoir operations. Instead of preserving storage to assure sufficient water supply for SCWD in the dry months, in all seasons Loch Lomond could be used as a climate independent resource for the region. Based upon the project assumptions and operational conditions, the project is estimated to produce up to 1,777 AFY of recycled water. The available supply for a SWA project would depend on the amount of secondary effluent available for reuse, the dilution ratio and the retention time in the reservoir needed to meet state regulations on the use of recycled water.

Due to the distance and lift required to convey advanced treated water to Loch Lomond Reservoir, there would be significant additional infrastructure, pumping and energy requirements for conveyance. The study estimated the total cost at $106.5 million and presents a summary of loaded capital costs, by facility component, as well an annual unit life cycle costs.

The RWFPS identifies the project's significant limitations and challenges as:

- High capital and unit costs due to extensive infrastructure required
- Challenging Regulatory, CEQA/NEPA And Permitting Requirements
- Operational complexity for treatment and reservoir management
- Significant energy for conveyance and treatment
- May limit future expansion at the Santa Cruz WWTF
- Additional limnological studies needed to confirm assumptions

The SWA project was not selected as a preferred alternative in the RWFPS; in the evaluation and sensitivity analysis of the eight alternatives, the SWA ranked towards the bottom. It should be noted that the assessment of this project was done within the context of the WSAC recommendations, to evaluate supplemental supply alternatives to address SCWD's water supply gap during times of extended drought. The MGA's principal planning objective is the Basin's sustainability goal. The initial feasibility assessment did not identify any regulatory "fatal flaws" for the implementation of a SWA project at Loch Lomond Reservoir. The identified limitations and challenges pertain to either addressing drought supply or the MGA's needs. Pending the potential implementation of Group 2 projects and management actions and the Basin's hydrologic response as indicated in the assessments of the sustainable management criteria as the GSP implementation progresses, the MGA may reevaluate the need to further evaluate SWA.

4.3.3 Recycled Water – Direct Potable Reuse

Current California regulations do not allow for the use of recycled water for Direct Potable Reuse (DPR). DRP is generally defined as the introduction of recycled water directly into a public water system. In 2010, the California Senate enacted legislation[2] to expand the Water Code regarding potable reuse of recycled water. In the decade since, state drinking water and public health regulatory agencies have continued the assessment and possible framework for the regulation of potable reuse projects. In its 2016 *Investigation on the Feasibility of Developing Uniform Water Recycling Criteria for Direct Potable Reuse,* the State Water Resources Control Board concluded "the use of recycled water for DPR has great potential but it presents very real scientific and technical challenges that must be addressed to ensure the public's health is reliably protected at all times (SWRCB, 2016).

No DPR projects currently exist in California and existing regulations have not been developed. However, it is conceivable that DPR will become a future strategy to augment public water

[2] Senate Bill (SB) 918 (Chapter 700, Statutes of 2010), which added sections 13560-13569 (Division 7, Chapter 7.3)

supplies. Accordingly, SCWD's Recycled Water Facilities Planning Study (RWFPS) evaluated the use of recycled water for Direct Potable Reuse (DPR) (Alternative 7) (Kennedy/Jenks, 2018). The source of supply would be wastewater effluent receiving secondary at the Santa Cruz WWTF. This effluent would receive full advanced treatment prior to blending with raw water coming from City's other flowing sources for further treatment at the GHWTP prior to distribution as potable water. The Advanced Water Treatment Facility's (AWTF) capacity would be sized based on the secondary effluent available in the summer, less secondary effluent delivered for other potential project demands. Up to 3.2 MGD (3,585 AFY) of advanced treated water production capacity at the City's WWTF would be utilized year-round. The study estimated the total cost at $110.6 million. In the future, if a mandate for additional treatment of wastewater effluent or a ban on ocean discharge is enacted SCWD would evaluate water recycling to achieve zero or near-zero discharge. If this situation occurs, DPR could be revisited to increase the amount of beneficial reuse.

The RWFPS evaluated these alternatives principally as a means to address SCWD's water supply needs during drought. However, conceptually DPR could serve to as a supplemental supply to address the sustainability goals of the GSP by reducing the need for groundwater pumping in the Basin. Conceptually, this would likely entail a dual-purpose approach designed to meet SCWD's drought needs and as well as serve as a supplemental supply to the MGA to assist in maintaining or enhancing protective water level elevations.

Based upon the current regulations and considerable uncertainty related to scientific, technical, and social considerations, DPR is not considered a viable strategy to achieve the basin sustainability goal. However, as the GSP implementation proceeds over the coming decades, the MGA anticipates evaluating the potential applicability of DPR in managing the Basin in a sustainable manner.

4.3.4 Groundwater Pumping Curtailment and/or Restrictions

In many of the groundwater basins subject to SGMA throughout the State, pumping restrictions are one of the key components of the GSP. The MGA believes that the current level of Basin pumping can be continued with the effective implementation of the Group 1 and Group 2 Projects and Management Actions. However, the MGA also acknowledges that pumping restrictions are an effective tool to achieve groundwater sustainability that may need to be used in the future.

For the purpose of the GSP, pumping restrictions are defined as reductions or limitations in the amount of water a current or future groundwater user can pump from the Basin. This would be applied in the case of a situation where the planned Projects and Management Actions are insufficient to reach and/or maintain sustainability and one or more sustainability indicator is likely to dip below the minimum threshold by 2040. Under such a curtailment scenario, the MGA would determine the amount of water that affected pumpers could take sustainably, and the pumpers would be required to reduce their groundwater extraction to that allocation. All pumpers subject to allocations and restriction would be required to be metered.