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Technical Memorandum

Date: February 28, 2019

From: Spencer Harris, HG 633

To: Rob Miller, P.E., Interim Executive Director
Los Osos Groundwater Basin Management Committee

SUBJECT: Los Osos Basin Plan Metric Trends Review and Infrastructure Program C Evaluation.

Dear Mr. Miller:

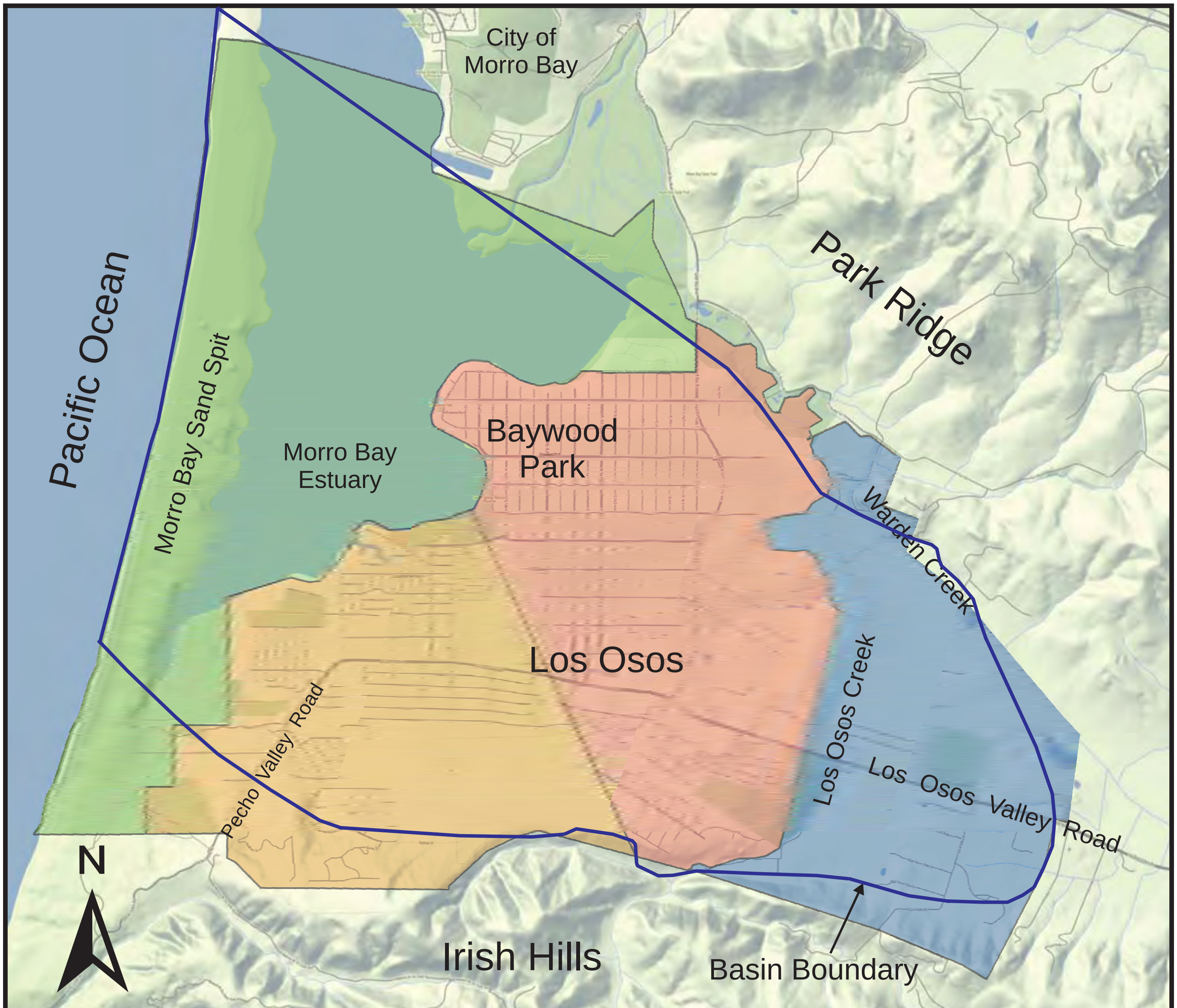
Cleath-Harris Geologists (CHG) has performed a metric trends review and basin infrastructure Program C evaluation as part of adaptive management for 2018. The purpose of this effort was to provide the Los Osos Basin Management Committee (BMC) with information and recommendations for making adjustments to the Los Osos Basin Plan (LOBP), as appropriate, based on a comparison of current basin metric trends with the anticipated trends, along with an evaluation of Program C using an updated existing population scenario. This memorandum presents the results of the adaptive management review.

Background

BMC members include water purveyors Golden State Water Company (GSWC), Los Osos Community Services District (LOCSD), and S&T Mutual Water Company, along with the County of San Luis Obispo. The basin refers to the adjudicated portion of the Los Osos Valley Groundwater Basin (DWR Basin 3-8), for which a Stipulated Judgment and the LOBP were approved by the San Luis Obispo Superior Court in October 2015. Figure 1 shows the basin and associated plan area boundaries. A brief overview of Program C and the basin metrics is provided below.

Basin Infrastructure Program C

Program C includes a set of infrastructure improvements that would allow the water purveyors to shift some groundwater production within the Lower Aquifer from the Western Area to the Central Area (Figure 1). Groundwater production from the Central Area generally results in less seawater intrusion than the same amount of production from the Western Area, which increases the sustainable yield of the Basin. Program C consists of three Expansion Wells located on the eastern side of the Central Area and associated pipelines. Implementation of Program C would have a direct, beneficial impact on mitigating seawater intrusion. (LOBP; ISJ, 2015).



Base Image: Stamen-Terrain

Explanation

Los Osos Basin Plan Areas:

- Dunes and Bay Area
- Western Area
- Central Area
- Eastern Area
- Basin Boundary from Los Osos Basin Plan

0 2000 4000 6000 8000 ft

Scale: 1 inch ≈ 4,000 feet

Figure 1
Basin Location and Plan Areas
Los Osos Groundwater Basin
2018 Adaptive Management TM

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General areas for the Program C Expansion Wells were described in the LOBP (pages 239-240). These areas, with some adjustments noted below, are shown in Figure 2.

South Expansion Well Area - Vicinity of the mobile home parks south of Los Osos Valley Road in the GSWC service area.

Central Expansion Well Area - Vicinity of Andre Avenue and Buckskin Avenue in the GSWC service area, similar to the original area identified for Expansion Well No. 2 in the LOBP.

North Expansion Well Area - Vicinity of north end of Sage Avenue east of the LOCSD service area. The area also includes a site currently under consideration in the south parking lot of the Los Osos Middle School play fields.

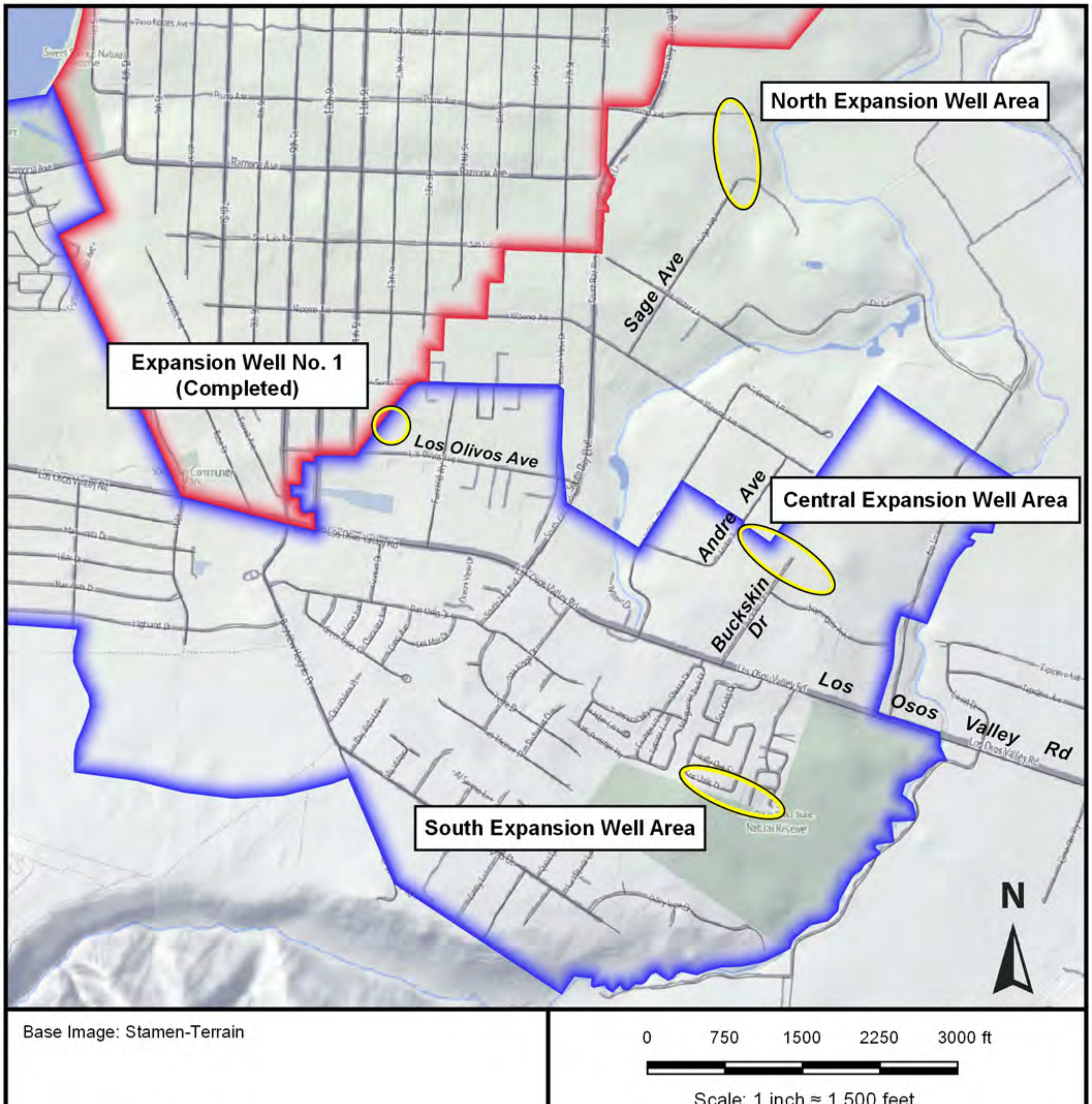
Expansion Well No. 1 (COMPLETED) - Originally planned in the vicinity of Buckskin Avenue north of Los Osos Valley Road and within the GSWC service area. GSWC relocated Expansion Well No. 1 to Los Olivos Avenue, and constructed a new Lower Aquifer well there in 2016.

The Program C evaluation for adaptive management considers whether additional Expansion Wells are needed, under current basin water demand, to achieve a Basin Yield Metric targeted value of 80 (BYM 80) or lower, and a distribution of pumping that reverses the historical seawater intrusion trend and maintains a stationary intrusion front at a location closer to the coast in accordance with LOBP goals. The seawater intrusion front for the basin is defined as the 250 mg/L chloride concentration contour.

Basin Metrics

The LOBP established two methods for measuring progress on seawater intrusion mitigation, one based on comparing annual groundwater extractions with the estimated sustainable yield of the basin as calculated by the basin numerical groundwater model, and one based on evaluating water level and water quality data from the Groundwater Monitoring Program. The first method involves the Basin Yield Metric and the Basin Development Metric, while the latter method involves the Water Level Metric and the Chloride Metric. A third method, the Upper Aquifer Water Level Profile, was introduced in the 2017 Annual Groundwater Monitoring Report to evaluate the potential for seawater intrusion in the Upper Aquifer , (CHG, 2018). A separate metric, the Nitrate Metric, was established in the LOBP to track nitrate concentrations in groundwater over time in areas of the basin that have historically been impacted by nitrates.

The metrics based on groundwater extractions are management tools. The Basin Yield Metric is used for comparing different infrastructure and pumping distribution combinations with respect to seawater intrusion mitigation and sustainable yield. The Basin Development Metric is a representation of the percentage of the Basin's maximum potential sustainable yield that has been developed, and is useful for identifying infrastructure programs needed to meet current and future water demands.



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Explanation

Potential Expansion Well Areas

Water Systems

Golden State Water Company - Los Osos

Los Osos CSD

Figure 2
Program C Potential Well Locations
Los Osos Groundwater Basin
2018 Adaptive Management TM

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Only the Basin Yield Metric has a nexus with some of the physical metrics based on groundwater monitoring data. Both the Water Level Metric and the Chloride Metric are measures of effectiveness for Lower Aquifer seawater intrusion mitigation, and can be correlated to changes in the Basin Yield Metric. The Basin Development Metric tracks infrastructure program development relative to maximum potential sustainable yield, which does not correlate in real time with changes in groundwater monitoring data.

There is also no relationship between the Basin Yield Metric and the Nitrate Metric. Sustainable yield in the basin is constrained primarily by the need to prevent Lower Aquifer seawater intrusion. Nitrate concentrations in the Upper Aquifer play a major role in basin infrastructure, and are the primary focus of Program B, but the Nitrate Metric itself is independent of Lower Aquifer seawater intrusion mitigation.

Basin Metric Trends Review

Trends in the basin metrics are indicators of whether basin conditions are improving or deteriorating over time, and can be compared to anticipated trendlines for adaptive management. Metric trends from the 2017 Annual Groundwater Monitoring Report are included in Attachment A. Anticipated trendlines for the Water Level Metric, Chloride Metric and Nitrate Metric from the LOBP are included in Attachment B. Note that actual basin metric trends are not expected to follow straight lines, but the trendlines shown in Attachment B are useful to depict the general nature of the anticipated trends.

Basin Yield Metric and Water Level Metric

A comparison between Basin Yield Metric and Water Level Metric trends over time is shown in Figure 3. The Basin Yield Metric compares the estimated amount of groundwater extracted in a given year with the estimated sustainable yield of the basin under then-current conditions. For example, the Basin Yield Metric for 2017 is a ratio expressed as follows:

$$\frac{\text{Year 2017 Groundwater Production}}{\text{Year 2017 Sustainable Yield}} * 100$$

A Basin Yield Metric of 100 (BYM 100) indicates that production is equal to the estimated sustainable yield. The LOBP established the Basin Yield Metric target at 80 (BYM 80) or less, so that at least 20 percent of the yield of the basin can be used as a buffer against uncertainty.

As shown in Figure 3, the Basin Yield Metric and the Water Level Metric are closely correlated due to the relationship between groundwater production and water levels. Between 1973 and 1988, a relatively sharp increase in the Basin Yield Metric (and associated groundwater production) is accompanied by a sharp decrease in the Water Level Metric. The trends for both metrics are reversed between 1989 and 2009, with flatter trendline slopes. Between 2009 and

Basin Yield Metric and Water Level Metric

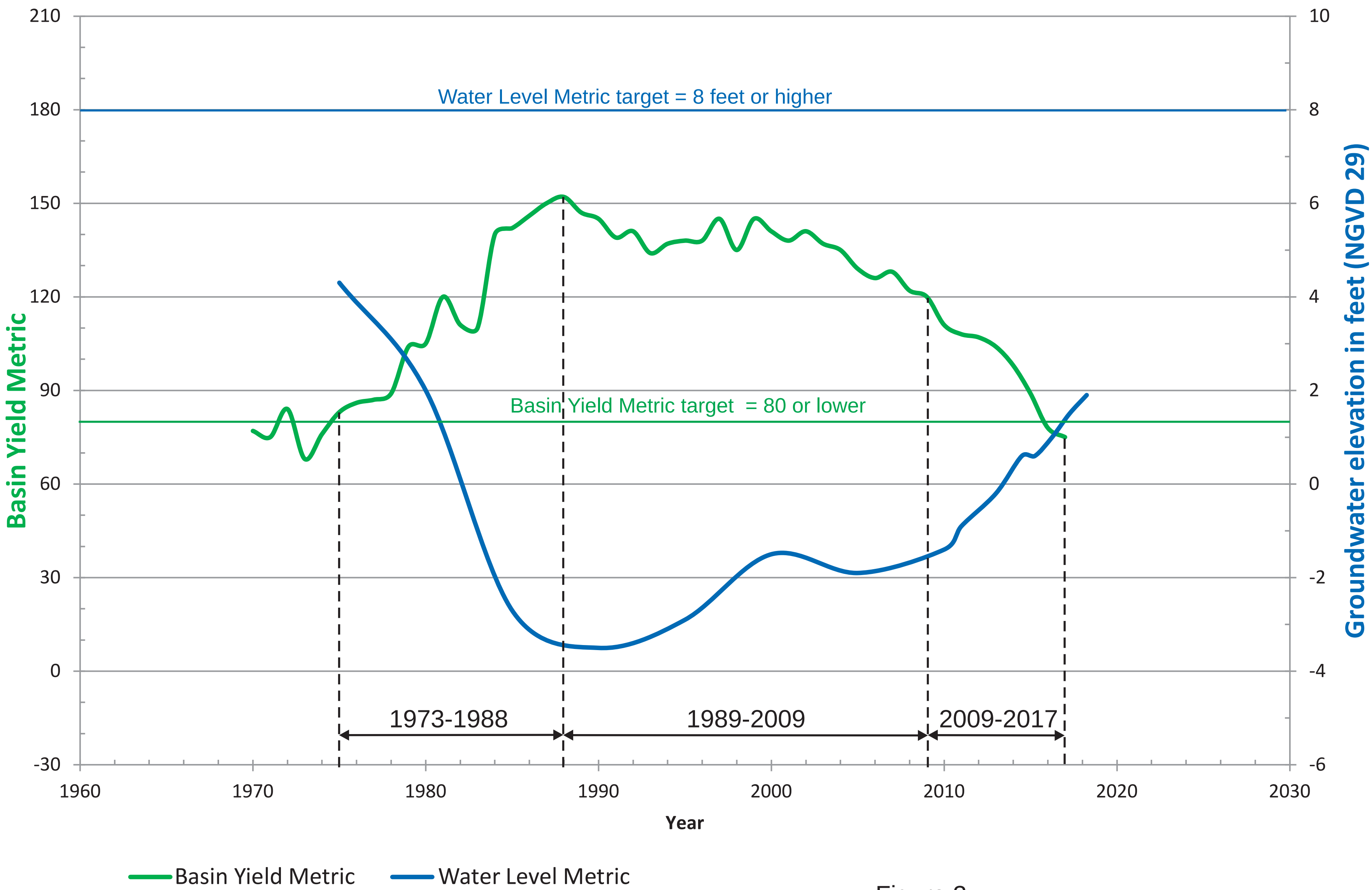

Figure 3
Basin Yield Metric and Water Level Metric
Los Osos Groundwater Basin
2018 Adaptive Management TM

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2017 there was a relatively sharp decrease in the Basin Yield Metric (and associated groundwater production), accompanied by a sharp increase in the Water Level Metric.

The anticipated trendline for the Water Level Metric was rising to reach the targeted value of 8 feet above mean sea level within approximately 10 years of achieving the targeted Basin Yield Metric value (Figure 37 from LOBP; Attachment B). The current Water Level Metric trend direction is consistent with the anticipated trend, although the timeline for reaching the target is extended. In Spring 2018, the Water Level Metric measured 1.9 feet elevation, compared to 1.5 feet elevation in Spring 2017 (NGVD 29 datum). If the metric continues to rise at the current rate of approximately 0.4 feet per year, the target threshold of 8 feet above sea mean sea would be reached in 2033, or approximately 18 years after achieving BYM 80.

In 2016, adjustments were made to some of the Water Level Metric well reference point elevations, along with removal of the density correction for water levels on the sandspit, which lowered the Water Level Metric compared to prior calculations. Reevaluation of the metric target is recommended following confirmation of reference point elevations by a licensed surveyor (CHG, 2018).

<u>Basin Yield Metric and Chloride Metric</u>

A comparison between Basin Yield Metric and Chloride Level Metric trends over time is shown in Figure 4. There is a correlation between these two metrics, although it is not as straightforward, compared to the Water Level Metric correlation.

Sustainable yield is the denominator for the Basin Yield Metric calculation. Estimates of sustainable yield are provided by the Basin Model, and are the maximum amount of groundwater that may be extracted from the basin while maintaining a stationary seawater intrusion front, and with no active well producing water with chloride concentrations above 250 milligrams per liter.

If the Basin Yield Metric is above 100, then production exceeds sustainable yield (an overdraft condition), the Chloride Metric rises, and seawater intrusion is projected by the Basin Model to advance inland and impact active drinking water wells. A Basin Yield Metric below 100, however, does not necessarily indicate a sustainable condition, as the distribution of pumping also affects movement of the seawater intrusion front. In other words, the same annual volume of groundwater may be pumped from different aquifers in different locations and would result in the same Basin Yield Metric value for that year, but would not necessarily be equally sustainable.

By 1979, the Basin Yield Metric had exceeded 100, but the Chloride Metric did not respond until almost two decades later, beginning to rise between 1995 and 2000. The reason for the delay is interpreted to be due to the travel time required for seawater intrusion precursors (including steadily increasing chloride concentrations) to reach the metric wells.

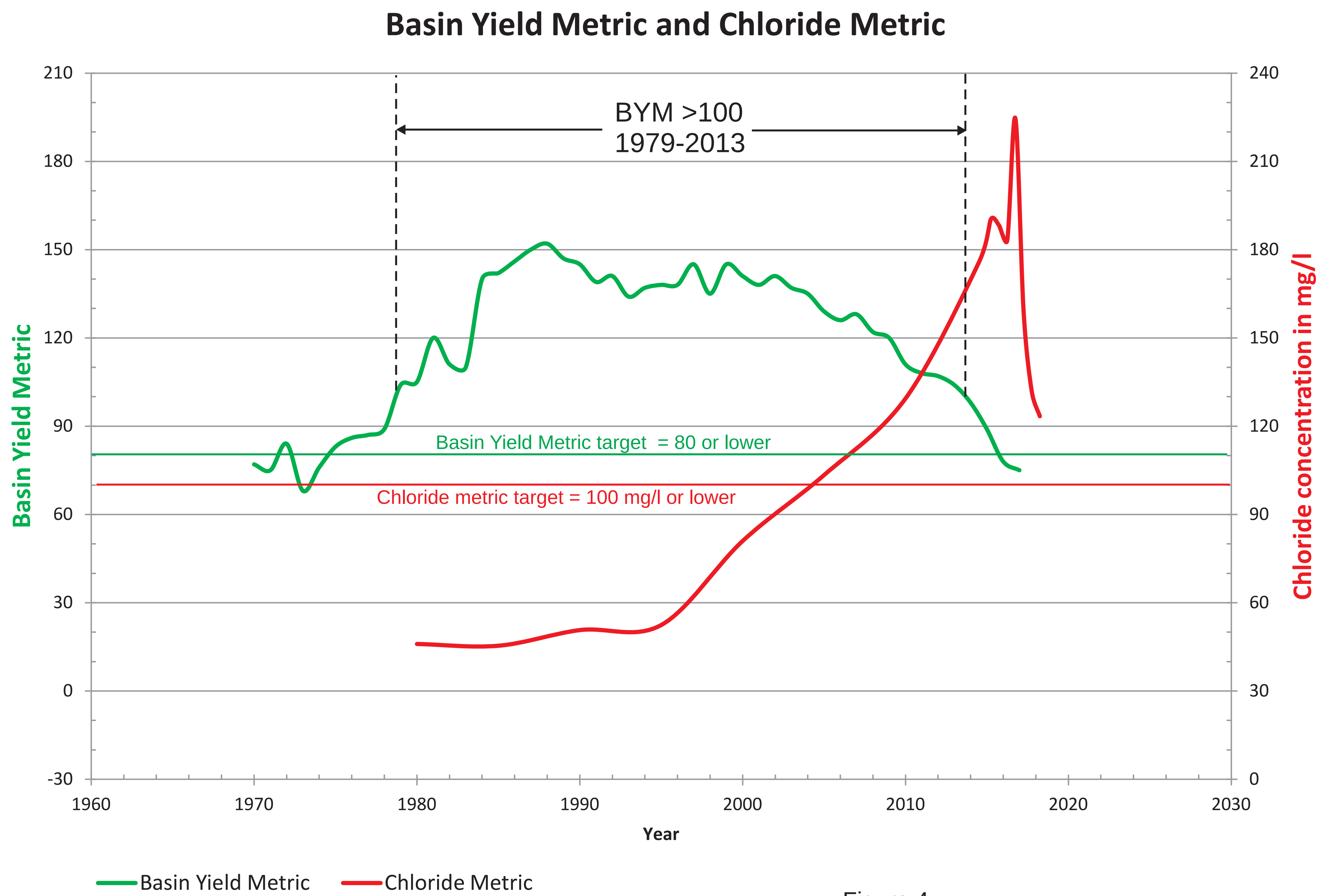

Figure 4
Basin Yield Metric and Chloride Metric
Los Osos Groundwater Basin
2018 Adaptive Management TM

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The anticipated trendline for the Chloride Metric was a continued rise in the metric up to approximately 220 mg/L chloride, followed by decline, reaching the targeted value of 100 mg/L chloride within approximately 30 years of achieving the targeted Basin Yield Metric value (Figure 37 from LOBP; Attachment B). The current Chloride Metric trend direction is consistent with the anticipated trendline, although the timeline for reaching the target is reduced. Chloride Metric values reached a maximum of 225 mg/L chloride in 2016, and have declining to 123 mg/L chloride through Spring 2018. If the metric continues to decline at the current rate of approximately 30 mg/L per year, the targeted value of 100 mg/L chloride or lower would be reached by 2019, approximately 4 years after the Basin Yield Metric moved below the targeted value of BYM 80.

A portion of the recent decline in the Chloride Metric is interpreted to be influenced by wellbore flow from the Upper Aquifer at one of the metric wells, although the majority of chloride concentration decline at the well appears to be occurring in the Lower Aquifer. Further evaluation of Upper Aquifer influence on the Chloride Metric is recommended as new data becomes available (CHG, 2018).

Nitrate Metric

Nitrate Metric trends through 2017 are shown in Figure 22 of the 2017 Annual Groundwater Monitoring Report (Attachment A). The five-year average for metric values increased by approximately 7 mg/L nitrate-nitrogen (NO_3-N) between 2002-2006 and 2013-2017. Individual year metric values reached 32 mg/L NO_3-N in 2017, over three times the Maximum Contaminant Level of 10 mg/L (the drinking water standard).

Elevated Nitrate concentrations in the urban area are attributable to historical wastewater discharges from high-density septic systems (LOBP, 2015), most of which are now conveyed to the Los Osos Wastewater Recycling Facility (LOWRF) for treatment and disposal. Recycled water being delivered to community leach field disposal sites from LOWRF contains approximately 2 mg/L total nitrogen, based on a 30-day average concentration reported for September 2017 (CHG, 2018).

The anticipated trendline for the Nitrate Metric was for values to remain stable through 2020, followed by a gradual decline, and reaching the targeted metric value of 10 mg/L by 2050 (Figure 31 from LOBP; Attachment B). The current Nitrate Metric trend is inconsistent with the anticipated trend, although a shift in the nitrate monitoring schedule may have influenced the 2016 and 2017 Nitrate Metric results and increased the metric compared to prior years (CHG, 2018).

Nitrate removal systems are in place at two locations, and provisions for additional nitrate removal capacity are planned during Upper Aquifer development under Program B. More time is needed for observing the effects of decreased nitrate loading to the basin under current conditions with the Los Osos Wastewater Project completed.

Infrastructure Program C Evaluation

The Program C evaluation for adaptive management considers whether additional Expansion Wells under LOBP Program C are needed, under current basin water demand, to achieve both a Basin Yield Metric target value of 80 (BYM 80) or lower, and a distribution of pumping that maintains a stationary seawater intrusion front closer the coast, similar to the position shown in LOBP Figure 38 (Attachment B). Program C calls for three expansion wells to be constructed to meet the LOBP goals of halting or reversing seawater intrusion and providing a sustainable water supply under the existing population scenario. Basin water demand for the existing population scenario was originally estimated at 2,230 AFY (Table 46 of the LOBP; ISJ, 2015). The updated existing population scenario assumes a water demand of 2,070 AFY, based on the estimated basin water use in 2017 (CHG, 2018).

<u>2017 Basin Yield Metric</u>

Water supply infrastructure at year-end 2017 included the following LOBP elements:

- Los Osos Wastewater Project
- Urban Water Reinvestment Program (U)
- Infrastructure Program A
- Partial completion of infrastructure Program C

The sustainable yield of program combination U+A is 2,650 acre-feet per year (AFY), as reported in Table 43 of the LOBP (Attachment B). Program C was partially completed in 2016 with the construction of Expansion Well No. 1 by GSWC at Los Olivos Avenue (Figure 2). The contribution of Program C to basin sustainable yield is the difference between the yield of program combination U+A (2,650 AFY) and program combination U+AC (3,000 AFY), which is 350 AFY. Close to one-third, or an estimated 110 AFY of the sustainable yield contribution from Program C was developed in 2016, bringing the total estimated sustainable yield for year-end 2017 conditions to 2,760 AFY (CHG, 2017; 2018).

Groundwater production in 2017 was estimated at 2,070 acre-feet, including 1,050 acre-feet of metered community purveyor production and 1,020 acre-feet of other non-metered production (golf course, community park, memorial park, non-purveyor domestic, and agriculture). The corresponding Basin Yield Metric for 2017 was 75, which met the LOBP target of BMY 80 or less for the second consecutive year (CHG, 2018).

<u>Program C Evaluation</u>

Basin Model results indicate no additional Expansion Wells would be required under the existing population scenario, based on the current basin water demand of 2,070 AFY, to achieve both a Basin Yield Metric targeted value of 80 (BYM 80) and a stationary seawater intrusion front closer the coast. The current 2017 Basin Yield Metric is 75, which meets the targeted value. A stationary seawater front can also be maintained at a position closer to the coast with the existing Expansion Well, assuming long-term precipitation averages 17.5 inches per year. There are other factors, however, which support construction of an additional Program C Expansion Well. These include water system reliability, drought impacts, and recycled water distribution.

Water System Reliability

Each purveyor well has a maximum annual production potential, based on historical performance and pumping tests. Nine of the 14 active purveyor wells are simulated to be pumping at maximum capacity in the Basin Model under the sustainable yield scenario for 2017 conditions. Some of the wells may need rehabilitation and other water system improvements may be required to provide the maximum capacity assumed in sustainable yield scenarios. For example, the LOCSD South Bay site has two supply wells, but needs a dedicated water supply main to the District's main pressure zone to convey the full capacity that the two wells are capable of. Municipal supply wells will also eventually require replacement, and not all of the well sites may be suitable for drilling a new well, such as the LOCSD 3rd Street site.

Currently, the only active purveyor wells with excess pumping capacity under 2017 sustainable yield conditions are in the Western Area and western Central Area. Any production shifted to these westerly well locations, however, would cause a sustainable yield decline. A second Expansion Well would provide greater system redundancy and flexibility by allowing an easterly shift in the pumping distribution, should any of the existing wells lose full capacity.

Drought Impacts

The recent exceptional drought (2012-2016) demonstrated that seawater intrusion can occur with a basin yield metric below BYM 100. The Chloride Metric continued to increase overall between 2012 and 2016, despite the Basin Yield Metric dropping below 100 in 2013, and below 80 in 2016 (Figure 4). Similar to the water reliability benefit, a second Expansion Well would provide greater flexibility for adjusting the pumping distribution, should any of the wells become temporarily impacted by seawater intrusion during exceptional drought.

Recycled Water Distribution

Recycled water flow from the Los Osos Water Recycling Facility (LOWRF) is estimated to be 580 AFY under the updated existing population scenario, which is 200 AFY less than anticipated (LOBP Table 32; ISJ, 2015). As a result, there is currently insufficient recycled water for all the reuse projects identified in the Urban Water Reinvestment Program.

Evaluation of seawater intrusion mitigation during prior studies have ranked various recycled water uses in terms of seawater intrusion mitigation and associated benefit to basin sustainable yield (Carollo Engineers, 2007; CHG, 2014). The ranking, from highest level of mitigation to lowest, is summarized in Table 1.

Table 1
Seawater Intrusion Mitigation Ranking
Equivalent Freshwater Head (EFH) Basin Model[1]

Rank	Disposal/Reuse Alternative	Seawater Mitigation Factor[2]	Comments
1	Urban Reuse (Community Park, Schools)	0.55	With decrease in Western Area Lower Aquifer pumping
	Agricultural Reuse (exchange)	0.55	Program D with decrease in Western Area Lower Aquifer pumping
2	Broderson Site Disposal	0.22	No change in pumping distribution
3	Agricultural Reuse (in lieu)	0.1	Decrease irrigation well pumping
	Memorial Park Reuse (in lieu)	0.1	Decrease irrigation well pumping
	Discharge to Los Osos Creek[3]	0.1	No change in pumping distribution
4	Agricultural Reuse (new demand)	0	No change in pumping distribution
	Reuse/Disposal outside of basin	0	No change in pumping distribution

[1] The EFH Basin Model was upgraded to SEAWAT in 2009. Use of seawater mitigation factors and associated EFH methodology to estimate Basin Yield was replaced by chloride concentrations and SEAWAT dual-density methodology.
[2] Disposal/reuse volume multiplied by mitigation factor for an alternative estimates the decrease in seawater intrusion at the coast, based on the Equivalent Freshwater Head (EFH) Basin Model (Carollo, 2007).
[3] Recycled water discharge to Los Osos Creek was not part of 2007 disposal/reuse analyses and the mitigation ranking is estimated based on subsequent work (CHG, 2014).

Agricultural exchange involves offsetting agricultural pumping with recycled water, combined with an equal amount of pumping from infrastructure Program D wells (Los Osos Creek valley wells; not currently being considered). Agricultural reuse with in-lieu recharge is just offsetting agricultural pumping with recycled water use, without Program D wells. Agricultural reuse for new water demand (expanded acreage or higher intensity cropping) without exchange or in-lieu recharge assumes no change in irrigation well pumping.

Program C wells can improve the potential seawater intrusion mitigation benefit and purveyor yield from both agricultural reuse with in-lieu recharge and from recycled water discharges to Los Osos Creek. For example, with the 2017 infrastructure in place, shifting recycled water from Broderson leachfield disposal to agricultural reuse with in-lieu recharge results in an estimated loss in purveyor yield of approximately 30 percent of the amount shifted. With a new Program C well, the loss in purveyor yield is reduced to an estimated 10 percent of the amount shifted. A new Program C well increases the ability of purveyors to capture any future in-lieu recharge or recycled water discharge in the Los Osos Creek valley.

Pumping Distribution and Basin Yield under Program C

The Basin Model is a tool to assist with the understanding of basin dynamics, to predict the effects of pumping distributions on basin yield and to compare different pumping distributions for maximizing yield while mitigating seawater intrusion. General guidelines for optimizing the pumping distribution include the following:

- Maximize Upper Aquifer production (nitrate removal or blending may be required). Implementing infrastructure Program B meets this guideline.

- Shift Lower Aquifer production away from the coast. Implementing Program C meets this guideline.

The basin sustainable yield with three Program C wells completed was estimated at 3,000 AFY (ISJ, 2015). With Expansion Well No. 1 completed, the estimated sustainable yield for 2017 is 2,760 AFY (CHG, 2018). The Basin Model has been used to estimate the increased sustainable yield with a new program C well in each of the potential areas shown in Figure 2. Results are summarized below in Table 1.

Table 1 - Program C Sustainable Yield Estimates

Program C Description	Estimated Sustainable Yield	Increase over 2017
	Acre-Feet per Year	
2017 Infrastructure (Expansion Well No. 1)	2,760	0
Add Expansion Well No. 2 in North Area	2,850	90
Add Expansion Well No. 2 in Central Area	2,900	140
Add Expansion Well No. 2 in South Area	2,950	190
Maximum for Program C (add two wells)	3,000	240

As shown in Table 1, constructing Expansion Well No. 2 in the south area would potentially add the greatest amount of sustainable yield (190 AFY), followed by the Central area 4 (140 AFY), and the north area (90 AFY). A combination of two new Expansion Wells (south and central areas or south and north areas) would potentially add an estimated 240 AFY of sustainable yield.

Conclusions and Recommendations

The following conclusions were reached during the basin metric review and Program C evaluation:

- Expectations are generally being met when comparing Water Level Metric and Chloride Metric trends to the anticipated trends. Both metrics are trending in the direction of improvement, as anticipated. The Water Level Metric trend is projected to reach the targeted value later than anticipated, however, while the Chloride Metric is anticipated to reach the targeted value sooner than anticipated.

- Expectations are not being met when comparing the Nitrate Metric trend to the anticipated trend. The Nitrate Metric is not improving, but is deteriorating. More time is needed for observing the effects of decreased nitrate loading to the basin under current conditions with the Los Osos Wastewater Project completed.

- No additional Program C wells are needed under the updated existing population scenario to achieve a Basin Yield Metric below 80 and a distribution of pumping that maintains a stationary seawater intrusion front closer to the coast. There are other considerations, however, that would support adding one additional Program C well, including water system reliability, drought protection, and recycled water reuse.

- The potential increases in sustainable yield from the addition of a second Program C Expansion Well are estimated to be 90 AFY in the north area, 140 AFY in the central area, and 190 AFY in the south area. The addition of two new Program C wells could potentially add an estimated 240 AFY of sustainable yield.

The following adaptive management recommendations are based on the above conclusions:

- No adjustments to the LOBP are recommended in response to the metric trends review. Although the Nitrate Metric is not meeting expectations, nitrate removal systems are in place and there are provisions for additional nitrate removal for Upper Aquifer development under Program B. It is also too early to observe the effects of decreased nitrate loading to the basin under Los Osos Wastewater Project conditions.

- A reduction in infrastructure Program C from three Expansion Wells to two Expansion Wells is recommended to meet LOBP objectives for the updated existing population scenario. One of the Expansion Wells has been completed, so only one additional well would be needed, rather than two more per the current LOBP.

References

Carollo, 2007, Viable Project Alternatives Fine Screening Analysis Final, prepared for San Luis Obispo County Los Osos Wastewater Project development, August 2007. http://archive.slocounty.ca.gov/Assets/PW/LOWWP/document+library/Final+Fine+Screening+Report-Stamped.pdf

Cleath-Harris Geologists, 2014, Recycled Water Discharges to Los Osos Creek, Draft Technical Memorandum prepared for the Los Osos ISJ Group, March 18, 2014. https://www.losososcsd.org/files/1d22a4813/Item+3+DRAFT+Technical+Memo+-+Recycled+Water+Discharges+to+Los+Osos+Creek.pdf

Cleath-Harris Geologists, 2017, Basin Yield Metric Response to reduced long-term precipitation in the Los Osos Groundwater Basin, Technical Memorandum prepared for the Los Osos Groundwater Basin Management Committee and Morro Bay National Estuary program, March 3, 2017. http://www.slocountywater.org/site/Water%20Resources/LosOsos/pdf/TM%20Basin%20Yield%20Metric%20Los%20Osos%20GW%20Basin%2020170303.pdf

Cleath-Harris Geologists, 2018, Los Osos Basin Plan, Groundwater Monitoring Program 2016 Annual Monitoring Report, prepared for the Los Osos Groundwater Basin Management Committee, June 2018. http://www.slocountywater.org/site/Water%20Resources/LosOsos/pdf/2017%20Annual%20Report%20Final.pdf

ISJ Group, 2015, Updated Basin Plan for the Los Osos Groundwater Basin, January 2015. http://www.slocountywater.org/site/Water%20Resources/LosOsos/pdf/Los%20Osos%20Groundwater%20Basin%20Plan%20January%202016.pdf

ATTACHMENTS

ATTACHMENT A:

Basin Metric Trends

Source:
2017 Annual Groundwater Monitoring Report

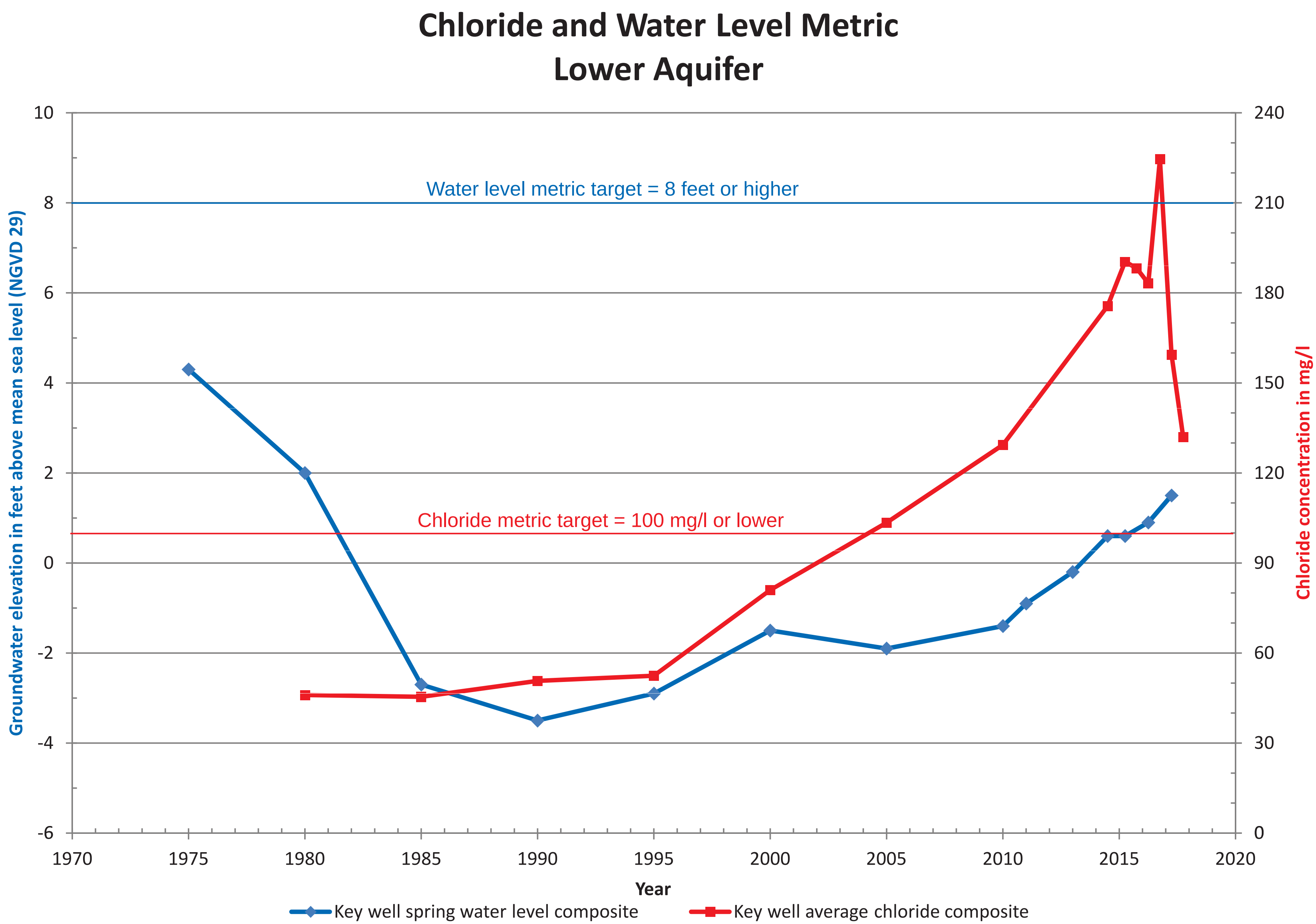

Figure 21
Chloride and Water Level Metric
Los Osos Groundwater Basin
2017 Annual Report

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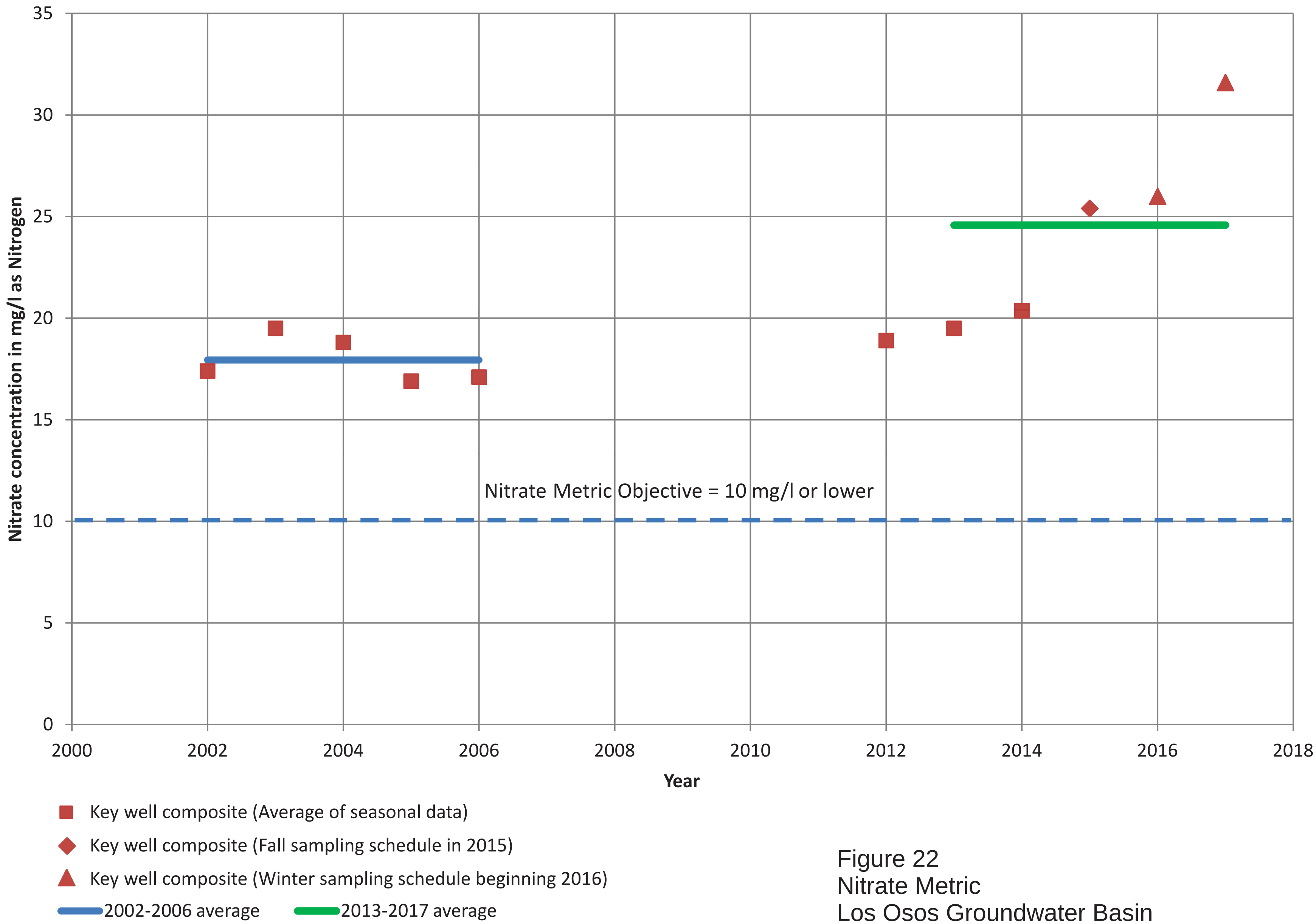
Reference: 2017 Annual Groundwater Monitoring Report (CHG, 2018)

Nitrate Metric
First Water



NOTE: Nitrate metric plots for 2013 and 2014 corrected to apply January 2014 data set to Winter 2013 season.

Figure 22
Nitrate Metric
Los Osos Groundwater Basin
2017 Annual Report

Cleath-Harris Geologists

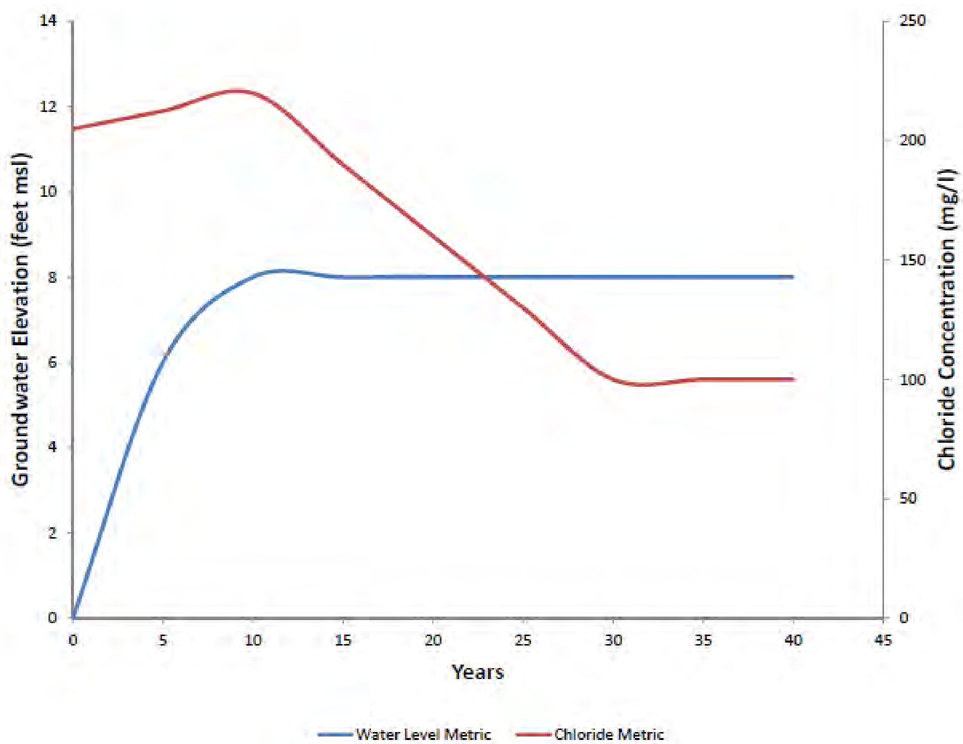
Reference: 2017 Annual Groundwater Monitoring Report (CHG, 2018)

ATTACHMENT B

Anticipated Metric Trends
Predicted Seawater Intrusion for Basin Metric Targets
Table 43

Source:
2015 Los Osos Groundwater Basin Plan Update

Figure 37. Water Level and Chloride Metric Target Trendlines



Based on the actions recommended in this Basin Plan, the Model predicts that the freshwater-seawater interface will be pushed seaward from its current location to that shown in Figure 38. As seen on that map, a Basin Yield Metric of 100 would maintain seawater intrusion (250 mg/l) at an equilibrium line underneath the landed portion of the Basin. This Basin Plan does not recommend allowing seawater intrusion to remain in the Basin to that extent, but rather to reverse the present location of seawater in the Basin (see Figure 26) to a position further seaward. In order to attain seawater intrusion at the seaward position, the Parties would need to achieve a Basin Yield Metric of 80 or below. Maintaining a buffer of 20 percent would shift seawater intrusion to a more favorable location than simply achieving a Basin Yield Metric of 100.

6.4 The Challenge of Uncertainty

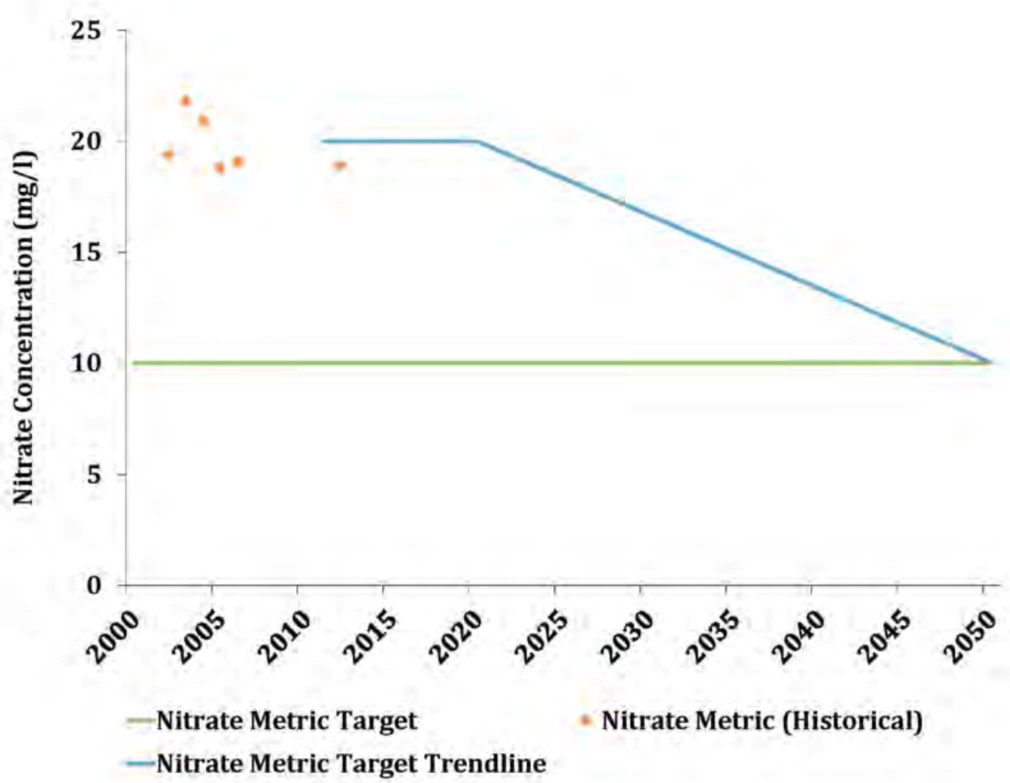
The prior sections of this chapter have addressed the two greatest threats to the Basin, namely, nitrate impacts to the Upper Aquifer and seawater intrusion into the Lower Aquifer. Those sections establish metrics for evaluating the twin threats and actions that will be taken to defend against them. In addition to past and present threats, however, there are also potential future threats. Future threats are particularly challenging to address because of their inherent uncertainty. Because these threats share that common condition, they are analyzed together as the single threat of uncertainty. Several sources of uncertainty are discussed below.

reducing the overall quantity of nitrate in the Basin. Nitrate removal facilities are components of the Basin Infrastructure Program set forth in Chapter 10.

Lastly, through the Basin Management Committee, the Parties will implement the Wellhead Protection Program set forth in Chapter 13. That program will ensure proper construction of new wells and abandonment of existing wells to prevent further impacts to either the Upper Aquifer or Lower Aquifer.

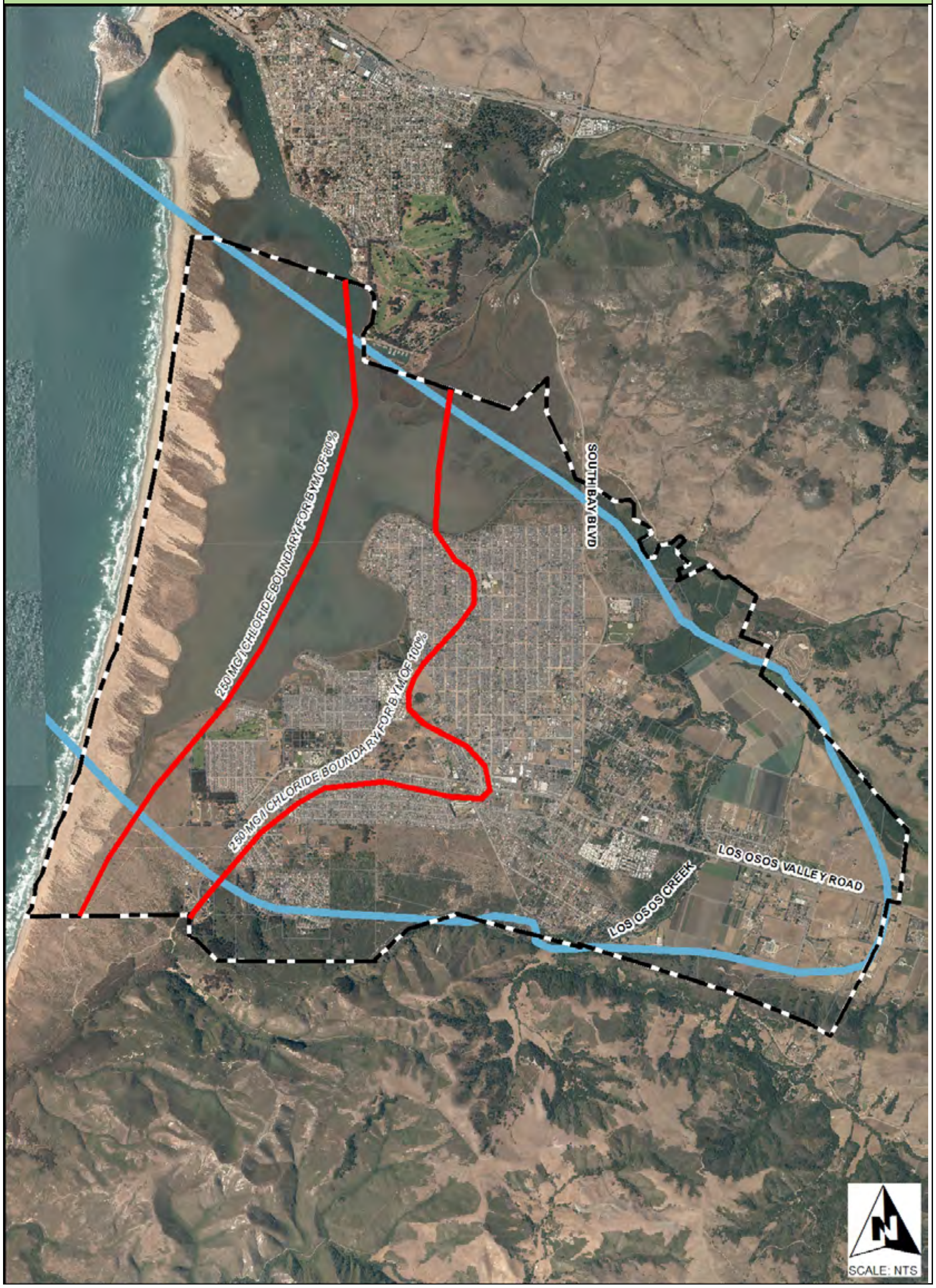
It is likely to take approximately 30 years for the Upper Aquifer to equilibrate to a change in nitrate loading, although the Nitrate Metric Target can potentially be achieved within a shorter time frame.[54] In the intervening years, nitrate removal or blending with other sources with lower nitrate levels will be required for extensive use of the Upper Aquifer as a source of drinking water. Figure 31 depicts a Nitrate Metric Target Trendline that will be used to measure progress toward the ultimate Nitrate Metric Target of 10 mg/l. The Parties will periodically evaluate the progress of the Nitrate Metric in relation to the trendline in Figure 31 in order to determine whether actions taken in the Basin are having the desired impacts on nitrate levels.

Figure 31. Nitrate Metric Target Trendline



[54] *See* Yates & Williams, *Simulated Effects of a Proposed Sewer Project on Nitrate Concentrations in the Los Osos Valley Groundwater Basin* (2003).

Figure 38. Predicted Seawater Intrusion for Basin Metric Targets



Reference: 2015 Los Osos Groundwater Basin Plan Update (ISJ, 2015) agricultural demands, this combination would result in less than full utilization of the Eastern Area. As noted above, the Agricultural Water Reinvestment Program would only be implemented if additional urban development were allowed by the County and Coastal Commission in Los Osos.

- **Urban Water Reinvestment Program with Basin Infrastructure Programs A, B, C and D and Supplemental Water (U+ABCD+S).** This combination would add desalinated groundwater from the Supplemental Water Program to Combination U+ABCD. The primary impact from adding desalinated groundwater would be demand-side, but there would be limited supply-side impacts as well. Since Supplemental Water is not recommended for implementation in this Basin Plan, its impact on the Basin was not specifically calculated using the Model.

Each of the combinations set forth above were analyzed to determine the resulting Sustainable Yield$_X$ of the Basin, as calculated by the Model. Table 43 lists the results of that analysis, including the Sustainable Yield$_X$ and Basin Development Metric of each combination. In addition, Figure 70 depicts the Sustainable Yield$_X$ attained by each combination in comparison to the Sustainable Yield$_P$ of 3,500 AFY. As more program components are implemented with each combination, the Sustainable Yield$_X$ generally increases, and the Basin Development Metric approaches 100 percent.

Table 43. Summary of Water Supply Program Combinations

Program Combination	Sustainable Yield$_X$	Basin Development Metric
N	2,450 AFY	70%
U	2,540 AFY	73%
A	2,570 AFY	73%
U+A	2,650 AFY	76%
U+AB	3,170 AFY	91%
U+AC	3,000 AFY	86%
U+ABC	3,350 AFY	96%
UG+ABC	3,350 AFY	96%
U+ABC+S	>3,350 AFY	>96%
U+ABCD	3,500 AFY	100%
UG+ABCD	3,500 AFY	100%
U+ABCD+S	>3,500 AFY	>100%