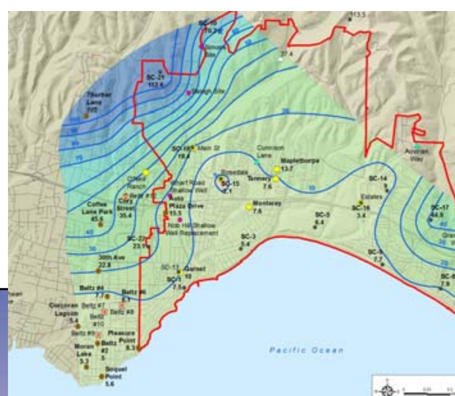
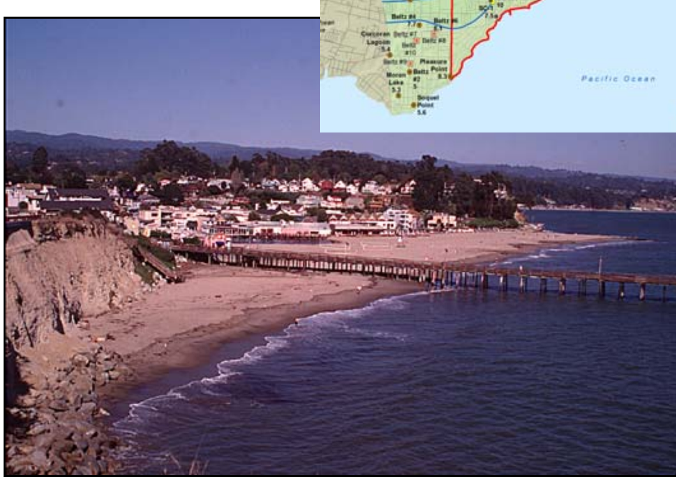
Soquel-Aptos Area Groundwater Management Annual Review and Report Water Year 2014

Prepared for:
Soquel-Aptos Groundwater Management Committee

May 2015





Prepared by:
HydroMetrics WRI

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ABBREVIATIONS

AF .... acre-feet
ARR ....Annual Review and Report
ASR.................................aquifer storage and recovery
BAG ....Groundwater Management Plan Basin Advisory Group
BIG.................................Basin Implementation Group
BMO ....basin management objective
CASGEM ....California Statewide Groundwater Elevation Monitoring
CDS ....Coastal Distribution System
CWD...............................Central Water District
DWSAP...........................Drinking Water Source Assessment and Protection
EIR ....environmental impact report
FTP ....file transfer protocol
GAMA ....Groundwater Ambient Monitoring and Assessment Program
GMP ....Groundwater Management Plan
GSA ....Groundwater Sustainability Agency
gpd ....gallons per day
IRWMP ....Integrated Regional Water Management Plan
JPA..................................Joint Exercise of Powers Agreement
LAFCO...........................Local Agency Formation Commission
MCL ....maximum contaminant level
mg/L ....milligrams per Liter
msl ....mean sea level (this report considers equivalent to NGVD29)
NGVD29 ....National Geodetic Vertical Datum of 1929
OEHHA ....California Office of Environmental Health Hazard Assessment
PDF.................................portable document format
PHG................................public health goal
PRMS..............................Precipitation-Runoff Modeling System
PVWMA ....Pajaro Valley Water Management Agency
RCD ....Resource Conservation District of Santa Cruz County
RPE ....reference point elevation
RWQCB ....Central Coast Regional Water Quality Control Board
SAGMA ....Soquel Aptos Groundwater Management Alliance
S-AGMC ....Soquel Aptos Groundwater Management Committee
SGMA ....Sustainable Groundwater Management Act

SCWD2 ....Santa Cruz Water Department/Soquel Creek Water District desalination project
SqCWD ....Soquel Creek Water District
SRP ....satellite reclamation plant
TMDL..............................total maximum daily load
TDS..................................total dissolved solids

EXECUTIVE SUMMARY – WATER YEAR 2014

INTRODUCTION

This Annual Review and Report (ARR) is part of the implementation of the Groundwater Management Plan (GMP) for the Soquel-Aptos basin approved by Soquel Creek Water District (SqCWD) and Central Water District (CWD) in 2007 (SqCWD and CWD, 2007). The ARR summarizes groundwater conditions in the Soquel-Aptos basin, documents the status of groundwater management activities, and recommends any amendments to the GMP. The report will serve as a living document that has been updated annually starting with the Water Year 2009 report. This report is presented to the Soquel Aptos Groundwater Management Committee, formerly called the Basin Implementation Group, which includes the City of Santa Cruz, Santa Cruz County, and a private well representative along with SqCWD and CWD.

GROUNDWATER CONDITIONS

Long-term overdraft of the basin has led to ongoing risk of seawater intrusion and pumping must be reduced to recover the basin. In Water Year 2014, coastal groundwater levels in seven out of thirteen SqCWD and City of Santa Cruz monitoring wells screened in productive units remained below elevations that protect the aquifers from seawater intrusion (Figure ES- *1*). Recovery of the basin and overdraft will be eliminated when coastal groundwater levels rise to protective elevations at all coastal wells.

In Water Year 2014, rainfall in the Soquel-Aptos basin was below average for the third straight year. SqCWD and the City of Santa Cruz declared a Stage 3 water shortage emergency with a drought curtailment target of 25% and CWD declared a Stage 2 water shortage alert with a drought curtailment target of 20%. In Water Year 2014, municipal production was the lowest total since 1980.

Recent estimates for SqCWD's share of long-term pumping yield (HydroMetrics WRI, 2012) are a combined 550 acre-feet below pumping goals stated in the GMP. Municipal production in Water Years 2009-2014 has been below the combined long-term pumping yield of 3,465 acre-feet per year by SqCWD and the City of Santa Cruz in the Purisima area. Municipal production has been below the combined long-term pumping yield of 2,060 acre-feet per year by SqCWD and CWD in the Aromas area three of the last five years. However, pumping at long term pumping yields will not protect the basin from seawater intrusion until after groundwater levels recover to protective elevations. Hence, the long term pumping yields are referred to as post recovery pumping yields. In Water Year 2014, SqCWD pumping dropped below the revised pumping goal of 2,400 acre-feet per year to achieve recovery in the Purisima area within 20 years. SqCWD pumping remained above the revised pumping goal of 850 acre-feet per year to achieve recovery in the Aromas area.

Figure ES- 2 shows groundwater level trends for the productive aquifer units across the basin over the last five years. Groundwater level trends in the western Purisima area (primarily the A/AA Units) have shown slight declines over the last five years. Groundwater level trends in the central Purisima areas (BC and DEF units) have been increasing over the last five years, but some of these wells showed declines from Water Year 2013 into Water Year 2014. Some of the coastal wells in the Purisima showed slight but atypical recovery in summer and fall of 2014 when pumping was reduced from previous years. The groundwater level trend in coastal wells in the Aromas area has generally been stable or increasing over the last five years while wells further inland in the Aromas area have shown declines over the last five years (Figure ES- 2).

There is ongoing risk of seawater intrusion into the productive units of the Soquel-Aptos basin due to coastal groundwater levels being below protective elevations. Observed Total Dissolved Solids (TDS) and chloride concentrations are used to assess seawater intrusion. The occurrence of seawater intrusion varies by area in the Soquel-Aptos basin:

- TDS and chloride concentrations do not suggest seawater intrusion at SqCWD's production wells or monitoring wells in the western Purisima area (A, AA, and Tu-units).
- TDS and chloride concentrations in one of the City of Santa Cruz's monitoring wells suggest seawater intrusion in the westernmost Purisima area (A-unit).
- TDS and chloride concentrations do not suggest seawater intrusion at SqCWD's production wells or monitoring wells in the central Purisima area (BC and DEF-units).
- TDS and chloride concentrations continue to be elevated in deep monitoring wells installed below the freshwater-saltwater interface in the Aromas area (Purisima F-unit and Aromas Red Sands).

- There is a long-term increasing trend in TDS and chloride concentrations at one well installed above the freshwater-saltwater interface in the Aromas area.

Naturally occurring constituents such as iron and manganese in the Purisima Formation and chromium VI in the Aromas Red Sands continue to have high concentrations in groundwater. The new drinking water standard for chromium VI came into effect in 2014 and concentrations at several SqCWD and CWD Wells exceeded the standard. High nitrate concentrations were detected at the Sells well which caused its removal from service in Water Year 2009. All delivered water met drinking water standards for constituents found in groundwater.

STATUS OF GROUNDWATER MANAGEMENT

The status of basin management objectives (BMO) is updated through Water Year 2013. The main basin management objectives of concern are BMO 1-1 to pump within the sustainable yield and BMO 2-2 to maintain groundwater levels to prevent seawater intrusion. Overall municipal production exceeds the combined long-term pumping yield, even though annual municipal production amounts for Water Years 2010 through 2014 were the lowest since 1985. Coastal groundwater levels remain below protective elevations at over half the coastal wells. Therefore, achieving BMOs 1-1 and 2-2 may require fulfilling BMO 1-2 to develop alternative water supplies for achieving a long-term balance between recharge and withdrawals in meeting current and future demand. However, plans for a regional desalination plant that would fulfill BMO 1-2 was put on hold in 2013 and other alternatives are currently being evaluated.

Basin management elements are specific projects, programs, and policies for meeting basin management objectives. The status of elements is also updated in this report.

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EXECUTIVE SUMMARY – WATER YEAR 2013

INTRODUCTION

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GROUNDWATER CONDITIONS

Long-term overdraft of the basin has led to ongoing risk of seawater intrusion and pumping must be reduced to recover the basin. In Water Year 2013, coastal groundwater levels in seven out of thirteen SqCWD and City of Santa Cruz monitoring wells screened in productive units remained below elevations that protect the aquifers from seawater intrusion (Figure ES- *1*). Recovery of the basin and overdraft will be eliminated when coastal groundwater levels rise to protective elevations at all coastal wells.

In Water Year 2013, rainfall in the Soquel-Aptos basin was below average for the second straight year. Although SqCWD declared a Stage 2 water shortage alert with a drought curtailment target of 15%, municipal production was higher than the previous three years with no or lower drought curtailment targets possibly due to improving economic conditions that reduced vacancies. Municipal production in the Soquel-Aptos basin was still lower for Water Year 2013 than all water years from 1985-2009.

Recent estimates for SqCWD's share of long-term pumping yield (HydroMetrics WRI, 2012) are a combined 800 acre-feet below pumping goals stated in the GMP. Municipal production in Water Years 2009-2013 has been below the combined long-term pumping yield of 3,375 acre-feet per year by SqCWD and the City of Santa Cruz in the Purisima area. Municipal production remains above the combined long-term pumping yield of 1,822 acre-feet per year by SqCWD and CWD in the Aromas area. However, pumping at long term pumping yields will not protect the basin from seawater intrusion until after groundwater levels recover to protective elevations. Hence, the long term pumping yields are referred to as post recovery pumping yields. SqCWD pumping remains above the revised pumping goals proposed for the GMP of 2,300 acre-feet per year in the Purisima area and 600 acre-feet per in the Aromas area to recover the basin within 20 years

In general, the groundwater level trends in these coastal wells in the western and central Purisima areas have been increasing over the last five years, but some wells showed declines in Water Year 2013. The groundwater level trend in coastal wells in the Aromas area has generally been stable over the last five years with some wells showing an increase over the last two years (Figure ES- 2).

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GROUNDWATER CONDITIONS

In Water Year 2012, rainfall in the Soquel-Aptos basin was below average. Although SqCWD declared a Stage 1 water shortage alert with a drought curtailment target of 5%, municipal production was higher than the previous two years with no drought curtailment. Water Years 2010 through 2012 had the three lowest years of production in the Soquel-Aptos basin since 1978 likely due to three factors:

1. Economic conditions that resulted in both residential and commercial vacancies or reduced use; and
2. Within SqCWD, completed water demand offsets for which the corresponding development had not yet been completed.
3. Heightened public awareness about the importance of sustained water conservation.

Recently estimated post-recovery pumping yields for SqCWD (HydroMetrics WRI, 2012) are a combined 800 acre-feet below pumping goals stated in the GMP. Municipal production in Water Years 2009-2012 has been below the combined post-recovery pumping yield of 3,375 acre-feet per year by SqCWD and the City of Santa Cruz in the Purisima area. Municipal production remains above the combined post-recovery pumping yield of 1,822 acre-feet per year by SqCWD and CWD in the Aromas area. However, pumping at post-recovery yields will not protect the basin from seawater intrusion until after groundwater levels recover to protective elevations.

Coastal groundwater levels in nine out of thirteen SqCWD and City of Santa Cruz monitoring wells screened in productive units remained below elevations that protect the aquifers from seawater intrusion (Figure ES- *1*). The basin remains in overdraft and future pumping must be below the post-recovery pumping yield to recover coastal groundwater levels to protective elevations. The combined accumulated pumping deficit for the approximately thirty year period when SqCWD production was above post-recovery pumping yields was calculated as 21,800 acre-feet. Based on SqCWD's current planning goal to pump 2,900 acre-feet per year in order to recover the basin, the estimated time to eliminate the accumulated pumping deficit and recover the basin is 20 years.

In general, the groundwater level trend in these coastal wells in the western and central Purisima areas has been increasing over the last four to five years. The groundwater level trend in coastal wells in the Aromas area has generally been stable over the last four years after showing declines over the previous several years (Figure ES- 2).

Wells that may provide an indication of basin storage include wells located in upgradient areas of the basin or screened in overlying aquifers. Many of these wells showed a declining groundwater level trend over the last five years or greater, but the trend has been stable over the last two to three years.

There is ongoing risk of seawater intrusion into the productive units of the Soquel-Aptos basin due to coastal groundwater levels being below protective elevations. Observed Total Dissolved Solids (TDS) and chloride concentrations are used to assess seawater intrusion. The occurrence of seawater intrusion varies by area in the Soquel-Aptos basin:

- TDS and chloride concentrations do not suggest seawater intrusion at SqCWD's production wells or monitoring wells in the western Purisima area (A, AA, and Tu-units).
- TDS and chloride concentrations in two of the City of Santa Cruz's monitoring wells suggest seawater intrusion in the westernmost Purisima area (A-unit).
- TDS and chloride concentrations do not suggest seawater intrusion at SqCWD's production wells or monitoring wells in the central Purisima area (BC and DEF-units).
- TDS and chloride concentrations continue to be elevated in deep monitoring wells installed below the freshwater-saltwater interface in the Aromas area (Purisima F-unit and Aromas Red Sands).

- There is a long-term increasing trend in TDS and chloride concentrations at wells installed above the freshwater-saltwater interface in the Aromas area.

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STATUS OF GROUNDWATER MANAGEMENT

The status of basin management objectives (BMO) is updated through Water Year 2012. The main basin management objective of concern is BMO 1-1, which addresses pumping within the sustainable yield. Overall municipal production exceeds the combined post-recovery pumping yield, even though annual municipal production for Water Years 2010 through 2012 were the lowest since 1989. Therefore, achieving BMO 1-1 may require fulfilling BMO 1-2 to develop alternative water supplies to achieve a long-term balance between recharge and withdrawals to meet current and future demand.

Achieving BMO 1-1 also affects the ability to achieve other basin management objectives, such as:

- BMO 1-3, Manage groundwater storage for future beneficial uses and drought reserve.
- BMO 2-2, Maintain groundwater levels to prevent seawater intrusion.

Basin management elements are specific projects, programs, and policies for meeting basin management objectives. The status of elements is also updated in this report.

GROUNDWATER MANAGEMENT PLAN REVIEW

Recommendations for updating the descriptions of groundwater conditions and basin management objectives in the GMP are included in this year's ARR.

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EXECUTIVE SUMMARY – WATER YEAR 2011

INTRODUCTION

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GROUNDWATER CONDITIONS

In Water Year 2011, precipitation in the Soquel-Aptos basin was above average for the second straight year. Although SqCWD did not declare a Precautionary Drought Curtailment as it did in Water Year 2009, municipal production in the Soquel-Aptos basin for Water Years 2010 and 2011 were the two lowest years of production since Water Year 1984 likely due to four factors:

1. Economic conditions that resulted in both residential and commercial vacancies or reduced use; and
2. Within SqCWD, completed water demand offsets for which the corresponding development had not yet been completed.
3. Higher precipitation and a cooler summer reduced demand for outdoor irrigation.
4. Heightened public awareness about the importance of sustained water conservation.

Recently estimated post-recovery pumping yields for SqCWD (HydroMetrics WRI, 2012) are a combined 800 acre-feet below pumping goals stated in the GMP. Municipal production in Water Years 2009-2011 has been below the combined post-recovery pumping yield of 3,375 acre-feet per year by SqCWD and the City of Santa Cruz in the Purisima area. Municipal production remains above the combined post-recovery pumping yield of 1,822 acre-feet per year by SqCWD and CWD in the Aromas area. However, pumping at post-recovery yields do not protect the basin from seawater intrusion until after groundwater levels recover to protective elevations.

Coastal groundwater levels in nine out of thirteen SqCWD and City of Santa Cruz monitoring wells screened in productive units remained below elevations that protect the aquifers from seawater intrusion (Figure ES- *1*). The basin remains in overdraft and future pumping must be below the post-recovery pumping yield to recover coastal groundwater levels to protective elevations. The combined accumulated pumping deficit for the approximately thirty year period when SqCWD production was above post-recovery pumping yields was calculated as 21,600 acre-feet. Based on SqCWD's current planning goal to pump 2,900 acre-feet per year in order to recover the basin, the estimated time to eliminate the accumulated pumping deficit and recover the basin is 20 years.

In general, the groundwater level trend in these coastal wells in the western and central Purisima areas has been increasing over the last three to four years. The groundwater level trend in coastal wells in the Aromas area has generally been stable over the last three years after showing declines over the previous several years (Figure ES- 2).

Wells that may provide an indication of basin storage include wells located in upgradient areas of the basin or screened in overlying aquifers. Many of these wells showed a declining groundwater level trend over the last five years or greater, but the trend has been stable over the last two to three years.

There is ongoing risk of seawater intrusion into the productive units of the Soquel-Aptos basin due to coastal groundwater levels being below protective elevations. Observed Total Dissolved Solids (TDS) and chloride concentrations are used to assess seawater intrusion. The occurrence of seawater intrusion varies by area in the Soquel-Aptos basin:

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- TDS and chloride concentrations continue to be elevated in deep monitoring wells installed below the freshwater-saltwater interface in the Aromas area (Purisima F-unit and Aromas Red Sands).

- There is a long-term increasing trend in TDS and chloride concentrations at wells installed above the freshwater-saltwater interface in the Aromas area.

Naturally occurring constituents such as iron and manganese in the Purisima Formation and chromium VI in the Aromas Red Sands continue to have high concentrations in groundwater. High nitrate concentrations were detected at the Sells well which caused its removal from service in Water Year 2009. All delivered water met drinking water standards for constituents found in groundwater.

STATUS OF GROUNDWATER MANAGEMENT

The status of basin management objectives (BMO) is updated through Water Year 2011. The main basin management objective of concern is BMO 1-1, which addresses pumping within the sustainable yield. Overall municipal production exceeds the combined post-recovery pumping yield, even though annual municipal production for Water Years 2010 and 2011 were the lowest for records starting in Water Year 1984. Therefore, achieving BMO 1-1 may require fulfilling BMO 1-2 to develop alternative water supplies to achieve a long-term balance between recharge and withdrawals to meet current and future demand.

Achieving BMO 1-1 also affects the ability to achieve other basin management objectives, such as:

- BMO 1-3, Manage groundwater storage for future beneficial uses and drought reserve.
- BMO 2-2, Maintain groundwater levels to prevent seawater intrusion.

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GROUNDWATER CONDITIONS

Precipitation in the Soquel-Aptos basin was above average in Water Year 2010. Although SqCWD did not declare a Precautionary Drought Curtailment as it did in Water Year 2009, municipal production in the Soquel-Aptos basin decreased for the second straight year. Annual municipal production (SqCWD, CWD, and the City of Santa Cruz) was the lowest since Water Year 1984 likely due to four factors:

1. Economic conditions that resulted in both residential and commercial vacancies or reduced use; and
2. Within SqCWD, completed water demand offsets for which the corresponding development had not yet been completed.
3. Higher precipitation and a cooler summer reduced demand for outdoor irrigation.

Heightened public awareness about the importance of sustained water conservation.

Starting in Water Year 2005, municipal production in the Soquel-Aptos basin has not significantly exceeded pumping goals stated in the GMP. However, a re-evaluation of sustainable yield estimates suggested that reasonable estimates of the sustainable yield in the Purisima Formation and Aromas Red Sands could be at least hundreds of acre-feet lower than the pumping goals stated in the GMP (HydroMetrics LLC, 2009c).

Coastal groundwater levels in SqCWD monitoring wells screened in productive units remained below elevations that protect the aquifers from seawater intrusion. The basin remains in overdraft and future pumping must be below the sustainable yield to recover coastal groundwater levels to protective elevations. In general, the groundwater level trend in these coastal wells in the western and central Purisima areas has been increasing over the last 2-3 years. The groundwater level trend in coastal wells in the Aromas area has generally been stable over the last two years after showing declines over the previous several years.

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STATUS OF GROUNDWATER MANAGEMENT

The status of basin management objectives (BMO) is updated through Water Year 2010. The main basin management objective of concern is BMO 1-1, which concerns pumping within the sustainable yield. Re-evaluation of the sustainable yield suggests that SqCWD pumping continues to exceed the sustainable yield, even though annual municipal production was the lowest for records starting in Water Year 1984. Therefore, achieving BMO 1-1 may require fulfilling BMO 1-2 to develop alternative water supplies to achieve a long-term balance between recharge and withdrawals to meet current and future demand.

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GROUNDWATER CONDITIONS

Both precipitation and production in the Soquel-Aptos basin were lower than average due to continuing drought conditions in Water Year 2009. Water Year 2009 was the third consecutive year with below average rainfall, leading SqCWD to declare a Precautionary Drought Curtailment for water use from May-October 2009. Annual municipal production (SqCWD, CWD, and the City of Santa Cruz) was the lowest since Water Year 1986 due to three factors in the SqCWD service area:

1. the voluntary drought curtailment;
2. economic conditions that resulted in both residential and commercial vacancies or reduced use; and
3. completed water demand offsets for which the corresponding development had not yet been completed.

Starting in Water Year 2005, municipal production in the Soquel-Aptos basin has not significantly exceeded pumping goals stated in the GMP. However, a re-evaluation of sustainable yield estimates suggested that reasonable estimates of the sustainable yield in the Purisima Formation and Aromas Red Sands should be at least hundreds of acre-feet lower than the pumping goals stated in the GMP (HydroMetrics LLC, 2009c).

Coastal groundwater levels in SqCWD monitoring wells screened in productive units remained below elevations that protect the aquifers from seawater intrusion. In general, the groundwater level trend in these coastal wells in the western and central Purisima areas has been stable over the last several years. The groundwater level trend in coastal wells in the Aromas area has generally been declining over the last several years.

Wells that may provide an indication of basin storage include wells located in upgradient areas of the basin or screened in overlying aquifers. Many of these wells show a declining groundwater level trend.

There is ongoing risk of seawater intrusion into the productive units of the Soquel-Aptos basin due to coastal groundwater levels being below protective elevations. Observed Total Dissolved Solids (TDS) and chloride concentrations are used to assess seawater intrusion. The occurrence of seawater intrusion varies by area in the Soquel-Aptos basin:

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STATUS OF GROUNDWATER MANAGEMENT

The status of basin management objectives (BMO) is updated through Water Year 2009. The main basin management objective of concern is BMO 1-1, which concerns pumping within the sustainable yield. Re-evaluation of the sustainable yield suggests that SqCWD pumping continues to exceed the sustainable yield, even though annual municipal production was the lowest since Water Year 1986. Therefore, achieving BMO 1-1 may require fulfilling BMO 1-2 to develop alternative water supplies to achieve a long-term balance between recharge and withdrawals to meet current and future demand.

Achieving BMO 1-1 also affects the ability to achieve other basin management objectives, such as:

- BMO 1-3, Manage groundwater storage for future beneficial uses and drought reserve
- BMO 2-2, Maintain groundwater levels to prevent seawater intrusion.

Basin management elements are specific projects, programs, and policies for meeting basin management objectives. The status of elements is also updated in this report.

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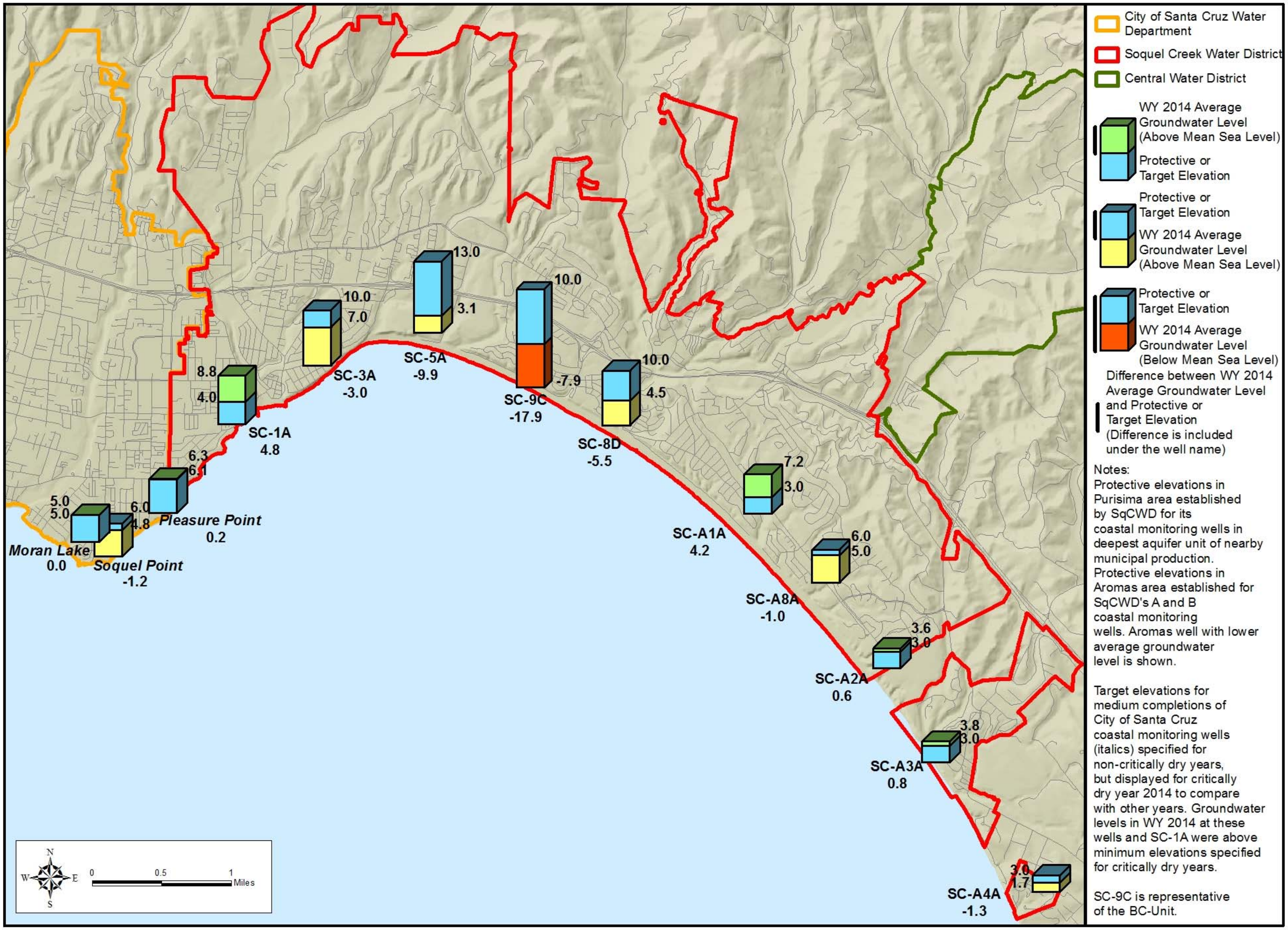

Figure ES- 1 (2014): Average Water Year 2014 Groundwater Levels at Coastal Monitoring Wells Relative to Protective Elevations

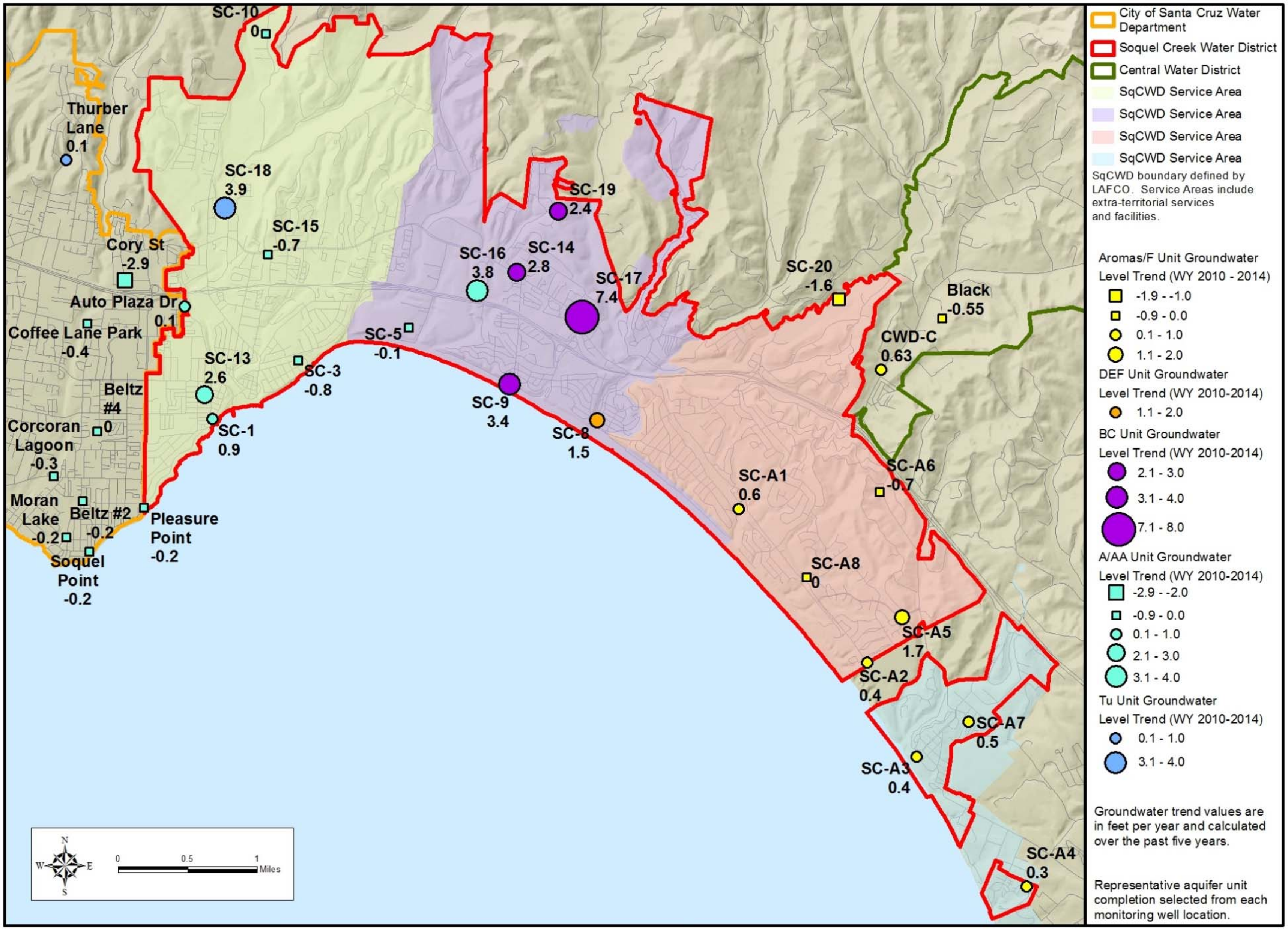

Figure ES- 2 (2014): Groundwater Level Trends Water Years 2010-2014 at Representative Monitoring Wells

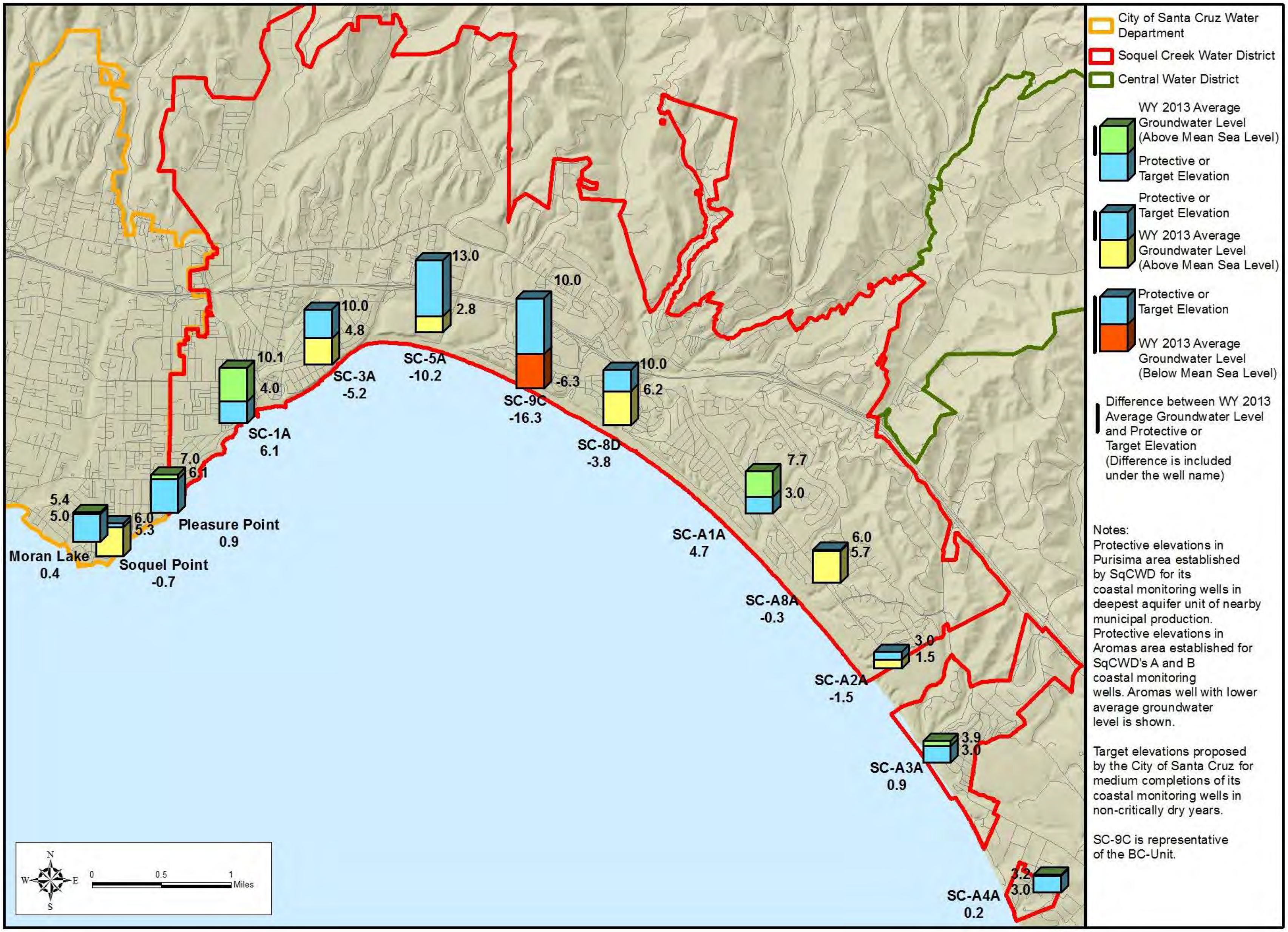

Figure ES- 1 (2013): Average Water Year 2013 Groundwater Levels at Coastal Monitoring Wells Relative to Protective Elevations

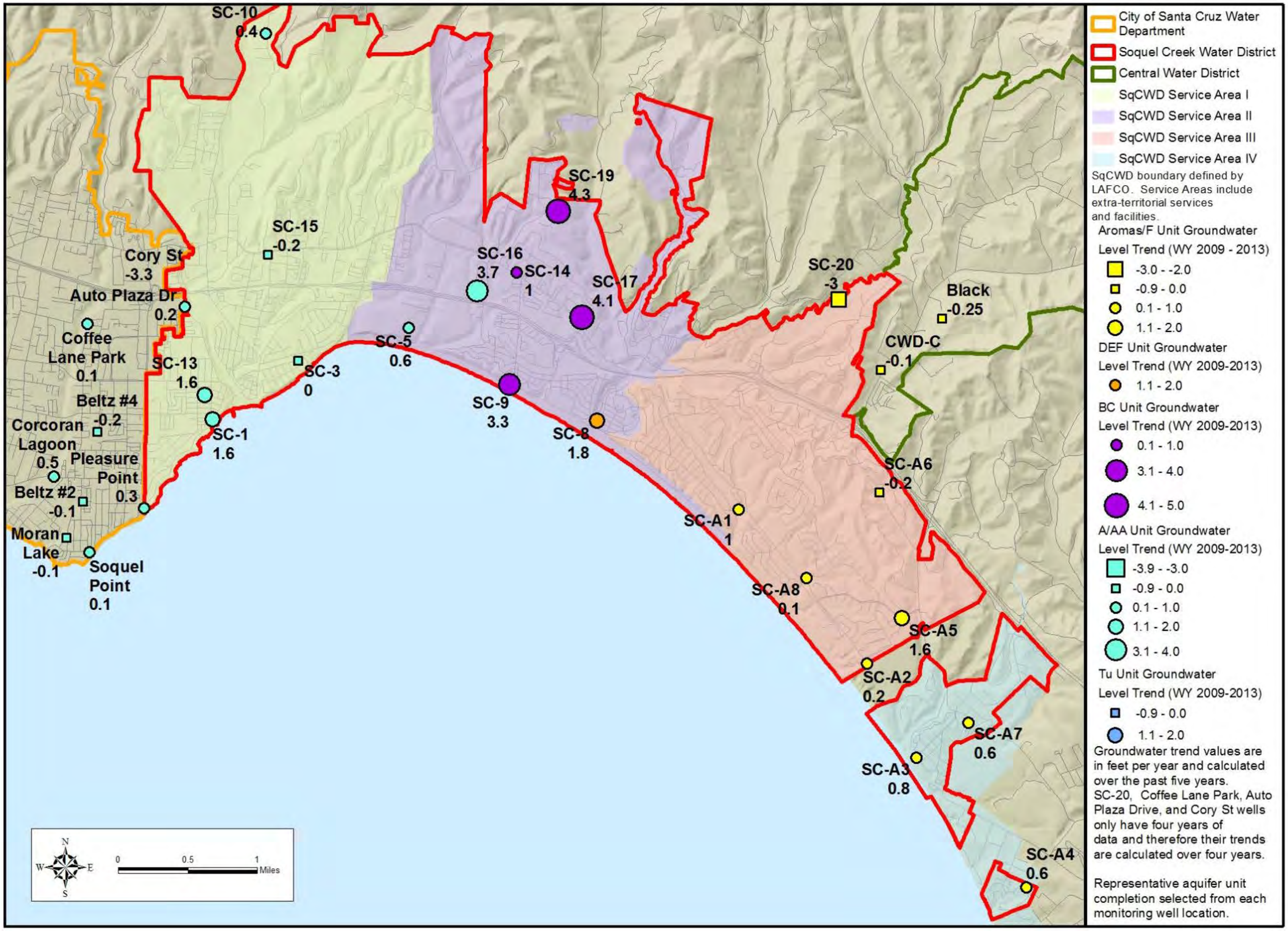

Figure ES- 2 (2013): Groundwater Level Trends Water Years 2009-2013 at Representative Monitoring Wells

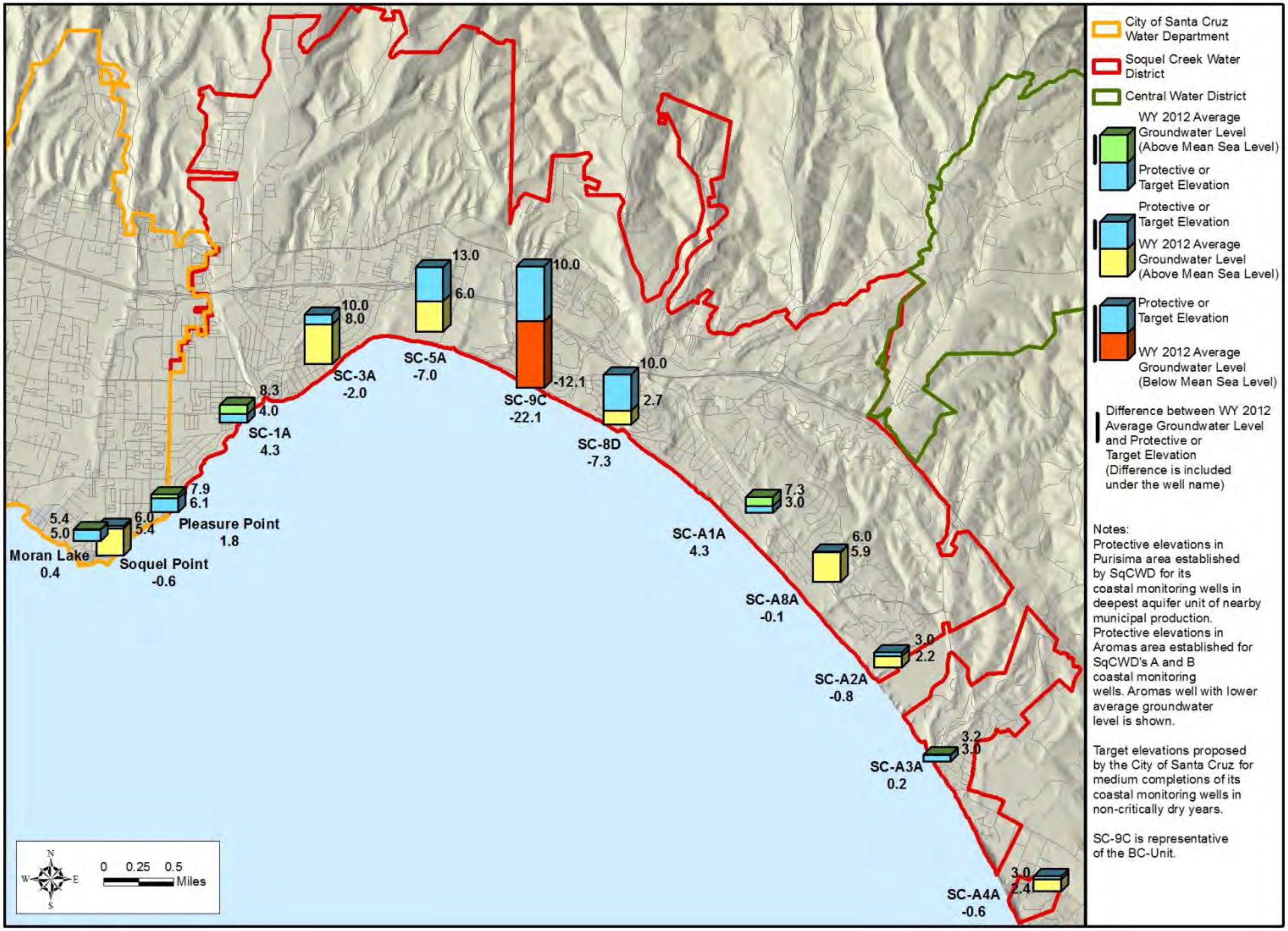

Figure ES- 1 (2012): Average Water Year 2012 Groundwater Levels at Coastal Monitoring Wells Relative to Protective Elevations

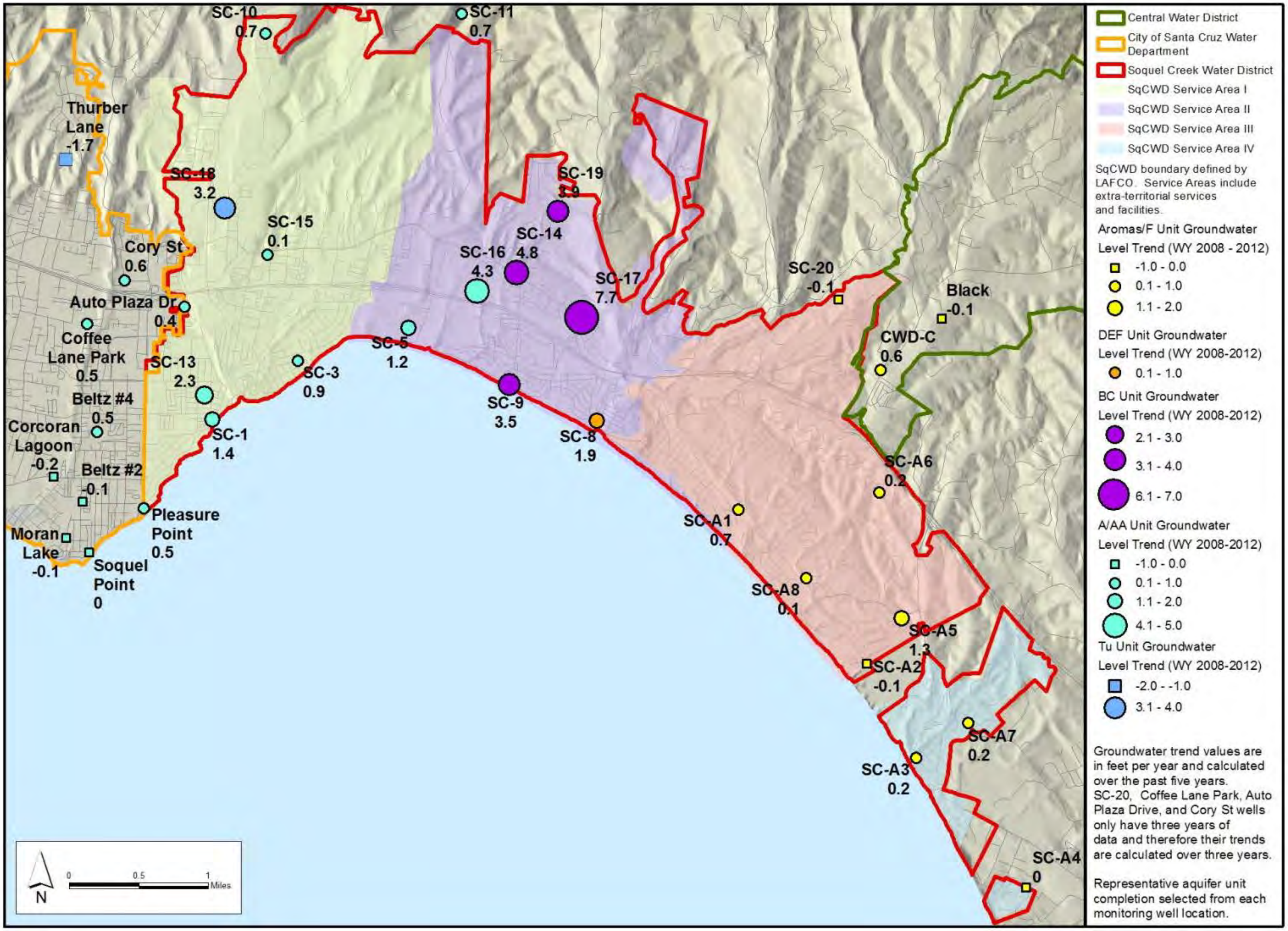

Figure ES- 2 (2012): Groundwater Level Trends Water Years 2008-2012 at Representative Monitoring Wells

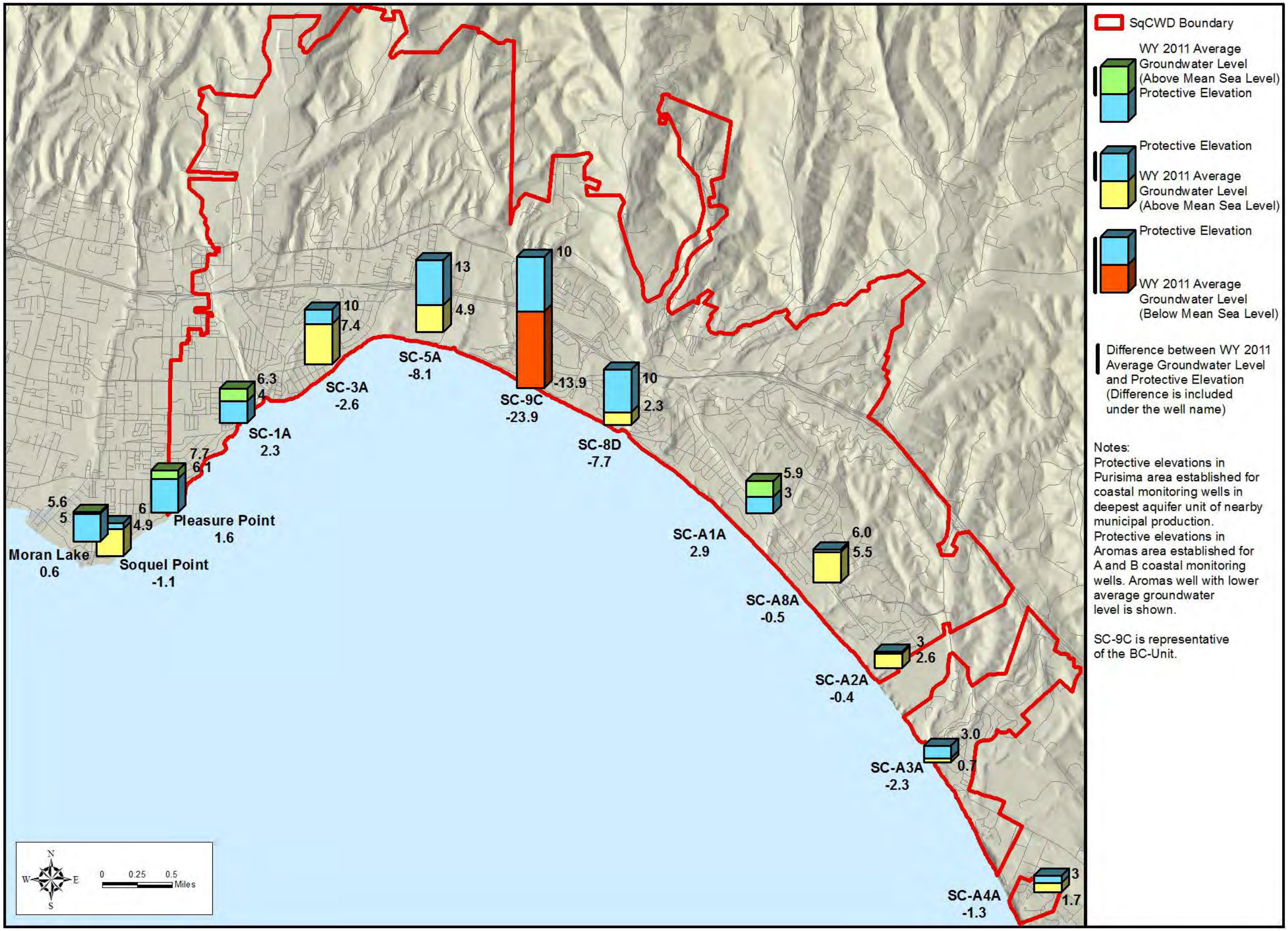

Figure ES- 1 (2011): Average Water Year 2011 Groundwater Levels at Coastal Monitoring Wells Relative to Protective Elevations

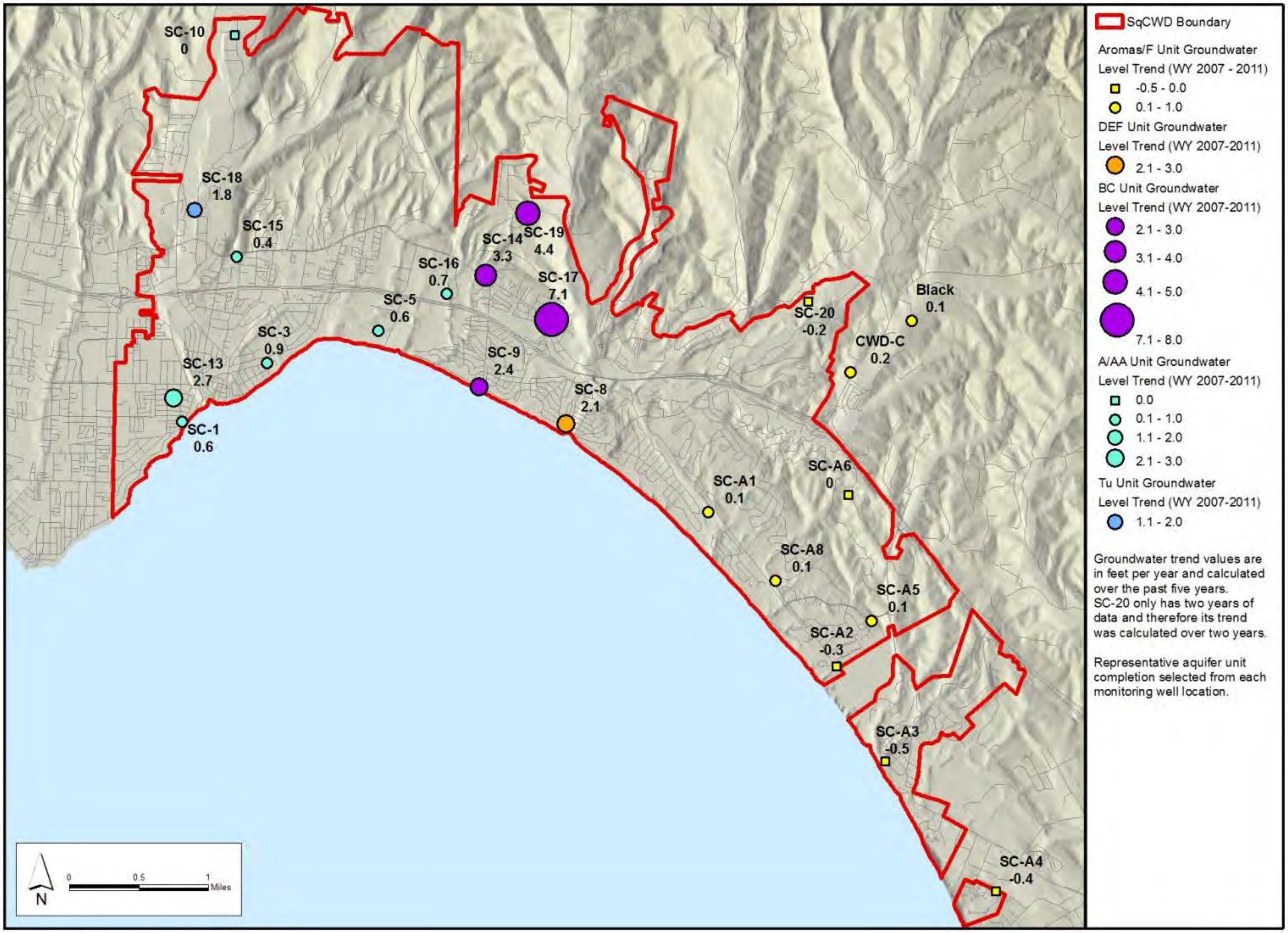

Figure ES- 2 (2011): Groundwater Level Trends Water Years 2007-2011 at Representative Monitoring Wells

SECTION 1
BACKGROUND AND SCOPE

Soquel Creek Water District (SqCWD) and Central Water District (CWD) approved a Groundwater Management Plan (GMP) in 2007 (SqCWD and CWD, 2007). Part of the GMP implementation requires preparation of an Annual Review and Report (ARR) following each water year. The ARR summarizes groundwater conditions in the Soquel-Aptos area, documents the status of groundwater management activities, and recommends amendments to the GMP. Under direction of the Soquel Aptos Groundwater Management Committee (S-AGMC, formerly the Basin Implementation Group), a new format for the report has been prepared starting with the Water Year 2009 ARR. The report will serve as a living document and be updated annually. This is the third annual update using the new format, covering Water Year 2014 (October 2013-September 2014).

1.1 GROUNDWATER MANAGEMENT PLAN REVIEW

Water Year 2012 ARR included a review of the GMP itself. Proposed revisions to the Existing Groundwater Conditions and Basin Management Objectives were approved by the Basin Implementation Group in 2013. An official update of the GMP requires approval of the governing bodies of members of the Soquel Groundwater Management Committee. The Sustainable Groundwater Management Act (SGMA) prohibits renewal of existing GMPs so these updates of the GMP will not be brought forward to be approved by the governing bodies. However, ongoing groundwater management is based on the proposed revisions so the revisions are referenced in this report. This report is also considered an addendum to the GMP so state requirements for the GMP that have been developed since approval of the GMP are included in the report.

1.2 LIVING DOCUMENT CONCEPT

The living document is contained in a three-ring binder and portable document format (PDF) electronic file that will be updated with new information on basin conditions each year. Summaries and maps of previous water years will remain in the binder and PDF file, with summaries and maps for the most recent water year successively added. Some maps will not change each year. The section reviewing the status of GMP implementation is similar to Section 3 of the Water Year 2008 report, but will be updated through the most recent water year. An executive summary of the entire water year will also be added to the front of the binder and PDF file each year. New map figures for the executive summary were added for Water Year 2011 and map figures for this and subsequent years will be added each year.

1.3 Document Organization

Sections 2-5 update basin conditions for the water year. Since each year new Sections 2-5 discussing the latest water year are inserted to the binder and PDF, the sections are labeled with the subject water year. Some figures and tables illustrating basin conditions or current basin understanding, such as multi-year graphs, are replaced when they are updated. Other figures and tables, such as snapshot contour maps, are added when updated and their figure and table numbers labeled with the subject water year.

Section 2 describes conditions for the subject water year such as precipitation and overall pumping that affect the entire basin. The updated Section 2 is inserted in front of the previous Section 2. Multi-year graphs of precipitation and pumping are replaced each year. Maps of rainfall stations, study areas, small water systems, and recharge areas will not change each year.

Sections 3-5 describe conditions for three different portions of the Soquel-Aptos area. Section 3 discusses the western portion of the Soquel-Aptos area, where the productive aquifer units are the Purisima A and AA-units and the sub-Purisima Tu-unit. Section 4 discusses the central portion of the Soquel-Aptos area, where the productive aquifer units are the Purisima BC and DEF-units. Section 5 discusses the eastern portion of the Soquel-Aptos area, where the productive aquifer units are the Purisima F-unit and Aromas Red Sands aquifer. The above productive aquifer units are defined by the basin hydrostratigraphy outlined in Johnson et al. (2004) (Figure 1-1). The deep to shallow sequence of productive aquifer units in the Purisima Formation is AA, A, BC, DEF, to F. The Aromas Red Sands overlies the Purisima F-unit.

Each of Sections 3-5 is organized as follows:

- A description of pumping for the relevant SqCWD service areas and CWD or City of Santa Cruz is summarized and inserted.

- A multi-year graph of the water agencies' pumping for the area is replaced. The estimates of non-agency pumping will also be replaced if there is new information.
- A summary of the overall groundwater condition and groundwater level trends for the water year is inserted.
- SqCWD has established and updated protective groundwater elevations in coastal monitoring wells to protect the basin from seawater intrusion over the long term (HydroMetrics LLC, 2009b and HydroMetrics WRI, 2012). There are also target groundwater elevations for the City of Santa Cruz's coastal monitoring wells included in the cooperative groundwater management agreement between SqCWD and the City (SqCWD and City, 2015). A table comparing coastal groundwater levels in the water year versus protective elevations for the aquifer group is inserted.
- Hydrographs of logger data at coastal monitoring wells that only required straightforward processing are added for the water year 2014 report and will be replaced. Additional logger data hydrographs will be added after processing is set up with a data management system.
- A map showing representative groundwater elevation contours for the spring and fall of the reported water year is inserted. The groundwater elevation contour maps from the water year 2007 report are also included as a baseline.
- A summary of the overall condition and trends of water quality for the water year is inserted.
- The section will include a discussion of any specific issues that arise for the reported water year.
- Hydrographs and chemographs will be replaced.

The current procedure is to update all items (summaries, tables, multi-year graphs, and contour maps) in Sections 2-5 each year except for review of information in the GMP. However, the S-AGMC may decide that not all items require an update every year. The S-AGMC may also decide that additional items should be added in subsequent years.

Section 6 discusses the updated status of GMP Basin Management Objectives and Basin Management Elements (projects, programs, or policies). This section will be replaced each year, but completion of any objectives or elements in previous years will remain in the description in order to keep an ongoing record of activities. This year, this section will include recommended revisions to the descriptions of Basin Management Objectives to include updated information.

Section 7 discusses current GMP action priorities, and data gaps. The current GMP action priorities should be considered the current guide for groundwater management programs, projects, and policies (GMP Elements) to implement. Section 7 includes recommended plans for addressing high priority data
Table 1-1 provides a summary of whether updated items in each report will be inserted or replaced in the binder and PDF.

Table 1-1: Summary of Items to Add or Replace for Each Annual Report

Report Item	**Insert or Replace in Report**
Executive Summary	
Text	Insert
Summary Maps	Insert
Section 1 - Background and Scope	Replace
Hydrostratigraphy Figures	Replace only if necessary
Section 2 - Basinwide Conditions	
Text	Insert
Precipitation and pumping charts	Replace
Recharge table	Insert
Location Maps	Replace only if necessary
GMP Information Review	2012 Only
Section 3 - 5 - Aquifer Conditions	
Text	Insert
Summary tables	Insert
Pumping charts	Replace
Contour maps	Insert
Logger Data Hydrographs	Replace
Hydrographs	Replace
Chemographs	Replace
Section 6 - GMP Implementation Status	Replace
Recommendations for BMO Revisions	2012 Only
Section 7 - Recommendations	Insert

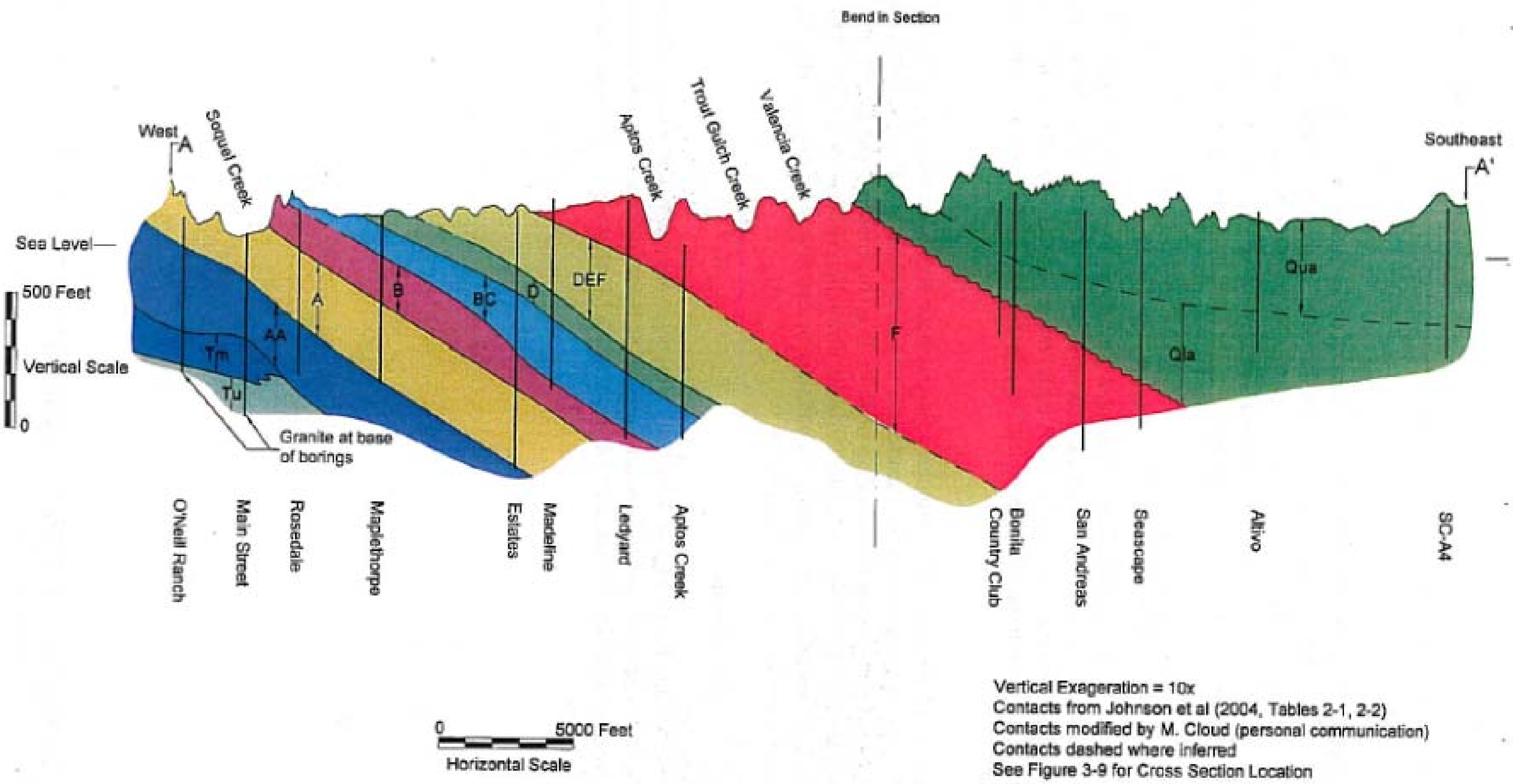

Figure 1-1: Cross-section of Basin Hydrostratigraphy (reproduced from GMP Figure 3-10)

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SECTION 2 – WATER YEAR 2014 BASINWIDE CONDITIONS IN THE SOQUEL-APTOS GROUNDWATER MANAGEMENT AREA

This section presents conditions in the Soquel-Aptos area for Water Year 2014 that affect the entire groundwater basin. This section also includes a review of information in GMP Section 3 (Existing Groundwater Conditions).

2.1 ANNUAL RAINFALL AND RECHARGE

SqCWD collects rainfall data from three gauges in the Soquel-Aptos area: the Mancarti gauge on Laurel Road, the Kraeger gauge on Longridge Road, and the weather station at the Main Street well site. Data loggers record rainfall at these gauges at 15-minute intervals. Precipitation at the Mancarti and Kraeger gauges during Water Year 2014 was 16.0 and 16.5 inches respectively. These rainfall totals were below the average (mean) values of 35.8 inches at the Mancarti gauge and 36.6 inches at the Kraeger gauge measured between Water Year 1984 and Water Year 2014. Water Year 2014 was the second full water year with data from the Main Street weather station and rainfall totaled 13.7 inches. Water Year 2014 ranks as the driest year in the 31 year record for both the Mancarti and Kraeger gauges, respectively. Annual rainfall totals by Water Year for all three gauges are presented on Figure 2-1.

Figure 2-1 also shows rainfall totals for the NOAA Cooperative station in Santa Cruz (station number 047916). Rainfall in Water Year 2014 at the Santa Cruz station was 14.4 inches, which was below the average value of 29.0 inches observed from Water Year 1984 through Water Year 2014. Water Year 2014 ranks as the 7^{h} driest year in the 72 year record for this station. The three year rainfall for Water Years 2012-2014 estimated for the Santa Cruz station was 54.6 inches, which is below the trigger condition of 68 inches that led SqCWD to declare a Stage 3 water shortage emergency and drought curtailment in 2014. Figure 2-2 shows the locations of the stations and estimated distribution of rainfall.

Six of the last eight water years have had below average rainfall. Water Year 1998 was the last year with rainfall above 50 inches per year. Results from the Soquel-Aptos Precipitation-Runoff Modeling System (PRMS) study (HydroMetrics WRI, 2011a) show that from 2001 through 2009 (which was the end of the modeled period), the average groundwater recharge was approximately 8,200 acre-feet per year, while the overall average for the calibrated period (1984 through 2009) was 10,800 acre-feet per year.

The two years (2005-2006) of above average precipitation was when the majority of the basin's recharge occurred, and those years were not wet enough to bring the average for the period up to the overall annual average recharge.

A relationship between rainfall and deep recharge has been derived from the calibrated PRMS simulation of Water Years 1984-2009 based on a best fit of rainfall and simulated deep recharge. The best fit quadratic equation for deep recharge based on rainfall at the Santa Cruz Cooperative station over the full water year is Deep Recharge = 15.855 x Rainfall^2 – 171.51 x Rainfall (HydroMetrics WRI, 2013a). Table 2-1 shows the estimated deep recharge based on this relationship for Water Years 2010-2014. The average recharge for Water Years 1984-2014 is estimated as 10,250 acre-feet per year based on these estimates combined with calibrated PRMS results. This annual average is 5% lower than the annual average of 10,800 acre-feet per year based on calibrated PRMS results for Water Years 1984-2009.

Table 2-1. Estimated Deep Recharge for Water Years 2010-2014

Water Year	Rainfall at Santa Cruz Co-op (inches)	Estimated Recharge (acre-feet)
2010	30.8	9,700
2011	42.2[1]	21,000
2012	22.2[1]	4,000
2013	18.0	2,100
2014	14.4	800

[1] Rainfall estimated based on De Laveaga totals due to missing data at Santa Cruz Co-op station

2.2 Annual Production

Total municipal production for the Soquel-Aptos area in Water Year 2014 was 4,772 acre-feet (AF), the lowest annual total since 1980. Annual production by water year for SqCWD, CWD, and the City of Santa Cruz is shown on Figure 2-3.

CWD pumping in Water Year 2014 was 500 acre-feet, representing an 8.5% reduction from the previous two years. CWD pumping is typically higher in years with below average rainfall and the Water Years 2012-2014 have all had below average rainfall. The only two water years since 1995 with less CWD pumping than Water Year 2014 were Water Years 2010 and 2011, which were years with above average rainfall. The reduction in pumping appears related to CWD's declaration of a Stage 2 water shortage consistent with the state's request for voluntary 20% reductions in water use.

SqCWD pumping of 3,761 acre-feet in Water Year 2014 was the lowest annual total since 1977. In addition, SqCWD pumping in Water Years 2010-2014 have been the five lowest annual totals since 1979. SqCWD reduced pumping in Water Year 2014 approximately 10% from the previous four years with low historical pumping. This reduction appears related to SqCWD's declaration of a Stage 3 water shortage emergency in 2014 with a drought curtailment target of 25% in 2014. After declaring a Stage 1 water shortage alert in 2012 and Stage 2 water shortage warning in 2013 with requests for voluntary conservation to meet a drought curtailment target of 5-15%, the Stage 3 declaration in 2014 included mandatory conservation measures.

For the reduced demand sustained over the last five years, it appears that economic conditions and conservation were likely factors in reduced demand as SqCWD has only declared drought curtailment in the last three years. The economic conditions resulted in both residential and commercial vacancies. Secondly, reduced demand within the SqCWD service area may have resulted from completed water demand offsets for which the corresponding development had not been completed. Thirdly, public awareness about the importance of sustained water conservation has been heightened in recent years due in part to ongoing outreach and education programs by local water agencies.

City of Santa Cruz Water Year 2014 production of 511 acre-feet was similar to the average water year pumping from Water Year 1984-2014 of 518 acre-feet. The City's pumping over its pumping season is better represented by the calendar year total production. In 2014, the City declared a Stage 3 water shortage emergency but in critically dry years, lower availability of supply from the City's primary surface water level supply results in increased groundwater pumping by the City. The City's pumping during calendar year 2014 was 616 acre-feet, which is less than the City's planned maximum groundwater production during critically dry years of 645 acre-feet per year (SqCWD and City, 2015).

In early 2012, SqCWD updated its estimates for its post-recovery pumping yields, which are meant to protect the Aromas and Purisima areas from seawater intrusion after groundwater levels recover to protective elevations. These estimates assume that only SqCWD would reduce pumping to maintain groundwater levels at protective elevations after recovery. The post-recovery pumping yields are based on modeled offshore flows required to protect against seawater intrusion; along with estimated recharge, non-SqCWD consumptive use, and SqCWD consumptive use factors

(HydroMetrics WRI, 2012). In 2014, SqCWD decided to use estimates that assume existing septic system return flow in its service area is included in its estimates for post-recovery pumping yields (HydroMetrics WRI, 2012), which are higher than yields cited in previous ARRs. SqCWD pumping for the Purisima area has ranged from 2,435 to 2,651 acre-feet per year the last six years, which is less than the estimated post-recovery pumping yield of 2,890 acre-feet per year for the Purisima area. SqCWD pumping in the Aromas area in Water Year 2014 of 1,326 acre-feet per year was below the post-recovery pumping yield of 1,440 acre-feet per year for the Aromas area for the second time since 1982. Total SqCWD production in Water Year 2014 was 569 acre-feet below the combined post-recovery pumping yield of 4,330 acre-feet per year for multiple years.

However, to recover groundwater levels to protective elevations, pumping must be reduced below post-recovery pumping yields for multiple years. SqCWD's current planning goal for allowing groundwater elevations to recover is to limit pumping to 3,250 acre-feet per year with an estimated recovery time frame of 20 years (HydroMetrics WRI, 2012). Based on the post-recovery pumping yield, the planning goal for recovery assumes that only SqCWD would reduce pumping to achieve recovery. The planning goal is also higher than goals cited in previous ARRs because existing septic system return flow is included. The post-recovery pumping yields and estimated recovery time frame also assume average annual recharge does not change from what has been estimated from current and historical data. A peer review did suggest that a higher estimate for sustainable yield was appropriate (Todd, 2014), but SqCWD continues to use the estimates above as a conservative goal for planning. A groundwater model is being developed that will be replace the water balance approach used for the estimates above (HydroMetrics WRI, 2014).

Since Water Year 2004 when CWD's maximum annual pumping of 632 acre-feet occurred, CWD pumping has ranged from 479 to 594 acre-feet per year which is less than the 622 acre-feet per year that is assumed for sustainable yield calculations in the GMP and more recent updates. For non-critically dry calendar years 2008 to 2013, City of Santa Cruz pumping ranged from 472 to 548 acre-feet per year. Including pumping from critically dry year 2014, the City's average pumping over the last seven years has been 532 acre-feet per year, similar to the 520 acre-feet per year cited as its long-term pumping goal in the recently finalized cooperative monitoring/adaptive groundwater management agreement between the City and SqCWD (2015).

Estimated production by private wells and small water systems, including residential, commercial, and agricultural supply, are also shown on Figure 2-3. Estimated private well production of approximately 1,711 acre-feet per year in the Purisima area has not been updated since Johnson et al. (2004) expanded on estimates developed by Wolcott (1999). The estimate for private well production in the Aromas area was updated to 974 acre-feet per year based on a land use study to estimate water use for the CWD groundwater model (HydroMetrics WRI and Kennedy/Jenks, 2014). Figure 2-4 shows the study areas for the Purisima and Aromas used for the estimates presented in Johnson et al. (2004) and how they relate to the Soquel-Aptos groundwater management area. The estimated private well pumping is based on water use factors estimated by Wolcott (1999). Water use factors for annual residential use include 0.39 acre-feet per parcel for suburban residences and 1.0 acre-feet per parcel for rural and mountain residences. The non-agricultural land use for the Aromas area is almost all rural and mountain residences. Estimates for private well water use are being re-evaluated as part of development of the groundwater model.

Santa Cruz County also compiled estimates for consumption and/or number of service connections for small water systems a few years ago (Ricker, 2012). Small water production is updated based on this information and an annual water use factor of 0.442 acre-feet per connection estimated by Wolcott (1999). A survey conducted by Pajaro Valley Water Management Agency in 2009 showed annual water use factors ranging from 0.47 to 0.73 acre-feet per parcel for Aromas Water District, Central Water District, and San Andreas Mutual (Carollo, 2010). Figure 2-4 shows the location of small water systems and several other known groundwater users. Additional updates are based on pumping information provided by the Santa Cruz County Parks Department and Cabrillo College. The Parks Department provided estimates of Polo Grounds park irrigation well pumping (Branham, 2007) but the irrigation system was off the well by the end of September 2011 as SqCWD converted the well to municipal use. Cabrillo College provided pumping records for calendar year 2009 (Cabrillo College, 2010) and then calendar year 2014 (Cabrillo College, 2014). Cabrillo College pumping for 2009 of 95 acre-feet was one-third of the estimate provided by Wolcott (285 acre-feet per year) and pumping for 2014 was 75 acre-feet. Table 2-2 summarizes water use estimates for the Purisima area in the Soquel-Aptos groundwater management area summarizes water use estimates for the Aromas area in the Soquel-Aptos groundwater management area.

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SECTION 2 – WATER YEAR 2013
BASINWIDE CONDITIONS IN THE SOQUEL-APTOS GROUNDWATER MANAGEMENT AREA

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2.1 ANNUAL RAINFALL AND RECHARGE

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Annual rainfall totals by Water Year for both gauges are presented on Figure 2-1. Water Year 2013 ranks as the 10th and 13th driest year in the 30 year record for the Mancarti and Kraeger gauges, respectively.

Figure 2-1 also shows rainfall totals for the NOAA Cooperative station in Santa Cruz (station number 047916). Rainfall in Water Year 2013 at the Santa Cruz station was 18.0 inches, which was below the average value of 29.5 inches observed from Water Year 1984 through Water Year 2013. Water Year 2013 ranks as the 7^{h} driest year in the 72 year record for this station. The two year rainfall for Water Years 2012-2013 estimated for the Santa Cruz station was 41.6 inches, which is below the trigger condition of 50 inches that led SqCWD to declare a Stage 2 water shortage warning in 2013. Figure 2-2 shows the locations of the stations and estimated distribution of rainfall.

Four of the last thirteen water years have had above average rainfall. Water Year 1998 was the last year with rainfall above 60 inches per year. Results from the Soquel-Aptos Precipitation-Runoff Modeling System (PRMS) study (HydroMetrics WRI, 2011a) show that from 2001 through 2009 (which was the end of the modeled period), the average groundwater recharge was approximately 8,200 acre-feet per year, while the overall average for the calibrated period (1984 through 2009) was 10,800 acre-feet per year. The two years (2005-2006) of above average precipitation was when the majority of the basin's recharge occurred, and those years were not wet enough to bring the average for the period up to the overall annual average recharge.

A relationship between rainfall and deep recharge has been derived from the calibrated PRMS simulation of Water Years 1984-2009 based on a best fit of rainfall and simulated deep recharge. The best fit quadratic equation for deep recharge based on rainfall at the Santa Cruz Cooperative station over the full water year is Deep Recharge = $15.855 \times \text{Rainfall}^2 - 171.51 \times \text{Rainfall}$ (HydroMetrics WRI, 2013a). Based on this relationship, the estimate for deep recharge in Water Year 2013 is 2,100 acre-feet, or 80% lower than the average simulated for the calibration period of Water Years 1984-2009 (HydroMetrics WRI, 2011a).

2.2 ANNUAL PRODUCTION

Total municipal production for the Soquel-Aptos area in Water Year 2013 was 5,292 acre-feet (AF), the fifth lowest annual total since Water Year 1984. However, this was the highest total since Water Year 2009. Annual production by water year for SqCWD, CWD, and the City of Santa Cruz is shown on Figure 2-3.

CWD pumping in Water Year 2013 was the highest since Water Year 2009. CWD production of 558 acre-feet in Water Year 2013 was the 8th highest annual total since records are available starting in Water Year 1974 (Johnson et al, 2004). The relatively high amount of pumping is likely related to below average rainfall in Water Year 2013. Five of the seven water years (2002, 2004, 2007-9) with greater CWD pumping occurred when rainfall was below average.

SqCWD pumping of 4,219 acre-feet in Water Year 2013 was the highest since Water Year 2009. However, SqCWD pumping in Water Years 2010-2013 have been the four lowest annual totals since 1979. It appears that economic conditions, weather, and conservation were likely factors in the reduced demand sustained over the four year period as SqCWD has only declared drought curtailment in the last two years. The economic conditions resulted in both residential and commercial vacancies. Secondly, reduced demand within the SqCWD service area may have resulted from completed water demand offsets for which the corresponding development had not been completed. Thirdly, public awareness about the importance of sustained water conservation has been heightened in recent years due in part to ongoing outreach and education programs by local water agencies.

After declaring a Stage 1 water shortage alert with a drought curtailment target of 5%, SqCWD declared a Stage 2 water shortage warning in 2013 with a drought curtailment target of 15% with requests for voluntary conservation. The increased demand in 2013 relative to the previous three years despite the higher drought curtailment target was likely due to improved economic conditions.

City of Santa Cruz Water Year 2013 production of 515 acre-feet was similar to the average water year pumping from Water Year 1984-2013 of 518 acre-feet. The City's pumping over its pumping season is better represented by the calendar year total production. The City's pumping during calendar year 2013 was 524 acre-feet, which is similar to the City's planned future maximum groundwater production during non-critically dry years of 525 acre-feet per year (Chambers Group, 2011).

In early 2012, SqCWD updated its estimates for its post-recovery pumping yields, which are meant to protect the Aromas and Purisima areas from seawater intrusion after groundwater levels recover to protective elevations. The post-recovery pumping yields are based on modeled offshore flows required to protect against seawater intrusion; along with estimated recharge, non-District consumptive use, and District consumptive use factors (HydroMetrics WRI, 2012). SqCWD pumping for the Purisima area has ranged from 2,582 to 2,651 acre-feet per year the last five years, which is less than the estimated post-recovery pumping yield of 2,800 acre-feet per year for the Purisima area. Although SqCWD pumping in the Aromas area in Water Year 2013 of 1,609 acre-feet per year was the fourth year in a row with lower amounts than recorded from Water Years 1984-2009, this amount is still above the post-recovery pumping yield of 1,200 acre-feet per year for the Aromas area. Total SqCWD production in Water Year 2013 was 219 acre-feet above the combined post-recovery pumping yield of 4,000 acre-feet per year. However, to recover groundwater levels to protective elevations, pumping must be reduced below post-recovery pumping yields. SqCWD's current planning goal for allowing groundwater elevations to recover is to limit pumping to 2,900 acre-feet per year with an estimated recovery time frame of 20 years (HydroMetrics WRI, 2012). SqCWD's pumping goal of 2,900 acre-feet per year has been proposed as a revised numerical target for the GMP's Basin Management Objective 1-1: Pump within the Sustainable Yield. Both the post-recovery pumping yields and estimated recovery time frame assume average annual recharge and non-District consumptive use does not change from what has been estimated from current and historical data.

Available records starting in Water Year 1974 show that CWD has never pumped more than 1% above its sustainable yield share of 622 acre-feet per year that is implied in the

GMP. From calendar year 1993 through 2012, City of Santa Cruz has not pumped more than 1% above its sustainable yield share of 575 acre-feet per year that is assumed in the GMP.

Estimated production by private wells and small water systems, including residential, commercial, and agricultural supply, are also shown on Figure 2-3. Estimated private well production of approximately 1,711 acre-feet per year in the Purisima area has not been updated since Johnson et al. (2004) expanded on estimates developed by Wolcott (1999). The estimate forprivate well production in the Aromas area was updated to 974 acre-feet per year based on a land use study to estimate water use for the CWD groundwater model (HydroMetrics WRI and Kennedy/Jenks, 2014). Figure 2-4 shows the study areas for the Purisima and Aromas used for the estimates presented in Johnson et al. (2004) and how they relate to the Soquel-Aptos groundwater management area. The estimated private well pumping is based on water use factors estimated by Wolcott (1999). Water use factors for annual residential use include 0.39 acre-feet per parcel for suburban residences and 1.0 acre-feet per parcel for rural and mountain residences. The non-agricultural land use for the Aromas area is almost all rural and mountain residences.

Santa Cruz County also compiled estimates for consumption and/or number of service connections for small water systems a few years ago (Ricker, 2012). Small water production is updated based on this information and an annual water use factor of 0.442 acre-feet per connection estimated by Wolcott (1999). A survey conducted by Pajaro Valley Water Management Agency in 2009 showed annual water use factors ranging from 0.47 to 0.73 acre-feet per parcel for Aromas Water District, Central Water District, and San Andreas Mutual (Carollo, 2010)Figure 2-4 shows the location of small water systems and several other known groundwater users. Additional updates are based on pumping information provided by the Santa Cruz County Parks Department and Cabrillo College. The Parks Department provided estimates of Polo Grounds park irrigation well pumping (Branham, 2007) but the irrigation system was off the well by the end of September 2011 as SqCWD converted the well to municipal use. Cabrillo College provided pumping records for calendar year 2009 (Cabrillo College, 2010). Cabrillo College pumping for that year was one-third of the estimate provided by Wolcott (285 acre-feet per year). Table 2-1 summarizes water use estimates for the Purisima area in the Soquel-Aptos groundwater management area. Table 2-2 summarizes water use estimates for the Aromas area in the Soquel-Aptos groundwater management area.

SECTION 2 – WATER YEAR 2012 BASINWIDE CONDITIONS IN THE SOQUEL-APTOS GROUNDWATER MANAGEMENT AREA

This section presents conditions in the Soquel-Aptos area for Water Year 2012 that affect the entire groundwater basin. This section also includes a review of information in GMP Section 3 (Existing Groundwater Conditions).

2.1 ANNUAL PRECIPITATION

SqCWD collects rainfall data from two gauges in the Soquel-Aptos area: the Mancarti gauge on Laurel Road and the Kraeger gauge on Longridge Road. Data loggers record rainfall at these gauges at 15-minute intervals. Precipitation at the Mancarti and Kraeger gauges during Water Year 2012 was 28.27 and 29.37 inches respectively. These rainfall totals were below the average (mean) values of 36.8 inches at the Mancarti gauge and 37.4 inches at the Kraeger gauge measured between Water Year 1984 and Water Year 2012.

Annual rainfall totals by Water Year for both gauges are presented on Figure 2-1. Water Year 2012 ranks as the 9th and 11th driest year in the 29 year record for the Mancarti and Kraeger gauges, respectively.

Figure 2-1 also shows rainfall totals for the NOAA Cooperative station in Santa Cruz (station number 047916). In Water Years 2011 and 2012, the totals are estimated based on data from the CIMIS station at De Laveaga (station number 104) using correlations between the two stations for water year totals from 1991-2010 (HydroMetrics WRI, 2013a). Rainfall in Water Year 2012 estimated for the Santa Cruz station was 22.15 inches, which was below the average value of 30.0 inches observed from Water Year 1984 through Water Year 2012. Water Year 2012 ranks as the 16th driest year in the 71 year record for this station

Four of the last twelve water years have had above average rainfall. Water Year 1998 was the last year with rainfall above 60 inches per year. Results from the Soquel-Aptos Precipitation-Runoff Modeling System (PRMS) study (HydroMetrics WRI, 2011a) show that from 2001 through 2009 (which was the end of the modeled period), the average groundwater recharge was approximately 8,200 acre-feet per year, while the overall average for the calibrated period (1984 through 2009) was 10,800 acre-feet per year. The two years of above average precipitation was when the majority of the basin's recharge occurs, and those years were not wet enough to bring the average for the period up to the overall annual average recharge.

A relationship between rainfall and deep recharge has been derived from the calibrated PRMS simulation of Water Years 1984-2009 based on a best fit of rainfall and simulated deep recharge. The best fit quadratic equation for deep recharge based on rainfall at the Santa Cruz Cooperative station over the full water year is Deep Recharge = 15.855 x Rainfall^2 – 171.51 x Rainfall (HydroMetrics WRI, 2013a). Based on this relationship, the estimate for deep recharge in Water Year 2012 is 4,000 acre-feet, or 60% lower than the average simulated for the calibration period of Water Years 1984-2009 (HydroMetrics WRI, 2011a).

2.2 ANNUAL PRODUCTION

Total municipal production for the Soquel-Aptos area in Water Year 2012 was 5,245 acre-feet (AF), the third lowest annual total since Water Year 1984. Only Water Years 2010 and 2011 had less municipal production. Annual production by water year for SqCWD, CWD, and the City of Santa Cruz is shown on Figure 2-2.

CWD pumped more in Water Year 2012 than the previous year. CWD production of 589 acre-feet in Water Year 2012 was the 7th highest annual total since records are available starting in Water Year 1974 (Johnson et al, 2004). The relatively high amount of pumping is likely related to below average rainfall in Water Year 2012. Five of the six water years (2002, 2004, 2007-9) with greater CWD pumping occurred when rainfall was below average.

SqCWD pumped more in Water Year 2012 than the previous year, which had the lowest annual total since 1978 (Johnson et al., 2004). SqCWD pumping of 4,162 acre-feet in Water Year 2012 was the third lowest annual total since 1978, greater than only Water Years 2011 and 2012 in that time span. In 2012, SqCWD declared a Stage 1 water shortage alert with a drought curtailment target of 5% with requests for voluntary conservation. However, there was no drought curtailment or additional conservation effort in the previous two years so it appears that economic conditions, weather, and conservation were likely factors in the reduced demand sustained over the three year period. The economic conditions resulted in both residential and commercial vacancies. Secondly, reduced demand within the SqCWD service area may have resulted from completed water demand offsets for which the corresponding development had not been completed. Thirdly, public awareness about the importance of sustained water conservation has been heightened in recent years due in part to ongoing outreach and education programs by local water agencies.

City of Santa Cruz Water Year 2012 production of 494 acre-feet was slightly less than the average water year pumping from Water Year 1984-2012 of 518 acre-feet. However, the City's pumping over its pumping season is better represented by the calendar year total production. The City's pumping during calendar year 2012 was 526 acre-feet, which is similar to the City's planned future maximum groundwater production during non-critically dry years of 525 acre-feet per year (Chambers Group, 2011).

Starting in Water Year 2005, SqCWD has not pumped more than 2% above its GMP pumping goal of 4,800 acre-feet per year. Previously, SqCWD had averaged 5,375 acre-feet of pumping per year from Water Year 1987 to 2004. Available records starting in Water Year 1974 show that CWD has never pumped more than 1% above its sustainable yield share of 622 acre-feet per year that is implied in the GMP. From calendar year 1993 through 2012, City of Santa Cruz has not pumped more than 1% above its sustainable yield share of 575 acre-feet per year that is assumed in the GMP.

In early 2012, SqCWD updated its estimates for its post-recovery pumping yields, which are meant to protect the Aromas and Purisima areas from seawater intrusion after groundwater levels recover to protective elevations. The post-recovery pumping yields are based on modeled offshore flows required to protect against seawater intrusion; along with estimated recharge, non-District consumptive use, and District consumptive use factors (HydroMetrics WRI, 2012). SqCWD pumping for the Purisima area has ranged from 2,582 to 2,651 acre-feet per year the last four years, which is less than the estimated post-recovery pumping yield of 2,800 acre-feet per year for the Purisima area. Although SqCWD pumping in the Aromas area in Water Year 2012 of 1,516 acre-feet per year was the third year in a row with lower amounts than recorded from Water Years 1984-2009, this amount is still above the post-recovery pumping yield of 1,200 acre-feet per year for the Aromas area. Total SqCWD production in Water Year 2012 was slightly above the combined post-recovery pumping yield of 4,000 acre-feet per year. However, to recover groundwater levels to protective elevations, pumping must be reduced below post-recovery pumping yields. SqCWD's current planning goal for allowing groundwater elevations to recover is to limit pumping to 2,900 acre-feet per year with an estimated recovery time frame of 20 years (HydroMetrics WRI, 2012). Both the post-recovery pumping yields and estimated recovery time frame assume average annual recharge and non-District consumptive use does not change from what has been estimated from current and historical data.

Estimated production by private wells and small water systems, including residential, commercial, and agricultural supply, are also shown on Figure 2-2. Estimated private well production of approximately 1,711 acre-feet per year in the Purisima area and 866 acre-feet per year in the Aromas area have not been updated since Johnson et al. (2004) expanded on estimates developed by Faler (1992) and Wolcott (1999). Figure 2-3 shows the study areas for the Purisima and Aromas used for the estimates presented in Johnson et al. (2004) and how they relate to the Soquel-Aptos groundwater management area. However, Santa Cruz County compiled estimates for consumption and/or number of service connections for small water systems a few years ago (Ricker, 2012). Small water production is updated based on this information. Figure 2-3 shows the location of small water systems and several other known groundwater users. Additional updates are based on pumping information provided by the Santa Cruz County Parks Department and Cabrillo College. The Parks Department provided estimates of Polo Grounds park irrigation well pumping (Branham, 2007) but the irrigation system was off the well by the end of September 2011 as SqCWD converted the well to municipal use. Cabrillo College provided pumping records for calendar year 2009 (Cabrillo College, 2010). Cabrillo College pumping for that year was one-third of the estimate provided by Wolcott (285 acre-feet per year). Table 2-1 summarizes water use estimates for the Purisima area in the Soquel-Aptos groundwater management area. Table 2-2 summarizes water use estimates for the Aromas area in the Soquel-Aptos groundwater management area.

2.3 Review of GMP Section on Groundwater Conditions

Subsections of GMP Section 3 related to groundwater conditions are briefly summarized and evaluated for whether they require updates below.

GMP Section 3.1.1 Physical Setting: Service Areas and Topography

This subsection describes the service areas and populations of SqCWD and CWD. The description is still generally accurate and sufficient for groundwater management planning. However, specific details such as the number of service connections have changed since 2007. This subsection should be updated.

GMP Section 3.1.2 Physical Setting: Climate and Rainfall

This subsection describes climatic averages and ranges for the area, specifically rainfall. The Soquel-Aptos Area Recharge Model (HydroMetrics WRI, 2011a) provides updated estimates for rainfall, including a map that will update GMP Figure 3-2 that shows the spatial distribution of rainfall. This subsection also discusses estimates of rainfall-recharge. This discussion should be updated with estimates from the Soquel-Aptos Area Recharge Model. This subsection should be updated.

GMP Section 3.2 Basin Boundaries and AB3030 Study Area

This subsection describes various definitions of basin boundaries and the GMP study area. These definitions have not changed since 2007 so most of this subsection does not require updating. One subsection that should be updated is section 3.2.2 Jurisdictional Boundaries-Cities, Special Districts, and County. A discussion of small water systems in the GMP study area, and a map of the systems should be included similar to Figure 2-3. Section 3.2.2 should be updated but the rest of section 3.2 does not need updating.

GMP Section 3.3.1 Local Geology and Hydrogeology: Geologic Units

This subsection describes the geologic units of the Purisima Formation and the Aromas Red Sands from which SqCWD and CWD wells extract water. The descriptions of these units do not require revision. This subsection does not need updating.

GMP Section 3.3.2 Local Geology and Hydrogeology: Geologic Structure

This subsection describes the nature and location of the Purisima Formation and the Aromas Red Sands in the Soquel-Aptos area. Information from borings installed since 2007 could be used to update maps of the geologic structure. County staff has performed technical work to this effect (Nguyen, 2013) and presented preliminary results to the Basin Advisory Group in 2012. In addition, consultants to the City of Santa Cruz have presented an alternate geologic structure for the Western Purisima (Hopkins, 2009). However, the GMP subsection only describes the structure in brief and general terms and does not include detailed maps of the geologic structure. Since additional technical work would be required to develop and add detailed structure maps, this subsection does not need updating at this time as groundwater management does not currently require updated maps.

GMP Sections 3.3.3 and 3.3.4 Local Geology and Hydrogeology: Offshore Geology and Faults

Section 3.3.3 describes how the Purisima Formation and Aromas Red Sands extend offshore beneath Monterey Bay. Section 3.3.4 identifies the Zayante Fault as the main fault that affects groundwater flow in the GMP area. These descriptions do not require revision. These subsections do not need to be updated.

GMP SECTIONS 3.3.5 LOCAL RECHARGE AREAS

It is recommended that a new subsection be added to meet the AB 359 requirement that the GMP include maps of recharge areas by 2013. The subsection could include recharge area maps developed by the County and/or information from the Soquel-Aptos recharge study (HydroMetrics WRI, 2011a). This subsection should also include any updates on the relative importance of stream and areal recharge mechanisms as discussed in the GMP under Basin Management Objective 3-1.

GMP SECTION 3.4.1 GROUNDWATER CONDITIONS: WATER LEVELS AND FLOW DIRECTIONS

This subsection describes groundwater conditions that are reviewed annually and reported in the ARR Section 3.2 for the Western Purisima, Section 4.2 for the Central Purisima, and Section 5.2 for the Aromas area. This subsection does not need to be updated beyond what is done for the ARR. Flow directions have not been described in ARRs, but should be described based on contour maps each year starting in Water Year 2013.

GMP SECTION 3.4.2 GROUNDWATER CONDITIONS: CURRENT GROUNDWATER EXTRACTION

Sections 3.4.2.1, 3.4.2.2, and 3.4.2.3 describe extraction by municipal agencies SqCWD, CWD, and City of Santa Cruz respectively. Extraction by these agencies is reviewed annually and reported in the ARR Section 3.1 for the Western Purisima (SqCWD and City of Santa Cruz), Section 4.1 for the Central Purisima (SqCWD), and Section 5.2 for the Aromas area (SqCWD and CWD). These subsections do not need to be updated beyond what is done for the ARR.

Section 3.4.2.4 describes private and agricultural extraction in the GMP area. Updated information on this extraction is available, such as County estimates of small water system production, production records from Cabrillo College. Other data currently being developed include estimates of private and agricultural pumping from the CWD Aromas and Purisima Groundwater Basin Management Study. Therefore, this subsection should be updated.

GMP SECTION 3.4.3 GROUNDWATER CONDITIONS: GROUNDWATER YIELD AND SUSTAINABILITY

This subsection describes basin overdraft conditions that increase risk of seawater intrusion and pumping goals to meet sustainable yield. As described above in Section 2.2, SqCWD has revised its pumping goals to recover the basin and to meet post-recovery yield. In addition, the City of Santa Cruz has established new pumping goals (Chambers Group, 2011). This GMP subsection should be updated to reflect these new goals.

GMP SECTION 3.5 NATURAL GROUNDWATER QUALITY

This subsection describes the mineral type of groundwater in the GMP area, and SqCWD and CWD testing procedures. These descriptions do not require an update. The subsection also discusses naturally occurring constituents detected in production wells that affect drinking water quality. Water quality is reviewed annually and reported annually in Section 3.3 for the Western Purisima, 4.3 for the Central Purisima, and 5.3 for the Aromas area. These descriptions of water quality conditions do not need to be updated beyond what is done for the ARR. However, this subsection does discuss specific water quality constituents detected in the basin and it is recommended to update discussion of current regulatory status for water quality constituents that affect groundwater management, such as the new public health goal for Chromium VI. It is also recommended that Section 3.5.2 be updated to include discussion of background chlorides and total dissolved solids concentrations observed in monitoring wells.

GMP SECTION 3.6 SEAWATER INTRUSION

This subsection describes seawater intrusion threats and water quality conditions related to seawater intrusion. Seawater intrusion is the primary focus of the annual water quality review and report in Section 3.3 for the Western Purisima, 4.3 for the Central Purisima, and 5.3 for the Aromas area. The descriptions of seawater intrusion conditions do not need to be updated beyond what is done for the ARR. However, since 2007, protective elevations for coastal monitoring wells to protect the basin from seawater intrusion have been developed (HydroMetrics WRI, 2012). The subsection should be updated with the new protective elevations.

GMP SECTION 3.7 MANMADE (ANTHROPOGENIC) CONTAMINATION

This subsection describes manmade contaminants that have been identified in the GMP area focusing on MTBE and PCE. Contaminants in the basin that have not been detected at municipal agency monitoring or production wells are not reviewed annually in the ARR. Therefore, current conditions related to manmade contamination in the GMP area should be reviewed and this subsection should be updated to reflect any changes in conditions.

GMP Sections 3.8 and 3.9 Historical and Ongoing Basin Management Activities and Key Basin Management Issues

Basin management activities and issues are reviewed annually and reported in the ARR Section 6. These GMP subsections do not need to be updated.

SECTION 2 – WATER YEAR 2011 BASINWIDE CONDITIONS IN THE SOQUEL-APTOS GROUNDWATER MANAGEMENT AREA

This section presents conditions in the Soquel-Aptos area for Water Year 2011 that affect the entire groundwater basin.

2.1 ANNUAL PRECIPITATION

SqCWD collects rainfall data from two gauges in the Soquel-Aptos area: the Mancarti gauge on Laurel Road and the Kraeger gauge on Longridge Road. Data loggers record rainfall at these gauges at 15-minute intervals. Precipitation at the Mancarti and Kraeger gauges during Water Year 2011 was 45.54 and 44.88 inches respectively. These rainfall totals were above the average (mean) values of 37.1 inches at the Mancarti gauge and 37.8 inches at the Kraeger gauge measured between Water Year 1984 and Water Year 2011.

Annual rainfall totals by Water Year for both gauges are presented on Figure 2-1. Water Year 2011 was the second consecutive year with above average and median rainfall at these gauges. Water Year 2011 ranks as the 8th and 9th wettest year in the 28 year record for the Mancarti and Kraeger gauges, respectively.

Figure 2-1 also shows rainfall totals for the NOAA Cooperative station in Santa Cruz (station number 047916). Rainfall in Water Year 2011 at this station was 40.06 inches, which was above the average value of 30.6 inches between Water Year 1984 and Water Year 2011. Water Year 2011 ranks as the 15th wettest year in the 70 year record for this station

Four of the last eleven water years have had above average rainfall. Water Year 1998 was the last year with rainfall above 60 inches per year. Results from the Soquel-Aptos Precipitation-Runoff Modeling System (PRMS) study (HydroMetrics WRI, 2011a) show that from 2001 through 2009 (which was the end of the modeled period), the average groundwater recharge was approximately 8,200 acre-feet per year, while the overall average for the calibrated period (1984 through 2009) was 10,800 acre-feet per year. The two years of above average precipitation was when the majority of the basin's recharge occurs, and those years were not wet enough to bring the average for the period up to the overall annual average recharge.

A relationship between rainfall and deep recharge has been derived from the calibrated PRMS simulation of Water Years 1984-2009 based on a best fit of rainfall and simulated deep recharge. The best fit quadratic equation for deep recharge based on rainfall at the Santa Cruz Cooperative station over the full water year is Deep Recharge = 15.855 x Rainfall^2 – 171.51 x Rainfall (Tana and King, 2012). Based on this relationship, the estimate for deep recharge in Water Year 2011 is 18,600 acre-feet, or 70% higher than the average simulated for the calibration period of Water Years 1984-2009 (HydroMetrics WRI, 2011a).

2.2 ANNUAL PRODUCTION

Total municipal production for the Soquel-Aptos area in Water Year 2011 was 5,150 acre-feet (AF), the second lowest annual total since Water Year 1984. Only Water Year 2010 had less municipal production. Annual production by water year for SqCWD, CWD, and the City of Santa Cruz is shown on Figure 2-2.

CWD and SqCWD pumped less in Water Year 2011 than the previous year. CWD production of 483 acre-feet was the lowest annual total since Water Year 1995. SqCWD pumping of 4,030 acre-feet was the lowest annual total since 1978 (Johnson et al., 2004). No drought curtailment or additional conservation effort took place in Water Year 2011 so it appears that economic conditions, weather, and conservation were likely factors in the reduced demand. The economic conditions resulted in both residential and commercial vacancies. Secondly, reduced demand within the SqCWD service area may have resulted from completed water demand offsets for which the corresponding development had not been completed. Thirdly, weather conditions reduced outdoor irrigation demand as precipitation was higher and the summer temperatures were cooler than Water Years 2007-2009. Lastly, public awareness about the importance of sustained water conservation has been heightened in recent years due in part to ongoing outreach and education programs by the local water agencies.

City of Santa Cruz Water Year 2011 production of 637 acre-feet was the largest annual water year production for the City since Water Year 1994. However, the City's pumping over its pumping season is better represented by the calendar year total production. The City's pumping during calendar year 2011 was 531 acre-feet, which is similar to the City's planned future maximum groundwater production during non-critically dry years of 525 acre-feet per year (Chambers Group, 2011).

Starting in Water Year 2005, SqCWD has not pumped more than 2% above its GMP pumping goal of 4,800 acre-feet per year. This goal has been met after averaging

5,375 acre-feet of pumping per year between Water Years 1987 and 2004. Available records starting in Water Year 1974 show that CWD has never pumped more than 1% above its sustainable yield share of 622 acre-feet per year that is implied in the GMP. From Water Year 1995 through 2010, City of Santa Cruz had not pumped more than 3% above its sustainable yield share of 575 acre-feet per year that is assumed in the GMP.

In early 2012, SqCWD updated its estimates for its post-recovery pumping yields, which are meant to protect the Aromas and Purisima areas from seawater intrusion after groundwater levels recover to protective elevations. The post-recovery pumping yields are based on modeled offshore flows required to protect against seawater intrusion; along with estimated recharge, non-District consumptive use, and District consumptive use factors (HydroMetrics WRI, 2012). SqCWD pumping for the Purisima area has ranged from 2,582 to 2,651 acre-feet per year the last three years, which is less than the estimated post-recovery pumping yield of 2,800 acre-feet per year for the Purisima area. Although SqCWD pumping in the Aromas area in Water Year 2011 of 1,396 acre-feet per year was the lowest annual total since 1982 (Johnson et al., 2004), this amount is still above the post-recovery pumping yield of 1,200 acre-feet per year for the Aromas area. Total SqCWD production in Water Year 2011 was nearly reduced to the combined post-recovery pumping yield of 4,000 acre-feet per year. However, to recover groundwater levels to protective elevations, pumping must be reduced below post-recovery pumping yields. SqCWD's current planning goal for allowing groundwater elevations to recover is to limit pumping to 2,900 acre-feet per year with an estimated recovery time frame of 20 years (HydroMetrics WRI, 2012).

Estimated production by private wells and small water systems, including residential, commercial, and agricultural supply, are also shown on Figure 2-2. Estimated private well production of approximately 2,236 acre-feet per year in the Purisima area and 954 acre-feet per year in the Aromas area have not been updated since Johnson et al. (2004) expanded on estimates developed by Faler (1992) and Wolcott (1999). The exceptions are more recent pumping information provided by the Santa Cruz County Parks Department and Cabrillo College. The Parks Department provided estimates of Polo Grounds park irrigation well pumping (Branham, 2007) and Cabrillo College provided pumping records for calendar year 2009 (Cabrillo College, 2010). Cabrillo College pumping for that year was one-third of the estimate provided by Wolcott (285 acre-feet per year). Figure 2-3 shows the study areas for the Purisima and Aromas used for these estimates presented in Johnson et al. (2004) and how they relate to the Soquel-Aptos groundwater management area. Table 2-1 summarizes water use estimates for the Purisima area. Table 2-2 summarizes water use estimates for the Aromas area.

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SECTION 2 – WATER YEAR 2010
BASINWIDE CONDITIONS IN THE SOQUEL-APTOS GROUNDWATER MANAGEMENT AREA

This section presents conditions in the Soquel-Aptos area for Water Year 2010 that affect the entire groundwater basin.

2.1 ANNUAL PRECIPITATION

SqCWD collects rainfall data from two gauges in the Soquel-Aptos area: the Mancarti gauge on Laurel Road and the Kraeger gauge on Longridge Road. Data loggers record rainfall at these gauges at 15-minute intervals. Precipitation at the Mancarti and Kraeger gauges during Water Year 2010 was 44.00 and 40.95 inches respectively. These rainfall totals were above the average (mean) values of 36.5 inches at the Mancarti gauge and 37.4 inches at the Kraeger gauge measured between Water Year 1984 and Water Year 2010.

Annual rainfall totals by Water Year for both gauges are presented on Figure 2-1. Water Year 2010 follows three consecutive years with below average and below median rainfall. Water Year 2010 ranks as the 8th and 10th wettest year in the 27 year record for the Mancarti and Kraeger gauges, respectively.

Figure 2-1 also shows rainfall totals for the NOAA Co-op station in Santa Cruz (station number 047916). Rainfall in Water Year 2010 at this station was 30.83 inches, above the average value of 30.2 inches between Water Year 1984 and Water Year 2010.

Only three of the last ten water years have had above average rainfall. Water Year 1998 was the last year with rainfall above 60 inches per year. The effects of this period of below average rainfall on deep groundwater recharge is currently being evaluated by a recharge study.

2.2 ANNUAL PRODUCTION

Total municipal production for the Soquel-Aptos area in Water Year 2010 was 5,104 acre-feet (AF), the lowest annual total since Water Year 1984. Annual production by water year for SqCWD, CWD, and the City of Santa Cruz is shown on Figure 2-2.

All three water agencies pumped less in Water Year 2010 than the previous year. CWD production of 508 acre-feet was the lowest annual total since Water Year 1995. City of Santa Cruz Water Year 2010 production of 451 acre-feet was within the annual production range of 296 to 594 acre-feet recorded since 1999. SqCWD pumping of 4,100 acre-feet was a historical low for all years back to Water Year 1984. No drought curtailment or additional conservation effort took place in Water Year 2010 so it appears that economic conditions, weather and conservation were likely factors in the reduced demand. The economic conditions resulted in both residential and commercial vacancies. Secondly, reduced demand within the SqCWD service area may have resulted from completed water demand offsets for which the corresponding development had not been completed Thirdly, weather conditions increased surface water supply for the City of Santa Cruz and reduced outdoor irrigation demand for all three agencies as precipitation was higher and the summer was cooler than the previous three years. Lastly, public awareness about the importance of sustained water conservation has been heightened in recent years due in part to ongoing outreach and education programs by the local water agencies.

Starting in Water Year 2005, SqCWD has not pumped more than 2% above its GMP pumping goal of 4,800 acre-feet per year. This goal has been met after averaging 5,375 acre-feet of pumping per year between Water Years 1987 and 2004. Available records starting in Water Year 1974 show that CWD has never pumped more than 1% above its sustainable yield share of 622 acre-feet per year that is implied in the GMP. Starting in Water Year 1995, City of Santa Cruz has not pumped more than 3% above its sustainable yield share of 576 acre-feet per year that is assumed in the GMP.

Sustainable yield estimates in the GMP were re-evaluated in 2009, based on modeled offshore flows required to protect against seawater intrusion (HydroMetrics LLC, 2009c). Using prior assumptions for recharge and consumptive use (Johnson et al., 2004), the evaluation showed that pumping goals in the GMP may not be adequate to protect the basin against seawater intrusion. The evaluation suggested that a reasonable estimate of SqCWD's share of the annual sustainable yield in the Purisima is 500 acre-feet less than SqCWD's pumping goal of 3,000 acre-feet per year stated in the GMP. Water Year 2010 pumping from SqCWD's wells in the Purisima was at a historical low for all years back to Water Year 1984 but was still approximately 12% higher than the revised estimate. The evaluation also concluded that the SqCWD's pumping goal of 1,800 acre-feet per year for the Aromas stated in the GMP was at least hundreds of acre-feet too high. Uncertainty in the calculations for the Aromas led to the recommendation that the USGS model of Pajaro Valley be reviewed before evaluating the concept of sustainable yield for the Aromas. The USGS model of Pajaro Valley is now due to be released in late 2011.

Estimated production by private wells and small water systems, including residential, commercial, and agricultural supply, are also shown on Figure 2-2. Estimated private well production of approximately 2,236 acre-feet per year in the Purisima area and 954 acre-feet per year in the Aromas area have not been updated since Johnson et al. (2004) expanded on estimates developed by Faler (1992) and Wolcott (1999). The exceptions are more recent pumping information provided by the Santa Cruz County Parks Department and Cabrillo College. The Parks Department provided estimates of Polo Grounds park irrigation well pumping (Branham, 2007) and Cabrillo College provided pumping records for calendar year 2009 (Cabrillo College, 2010). Cabrillo College pumping for that year was one-third of the estimate provided by Wolcott (285 acre-feet per year). Figure 2-3 shows the study areas for the Purisima and Aromas used for these estimates presented in Johnson et al. (2004) and how they relate to the Soquel-Aptos groundwater management area. Table 2-1 summarizes water use estimates for the Purisima area. Table 2-2 summarizes water use estimates for the Aromas area.

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SECTION 2 – WATER YEAR 2009 BASINWIDE CONDITIONS IN THE SOQUEL-APTOS GROUNDWATER MANAGEMENT AREA

This section presents conditions in the Soquel-Aptos area for Water Year 2009 that affect the entire groundwater basin.

2.1 Annual Precipitation

SqCWD collects rainfall data from two gauges in the Soquel-Aptos area: the Mancarti gauge and the Kraeger gauge. Data loggers record rainfall at these gauges at 15-minute intervals. Precipitation at the Mancarti and Kraeger gauges during Water Year 2009 was 33.38 and 29.62 inches respectively. These rainfall totals were below the average values of 36.5 inches at the Mancarti gauge and 37.4 inches at the Kraeger gauge measured between Water Year 1984 and Water Year 2009. Annual precipitation totals by Water Year for both gauges are presented on Figure 2-1.

Water Year 2009 was the third consecutive year with below average rainfall. Only two of the last eight water years have had above average rainfall. Water Year 1998 was the last year with rainfall above 60 inches per year. The effects of this period of below average rainfall on deep groundwater recharge has not been fully evaluated, but may partially explain the lack of groundwater recovery despite decreased production over the same period.

2.2 Annual Production

Total municipal production for the Soquel-Aptos area in Water Year 2009 was 5,536 acre-feet (AF), the lowest annual total since Water Year 1986. Annual production by water year for SqCWD, CWD, and the City of Santa Cruz is shown on Figure 2-2. The decline in production in Water Year 2009 was achieved primarily by SqCWD. Due to the third consecutive drought year, SqCWD declared a Precautionary Drought Curtailment for a voluntary reduction in water use of 15% from May-October. Approximately 350 acre-feet of SqCWD's total 460 acre-feet annual reduction from the Water Year 2005-2008 average was achieved between May and the end of September, 2009. In addition to the voluntary curtailment, economic conditions that resulted in both residential and commercial vacancies or reduced use and completed water demand offsets for which the corresponding development had not been completed also contributed to the reduced demand.

Starting in Water Year 2005, SqCWD has pumped no greater than 2% higher than its pumping goal of 4,800 acre-feet per year as stated in the GMP. This goal has been met after averaging 5,375 acre-feet per year from Water Years 1987-2004. For available records starting in Water Year 1974, CWD has pumped no greater than 1% higher than its share of sustainable yield of 622 acre-feet per year implied in the GMP. Starting in Water Year 1995, City of Santa Cruz has pumped no greater than 2% higher than its share of sustainable yield of 576 acre-feet per year assumed in the GMP and less than the 645 acre-feet per year planned by the City for normal years according to its *Integrated Water Plan* (Gary Fiske and Associates, 2003).

However, sustainable yield estimates were re-evaluated based on modeled offshore flows required to achieve groundwater elevations protective against seawater intrusion (HydroMetrics LLC, 2009c). Using prior assumptions for recharge and consumptive use (Johnson et al., 2004), the evaluation showed that pumping goals in the GMP may not be adequate to protect the basin against seawater intrusion after the basin recovers to protective elevations. The evaluation suggested that a reasonable estimate of the annual sustainable yield in the Purisima is 500 acre-feet less than the pumping goal of 3,000 acre-feet stated in the GMP. Water Year 2009 pumping from SqCWD's wells in the Purisima were approximately 17% higher than the revised estimate. The evaluation also concluded that the GMP pumping goal of 1,800 acre-feet per year for the Aromas was at least hundreds of acre-feet too high. Uncertainty in the calculations for the Aromas led to the recommendation that the USGS model of Pajaro Valley be reviewed before evaluating the concept of sustainable yield for the Aromas. The USGS model of Pajaro Valley is due to be released in 2010.

Estimates for production by private wells and small water systems, including residential, commercial, and agricultural supply, are also shown on Figure 2-2. Estimates of approximately 2,236 acre-feet per year in the Purisima and 954 acre-feet per year in the Aromas have not been updated since Johnson et al. (2004) documented estimates based on a previous SqCWD study (Faler, 1992) and a Santa Cruz County Environmental Health Services report (Wolcott, 1999), except for more recent information provided by the Santa Cruz County Parks Department and Cabrillo College. The Parks Department provided the estimate of Polo Grounds park irrigation well pumping (Branham, 2007) and Cabrillo College provided pumping records for calendar year 2009 (2010). Figure 2-3 shows the study areas for the Purisima and Aromas used for these estimates presented in Johnson et al. (2004) and how they relate to the Soquel-Aptos groundwater management area. Table 2-1 summarizes water use estimates for the Purisima area. Table 2-2 summarizes water use estimates for the Aromas area.

Table 2-2: Estimates of Non-Water Agency Pumping in the Purisima Area

User		Estimated Water Use (AF/year)	Source	Comments
Private Urban	Residential and Commercial	124	Wolcott, 1999	may include stream diversions
	Agriculture	93		
	Seascape Golf Course	232		
Private Rural	Residential and Commercial	1,099	Wolcott, 1999	
	Agriculture	163		
Small Water Systems	Cabrillo College	75-95	Cabrillo College, 2010 and 2015	95 AF/ year based on Calendar Year 2009 assumed through WY 2013. 75 AF/year for Calendar Year 2014 assumed for WY 2014
	Other Urban	21	Ricker, 2012, Wolcott 1999	Total connections from County and water use factor from Wolcott. 19 of 24 Pot Belly Beach Club connections removed from coastal wells in 2011 estimated to reduce pumping 8 AFY
	Rural	161		Annual consumption from County OR Total connections from County and water use factor from Wolcott
Total Purisima Area		**1,988**		

Table 2-3: Estimates of Non-Water Agency Pumping in the Aromas Area

User		Estimated Water Use (AF/year)	Source	Comments
	Polo Grounds Park	0	Branham, 2007	30 AFY to irrigate Park through 2011 prior to conversion to municipal well
Private Rural	Residential and, Commercial	601	HydroMetrics WRI and Kennedy/Jenks 2014	Calculated from GIS study of land use by parcel and water use factors from Wolcott
	Agriculture	373		
Small Water Systems	Rural	108	Ricker, 2012, Wolcott 1999, Faler 1992	Annual consumption from County OR Annual consumption from Faler OR Total connections compiled by County and water use factor from Wolcott
Total Aromas Area		**1,082**		

Water use factor from Wolcott is 0.442 AFY/connection.

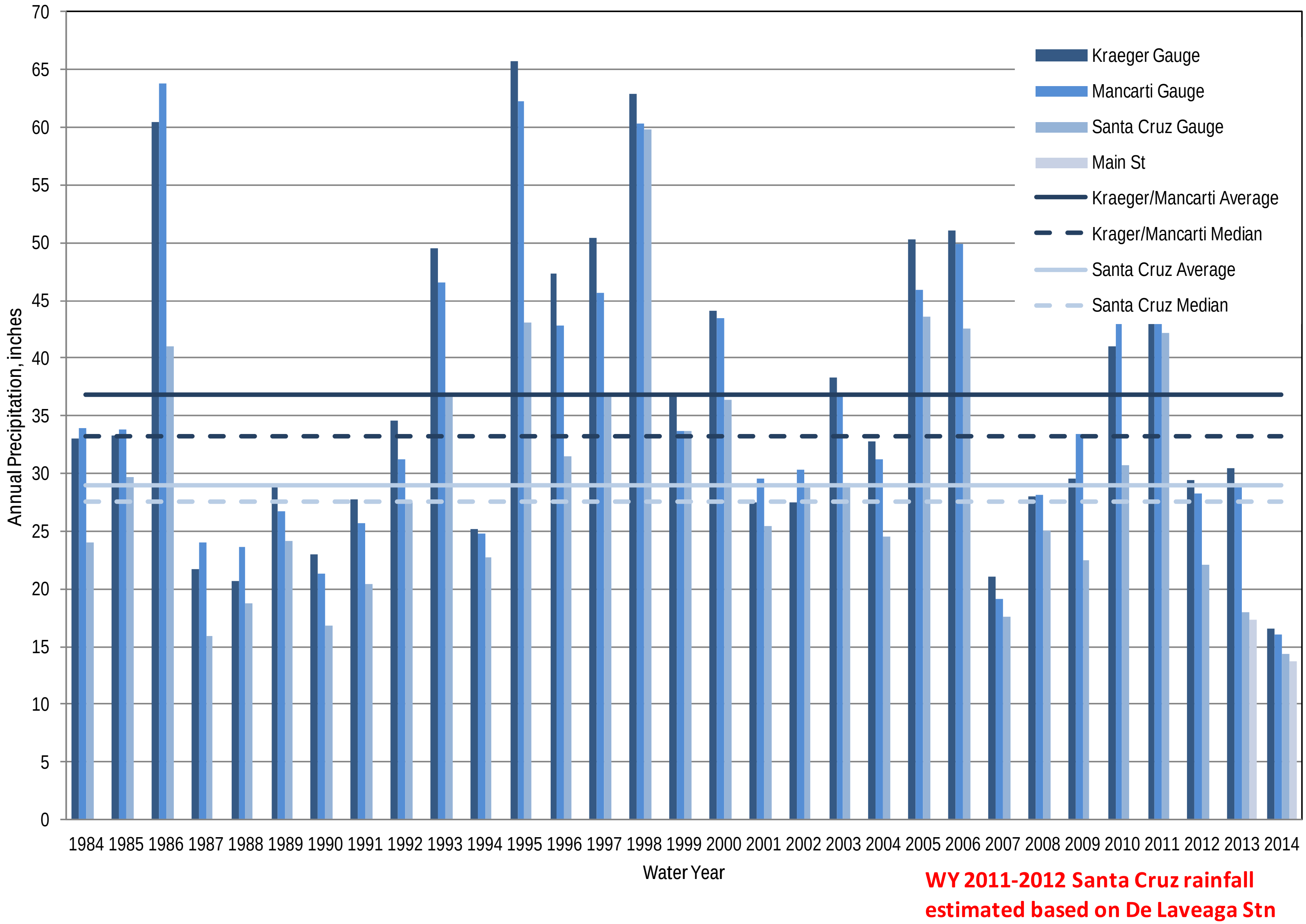

Figure 2-1: Precipitation at Kraeger, Mancarti, Santa Cruz Co-op, and Main Street Gauges

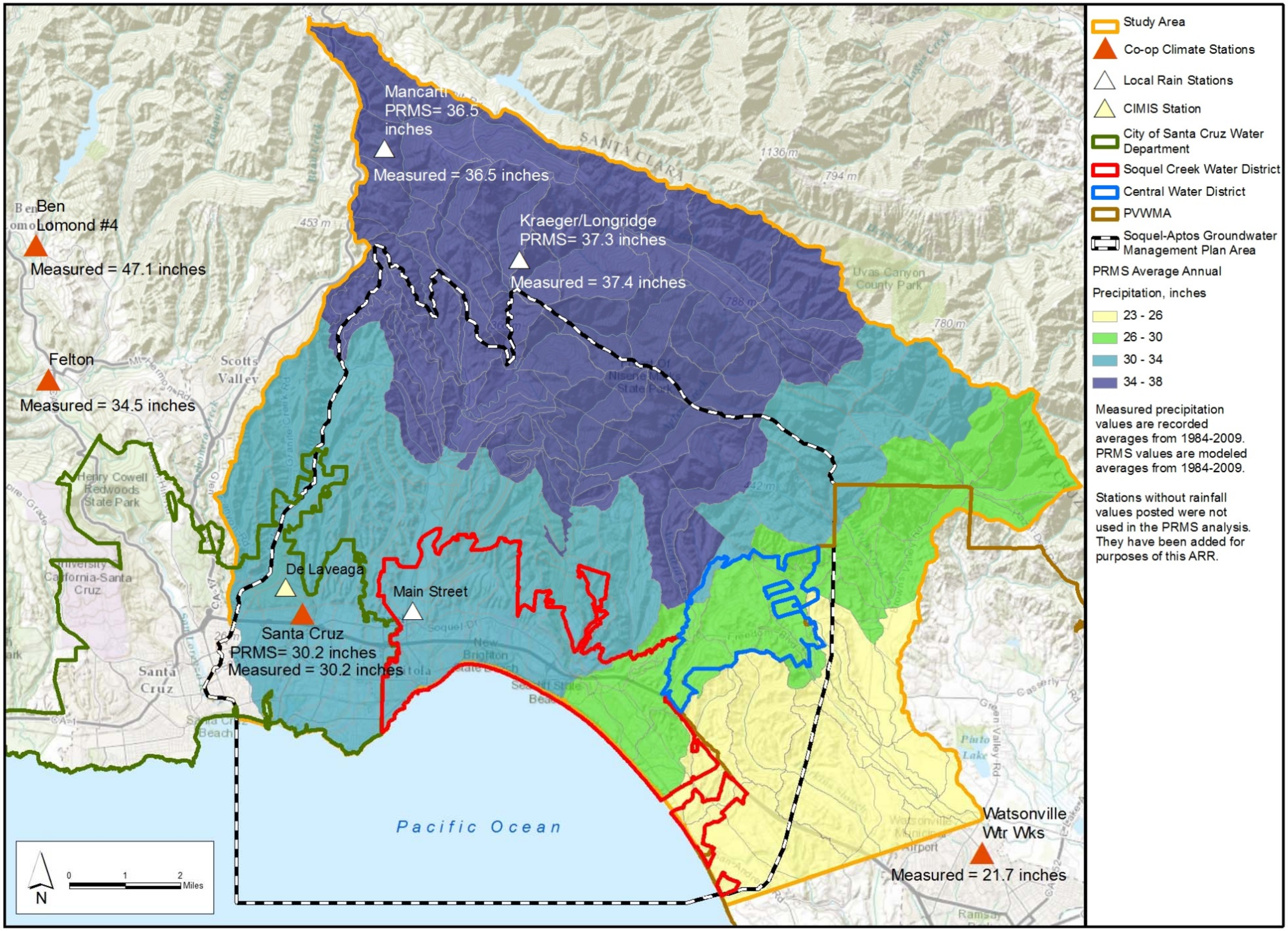

Figure 2-2: Rainfall Station Locations

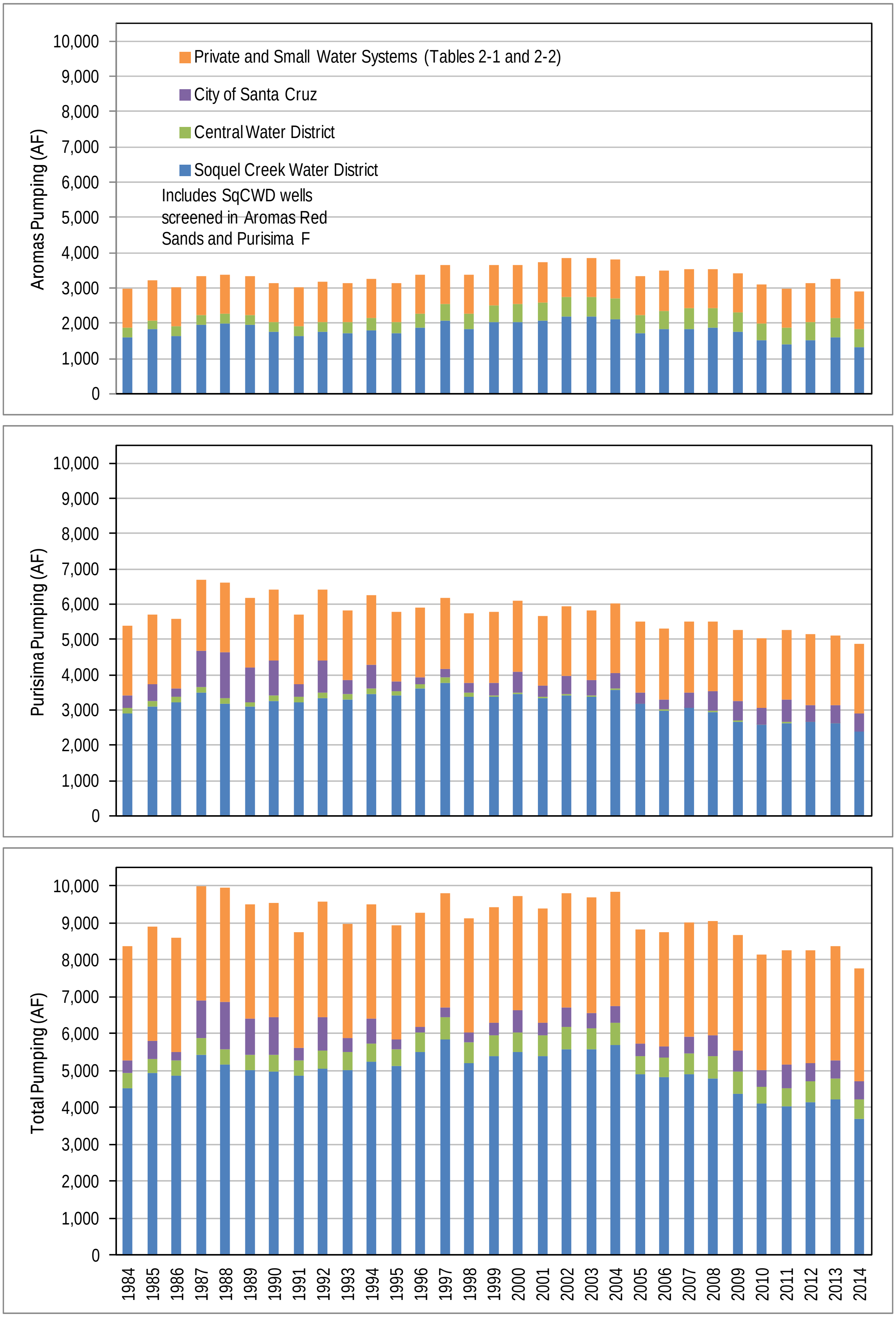

Figure 2-3: Pumping by Water Year in Acre-Feet

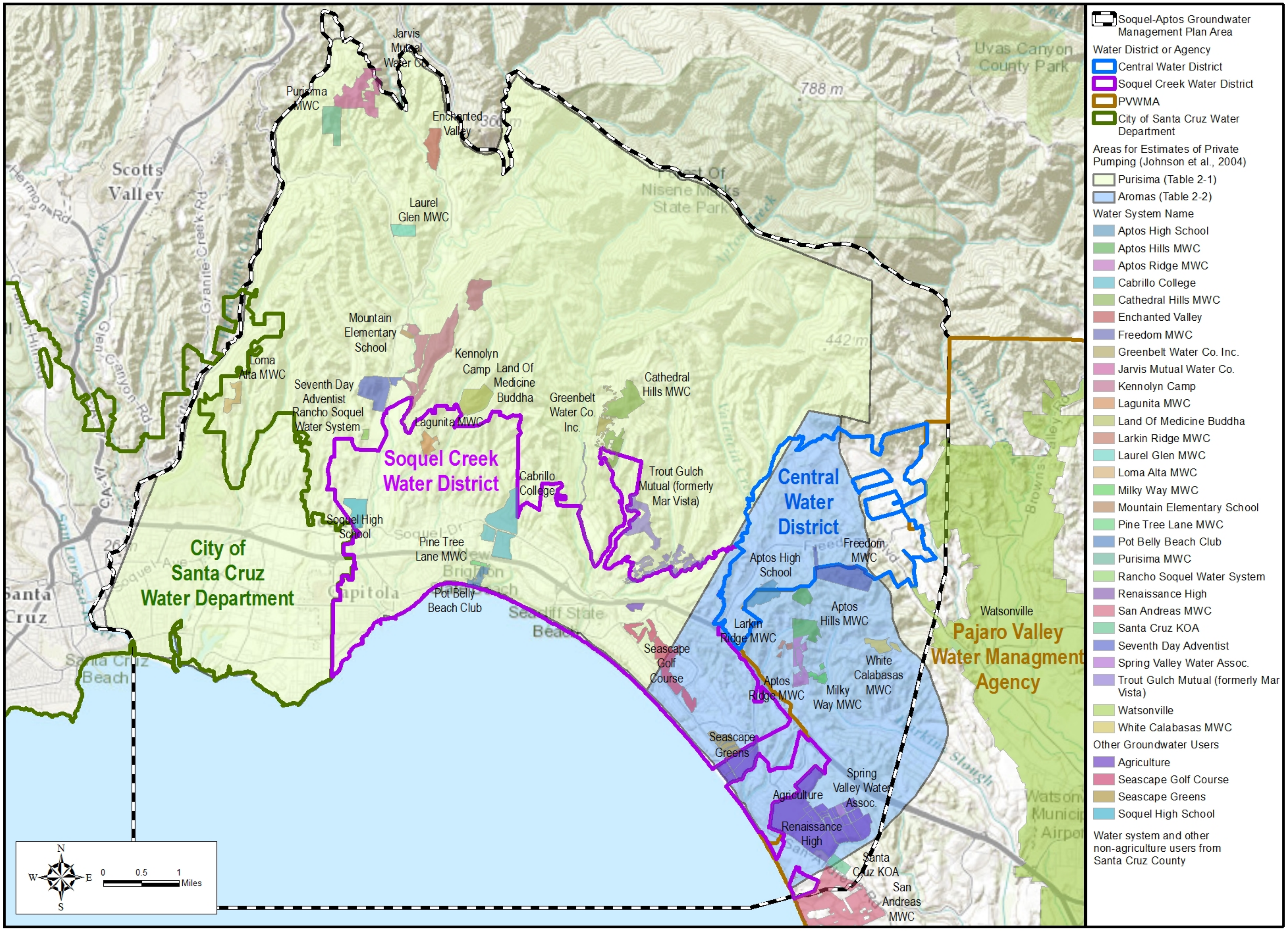

Figure 2-4: Study Areas for Estimating Private Pumping and Locations of Small Water Systems

HydroMetrics WRI

SECTION 3 - WATER YEAR 2014 AQUIFER CONDITIONS FOR WESTERN PURISIMA AREA (A/AA/TU-UNITS)

This section presents groundwater level and water quality conditions for Water Year 2014 in the western portion of the Soquel-Aptos area where the primary production aquifers are the Purisima A-unit, the Purisima AA-unit, and the sub-Purisima Tu-unit.

3.1 SQCWD SERVICE AREA I AND CITY OF SANTA CRUZ ANNUAL PRODUCTION

In the western portion of the Soquel-Aptos area, groundwater is produced for municipal purposes by SqCWD in its Service Area I and the City of Santa Cruz from its Live Oak well field. SqCWD's Estates well in Service Area II to the east is also partially completed in the A-unit.

SqCWD's Service Area I production was 1,618 acre-feet in Water Year 2014, the lowest annual amount since service area data have been recorded starting in 1984. Production in Service Area I has been below the historical average since Water Year 2004. Water Year 2014 pumping in Service Area I was approximately 56% of the SqCWD's revised estimate of its post-recovery pumping yield for the Purisima area (HydroMetrics WRI, 2012). Water Year 2014 production at the Estates well in Service Area II was 236 acre-feet. This is the third-lowest amount since the well was brought online in 1986, only higher than the previous two water years; production at the Estates well in each of the last six years was lower than all years since 1991.

The City of Santa Cruz's production from the Live Oak well field was 511 acre-feet in Water Year 2014. However, the City's pumping season spans two water years as the pumping season typically extends from April-May to November-December so the City manages pumping based on calendar year totals. In critically dry years such as 2014, the City increases its groundwater pumping due to reductions in its surface water supply. The City's pumping in calendar year 2014 was 616 acre-feet, less than its planned maximum of 645 acre-feet per year during critically dry years (SqCWD and City, 2015).

The City of Santa Cruz's groundwater production depends on availability of its surface water supply resulting in larger annual variation in groundwater production than SqCWD. For calendar years 2008 to 2014, City production ranged from 473 to 615 acre-feet per year with an average of 532 acre-feet per year.

Figure 3-1 shows production at SqCWD wells in Service Area I, the Estates well, and the City's Live Oak well field by water year.

3.2 GROUNDWATER LEVEL CONDITIONS AND TRENDS

SqCWD has established protective groundwater elevations in coastal monitoring wells to protect the Purisima A-unit in the western portion of the Soquel-Aptos area from seawater intrusion. Cross-sectional models were used to estimate groundwater elevations that result in the long term freshwater-salt water interface in the Purisima A-unit being seaward of the coast (HydroMetrics LLC, 2009b).

In Water Year 2014, average coastal groundwater levels in two of the three SqCWD A-unit monitoring wells remained below protective elevations, as shown in Table 3-1.
Figure 3-2 shows the hydrograph of groundwater levels at SC-1A based on logger data used in the calculation of the annual average. Due to a revision in surveyed reference elevations, average groundwater levels at SC-1A have been above the protective elevation in more years than previously thought, although they had been below the protective elevation in eight of nine water years from 2001 to 2009. Average groundwater levels have been above protective elevations starting in Water Year 2010. These groundwater levels coincide with lower pumping at the Garnet well; annual pumping ranged from 132 to 325 acre-feet in Water Years 2010 to 2013, the lowest four years since Water Year 1997. Water Year 2014 pumping of 132 acre-feet was the lowest annual amount and the average groundwater level at SC-1A was the highest level since the Garnet well came online in 1996.

Groundwater levels at SC-3A and SC-5A did not meet protective elevations to protect against seawater intrusion in Water Year 2014.
Figure 3-2 shows the hydrograph of groundwater levels at SC-3A based on logger data. The hydrographs at the end of the section show that average

groundwater levels have been below protective elevations for the entire period of record at SC-3A and SC-5A.

Table 3-1 (2014): Comparison of Water Year 2014 Coastal Groundwater Levels with Protective Levels in Western Purisima Area

Unit A Well	Location	Minimum Groundwater Elevation[1] (feet msl)[2]	Maximum Groundwater Elevation (feet msl)	Average Groundwater Elevation (feet msl)	Protective or Target Elevation (feet msl)
SC-1A[4]	Prospect	5.8	11.8	8.8	4
SC-3A[5]	Escalona	0.6	12.0	7.0	10
SC-5A[6]	New Brighton	-2.6	6.5	3.1	13
Moran Lake Medium[7]		4.5	5.8	5.0	5.0[3]
Soquel Point Medium[7]		3.8	6.1	4.8	6.0[3]
Pleasure Point Medium[7]		4.5	9.0	6.3	6.1[3]

[1] Based on monthly data except where noted
[2] msl = mean sea level
[3] Target elevations in cooperative groundwater management agreement for non-critically dry years (SqCWD and City, 2015)
[4] Based on monthly measurements October-December and logger data from January 24-September 30, 2014
[5] Based on logger data for full water year
[6] Based on four months of sounding data: October, January, April, and July
[7] Multiple sounding measurements in a month were averaged before calculating annual average.

The cooperative groundwater management agreement between the City and SqCWD (2015) lists annual averages of 5.0-6.1 feet msl as target groundwater elevations for its coastal monitoring wells at Pleasure Point, Soquel Point, and Moran Lake during non-critically dry years. Groundwater levels from the Medium completion of these well clusters are used because it is the deepest completion in the A unit, which is the primary aquifer supplying the Live Oak well field, and it has lower groundwater levels than the Deep completion in the AA unit. For all years including critically dry years, the cooperative groundwater management agreement lists 2 feet msl as minimum groundwater elevations based on 90 day running averages. The City defines critically dry years as years with less than 29,000 acre-feet runoff at the Felton gauge on the San Lorenzo River (City of Santa Cruz, 2009). The hydrographs for these wells identify when water years were classified as critically dry and the groundwater elevation used for management would have been the minimum quarterly average of 2 feet msl.

Water Year 2014 was critically dry, and the annual average elevations for the City of Santa Cruz coastal monitoring wells were 4.8-6.3 feet msl. Even though 2014 was critically dry Table 3-1 compares annual averages to the non-critically dry year target elevation, as that is the long-term target and facilitates comparison from year to year. The average groundwater level in the Soquel Point well continued to be below the City's target elevation as it has been since Water Year 2008. The average groundwater levels in the Moran Lake and Pleasure Point wells continued to be at or above the City's target elevation in Water Year 2014. The lack of change in this status may be due to City pumping for the water year not being increased with pumping increases being realized after September 30, 2014. Minimum groundwater elevations were above the 2 foot threshold for a critically dry year. For Water Year 2014 average groundwater levels in the Moran Lake well have been at or above the target elevation since the well was installed in 2004. Average groundwater levels in the Pleasure Point well have been above the target elevation the last five years after falling below the target elevation in Water Year 2009. Combined Beltz #7/#10 and #8 well pumping has been between 211 and 316 acre-feet per year for the last five water years after being between 383 and 411 acre-feet per year for the previous three water years.

Table 3-2 summarizes the important groundwater level trends by monitoring well. Changes to trends in WY 2014 include:

- Continued decline in groundwater levels at SC-3A though there was a slight recovery during summer and fall months coinciding with lower production than usual during those months (
- Figure 3-2)
- Steady groundwater elevation trend at SC-5A following a decline in Water Year 2013, when there was an increase in Service Area I pumping
- Some evidence of recovery at inland monitoring wells following declines observed in Water Year 2013; groundwater elevation rose over 10 feet at SC-18AA in Water Year 2014, likely due to a reduced pumping at the Main Street well with the well offline for much of the year.

Table 3-2 (2014): Summary of Groundwater Level Trends in Western Purisima Area

Category	Well	Groundwater Level Trend Description	Notes
SqCWD Coastal Monitoring A-unit Wells	SC-1A	Long-term increasing trend, but decline of ~7 feet since WY 2013 following abrupt rise	Increased pumping at Garnet from WY 2013-2014
	SC-3A	Decline of ~5 feet from WY 2010-2014	Increased pumping at Rosedale in WY 2011-2014 vs. WY 2009-2010
	SC-5A	Slight decline since WY 2012	Pumping from Estates and Tannery II increased since WY 2011
City of Santa Cruz Coastal A and AA-unit Wells	Moran Lake Soquel Point	Slight decline since WY 2006	Increased pumping at Beltz #9 WY 2008-2013 compared to WY 1999-2007
	Pleasure Point	Slight decline since WY 2010	Small increase in pumping at Beltz #8 since WY 2010, Beltz #10 pumping steady
SqCWD Coastal Monitoring B and BC-unit Wells	SC-1B	Decline of ~8 feet since WY 2011, overall downward trend since WY 1998	Lower precipitation in WY 2012-2014 compared to WY 2010-2011. Decreased rainfall since WY 1998
	SC-3C	Long term downward trend, decline of ~5 feet since WY 2010	Lower precipitation in WY 2012-2014 compared to WY 2010-2011
Inland A and AA unit wells	Coffee Lane Park	Decline since WY 2011 after rise WY 2010-2011	None
	Auto Plaza Drive	Steady since WY 2011	None
	Cory Street	Decline ~10 ft in WY 2013, some recovery through 2014 before test	None
	SC-18A	~20 foot rise in WY 2014	Main St pumping offline much of WY 2014
	SC-10AA	Steady since WY 2012	None
Tu-(or SM) unit Wells	Beltz #7 Test	10+ foot rise since 2004	None
	SC-18AA	Overall rise since WY 2001	Decreased pumping at Main St.
	Thurber Lane Deep	Decline of ~50 feet from 2004-2012; 10+ foot rise since 2012	None

Hydrographs for multiple completions of these wells follow at the end of this section. Hydrographs for multiple completions of monitoring wells adjacent to production wells are also included following this section.

Hydrographs for single wells including production wells are included with chemographs. These hydrographs show trend lines and rates of change for Water Years 2010-2014 when municipal production for the Western Purisima has been below historical averages.

Contour maps of groundwater elevations in Spring and Fall 2014 for the Purisima A-unit and AA-unit are shown in Figure 3-3 and Figure 3-4. Figure 3-3 shows that spring coastal groundwater levels in the A-unit were generally higher than SqCWD's protective elevation and the City's target elevations in the western half of the western Purisima area, with a local depression inland of the coast around the Rosedale well. Figure 3-3 shows that fall coastal groundwater levels in the A-unit were lower than protective or target elevations in much of the area, with a pumping depression inland of the coast resulting in groundwater elevations below sea level extending from the Maplethorpe well to the Estates well in the eastern portion of the A-unit. The area of pumping depressions below sea level was smaller in Fall 2014 than Fall 2013 when the area of groundwater levels below sea level extended to the coast at SC-5A and SC-9A.
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As inferred from the contour maps, groundwater flows towards a large pumping depression around SqCWD's production wells. Groundwater flows from inland toward the coast to be intercepted by the City of Santa Cruz's production wells in the most western portion of the Purisima area. The contour maps indicate significant flow from the northwest consistent with outcrop areas for the A and AA- units being towards the north and west (Johnson et al., 2004).

Figure 3-5 and Figure 3-6 show spring and fall groundwater levels in the Tu unit below the Purisima Formation as snapshots of conditions before SqCWD's O'Neill Ranch and the City's Beltz 12 well come online in 2015. Flow tests at these wells indicate significant flow in these wells comes from the Tu unit (also called the SM unit as it may be Santa Margarita formation), but pumping tests at these wells showed slow recovery so monitoring groundwater levels in the Tu unit will be important for assessing the reliability of supply from these wells. Figure 3-5 and Figure 3-6 show that fall groundwater levels were higher than spring groundwater levels in the Tu unit for Water Year 2015. Data from previous years show this is an atypical seasonal pattern. The pattern for Water Year 2014 may be related to the Main Street well being offline the second half of

Water Year 2014 and/or continued recovery from pump testing at the O'Neill Ranch and Beltz #12 wells in 2012 and 2013. As shown in Table 3-2 and hydrographs following this section, there has been a rise in groundwater levels in Tu unit wells over at least the last 2-3 years.

3.3 WATER QUALITY CONDITIONS AND TRENDS

The most significant groundwater quality threat in the Soquel-Aptos basin is seawater intrusion. As discussed above, average groundwater levels were below protective and target elevations in three of six coastal monitoring wells in the A-unit as of Fall 2014. As a result, there is ongoing risk of seawater intrusion into the productive units of the western Purisima area.

Observed Total Dissolved Solids (TDS) and chloride concentrations in production wells do not suggest any seawater intrusion impacting SqCWD's production wells in the Purisima A and AA-units and sub-Purisima Tu-unit. Observed TDS and chloride concentrations in SqCWD's monitoring wells also do not indicate incipient seawater intrusion. The maximum contaminant limit (MCL) for chlorides is 250 mg/L and recent chloride concentrations in both production and monitoring wells have been below 100 mg/L or less except for a one-time measurement at SC-3RC in April 2010 (wells replacing SC-3 wells at Escalona in 2009 were labeled SC-3R). Chemographs for SqCWD wells in the area are included at the end of this section.

Higher chlorides and TDS concentrations were observed in Water Year 2013 at SC-1A than previous years, but the trend for these constituents appears to have stabilized in Water Year 2014. A previous evaluation of the general mineral composition concluded that there was no consistent indication of seawater intrusion (HydroMetrics WRI, 2014). These elevated salt concentrations continued to be coincident with relatively high groundwater elevations at this well. At wells where chloride concentrations are less than 100 mg/L, there is generally no correlation between changes in salt concentrations and groundwater levels.

TDS and chloride concentrations at two City of Santa Cruz monitoring wells near the coast have suggested seawater intrusion. Chloride concentrations in the Medium completion (A-unit) of the Moran Lake well cluster have steadily decreased from a maximum of 700 mg/L in 2005 to below 250 mg/L in 2012 for the first time since measurements began in 2004. Chloride concentrations in the

Medium completion (A-unit) of the Soquel Point well cluster have remained relatively stable above 1,100 mg/L starting in 2005. Chloride concentrations in the Deep completion (AA-unit) of the Soquel Point well cluster have shown an increasing trend from 67 mg/L to 130 mg/L since 2004. The City replaced the Deep Soquel Point well in 2012 due to concerns about whether water quality data from the well were representative, but samples from the replacement well in 2013 confirm the increasing trend in chloride concentrations

Groundwater pumped from the Purisima formation continues to be treated for iron and manganese to meet drinking water standards. In Water Year 2014, color and turbidity were also reduced during treatment to meet drinking water standards.

3.4 STATE OF THE AQUIFER SUMMARY

Seawater intrusion has not been detected in most of the Western Purisima area. However, the productive Purisima A and AA-units remain at risk for seawater intrusion as coastal groundwater levels remain below SqCWD's protective elevations or the City's target elevations in three of the six coastal monitoring well locations. There has been lower overall production in Service Area I over the last eight years versus the historical average, but changes in pumping distribution has led to groundwater level trends varying by location. In the summer and fall of 2014, there was some recovery at the coastal wells that is atypical for the season likely related to lower pumping from drought curtailment. A longer period of low production with adaptive management of the pumping distribution will be required to fully recover the basin to protect against the risk of seawater intrusion.

SqCWD and the City have installed inland production wells (O'Neill Ranch and Beltz #12) that will extract primarily from the Tu unit. Groundwater levels measured during testing of these wells indicate recharge rate of the Tu unit may be limited so active management of pumping these wells based on groundwater levels in the Tu unit will be needed when these wells come online.

SECTION 3 - WATER YEAR 2013 AQUIFER CONDITIONS FOR WESTERN PURISIMA AREA (A/AA/TU-UNITS)

This section presents groundwater level and water quality conditions for Water Year 2013 in the western portion of the Soquel-Aptos area where the primary production aquifers are the Purisima A-unit, the Purisima AA-unit, and the sub-Purisima Tu-unit.

3.1 SQCWD SERVICE AREA I AND CITY OF SANTA CRUZ ANNUAL PRODUCTION

In the western portion of the Soquel-Aptos area, groundwater is produced for municipal purposes by SqCWD in its Service Area I and the City of Santa Cruz from its Live Oak well field. SqCWD's Estates well in Service Area II to the east is also partially completed in the A-unit.

SqCWD's Service Area I production was 2,013 acre-feet in Water Year 2013, the seventh lowest annual amount since service area data have been recorded starting in 1984, but the highest in the last seven years. Production in Service Area I over the last nine years has been below the historical average. Water Year 2013 pumping in Service Area I was approximately 72% of the SqCWD's revised estimate of its post-recovery pumping yield for the Purisima area (HydroMetrics WRI, 2012). Water Year 2013 production at the Estates well in Service Area II was 221 acre-feet, the lowest amount since the well was brought online in 1986. Production at the Estates well in each of the last five years was lower than all years since 1991.

The City of Santa Cruz's production from the Live Oak well field was 515 acre-feet in Water Year 2013. However, the City's pumping season spans two water years as the pumping season typically extends from April-May to November-December so the City manages pumping based on calendar year totals. The City's pumping in calendar year 2013 was 524 acre-feet, which is similar to the City's planned maximum groundwater production during non-critically dry years such as 2013 of 525 acre-feet per year (Chambers Group, 2011). The planned pumping of 525 acre-feet per year is based on average annual production by the City since 1984.

The City of Santa Cruz's groundwater production depends on availability of its surface water supply resulting in larger annual variation in groundwater production than SqCWD. For calendar years 2008 to 2013, City production ranged from 473 to 548 acre-feet per year with an average of 517 acre-feet per year.

Figure 3-1 shows production at SqCWD wells in Service Area I, the Estates well, and the City's Live Oak well field by water year.

3.2 GROUNDWATER LEVEL CONDITIONS AND TRENDS

SqCWD has established protective groundwater elevations in coastal monitoring wells to protect the Purisima A-unit in the western portion of the Soquel-Aptos area from seawater intrusion. Cross-sectional models were used to estimate groundwater elevations that result in the long term freshwater-salt water interface in the Purisima A-unit being seaward of the coast (HydroMetrics LLC, 2009b).

In Water Year 2013, average coastal groundwater levels in two of the three SqCWD A-unit monitoring wells remained below protective elevations, as shown in Table 3-1. Due to a revision in surveyed reference elevations, average groundwater levels at SC-1A have been above the protective elevation in more years than previously thought, although they had been below the protective elevation in eight of nine water years from 2001 to 2009. Average groundwater levels have been above protective elevations starting in Water Year 2010. These groundwater levels coincide with lower pumping at the Garnet well; Annual pumping ranged from 132 to 325 acre-feet in Water Years 2010 to 2013, the lowest four years since Water Year 1997. Water Year 2013 pumping of 132 acre-feet was the lowest annual amount and the average groundwater level at SC-1A was the highest level since the Garnet well came online in 1996.

Groundwater levels at SC-3A and SC-5A did not meet protective elevations to protect against seawater intrusion in Water Year 2013. The hydrographs at the end of the section show that average groundwater levels have been below protective elevations for the entire period of record at SC-3A and SC-5A.

Table 3-1 (2013): Comparison of Water Year 2013 Coastal Groundwater Levels with Protective Levels in Western Purisima Area

Unit A Well	Location	Minimum Groundwater Elevation[1] (feet msl)[2]	Maximum Groundwater Elevation (feet msl)	Average Groundwater Elevation (feet msl)	Protective or Target Elevation (feet msl)
SC-1A	Prospect	3.7	14.9	10.1	4
SC-3A[4]	Escalona	1.8	6.710.2	4.8	10
SC-5A[5]	New Brighton	-1.0	7.8	2.8	13
Moran Lake Medium		4.8	6.3	5.5	5.0[3]
Soquel Point Medium		4.2	6.8	5.3	6.0[3]
Pleasure Point Medium		4.6	9.2	7.0	6.1[3]

[1] Based on monthly data except where noted

[2] msl = mean sea level

[3] Target elevations proposed by City of Santa Cruz (Almond, 2012)

[4] Based on seven months of data: October, December, February, and April-July.

[5] Based on six months of data: October, December, February, and April, June, and July

The City of Santa Cruz has proposed annual averages of 5.0-6.1 feet msl as target groundwater elevations for its coastal monitoring wells at Pleasure Point, Soquel Point, and Moran Lake during non-critically dry years. For critically dry years, the City has proposed minimum quarterly averages of 2 feet msl as target groundwater elevations for its three coastal monitoring wells (Almond, 2012). The City defines critically dry years as years with less than 29,000 acre-feet runoff at the Felton gauge on the San Lorenzo River (City of Santa Cruz, 2009). The hydrographs for these wells identify when water years were classified as critically dry and the target groundwater elevation would have been the minimum quarterly average of 2 feet msl.

Water Year 2013 was not critically dry; and the target elevations for the City of Santa Cruz coastal monitoring wells were 5.0-6.1 feet msl. As shown on Table 3-1, the average groundwater level in the Soquel Point well was below the City's target elevation, while the average groundwater levels in the Moran Lake and Pleasure Point wells were above the City's target elevation in Water Year 2013. Due to a revision in surveyed reference elevations, groundwater levels in the Soquel Point well have been higher than previously thought, but average groundwater levels have still been below target elevations since Water Year 2008. Average groundwater levels in the Moran Lake well have been above the target elevation since the well was installed in 2004. Average groundwater levels in the Pleasure Point well have been above the target elevation the last four years after falling below the target elevation in Water Year 2009. Combined Beltz #7/#10 and #8 well pumping has been between 211 and 316 acre-feet per year for the last four years after being between 383 and 411 acre-feet per year for the previous three years. Groundwater levels from the Medium completion of these well clusters are used because it is the deepest completion in the A unit, which is the primary aquifer supplying the Live Oak well field, and it has lower groundwater levels than the Deep completion in the AA unit.

Table 3-2 summarizes the important groundwater level trends by monitoring well. Changes to trends in WY 2013 include:

- Decline in groundwater levels at SC-3A and SC-5A in WY 2013 though the long term trend is rising. SqCWD service area I pumping was increased in WY 2013.
- A decline of groundwater levels at inland monitoring wells. Groundwater levels at City of Santa Cruz Coffee Lane Park, Auto Plaza Drive, and Cory Street declined over WY 2013 with Cory Street groundwater levels dropping approximately 10 feet from WY 2012. Although the City's 30th Avenue and SqCWD's SC-22 wells were only installed in 2012 and there is not much of a previous record for comparison, there were declines in groundwater levels at those wells over WY 2013 also. There were several pumping tests at the City's newly constructed Beltz 12 well near Cory Street during October-November 2012 and August 2013 but this may not fully explain the decline that is consistent from month to month. Monitoring of the O'Neill well during the August 2013 test showed slow recovery. The recently constructed O'Neill well and Beltz 12 well are expected to extract mostly from the sub-Purisima Tu unit. The long-term recharge rate of the Tu unit may be limited.

Hydrographs for multiple completions of these wells follow at the end of this section. Hydrographs for multiple completions of monitoring wells adjacent to production wells are also included following this section.

Hydrographs for single wells including production wells are included with chemographs. These hydrographs show trend lines and rates of change for Water Years 2009-2013 when municipal production for the Western Purisima has been below historical averages.

Contour maps of groundwater elevations in Spring and Fall 2012 for the Purisima A-unit and AA-unit are shown in Figure 3-2 and Figure 3-3. Figure 3-2 shows that spring coastal groundwater levels in the A-unit were higher than SqCWD's protective elevation and the City's target elevations in the western half of the western Purisima area, but Figure 3-3 shows that fall coastal groundwater levels in the A-unit were lower than protective or target elevations in much of the area. Figure 3-3 shows Fall 2013 pumping depressions below sea level extending from the Maplethorpe well to the Estates well in the eastern portion of the A-unit, and included a portion of the coast. The area of pumping depressions below sea level was similar to Fall 2012.

As inferred from the contour maps, groundwater flows towards a large pumping depression around SqCWD's production wells and a smaller pumping depression around the City of Santa Cruz's production wells. The contour maps indicate significant flow from the northwest consistent with outcrop areas for the A and AA- units being towards the north and west (Johnson et al., 2004).

Table 3-2 (2013): Summary of Groundwater Level Trends in Western Purisima Area

Category	Well	Groundwater Level Trend Description	Notes
SqCWD Coastal Monitoring A-unit Wells	SC-1A	Rise of 6 feet from WY 2009 to WY 2013.	Reduced pumping at Garnet
	SC-3A	Decline of ~4 feet from WY 2010-2013	Increased pumping at Rosedale in WY 2011-2013 vs. WY 2009-2010
	SC-5A	Long-term increasing trend, but decline of 3 feet in WY 2013 from Wy 2012	No substantial change in Estates and Tannery II pumping in WY 2013, but Service Area I pumping increased
City of Santa Cruz Coastal A and AA-unit Wells	Moran Lake	Decline since WY 2006	Increased pumping at Beltz #9 WY 2008-2013 compared to WY 1999-2007
	Soquel Point	Steady since WY 2009	
	Pleasure Point	Rise WY 2010-2013	Reduced pumping at Beltz #8 and #10 WY 2010-2013 compared to WY 2007-2009
SqCWD Coastal Monitoring B and BC-unit Wells	SC-1B SC-3C	Decline of 5-10 feet in overlying unit since WY 1998	Decreased rainfall since WY 1998
		Decline since WY 2011 after slight rise WY 2010-2011	Lower precipitation in WY 2012-2013 compared to WY 2010-2011
Inland A and AA unit wells	Coffee Lane Park	Decline since WY 2011 after rise WY 2010-2011	None
	Auto Plaza Drive	Decline over WY 2013	None
	Cory Street	Decline ~10 ft in WY 2013	Testing of Beltz 12 well Oct-Nov 2012 and Aug 2013
Inland AA and Tu-unit Wells	SC-10AA	Decline of 5-10 feet in inland AA-unit since WY 2002; Steady in WY 2012-2013	None
	Thurber Lane Deep	Decline of 50 feet in inland Tu-unit since WY 2005; Slight decline WY 2009-2013	None

3.3 WATER QUALITY CONDITIONS AND TRENDS

The most significant groundwater quality threat in the Soquel-Aptos basin is seawater intrusion. As discussed above, average groundwater levels generally remain below protective elevations in the A-unit. As a result, there is ongoing risk of seawater intrusion into the productive units of the western Purisima area.

Observed Total Dissolved Solids (TDS) and chloride concentrations in production wells do not suggest any seawater intrusion impacting SqCWD's production wells in the Purisima A and AA-units and sub-Purisima Tu-unit. Observed TDS and chloride concentrations in SqCWD's monitoring wells also do not indicate incipient seawater intrusion. The maximum contaminant limit (MCL) for chlorides is 250 mg/L and recent chloride concentrations in both production and monitoring wells have been below 100 mg/L or less except for a one-time measurement at SC-3RC in April 2010 (wells replacing SC-3 wells at Escalona in 2009 were labeled SC-3R). Chemographs for SqCWD wells in the area are included at the end of this section.

Higher chlorides and TDS concentrations were observed in Water Year 2013 at SC-1A than previous years. However, an evaluation of the general mineral composition concluded that there was no consistent indication of seawater intrusion (HydroMetrics WRI, 2014). Another indication that seawater intrusion is not occurring is the higher salt concentrations coincided with higher groundwater levels at SC-1A. At wells where chloride concentrations are less than 100 mg/L, there is generally no correlation between changes in salt concentrations and groundwater levels.

TDS and chloride concentrations at two City of Santa Cruz monitoring wells near the coast have suggested seawater intrusion. Chloride concentrations in the Medium completion (A-unit) of the Moran Lake well cluster have steadily decreased from a maximum of 700 mg/L in 2005 to below 250 mg/L in 2012 for the first time since measurements began in 2004. Chloride concentrations in the Medium completion (A-unit) of the Soquel Point well cluster have remained relatively stable above 1,100 mg/L starting in 2005. Chloride concentrations in the Deep completion (AA-unit) of the Soquel Point well cluster have shown an increasing trend from 67 mg/L to 130 mg/L since 2004. The City replaced the Deep Soquel Point well in 2012 due to concerns about whether water quality data from the well were representative, but samples from the replacement well in 2013 confirm the increasing trend in chloride concentrations

Groundwater pumped from the Purisima formation continues to be treated for iron and manganese to meet drinking water standards. In Water Year 2013, color and turbidity were also reduced during treatment to meet drinking water standards.

3.4 State of the Aquifer Summary

Seawater intrusion has not been detected in most of the Western Purisima area. However, the productive Purisima A and AA-units remain at risk for seawater intrusion as coastal groundwater levels remain below SqCWD's protective elevations or the City's target elevations in three of the six coastal monitoring well locations. There has been lower overall production in the last seven years versus the historical average. However, increased production in WY 2013 compared to the previous six years resulted in some groundwater level declines at wells in the Purisima A and AA-units. A longer period of low production with adaptive management of the pumping distribution will be required to recover the basin to protect against the risk of seawater intrusion.

SqCWD and City have installed inland production wells (O'Neill Ranch and Beltz #12) that will extract primarily from the Tu unit. Groundwater levels measured during testing of these wells indicate recharge rate of the Tu unit may be limited so active management of pumping these wells based on groundwater levels in the Tu unit will be needed when these wells come online.

SECTION 3 - WATER YEAR 2012 AQUIFER CONDITIONS FOR WESTERN PURISIMA AREA (A/AA/TU-UNITS)

This section presents groundwater level and water quality conditions for Water Year 2012 in the western portion of the Soquel-Aptos area where the primary production aquifers are the Purisima A-unit, the Purisima AA-unit, and the sub-Purisima Tu-unit.

3.1 SQCWD SERVICE AREA I AND CITY OF SANTA CRUZ ANNUAL PRODUCTION

In the western portion of the Soquel-Aptos area, groundwater is produced for municipal purposes by SqCWD in its Service Area I and the City of Santa Cruz from its Live Oak well field. SqCWD's Estates well in Service Area II to the east is also partially completed in the A-unit.

SqCWD’s Service Area I production was 1,971 acre-feet in Water Year 2012, the sixth lowest annual amount since service area data have been recorded starting in 1984, but the highest in the last five years. Production in Service Area I over the last eight years has been below the historical average. Water Year 2012 pumping in Service Area I was approximately 70% of the SqCWD's revised estimate of its post-recovery pumping yield for the Purisima area (HydroMetrics WRI, 2012). Water Year 2012 production at the Estates well in Service Area II was 229 acre-feet, the lowest amount since the well was brought online in 1986. Production at the Estates well in each of the last four years was lower than all years since 1991.

The City of Santa Cruz’s production from the Live Oak well field was 494 acre-feet in Water Year 2012. However, the City’s pumping season spans two water years as the pumping season typically extends from April-May to November-December so the City manages pumping based on calendar year totals. The City’s pumping in calendar year 2012 was 526 acre-feet, which is similar to the City’s planned future maximum groundwater production during non-critically dry years of 525 acre-feet per year (Chambers Group, 2011). The planned pumping of 525 acre-feet per year is based on average annual production by the City since 1984.

The City of Santa Cruz's groundwater production depends on availability of its surface water supply resulting in larger annual variation in groundwater production than SqCWD. For calendar years 2008 to 2012, City production ranged from 473 to 548 acre-feet per year with an average of 517 acre-feet per year.

Figure 3-1 shows production at SqCWD wells in Service Area I, the Estates well, and the City's Live Oak well field by water year.

3.2 GROUNDWATER LEVEL CONDITIONS AND TRENDS

SqCWD has established protective groundwater elevations in coastal monitoring wells to protect the Purisima A-unit in the western portion of the Soquel-Aptos area from seawater intrusion. Cross-sectional models were used to estimate groundwater elevations that result in the long term freshwater-salt water interface in the Purisima A-unit being seaward of the coast (HydroMetrics LLC, 2009b).

In Water Year 2012, average coastal groundwater levels in two of the three SqCWD A-unit monitoring wells remained below protective elevations, as shown in Table 3-1. Due to a revision in surveyed reference elevations, average groundwater levels at SC-1A have been above the protective elevation in more years than previously thought, although they had been below the protective elevation in eight of nine water years from 2001 to 2009. Average groundwater levels have been above protective elevations from Water Year 2010. These groundwater levels coincide with lower pumping at the Garnet well; annual pumping ranged from 179 to 325 acre-feet in Water Years 2010 to 2012, the lowest three years since Water Year 1997.

Although maximum groundwater levels met protective elevations at SC-3A, average groundwater levels must meet protective elevations to protect against seawater intrusion. Hydrographs for these wells follow at the end of this section. The hydrographs show that average groundwater levels have been below protective elevations for the entire period of record at SC-3A and SC-5A.

Table 3-1 (2012): Comparison of Water Year 2012 Coastal Groundwater Levels with Protective Levels in Western Purisima Area

Unit A Well	Location	Minimum Groundwater Elevation (feet msl)[1]	Maximum Groundwater Elevation (feet msl)	Average Groundwater Elevation (feet msl)	Protective or Target Elevation (feet msl)
SC-1A	Prospect	6.8	12.1	8.3	4
SC-3A	Escalona	5.5	10.2	8.0	10
SC-5A	New Brighton	1.4	9.1	6	13
Moran Lake Medium		4.4	6.1	5.4	5.0[2]
Soquel Point Medium		4.2	6.8	5.4	6.0[2]
Pleasure Point Medium		5.4	10.3	7.9	6.1[2]

[1] msl = mean sea level

[2] Target elevations proposed by City of Santa Cruz (Almond, 2012)

The City of Santa Cruz has proposed annual averages of 5.0-6.1 feet msl as target groundwater elevations for its coastal monitoring wells at Pleasure Point, Soquel Point, and Moran Lake during non-critically dry years. For critically dry years, the City has proposed minimum quarterly averages of 2 feet msl as target groundwater elevations for its three coastal monitoring wells (Almond, 2012). The City defines critically dry years as years with less than 29,000 acre-feet runoff at the Felton gauge on the San Lorenzo River (City of Santa Cruz, 2009). The hydrographs for these wells identify when water years were classified as critically dry and the target groundwater elevation would have been the minimum quarterly average of 2 feet msl.

Water Year 2012 was not critically dry; and the target elevations for the City of Santa Cruz coastal monitoring wells were 5.0-6.1 feet msl. As shown on Table 3-1, the average groundwater level in the Soquel Point well was below the City's target elevation, while the average groundwater levels in the Moran Lake and Pleasure Point wells were above the City's target elevation in Water Year 2012. Due to a revision in surveyed reference elevations, groundwater levels in the Soquel Point well have been higher than previously thought, but average groundwater levels have still been below target elevations since Water Year 2008. Average groundwater levels in the Moran Lake well have been above the target elevation since the well was installed in 2004. Average groundwater levels in the Pleasure Point well have been above the target elevation the last three years after falling below the target elevation in Water Year 2009. Combined Beltz #7/#10 and

#8 well pumping has been between 211 and 296 acre-feet the last two years after being between 383 and 411 acre-feet the previous three years. Groundwater levels from the Medium completion of these well clusters are used because it is the deepest completion in the A unit, which is the primary aquifer supplying the Live Oak well field, and it has lower groundwater levels than the Deep completion in the AA unit.

The groundwater levels in Table 3-1 are based on monthly measurements at the wells and do not reflect tidal variations. Loggers have been installed in the SqCWD wells to monitor the tidal variation. Logger measurements from well SC-1A from 2007 and 2008 show a tidal range of approximately 5 feet. With a tidal range of this magnitude, average groundwater elevation based on monthly measurements may not be adequate for comparison with the protective elevation because the monthly measurements are dependent on measurement time and do not represent a tidal average. Monthly measurements at SC-1A for 2007 and 2008 underestimated average groundwater levels when compared to the full tidal range. Although logger data showed some tidal variation at SC-3A and SC-5A, the hydrographs show that the monthly measurements are representative of the time series. Average groundwater levels could not be calculated from logger data for Water Year 2012 as loggers were not installed for the full water year.

Groundwater levels show increasing trends since Water Year 2008 in SqCWD's coastal monitoring wells completed in the productive A-unit. The increasing trends are likely due to reduced pumping at nearby SqCWD production wells (Figure 3-1). However, groundwater level rises at SC-3A and SC-5A leveled off in Water Year 2012 with increases in pumping at the Rosedale and Tannery II wells over the previous years.

Groundwater levels at the City of Santa Cruz's coastal monitoring wells completed in the A and AA-units show different recent trends depending on location. Groundwater levels at the Pleasure Point wells show an increasing trend over the last three years, coinciding with decreased pumping at Beltz #8 and #10 wells.

Groundwater levels in Water Year 2012 at the Moran Lake well continued to show a decreasing trend since Water Year 2006. Groundwater levels at the Soquel Point well show a steady trend.

Groundwater levels show declining trends since Water Year 1998 in coastal monitoring wells completed in the unconfined B and BC-units. Rainfall was higher in 1998 than in any of the subsequent eleven years. This trend therefore is consistent with a correlation between declining basin storage and reduced precipitation. After two years of groundwater levels in the B and BC units showing slight increases coincident with higher rainfall over those two years, groundwater levels in the units declined again in Water Year 2012 with lower rainfall.

Multi-year declines of at least six years have been observed in wells completed in the AA and Tu-units upgradient of the municipal production wells. However, the rate of decline of groundwater levels at the Thurber Lane Deep well has been much smaller over the last four water years (2009 to 2012) than the previous four years. After two water years with slight increases in groundwater levels, SC-10AA showed stable groundwater levels over Water Year 2012.

Monitoring wells at three locations inland of the Live Oak well field were installed in 2009. These wells at Coffee Lane Park, Cory Street, and Auto Plaza Drive, screened in the A and AA units, generally show rising groundwater levels over the last three years.

Table 3-2 summarizes the important groundwater level trends by monitoring well. Hydrographs for multiple completions of these wells follow at the end of this section. Hydrographs for multiple completions of monitoring wells adjacent to production wells are also included following this section.

Hydrographs for single wells including production wells are included with chemographs. These hydrographs show trend lines and rates of change for Water Years 2008-2012 when municipal production for the Western Purisima has been decreasing and been below historical averages.

Contour maps of groundwater elevations in Spring and Fall 2012 for the Purisima A-unit and AA-unit are shown in Figure 3-2 and Figure 3-3. Figure 3-2 shows that spring coastal groundwater levels in the A-unit were higher than SqCWD's protective elevation and the City's target elevations in the western half of the western Purisima area, but Figure 3-3 shows that fall coastal groundwater levels in the A-unit were lower than protective or target elevations in much of the area. Figure 3-3 shows Fall 2012 pumping depressions below sea level extending from the Main Street well in the western portion of the A-unit and the Estates well in the eastern portion of the A-unit, and included a portion of the coast. The area of pumping depressions below sea level was larger than Fall 2011 and similar to Fall 2010.

Table 3-2 (2012): Summary of Groundwater Level Trends in Western Purisima Area

Category	Well	Groundwater Level Trend Description	Notes
SqCWD Coastal Monitoring A-unit Wells	SC-1A	Rise of 4 feet from WY 2009 to WY 2012.	Reduced pumping at Garnet
	SC-3A	Rise WY 2009-2010 then steady in WY 2011-2012	Reduced pumping at Rosedale in WY 2009-2010
	SC-5A	Rise WY 2009-2011 then steady in WY 2012. WY 2011-2012 summer minimums ~5 feet higher than previous years.	Reduced pumping at Estates in WY 2009-2012, but increased pumping at Tannery II in WY 2012. 19 of 24 Pot Belly Beach Club residences removed from coastal wells in WY 2011.
City of Santa Cruz Coastal A and AA-unit Wells	Moran Lake	Decline since WY 2006	Increased pumping at Beltz #9 WY 2008-2012
	Soquel Point	Steady since WY 2006	
	Pleasure Point	Rise WY 2010-2012	Reduced pumping at Beltz #8 and #10 WY 2010-2012
SqCWD Coastal Monitoring B and BC-unit Wells	SC-1B SC-3C	Decline of 5-10 feet in overlying unit since WY 1998	Decreased rainfall since WY 1998
		Decline in WY 2012 after slight rise WY 2010-2011	Lower precipitation in WY 2012 compared to WY 2010-2011
Inland A and AA unit wells	Coffee Lane Park	Decline in WY 2012 after rise WY 2010-2011	None
	Cory Street Auto Plaza Drive	Rise over WY 2010-2012	None
Inland AA and Tu-unit Wells	SC-10AA	Decline of 5-10 feet in inland AA-unit since WY 2002; Slight decline in WY 2012 after slight rise WY 2010-2011	None
	Thurber Lane Deep	Decline of 50 feet in inland Tu-unit since WY 2005; Slight decline WY 2009-2012	None

Contour maps for years prior to 2012 have inaccuracies related to survey elevations at Soquel Point, SC-1 and SC-3R used to calculate groundwater levels that have since been revised. These contour maps will be revised and replaced with the Water Year 2013 Annual Report and Review.

3.3 WATER QUALITY CONDITIONS AND TRENDS

The most significant groundwater quality threat in the Soquel-Aptos basin is seawater intrusion. As discussed above, average groundwater levels generally remain below protective elevations in the A-unit. As a result, there is ongoing risk of seawater intrusion into the productive units of the western Purisima area.

Observed Total Dissolved Solids (TDS) and chloride concentrations in production wells do not suggest any seawater intrusion impacting SqCWD's production wells in the Purisima A and AA-units and sub-Purisima Tu-unit. Observed TDS and chloride concentrations in SqCWD's monitoring wells also do not indicate incipient seawater intrusion. The maximum contaminant limit (MCL) for chlorides is 250 mg/L and recent chloride concentrations in both production and monitoring wells have been below 100 mg/L or less except for a one-time measurement at SC-3RC in April 2010 (wells replacing SC-3 wells at Escalona in 2009 were labeled SC-3R). Chemographs for SqCWD wells in the area are included at the end of this section.

TDS and chloride concentrations at two City of Santa Cruz monitoring wells near the coast have suggested seawater intrusion. Chloride concentrations in the Medium completion (A-unit) of the Moran Lake well cluster have steadily decreased from a maximum of 700 mg/L in 2005 to below 250 mg/L in 2012 for the first time since measurements began in 2004. Chloride concentrations in the Medium completion (A-unit) of the Soquel Point well cluster have remained relatively stable above 1,100 mg/L starting in 2005. Chloride concentrations in the Deep completion (AA-unit) of the Soquel Point well cluster have shown an increasing trend from 67 mg/L to above 120 mg/L since 2004, but have stabilized at 120 mg/L since 2011. The City replaced the Deep Soquel Point well in 2012 due to concerns about whether water quality data from the well was representative.

Groundwater pumped from the Purisima formation continues to be treated for iron and manganese to meet drinking water standards. In Water Year 2012, color and turbidity were also reduced during treatment to meet drinking water standards.

3.4 STATE OF THE AQUIFER SUMMARY

Seawater intrusion has not been detected in most of the Western Purisima area. However, the productive Purisima A and AA-units remain at risk for seawater intrusion as coastal groundwater levels remain below SqCWD's protective elevations or the City's target elevations in three of the six coastal monitoring well locations. Despite relatively low overall production, changes in pumping distribution resulted in groundwater level recovery at some Purisima A and AA unit wells, although these wells had groundwater levels already above protective or target elevations. At wells in the Purisima A and AA-units with groundwater levels below protective or target elevations, there was less recovery in Water Year 2012 than the previous year. A longer period of low production with adaptive management of the pumping distribution will be required to recover the basin to protect against the risk of seawater intrusion.

SECTION 3 - WATER YEAR 2011
AQUIFER CONDITIONS FOR
WESTERN PURISIMA AREA (A/AA/TU-UNITS)

This section presents groundwater level and water quality conditions for Water Year 2011 in the western portion of the Soquel-Aptos area where the primary production aquifers are the Purisima A-unit, the Purisima AA-unit, and the sub-Purisima Tu-unit.

3.1 SqCWD SERVICE AREA I AND CITY OF SANTA CRUZ ANNUAL PRODUCTION

In the western portion of the Soquel-Aptos area, groundwater is produced for municipal purposes by SqCWD in its Service Area I and the City of Santa Cruz from its Live Oak well field. SqCWD's Estates well in Service Area II to the east is also partially completed in the A-unit.

SqCWD’s Service Area I production was 1,833 acre-feet in Water Year 2011, the third lowest annual amount since service area data have been recorded starting in 1984. The only two years with lower production in Service Area 1 are Water Years 2009 and 2010. Production in Service Area I over the last seven years has been below the historical average. Water Year 2011 pumping in Service Area I was approximately 65% of the SqCWD's revised estimate of its post-recovery pumping yield for the Purisima area (HydroMetrics WRI, 2012). Water Year 2011 production at the Estates well in Service Area II was 326 acre-feet, slightly higher than the 300-307 acre-feet produced in Water Years 2009 and 2010. Production at the Estates well in each of the last three years was lower than all years since 1991.

The City of Santa Cruz’s production from the Live Oak well field was 637 acre-feet in Water Year 2011, which is the largest annual water year production for the City since Water Year 1994. However, the City’s pumping season spans two water years as the pumping season typically extends from April-May to November-December. The City pumped 136 acre-feet from October-December 2010. The City’s pumping in calendar year 2011 was 531 acre-feet, which is similar to the City’s planned future maximum groundwater production during non-critically dry years of 525 acre-feet per year (Chambers

Group, 2011). The planned pumping of 525 acre-feet per year is based on average annual production by the City since 1984.

The City of Santa Cruz's groundwater production depends on availability of its surface water supply resulting in larger annual variation in groundwater production than SqCWD. For calendar years 2008 to 2011, City production ranged from 473 to 548 acre-feet per year with an average of 514 acre-feet per year.

Figure 3-1 shows production at SqCWD wells in Service Area I, the Estates well, and the City's Live Oak well field by water year.

3.2 GROUNDWATER LEVEL CONDITIONS AND TRENDS

SqCWD has established protective groundwater elevations in coastal monitoring wells to protect the Purisima A-unit in the western portion of the Soquel-Aptos area from seawater intrusion. Cross-sectional models were used to estimate groundwater elevations that result in the long term freshwater-salt water interface in the Purisima A-unit being seaward of the coast (HydroMetrics LLC, 2009b).

In Water Year 2011, average coastal groundwater levels in two of the three SqCWD A-unit monitoring wells remained below protective elevations, as shown in Table 3-1. Average groundwater levels at SC-1A were above the protective elevation in the Water Year 2011 for the first year since Water Year 1999. Pumping at the nearby Garnet well has been decreased steadily since 2004 and the amount pumped in Water Year 2011 was the lowest amount since Water Year 1997 (Figure 3-1). Although maximum groundwater levels exceed protective elevations at SC-3A, average groundwater levels must meet protective elevations to protect against seawater intrusion. Hydrographs for these wells follow at the end of this section. The hydrographs show that average groundwater levels have been below protective elevations for the entire period of record at SC-3A and SC-5A.

Table 3-1 (2011): Comparison of Water Year 2011 Coastal Groundwater Levels with Protective Levels in Western Purisima Area

Unit A Well	Location	Minimum Groundwater Elevation (feet msl)[1]	Maximum Groundwater Elevation (feet msl)	Average Groundwater Elevation (feet msl)	Protective Elevation (feet msl)
SC-1A	Prospect	3.9	7.4	6.3	4
SC-3A	Escalona	3.7	10.5	7.4	10
SC-5A	New Brighton	-0.31	8.7	4.9	13
Moran Lake Medium		4.9	6.0	5.6	5.0[2]
Soquel Point Medium		3.7	5.8	4.9	6.0[2]
Pleasure Point Medium		5.7	8.9	7.7	6.1[2]

[1] msl = mean sea level

[2] Proposed by City of Santa Cruz (Almond, 2012)

The City of Santa Cruz has proposed annual averages of 5.0-6.1 feet msl as protective groundwater elevations for its coastal monitoring wells at Pleasure Point, Soquel Point, and Moran Lake during non-critically dry years. For critically dry years, the City has proposed minimum quarterly averages of 2 feet msl as protective groundwater elevations for its three coastal monitoring wells (Almond, 2012). The City defines critically dry years as years with less than 29,000 acre-feet runoff at the Felton gauge on the San Lorenzo River (City of Santa Cruz, 2009). The hydrographs for these wells identify when water years were classified as critically dry and the protective groundwater elevation would have been the minimum quarterly average of 2 feet msl.

Water Year 2011 was not critically dry; and the protective elevations for the City of Santa Cruz coastal monitoring wells were 5.0-6.1 feet msl. As shown on Table 3-1, the average groundwater level in the Soquel Point well was below the City's protective elevation, while the average groundwater levels in the Moran Lake and Pleasure Point wells were above the City's protective elevation in Water Year 2011. Average groundwater levels in the Pleasure Point well have been above the protective elevation the last two years, which has coincided with combined Beltz #7 and #8 pumping being between 211 and 287 acre-feet the last two years after being between 383 and 411 acre-feet the previous three years. Groundwater levels from the Medium completion of these well clusters are used because it is the deepest completion in the A unit, which is the primary aquifer supplying the

Live Oak well field, and it has lower groundwater levels than the Deep completion in the AA unit.

The groundwater levels in Table 3-1 are based on monthly measurements at the wells and do not reflect tidal variations. Loggers have been installed in the SqCWD wells to monitor the tidal variation as shown in the hydrographs at the end of this section. Logger measurements from well SC-1A from 2007 and 2008 show a tidal range of approximately 5 feet. With a tidal range of this magnitude, average groundwater elevation based on monthly measurements may not be adequate for comparison with the protective elevation because the monthly measurements are dependent on measurement time and do not represent a tidal average. Monthly measurements at SC-1A for 2007 and 2008 underestimated average groundwater levels when compared to the full tidal range. Although there is some tidal variation at SC-3A and SC-5A, the hydrographs show that the monthly measurements are representative of the time series.

Groundwater levels show increasing trends since Water Year 2008 in SqCWD's coastal monitoring wells completed in the productive A-unit. The increasing trends are likely due to reduced pumping at nearby SqCWD production wells (Figure 3-1). However, groundwater level rises at SC-3A and SC-5A leveled off in Water Year 2011 with increases in pumping at the Rosedale and Estates wells over the previous years.

Groundwater levels at the City of Santa Cruz's coastal monitoring wells completed in the A and AA-units show different recent trends depending on location. Groundwater levels at the Pleasure Point wells have increased over the last two years, coinciding with decreased pumping at Beltz #8 and #10. Groundwater levels at the Soquel Point and Moran Lake wells in Water Year 2011 were near minimums measured at the wells since the wells were installed in 2004.

Groundwater levels show declining trends since Water Year 1998 in coastal monitoring wells completed in the unconfined B and BC-units. Rainfall was higher in 1998 than in any of the subsequent eleven years. This trend therefore is consistent with a correlation between declining basin storage and reduced precipitation. Groundwater levels in the B and BC units during Water Years 2010 and 2011 show slight increases, which coincides with higher rainfall over these two years, compared to the longer-term declining trend.

Multi-year declines of at least six years have been observed in wells completed in the AA and Tu-units upgradient of the municipal production wells. However, groundwater levels over the last three water years (2009 to 2011) have been relatively stable at the Thurber Lane Deep well and have shown slight increases over the last two water years (2010 to 2011) at SC-10AA.

Monitoring wells at three locations inland of the Live Oak well field were installed in 2009. These wells at Coffee Lane Park, Cory Street, and Auto Plaza Drive screened in the A and AA units show rising groundwater levels over the last two years.

Table 3-2 summarizes the important groundwater level trends by monitoring well. Hydrographs for multiple completions of these wells follow at the end of this section. Hydrographs for multiple completions of monitoring wells adjacent to production wells are also included following this section.

Hydrographs for single wells including production wells are included with chemographs. These hydrographs show trend lines and rates of change for Water Years 2007-2011 when municipal production for the Western Purisima has been decreasing and been below historical averages.

Contour maps of groundwater elevations in Spring and Fall 2011 for the Purisima A-unit are shown in Figure 3-2 and Figure 3-3. Figure 3-2 shows that spring coastal groundwater levels in the A-unit were lower than protective elevations in much of the western Purisima area and Figure 3-3 shows even lower coastal groundwater levels in the fall. Figure 3-3 shows Fall 2011 pumping depressions below sea level included the Main Street well in the western portion of the A-unit and the Estates well in the eastern portion of the A-unit, and included a portion of the coast. The area of pumping depressions below sea level was smaller than Fall 2010.

Table 3-2 (2011): Summary of Groundwater Level Trends in Western Purisima Area

Category	Well	Groundwater Level Trend Description	Notes
SqCWD Coastal Monitoring A-unit Wells	SC-1A	Rise of 3 feet from WY 2009 to WY 2011	Reduced pumping at Garnet
	SC-3A	Decline of 1.5 feet from WY 2010 to WY 2011	Increased pumping at Rosedale in WY 2011
	SC-5A	Rise of 4.5 feet from WY 2008 to WY 2011	Reduced pumping at Estates in WY 2009-2011
City of Santa Cruz Coastal A and AA-unit Wells	Moran Lake Soquel Point	Decline in WY 2011	Increased pumping at Beltz #9 in WY 2011
	Pleasure Point	Rise in WY 2010 and 2011	Reduced pumping at Beltz #7 and #8
SqCWD Coastal Monitoring B and BC-unit Wells	SC-1B SC-3C	Decline of 5-10 feet in overlying unit since WY 1998	Decreased precipitation since WY 1998
		Slight rise WY 2010-2011	Higher precipitation compared to WY 2007-2009
Inland A and AA unit wells	Coffee Lane Park Cory Street Auto Plaza Drive	Rise over WY 2010-2011	None
Inland AA and Tu-unit Wells	SC-10AA	Decline of 5-10 feet in inland AA-unit since WY 2002; Slight rise WY 2010-2011	None
	Thurber Lane Deep	Decline of 50 feet in inland Tu-unit since WY 2005; Stable WY 2009-2011	None

3.3 WATER QUALITY CONDITIONS AND TRENDS

The most significant groundwater quality threat in the Soquel-Aptos basin is seawater intrusion. As discussed above, average groundwater levels generally remain below protective elevations in the A-unit. As a result, there is ongoing risk of seawater intrusion into the productive units of the western Purisima area.

Observed Total Dissolved Solids (TDS) and chloride concentrations in production wells do not suggest any seawater intrusion impacting SqCWD's production wells in the Purisima A and AA-units and sub-Purisima Tu-unit. Observed TDS and chloride concentrations in SqCWD's monitoring wells also do not indicate incipient seawater intrusion. The maximum contaminant limit (MCL) for chlorides is 250 mg/L and recent chloride concentrations in both production and monitoring wells have been below 100 mg/L or less except for a one-time measurement at SC-3RA in April 2010 (wells replacing SC-3 wells at Escalona in 2009 were labeled SC-3R). Chemographs for SqCWD wells in the area are included at the end of this section.

TDS and chloride concentrations at two City of Santa Cruz monitoring wells near the coast suggest seawater intrusion. Chloride concentrations in the Medium completion (A-unit) of the Moran Lake well cluster has been above 300 mg/L since measurements began in 2004, although concentrations have been decreasing since that time. Chloride concentrations in the Medium completion (A-unit) of the Soquel Point well cluster have remained relatively stable above 1,100 mg/L starting in 2005. Chloride concentrations in the Deep completion (AA-unit) of the Soquel Point well cluster have shown an increasing trend from 67 mg/L to above 120 mg/L since 2004.

Groundwater pumped from the Purisima formation continues to be treated for iron and manganese to meet drinking water standards. In Water Year 2011, color and turbidity were also reduced during treatment to meet drinking water standards.

3.4 State of the Aquifer Summary

Seawater intrusion has not been detected in most of the Western Purisima area. However, the productive Purisima A and AA-units remain at risk for seawater intrusion as coastal groundwater levels remain below protective elevations. Despite relatively low overall production, changes in pumping distribution resulted in groundwater levels in the Purisima A and AA-units showing less recovery in Water Year 2011 than the previous year. A longer period of low production will be required to recover the basin to be protected against the risk for seawater intrusion.

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SECTION 3 - WATER YEAR 2010 AQUIFER CONDITIONS FOR WESTERN PURISIMA AREA (A/AA/TU-UNITS)

This section presents groundwater level and water quality conditions for Water Year 2010 in the western portion of the Soquel-Aptos area where the primary production aquifers are the Purisima A-unit, the Purisima AA-unit, and the sub-Purisima Tu-unit.

3.1 SqCWD Service Area I and City of Santa Cruz Annual Production

In the western portion of the Soquel-Aptos area, groundwater is produced for municipal purposes by SqCWD in its Service Area I and the City of Santa Cruz from its Live Oak well field. SqCWD's Estates well in Service Area II to the east is also partially completed in the A-unit.

SqCWD’s Service Area I production was 1,769 acre-feet in Water Year 2010, the lowest annual amount since service area data have been recorded starting in 1984. Production in Service Area I over the last six years has been below the historical average. Water Year 2010 pumping in Service Area I was approximately 71% of the SqCWD's revised estimate of its share of the annual sustainable yield in the Purisima area (HydroMetrics LLC, 2009c). Water Year 2010 production at the Estates well in Service Area II was 306 acre-feet, slightly higher than the 300 acre-feet produced in Water Year 2009. Production at the Estates well in each of the last two years was lower than every other year since 1991.

The City of Santa Cruz’s production from the Live Oak well field was 451 acre-feet in Water Year 2010, which is within the annual production range of 296 to 594 acre-feet recorded since 1999. The City of Santa Cruz's groundwater production depends on availability of its surface water supply resulting in larger annual variation in groundwater production than SqCWD. In only two years since 1999 have City production exceeded the City's share of sustainable yield assumed in the GMP and then only by 3%. Figure 3-1 shows production at SqCWD wells in Service Area I, the Estates well, and the Live Oak well field by water year.

3.2 GROUNDWATER LEVEL CONDITIONS AND TRENDS

SqCWD has established protective groundwater elevations in coastal monitoring wells to protect the Purisima A-unit in the western portion of the Soquel-Aptos area from seawater intrusion. Cross-sectional models were used to estimate groundwater elevations that result in the long term freshwater-salt water interface in the Purisima A-unit being seaward of the coast (HydroMetrics LLC, 2009b).

Average coastal groundwater levels in the SqCWD's A-unit monitoring wells remained below protective elevations in Water Year 2010, as shown in Table 3-1. Although maximum groundwater levels exceed protective elevations at SC-1A and SC-3A, average groundwater levels must meet protective elevations to protect against seawater intrusion. Hydrographs for these wells follow at the end of this section. The hydrographs show that average groundwater levels have been below protective elevations since Water Year 2000 at SC-1A and for the entire period of record at SC-3A and SC-5A.

Table 3-1 (2010): Comparison of Water Year 2010 Coastal Groundwater Levels with Protective Levels in Western Purisima Area

Unit A Well	Location	Minimum Groundwater Elevation (feet msl)[1]	Maximum Groundwater Elevation (feet msl)	Average Groundwater Elevation (feet msl)	Protective Elevation (feet msl)
SC-1A	Prospect	4.0	6.5	4.9	4
SC-3A	Escalona	3.4	12.3	8.8	10
SC-5A	New Brighton	-4.8	11.4	3.3	13
Moran Lake Medium		5.2	6.3	5.7	6[2]
Soquel Point Medium		3.0	6.2	5.2	6[2]
Pleasure Point Medium		4.5	8.8	6.8	6[2]

[1] mean sea level

[2] Proposed by City of Santa Cruz (Almond, 2010)

The City of Santa Cruz has proposed a protective groundwater elevation of 6 feet msl for its coastal monitoring wells at Pleasure Point, Soquel Point, and Moran Lake during non-critically dry years and 2 feet msl for critically dry years (Almond, 2010). The City defines critically dry years as years with less than 29,000 acre-feet runoff at the Felton gauge on the San Lorenzo River (Hopkins, 2010). The hydrographs for these wells identify when water years were classified as critically dry and the protective groundwater elevation would have been 2 feet.

Water Year 2010 was not critically dry; and the protective elevation for the City of Santa Cruz coastal monitoring wells was 6 feet. As shown on Table 3-1, average groundwater levels in the Moran Lake and Soquel Point wells were below the City's protective elevation, while the average groundwater level in the Pleasure Point well was above the City's protective elevation in Water Year 2010. Groundwater levels from the Medium completion of these well clusters are used because it is the deepest completion in the A unit, the primary aquifer supplying the Live Oak well field and it has lower groundwater levels than the Deep completion in the AA unit.

The groundwater levels in Table 3-1 are based on monthly measurements at the wells and do not reflect tidal variations. Loggers have been installed in the SqCWD wells to monitor the tidal variation as shown in the hydrographs at the end of this section. Logger measurements from well SC-1A from 2007 and 2008 show a tidal range of approximately 5 feet. With a tidal range of this magnitude, average groundwater elevation based on monthly measurements may not be adequate for comparison with the protective elevation because the monthly measurements are dependent on measurement time and do not represent a tidal average. Monthly measurements at SC-1A for 2007 and 2008 underestimated average groundwater levels when compared to the full tidal range. Although there is some tidal variation at SC-3A and SC-5A, the hydrographs show that the monthly measurements are representative of the time series.

Groundwater levels show increasing trends since Water Year 2008 in SqCWD's coastal monitoring wells completed in the productive A-unit . The increasing trends are likely due to reduced pumping at nearby SqCWD production wells (Figure 3-1).

Groundwater levels at the City of Santa Cruz's coastal monitoring wells completed in the A and AA-units were either slightly higher in Water Year 2010 than Water Years 2008-2009 or relatively stable compared to the previous two years. The overall increase in groundwater levels is likely a result of Live Oak well field production in Water Year 2010 decreasing from the previous two years, when annual pumping was higher than any year since Water Year 2000. The City of Santa Cruz's groundwater production is based on the availability of surface water supply. Weather conditions in Water Year 2010 led to greater surface water supply, lower demand, and lower groundwater pumping than the previous two years.

Groundwater levels show declining trends since Water Year 1998 in coastal monitoring wells completed in the unconfined B and BC-units . Rainfall was higher in 1998 than in any of the subsequent eleven years. This trend therefore is consistent with a correlation between declining basin storage and reduced precipitation. Groundwater levels in the B and BC units during Water Years 2009 and 2010 were relatively stable compared to the longer-term declining trend.

Groundwater levels continue to fall in deep aquifer units upgradient of the municipal production wells. Multi-year declines of at least six years have been observed in wells completed in the AA and Tu-units. However, groundwater levels over the last two water years (2009 to 2010) have been relatively stable.

Table 3-2 summarizes the important groundwater level trends by monitoring well. Hydrographs for multiple completions of these wells follow at the end of this section. Hydrographs for multiple completions of monitoring wells adjacent to production wells are also included following this section.

Hydrographs for single wells including production wells are included with chemographs. These hydrographs show trendlines for Water Years 2005-2010 when municipal production for the basin has been at or below pumping goals in the Groundwater Management Plan.

Contour maps of groundwater elevations in Spring and Fall 2010 for the Purisima A-unit are shown in Figure 3-2 and Figure 3-3. Figure 3-2 shows that Spring coastal groundwater levels in the A-unit were higher than protective elevations in much of the western Purisima area. Figure 3-3 shows that Fall coastal groundwater levels in the A-unit were lower than protective elevations in much of the western Purisima area. Figure 3-3 shows Fall 2010 pumping depressions below sea level extended from the Main Street well in the western portion of the A-unit to the Estates well in the eastern portion of the A-unit, and included a portion of the coast.

Table 3-2 (2010): Summary of Groundwater Level Trends in Western Purisima Area

Category	Well	Groundwater Level Trend Description	Notes
SqCWD Coastal Monitoring A-unit Wells	SC-1A	Increased 2+ feet from WY 2009 to WY 2010	Reduced pumping at Garnet
	SC-3A	Increasing trend Fall 2009-WY 2010; max up to 6 feet higher in 2010	Reduced pumping at Rosedale in WY 2009-2010
	SC-5A	Increasing trend Fall 2009-WY 2010; max 3-4 feet higher in 2010	Reduced pumping at Estates in WY 2009-2010
City of Santa Cruz Coastal A and AA-unit Wells	Moran Lake Soquel Point	Stable Fall 2008-2010	Reduced pumping at Live Oak in WY 2010 but increase at Beltz #9
	Pleasure Point	Increased 1.5+ feet from WY 2009 to WY 2010	Reduced pumping at Beltz #8
SqCWD Coastal Monitoring B and BC-unit Wells	SC-1B SC-3C	Decline of 5-10 feet in overlying unit since WY 1998	Decreased precipitation since WY 1998
		Stable WY 2009-2010	Increasing precipitation compared to WY 2007-2008
Inland AA and Tu-unit Wells	SC-10AA	Decline of 5-10 feet in inland AA-unit since WY 2002; Stable WY 2009-2010	None
	Thurber Lane Deep	Decline of 50 feet in inland Tu-unit since WY 2005; Stable WY 2009-2010	None

3.3 Water Quality Conditions and Trends

The most significant groundwater quality threat in the Soquel-Aptos basin is seawater intrusion. As discussed above, average groundwater levels generally remain below protective elevations in the A-unit. As a result, there is ongoing risk of seawater intrusion into the productive units of the western Purisima area.

Observed Total Dissolved Solids (TDS) and chloride concentrations in production wells do not suggest any seawater intrusion impacting SqCWD's production wells in the Purisima A and AA-units and sub-Purisima Tu-unit.

Observed TDS and chloride concentrations in SqCWD's monitoring wells also do not indicate incipient seawater intrusion. The maximum contaminant limit (MCL) for chlorides is 250 mg/L and recent chloride concentrations in both production and monitoring wells have been below 100 mg/L or less except for a one-time measurement at SC-3RA (wells replacing SC-3 wells at Escalona in 2009 were labeled SC-3R). Chemographs for SqCWD wells in the area are included at the end of this section.

TDS and chloride concentrations at two City of Santa Cruz monitoring wells near the coast suggest seawater intrusion. Chloride concentrations in the Medium completion (A-unit) of the Moran Lake well cluster has been above 350 mg/L since measurements began in 2004, although concentrations have been decreasing since that time. Chloride concentrations in the Medium completion (A-unit) of the Soquel Point well cluster have remained stable above 1,200 mg/L starting in 2005. Chloride concentrations in the Deep completion (AA-unit) of the Soquel Point well cluster have shown an increasing trend from 67 mg/L to above 100 mg/L since 2004.

Groundwater pumped from the Purisima formation continues to be treated for iron and manganese to meet drinking water standards. In Water Year 2010, color and turbidity were also reduced during treatment to meet drinking water standards.

3.4 State of the Aquifer Summary

Seawater intrusion has not been detected in most of the Western Purisima area. However, the productive Purisima A and AA-units remain at risk for seawater intrusion as coastal groundwater levels remain below protective elevations. Due to historically low production, groundwater levels in the Purisima A and AA-units showed recovery in Water Year 2010. A longer period of low production will be required to recover the basin to be protected against the risk for seawater intrusion.

SECTION 3 - WATER YEAR 2009 AQUIFER CONDITIONS FOR WESTERN PURISIMA AREA (A/AA/TU-UNITS)

This section presents groundwater level and water quality conditions for Water Year 2009 in the western portion of the Soquel-Aptos area where the primary production aquifers are the Purisima A-unit, the Purisima AA-unit, and the sub-Purisima Tu-unit.

3.1 SQCWD SERVICE AREA I AND CITY OF SANTA CRUZ ANNUAL PRODUCTION

In the western portion of the Soquel-Aptos area, groundwater is produced for municipal purposes by SqCWD in its Service Area I and the City of Santa Cruz from its Live Oak well field. SqCWD's Estates well in Service Area II to the east is also partially completed in the A-unit.

Service Area I production was 1,824 acre-feet in Water Year 2009, the lowest annual amount since service area data have been recorded starting in 1984. Production in Service Area I over the last five years has been below the historical average. The recent evaluation of the sustainable yield (HydroMetrics LLC, 2009c) did not estimate annual sustainable yield specifically for Service Area I wells, but Water Year 2009 pumping in Service Area I was approximately 73% of the suggested estimate of SqCWD's share of the annual sustainable yield in the Purisima. Water Year 2009 production at the Estates well in Service Area II was 300 acre-feet, the lowest annual total since 1991.

Production at the Live Oak well field was 550 acre-feet in Water Year 2009, the highest amount since Water Year 2000, but still below the City's share of sustainable yield assumed in the GMP. Figure 3-1 shows production at SqCWD wells in Service Area I, the Estates well, and the Live Oak well field by water year.

3.2 GROUNDWATER LEVEL CONDITIONS AND TRENDS

SqCWD has established protective groundwater elevations in coastal monitoring wells to protect the Purisima A-unit in the western portion of the Soquel-Aptos area from seawater intrusion over the long term. Cross-sectional models were used to estimate groundwater elevations that result in the long term freshwater-salt water interface in the Purisima A-unit being seaward of the coast (HydroMetrics LLC, 2009b).

Coastal groundwater levels in the SqCWD's A-unit monitoring wells remained below protective elevations in Water Year 2009, as shown in Table 3-1. Hydrographs for these wells follow at the end of this section. The hydrographs show that average groundwater levels have been below protective elevations since Water Year 2000 at SC-1A and for the entire period of record at SC-3A and SC-5A. Although maximum groundwater levels exceed protective elevations for brief durations, this is not sufficient to be protective against seawater intrusion.

Table 3-1 (2009): Comparison of Water Year 2009 Coastal Groundwater Levels with Protective Levels in Western Purisima Area

Unit A Well	Location	Minimum Groundwater Elevation (feet msl)	Maximum Groundwater Elevation (feet msl)	Average Groundwater Elevation (feet msl)	Protective Elevation (feet msl)
SC-1A	Prospect	1.9	3.9	3.2	4
SC-3A	Escalona	-0.3	6.4	4.0	10
SC-5A	New Brighton	-6.4	7.6	0.8	13

In general, the groundwater level trend at SqCWD's coastal monitoring wells completed in the productive A-unit in this area has been stable over the last 3-5 years. Groundwater levels at these wells are higher than levels prior to the recent stable trend. The higher levels are likely due to a reduction in pumping at nearby SqCWD production wells.

Likewise, the groundwater level trend at the City of Santa Cruz's coastal monitoring wells completed in the A and AA-units has been stable over the last three years. Groundwater levels at these wells are lower than levels prior to the recent stable trend, likely due to increases in pumping at the nearby Live Oak production wells.

The groundwater level trend at coastal monitoring wells completed in unconfined overlying B and BC-units has been declining since 1998, a year with more precipitation than the subsequent eleven years. This trend is consistent with a correlation between declining basin storage and reduced precipitation.

Groundwater levels continue to fall in deep aquifer units in areas upgradient of the municipal production wells. Multi-year declines have been observed in wells completed in the AA and Tu-units. Low groundwater levels measured at these wells in Water Year 2009 were similar to lows measured the previous year.

Table 3-2 summarizes the important groundwater level trends by well. Hydrographs for these wells follow at the end of this section. Hydrographs for monitoring wells adjacent to production wells, and static groundwater levels in the production wells are also included following this section.

Table 3-2 (2009): Summary of Groundwater Level Trends in Western Purisima Area

Category	Well	Groundwater Level Trend Description	Notes
SqCWD Coastal Monitoring A-unit Wells	SC-1A	Stable WY 2005-2009; higher than prior	Constant pumping at Garnet
	SC-3A	Stable WY 2006-2009; higher than prior	Monterey removed from service in 2005
		Fall 2009 higher than previous years	Reduced pumping at Rosedale in Summer-Fall 2009
	SC-5A	Stable WY 2007-2009; higher than prior	Reduced pumping at Tannery II and Estates since WY 2006
City of Santa Cruz Coastal A and AA-unit Wells	Moran Lake Soquel Point Pleasure Point	Stable WY 2007-2009; lower than prior	Increased pumping at Live Oak since WY 2006
SqCWD Coastal Monitoring B and BC-unit Wells	SC-1B SC-3C	Decline of 5-10 feet in overlying unit since WY 1998	Reduced precipitation since WY 1998
Inland AA and Tu-unit Wells	SC-10AA	Decline of 5-10 feet in inland AA-unit since WY 2002	None
	Thurber Lane Deep	Decline of 50 feet in inland Tu-unit since WY 2005	None

Contour maps of groundwater elevations in spring and fall 2009 for the Purisima A-unit are shown in Figure 3-2 and Figure 3-3. Figure 3-2 shows that groundwater levels in the A-unit were above sea level in spring 2009 but not high enough to bring coastal groundwater levels up to protective elevations. Figure 3-3 shows fall 2009 pumping depressions below sea level were relatively inland at the Main Street well in the western portion of the A-unit. Also, the eastern portion of the A-unit has depressed groundwater levels around the Estates well, and extending out to the coast.

3.3 WATER QUALITY CONDITIONS AND TRENDS

The most significant groundwater quality threat in the Soquel-Aptos basin is seawater intrusion. As discussed above, groundwater levels remain below protective elevations in the A-unit. As a result, there is ongoing risk of seawater intrusion into the productive units of the western Purisima area.

Observed Total Dissolved Solids (TDS) and chloride concentrations do not suggest any seawater intrusion impacting SqCWD's production wells in the Purisima A and AA-units and sub-Purisima Tu-unit. Observed TDS and chloride concentrations at SqCWD's monitoring wells also do not indicate incipient seawater intrusion. Recent chloride concentrations in both production and monitoring wells are at 100 mg/L or less, while the maximum contaminant limit (MCL) for chlorides is 250 mg/L. Chemographs for SqCWD wells in the area are included at the end of this section.

TDS and chloride concentrations at two City of Santa Cruz monitoring wells near the coast suggest seawater intrusion. Chloride concentrations in the A-unit middle screen of the Moran Lake well has been above 400 mg/L since measurements began in 2004, although concentrations have been decreasing since that time. Chloride concentrations in the A-unit middle screen of the Soquel Point well have remained stable above 1,200 mg/L starting in 2005.

Groundwater pumped from the Purisima formation continues to be treated for iron and manganese to meet drinking water standards. In Water Year 2009, color and turbidity were also reduced during treatment to meet drinking water standards.

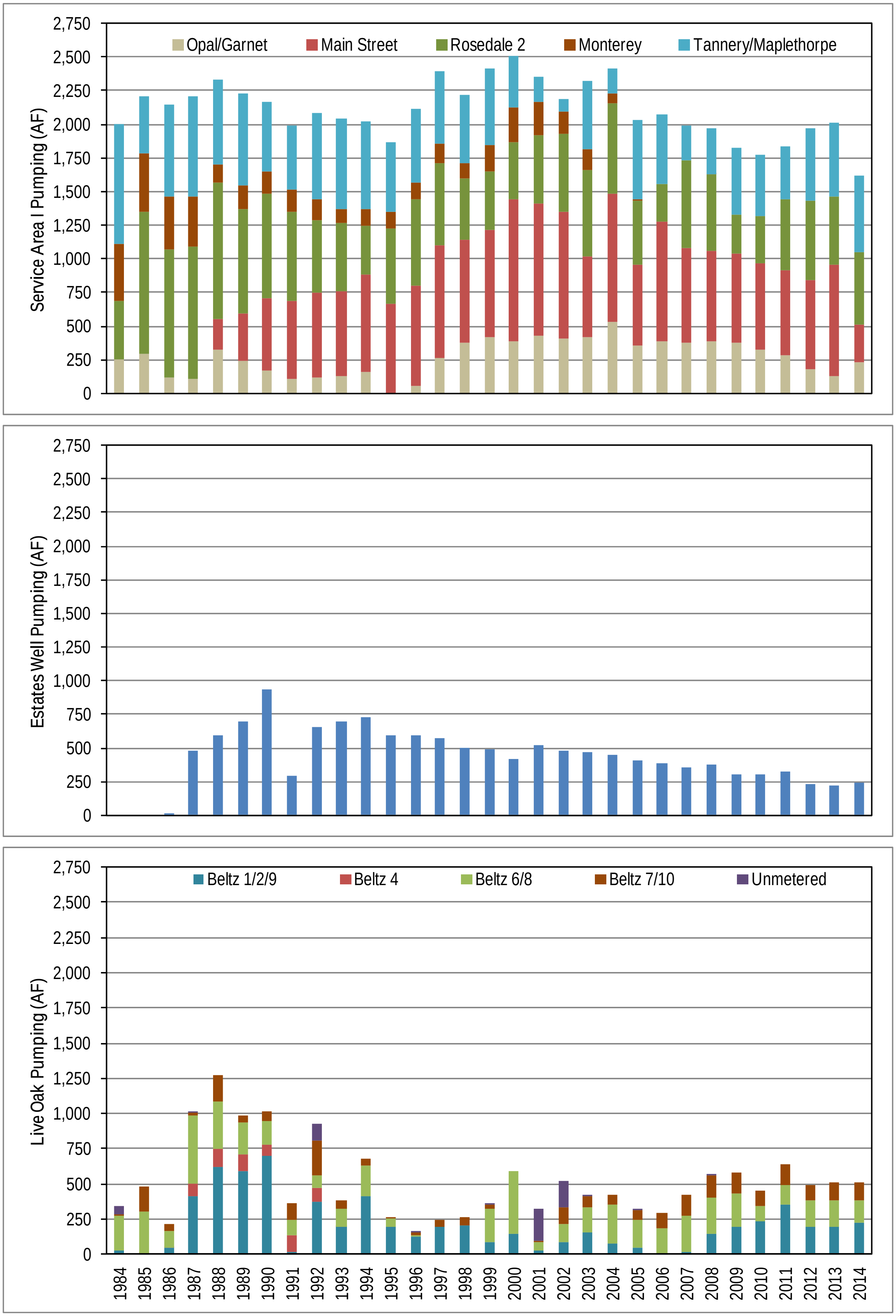
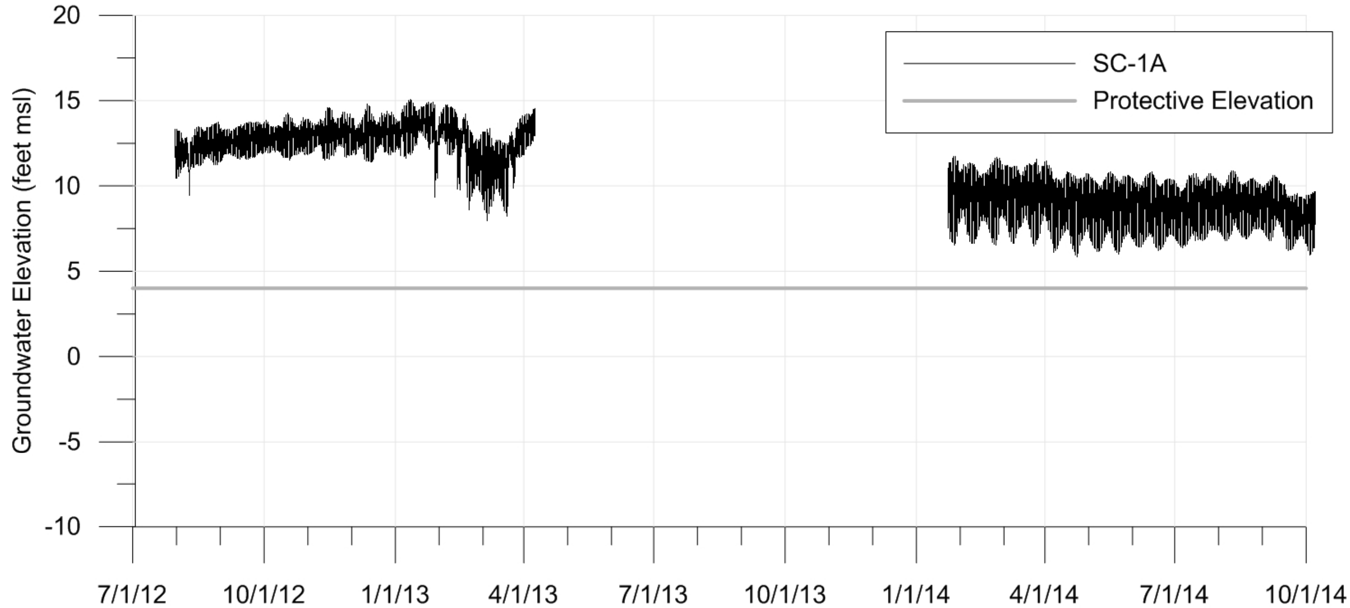


Figure 3-1: Pumping by Water Year in Western Purisima Area



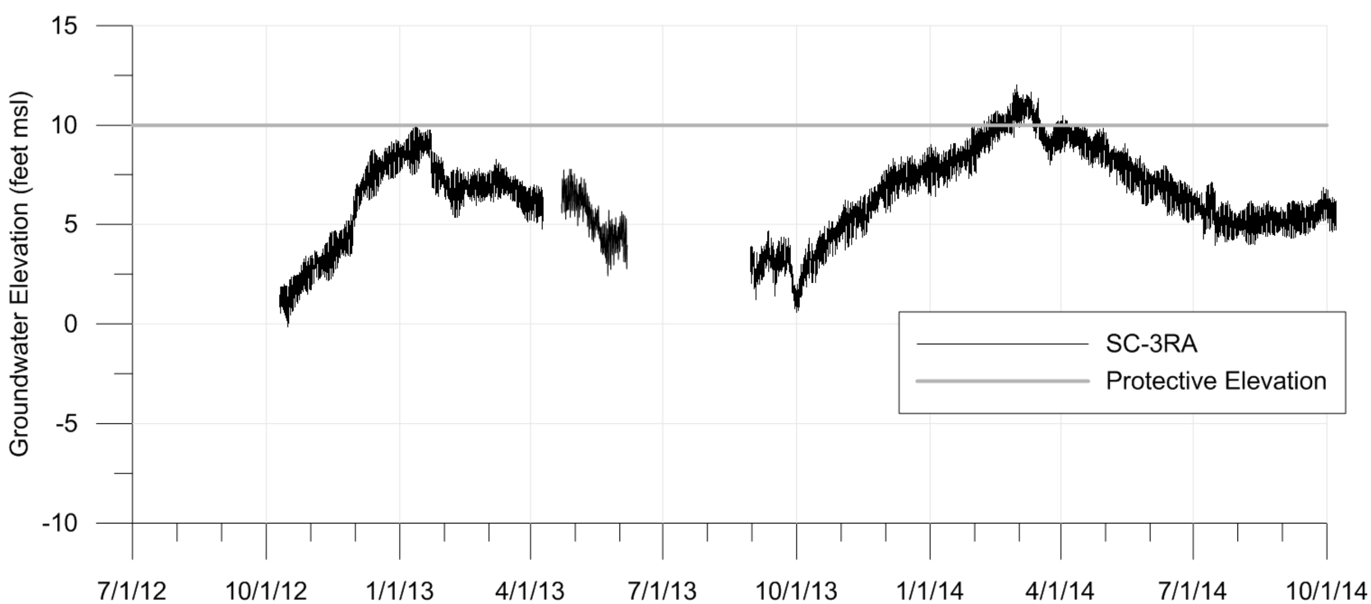


Figure 3-2: Groundwater Level Logger Hydrographs for SC-1A and SC-3A

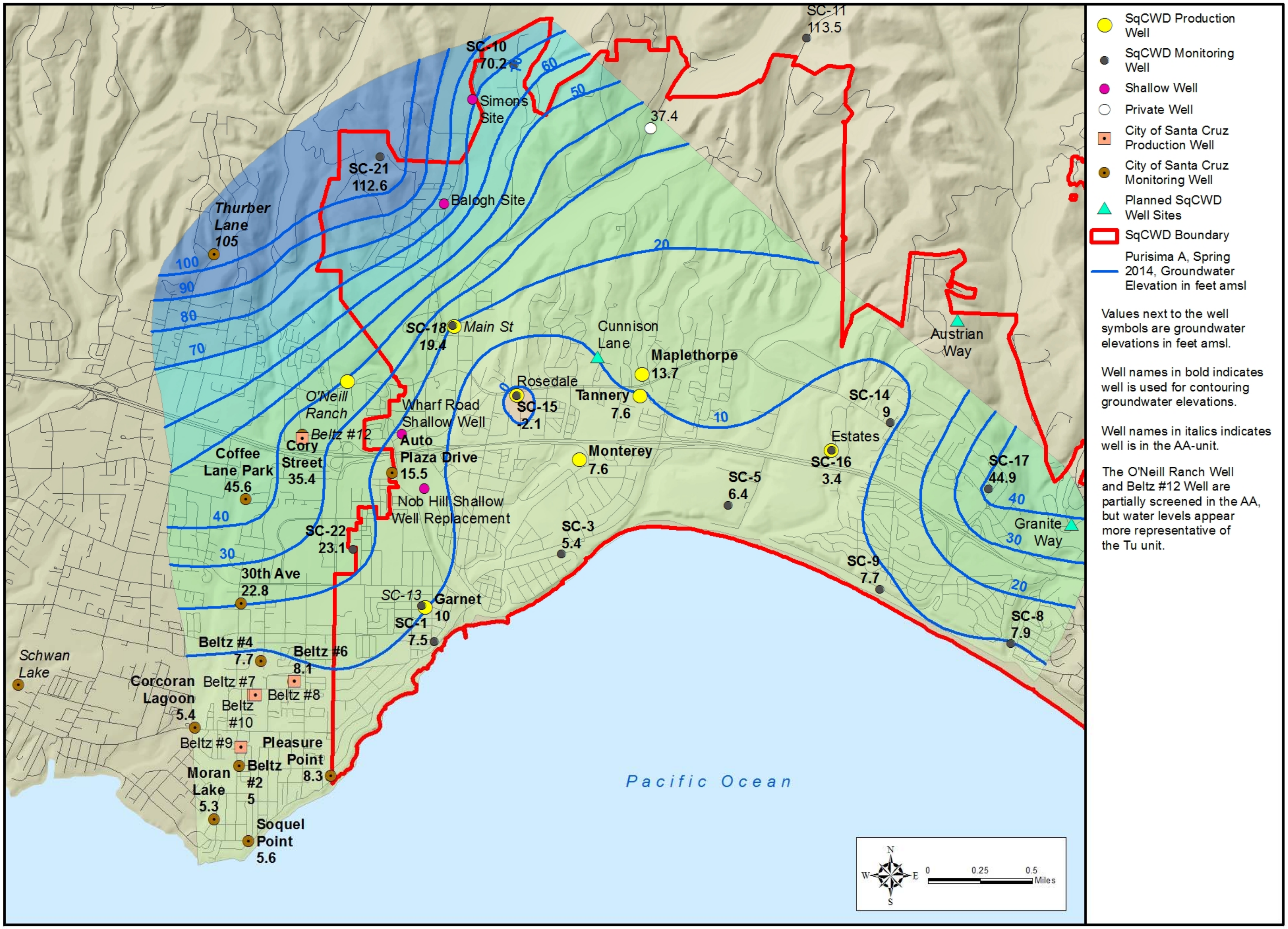


Figure 3-3 (2014): Groundwater Elevation Contours, Purisima A-Unit, Spring 2014

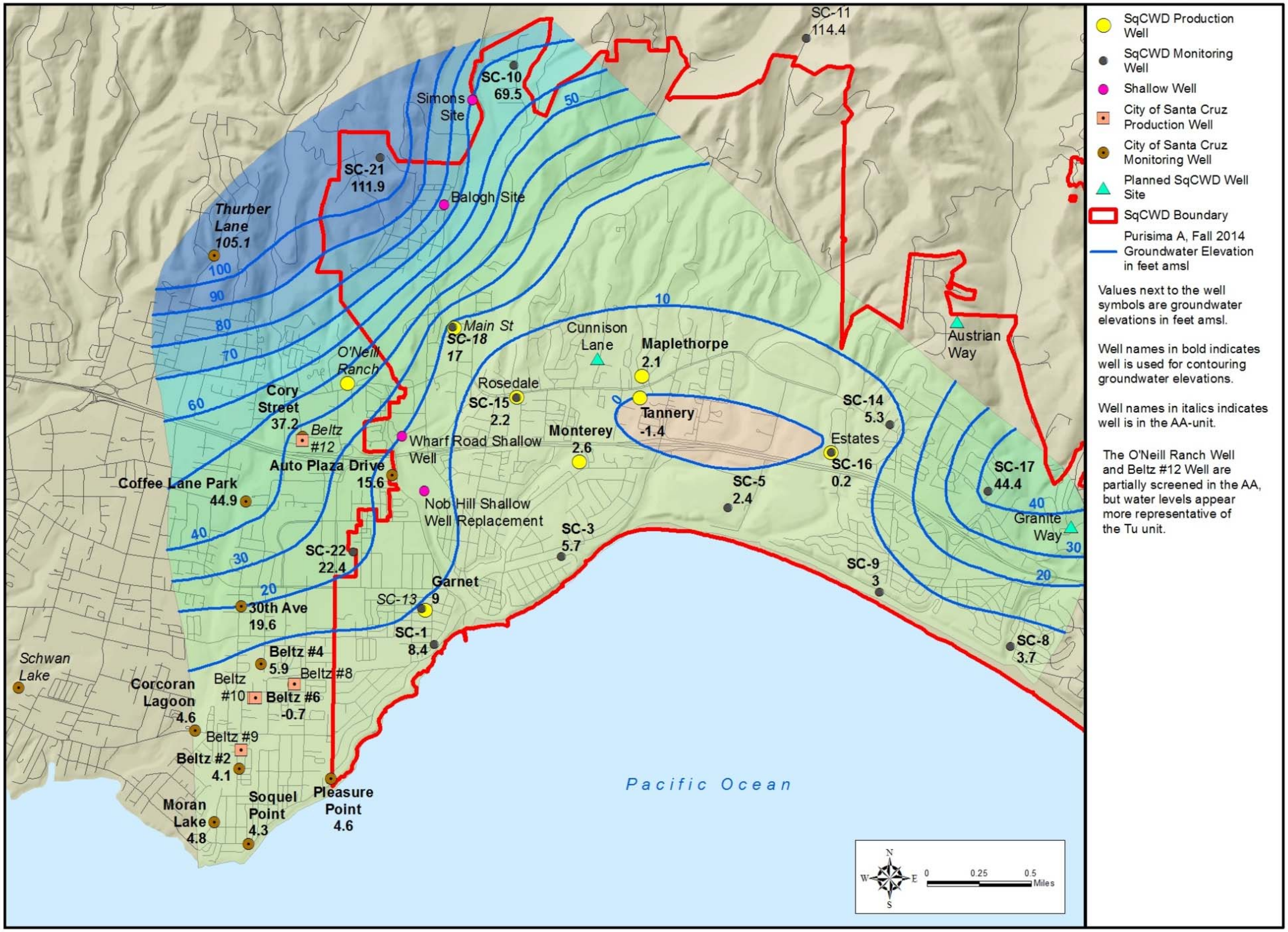


Figure 3-4 (2014): Groundwater Elevation Contours, Purisima A-Unit, Fall 2014

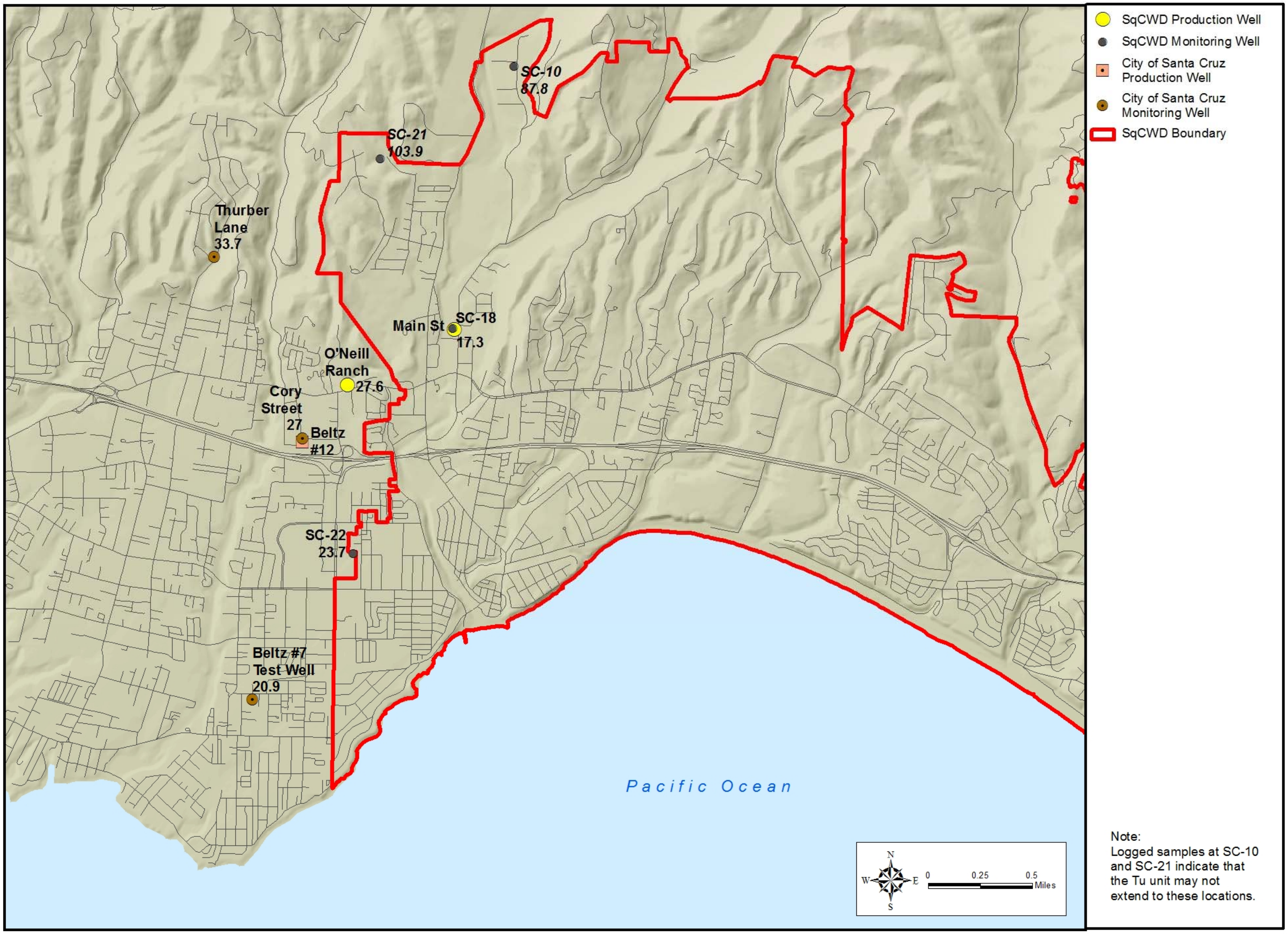


Figure 3-5 (2014): Groundwater Elevations Tu Unit, Spring 2014

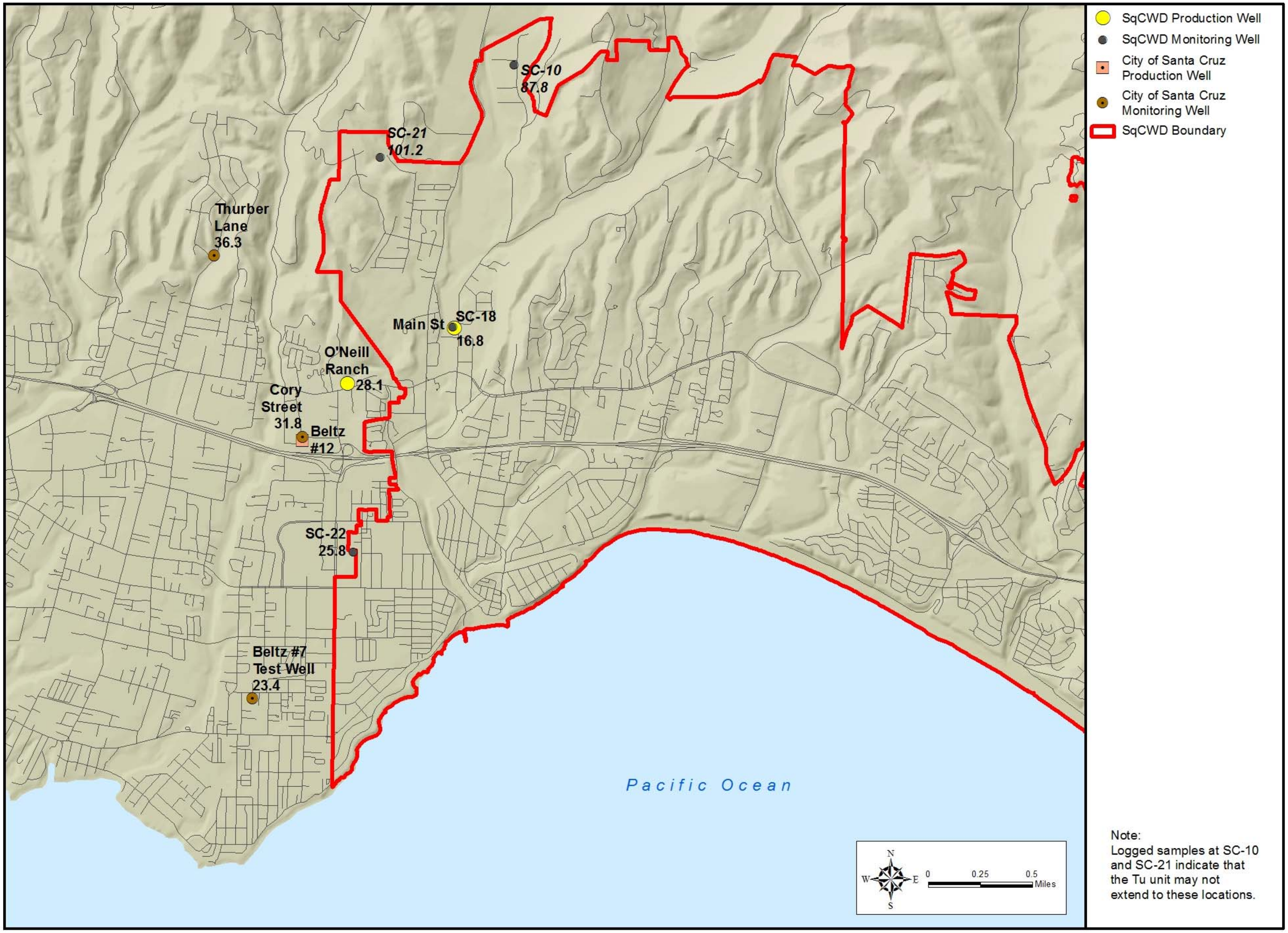


Figure 3-6 (2014): Groundwater Elevations Tu Unit, Fall 2014

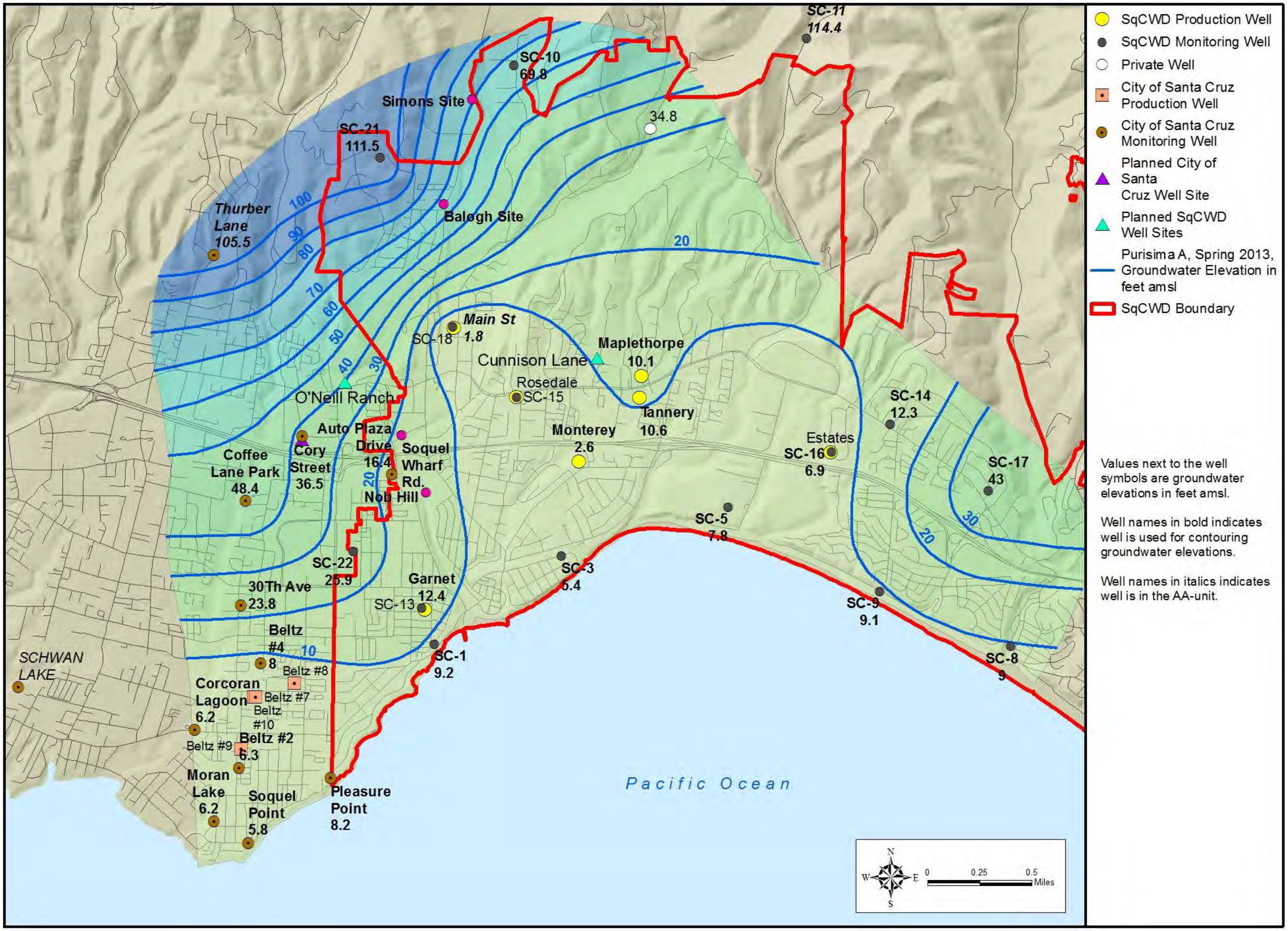


Figure 3-2 (2013): Groundwater Elevation Contours, Purisima A-Unit, Spring 2013

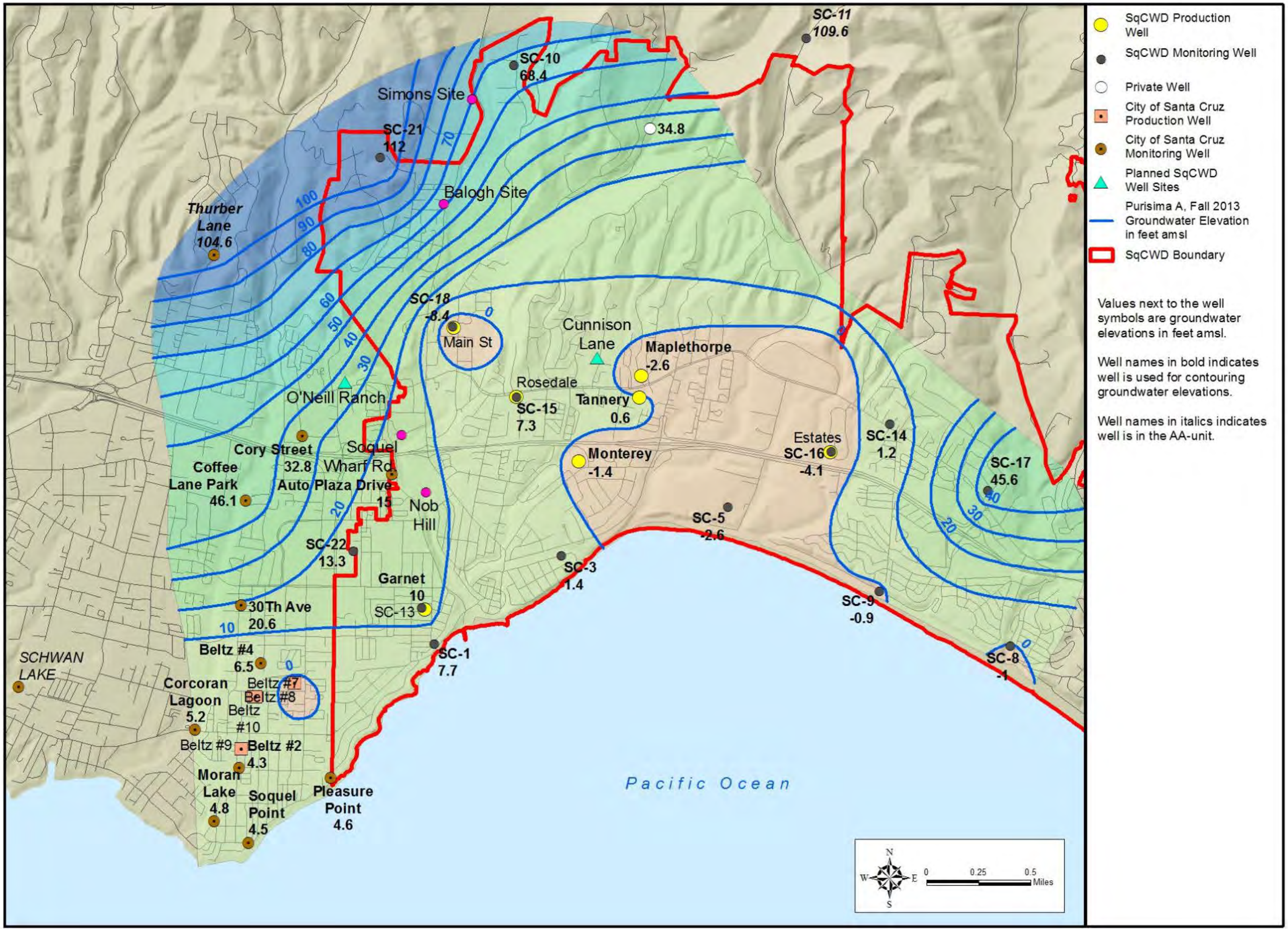


Figure 3-3 (2013): Groundwater Elevation Contours, Purisima A-Unit, Fall 2013

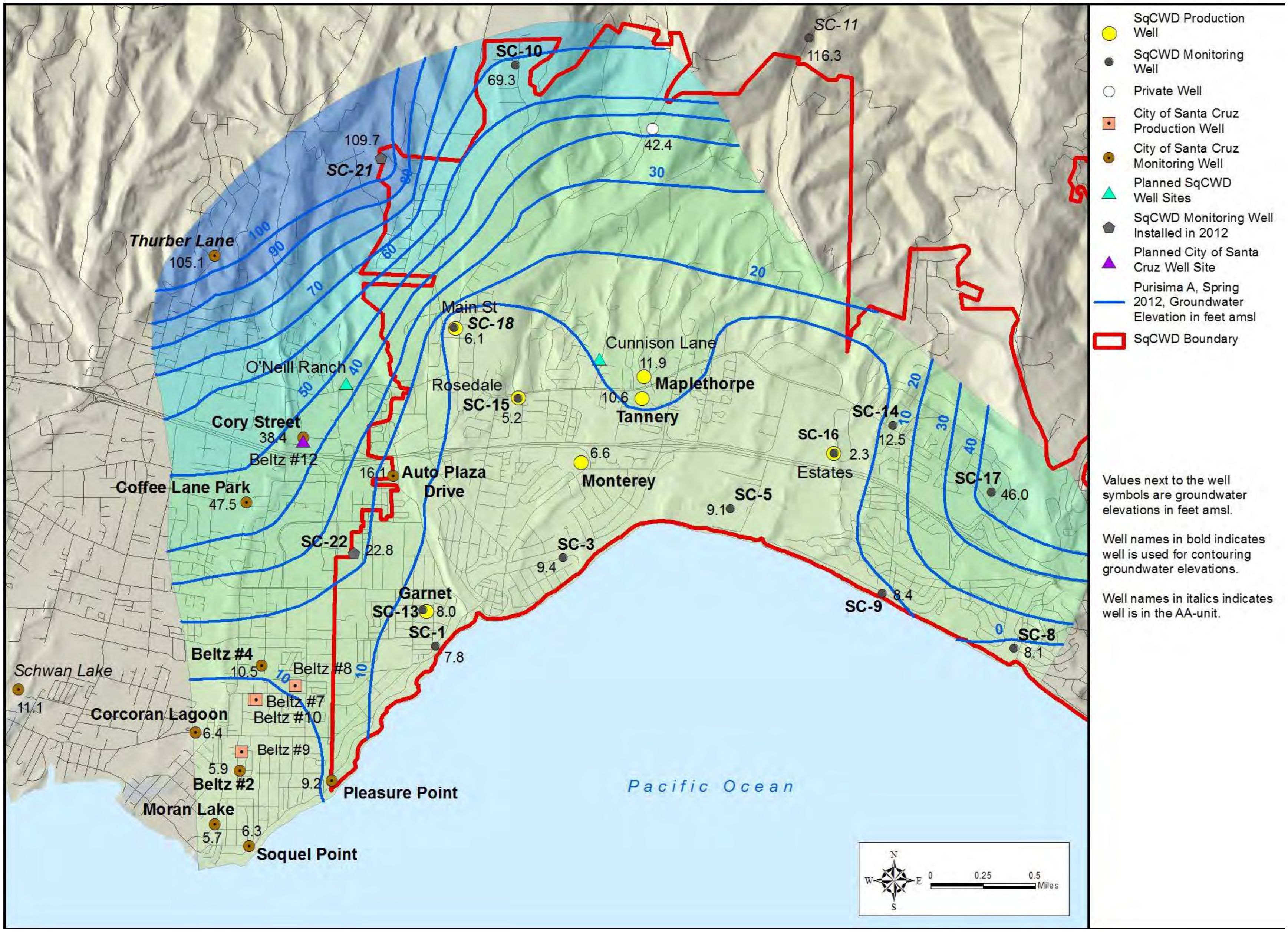


Figure 3-2 (2012): Groundwater Elevation Contours, Purisima A-Unit, Spring 2012

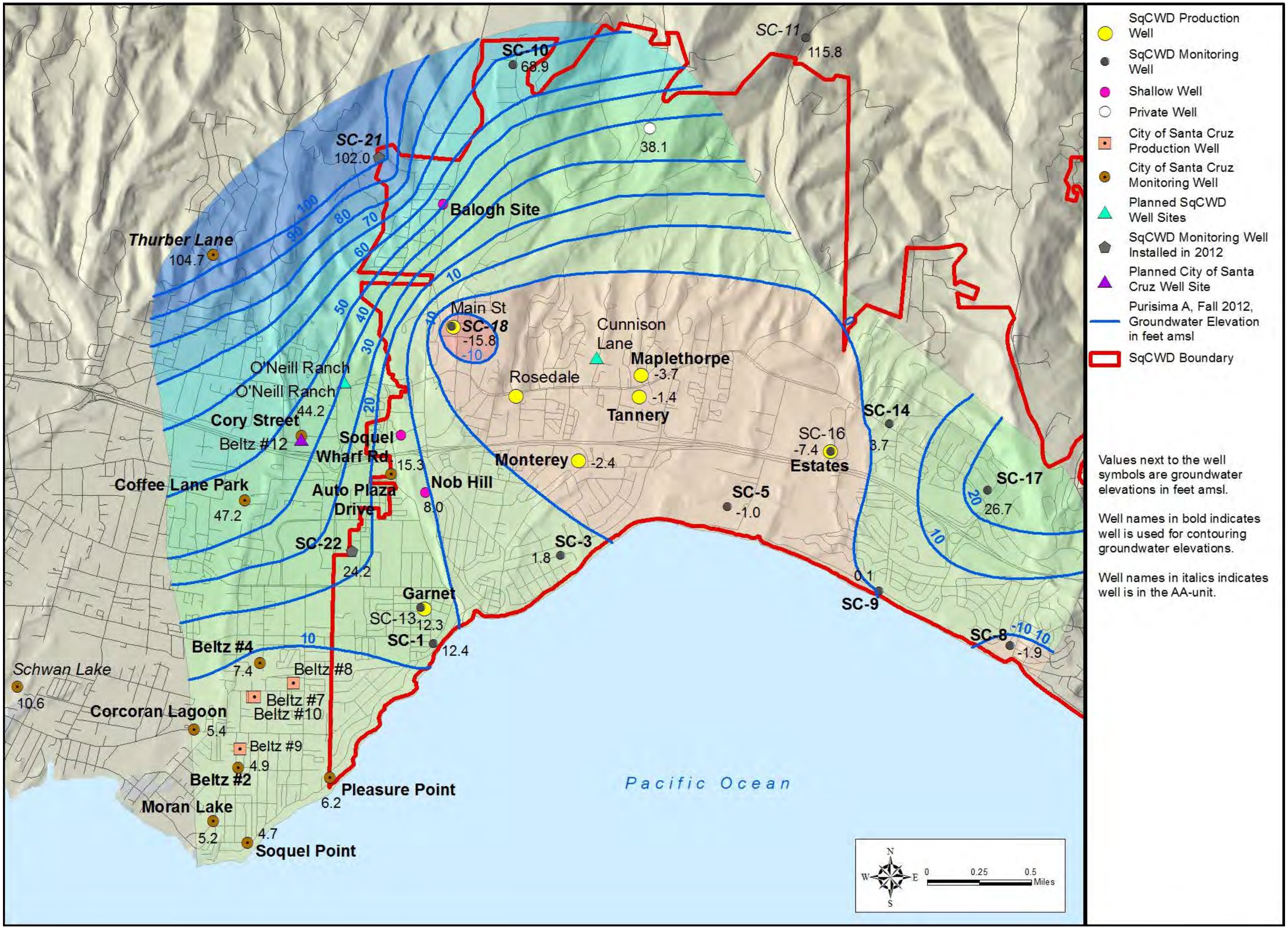


Figure 3-3 (2012): Groundwater Elevation Contours, Purisima A-Unit, Fall 2012

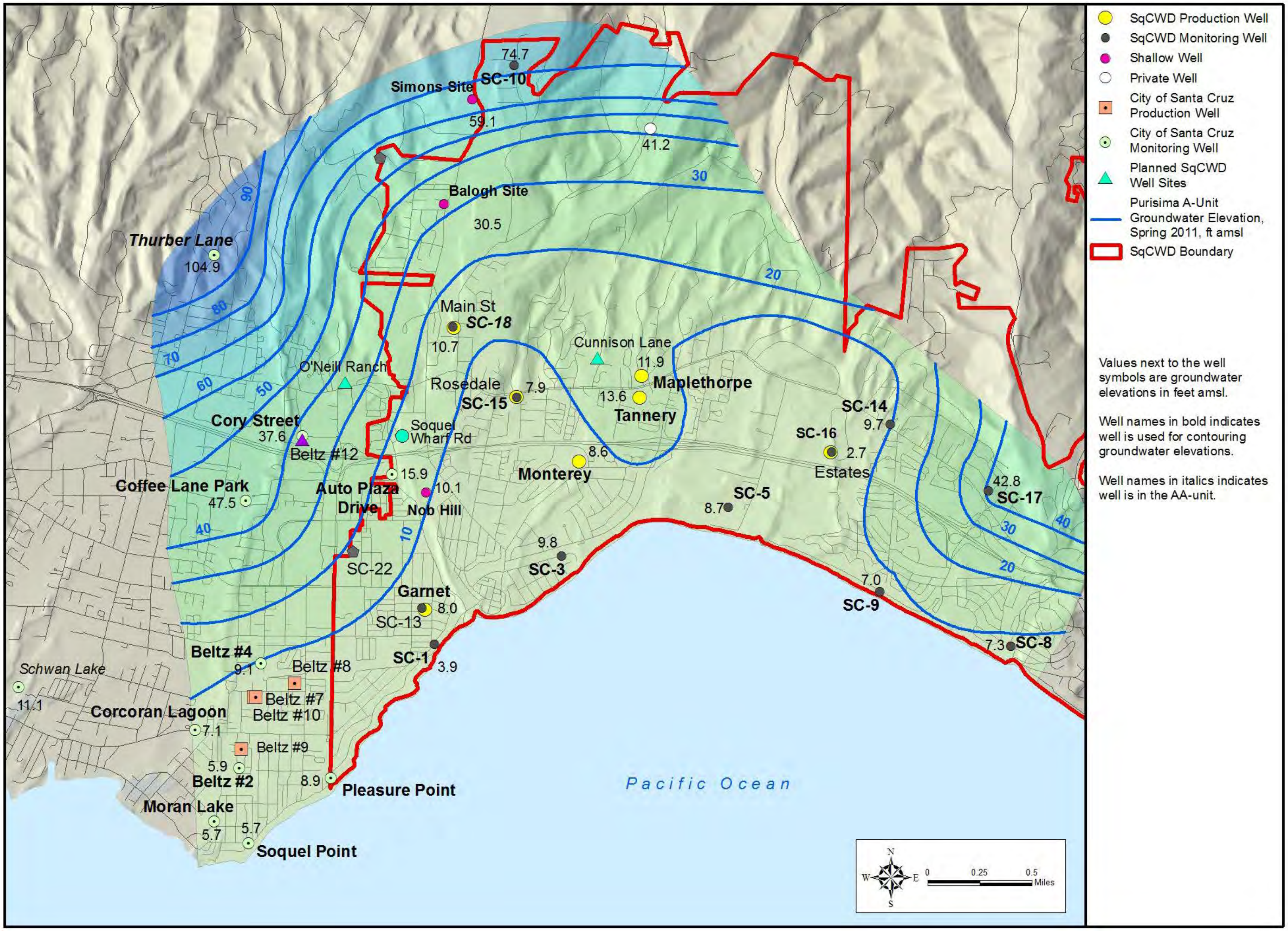


Figure 3-2 (2011): Groundwater Elevation Contours, Purisima A-Unit, Spring 2011

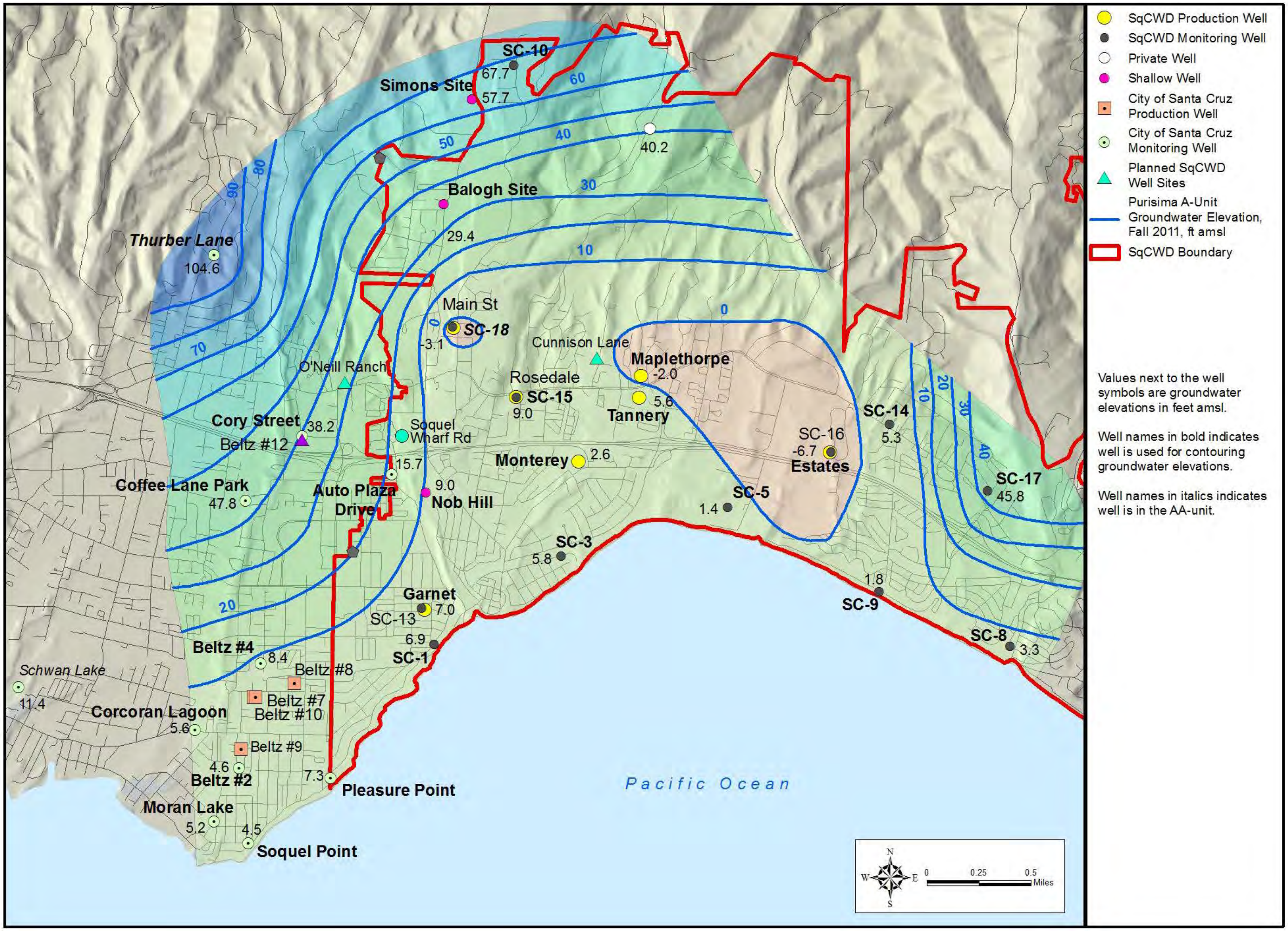


Figure 3-3 (2011): Groundwater Elevation Contours, Purisima A-Unit, Fall 2011

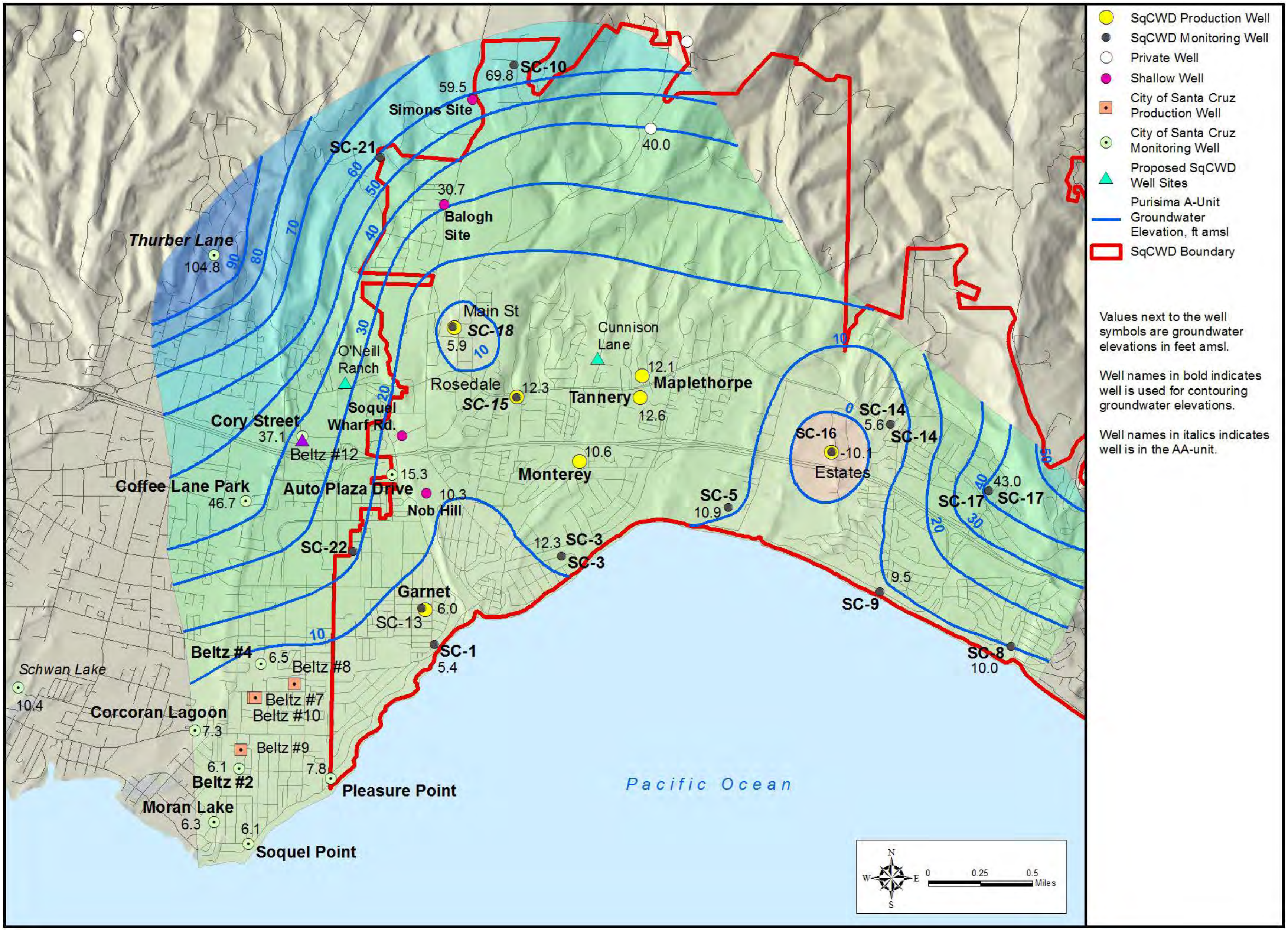


Figure 3-2 (2010): Groundwater Elevation Contours, Purisima A-Unit, Spring 2010

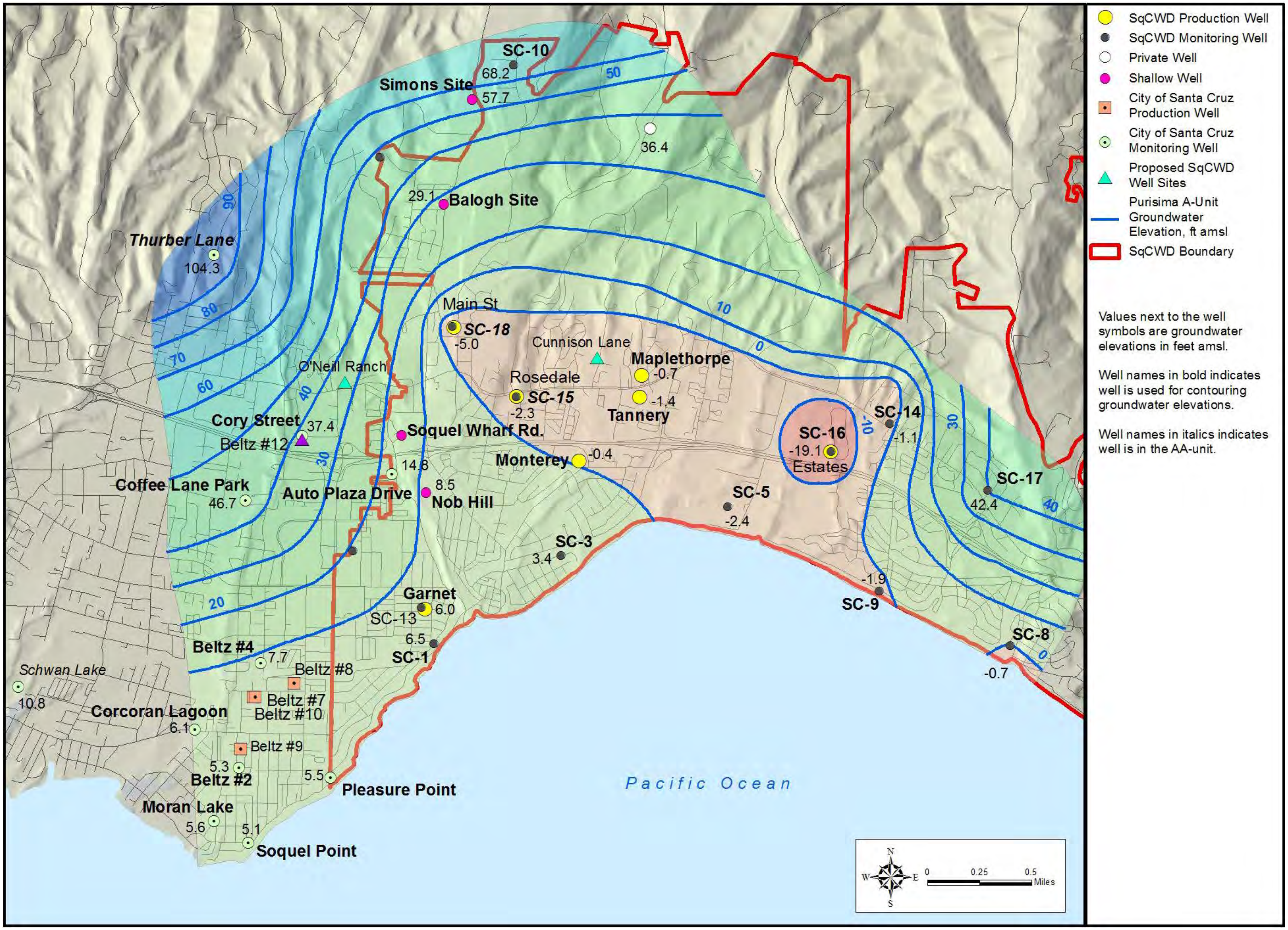


Figure 3-3 (2010): Groundwater Elevation Contours, Purisima A-Unit, Fall 2010

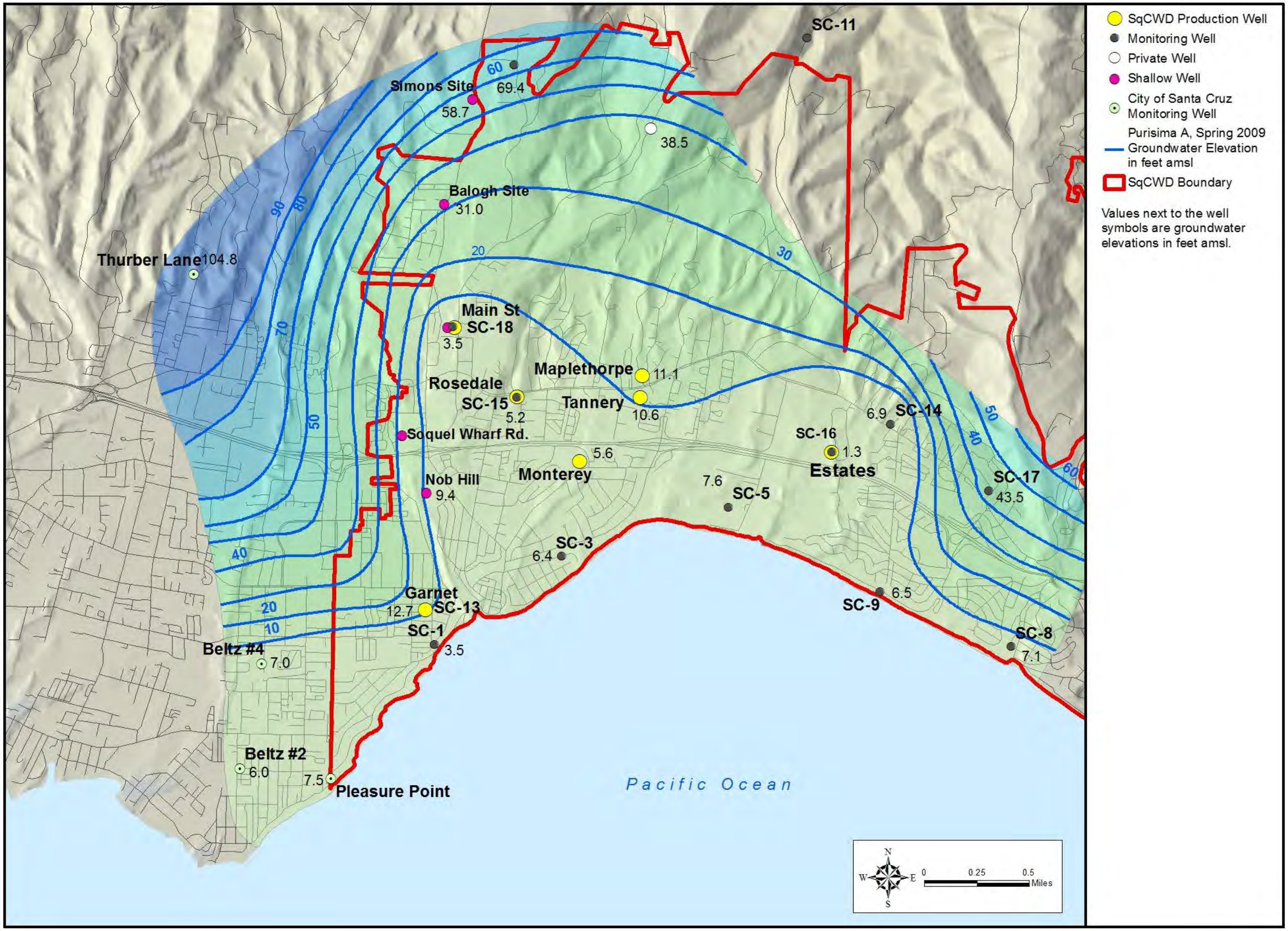


Figure 3-2 (2009): Groundwater Elevation Contours, Purisima A-Unit, Spring 2009

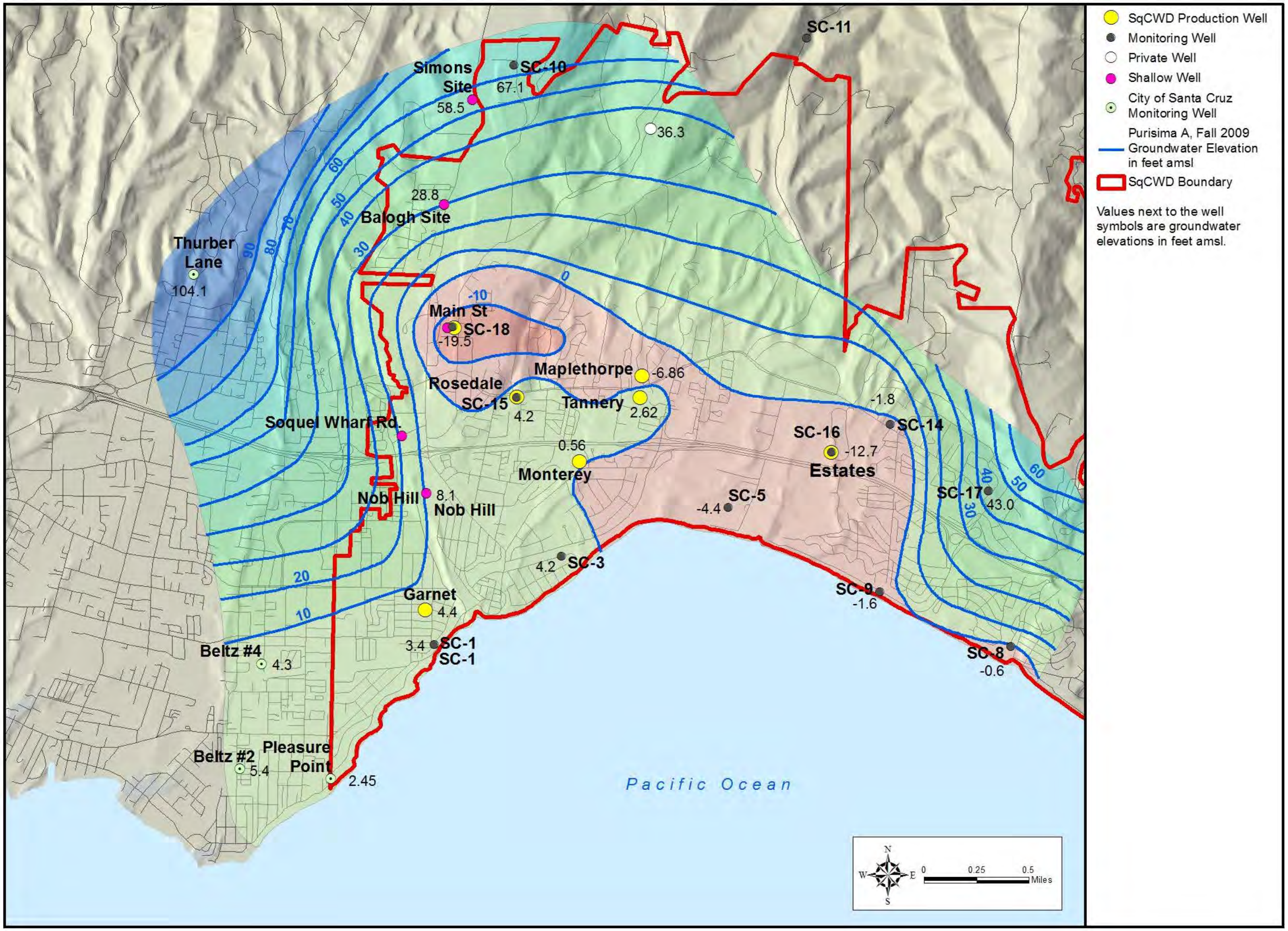


Figure 3-3 (2009): Groundwater Elevation Contours, Purisima A-Unit, Fall 2009

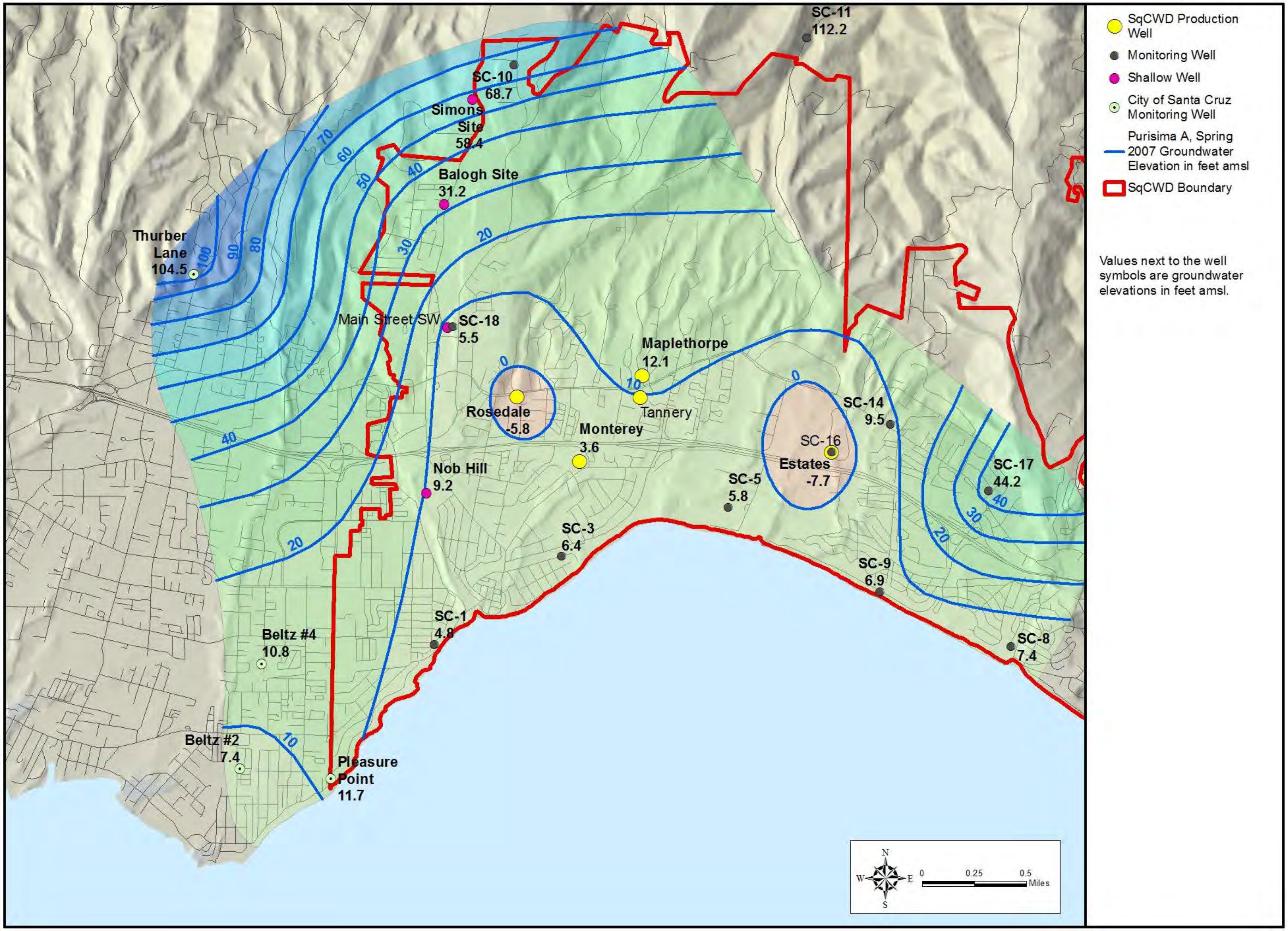


Figure 3-1 (2007): Groundwater Elevation Contours, Purisima A-Unit, Spring 2007

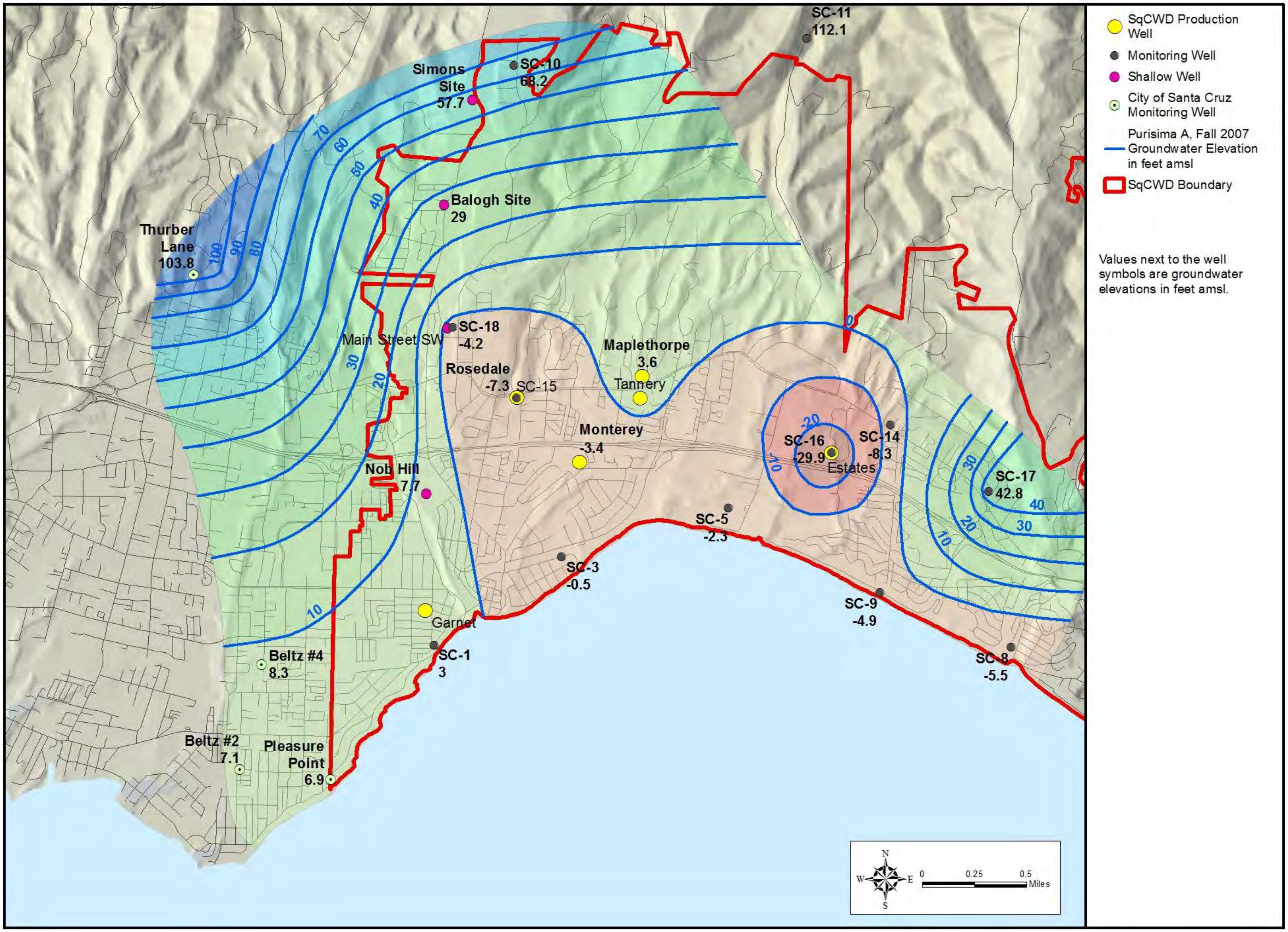


Figure 3-3 (2007): Groundwater Elevation Contours, Purisima A-Unit, Fall 2007

Monitoring Well Hydrographs for Western Purisima Area

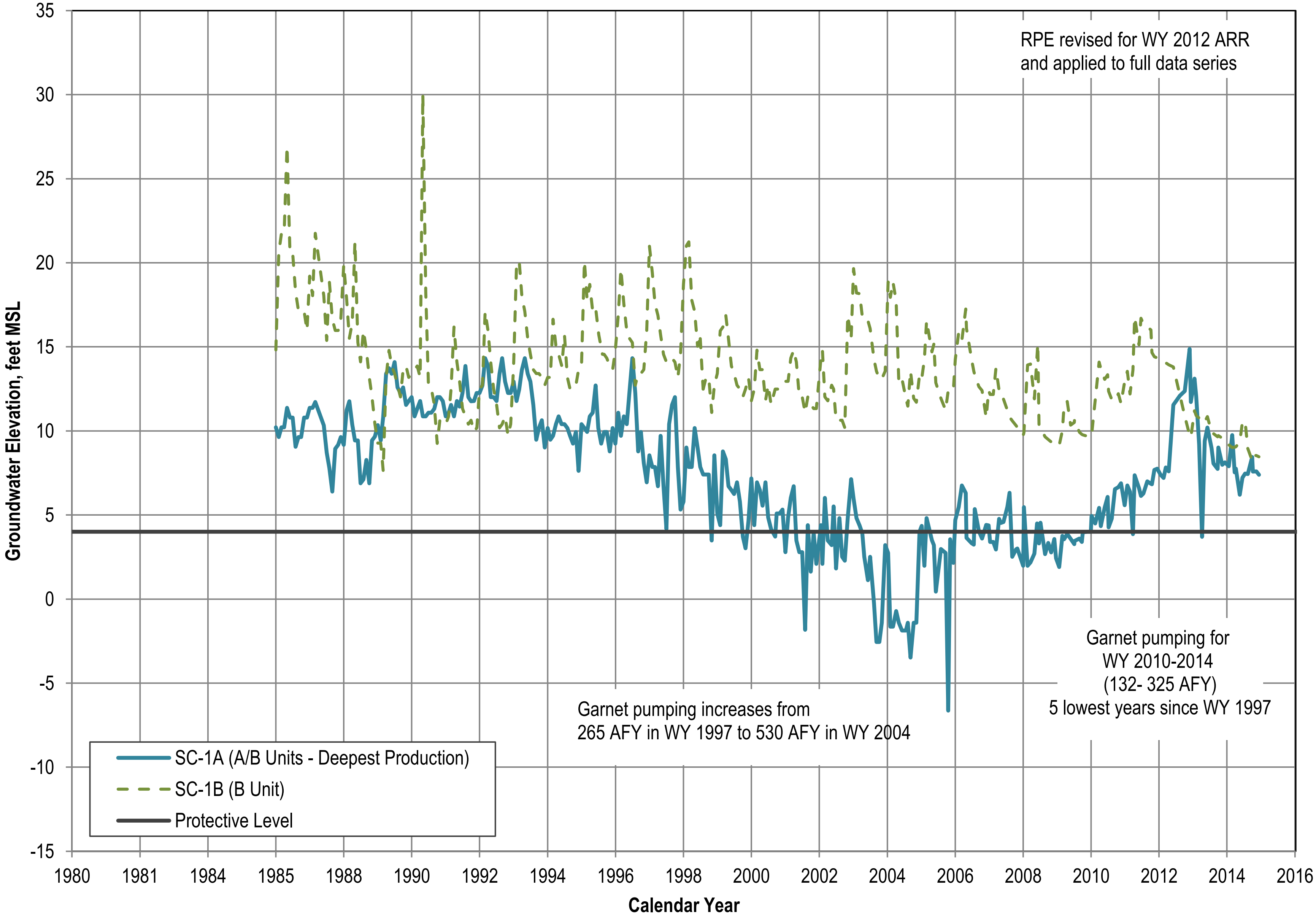
Hydrographs of SqCWD Coastal Monitoring Well Clusters

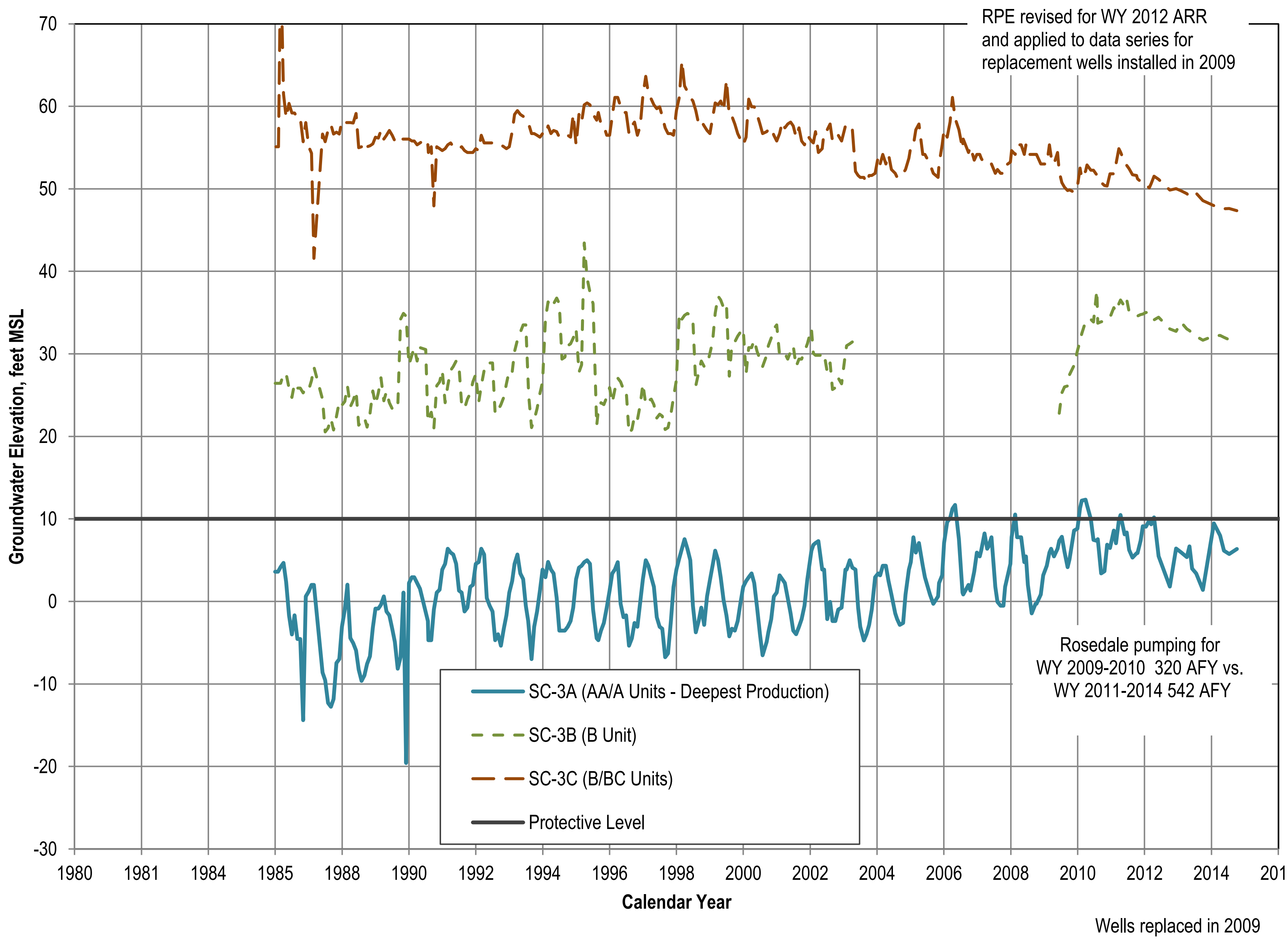
Hydrographs of City of Santa Cruz Coastal Monitoring Well Clusters

Hydrographs of SqCWD Inland Monitoring Well Clusters

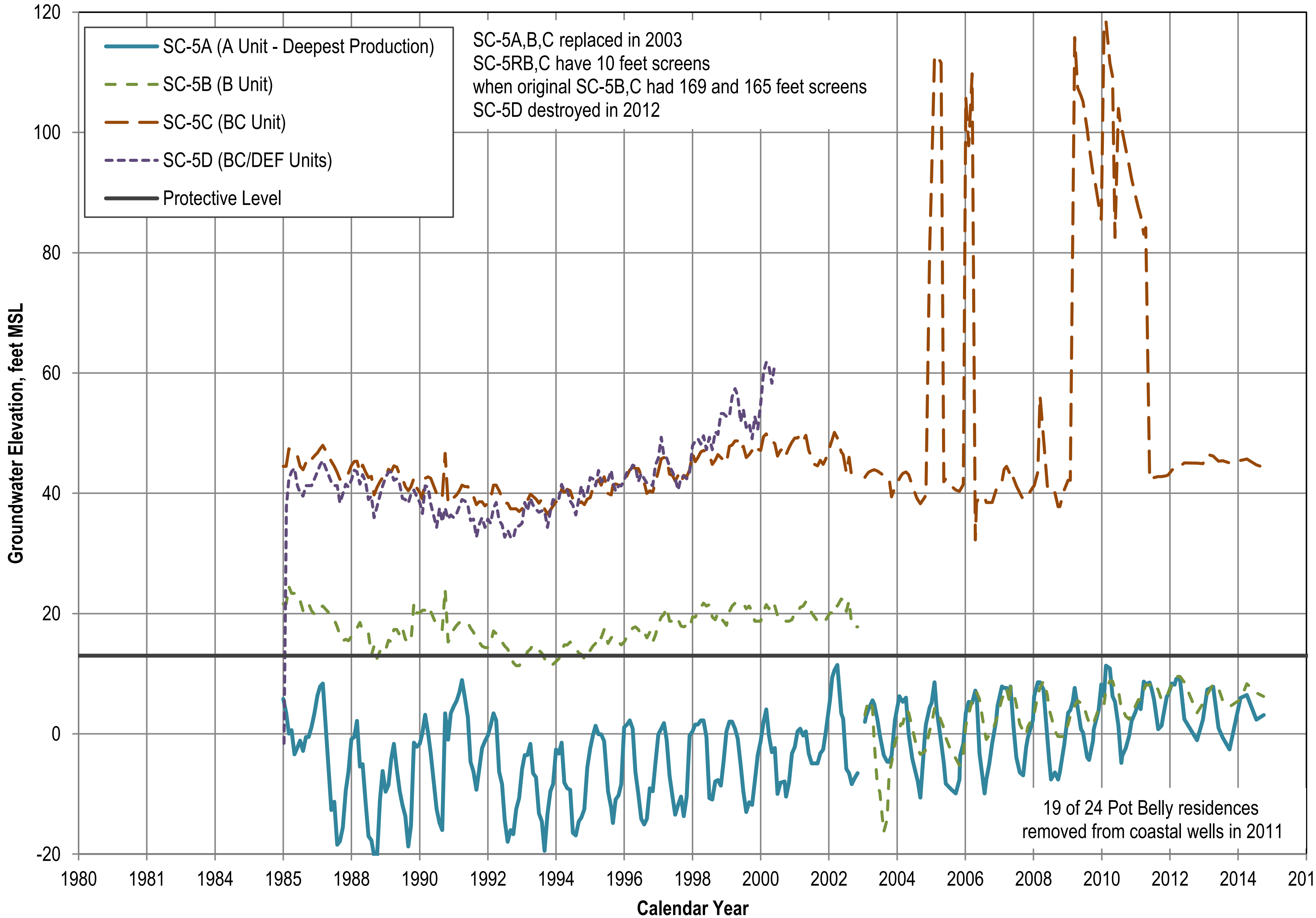
Hydrographs of City of Santa Cruz Inland Monitoring Well Clusters

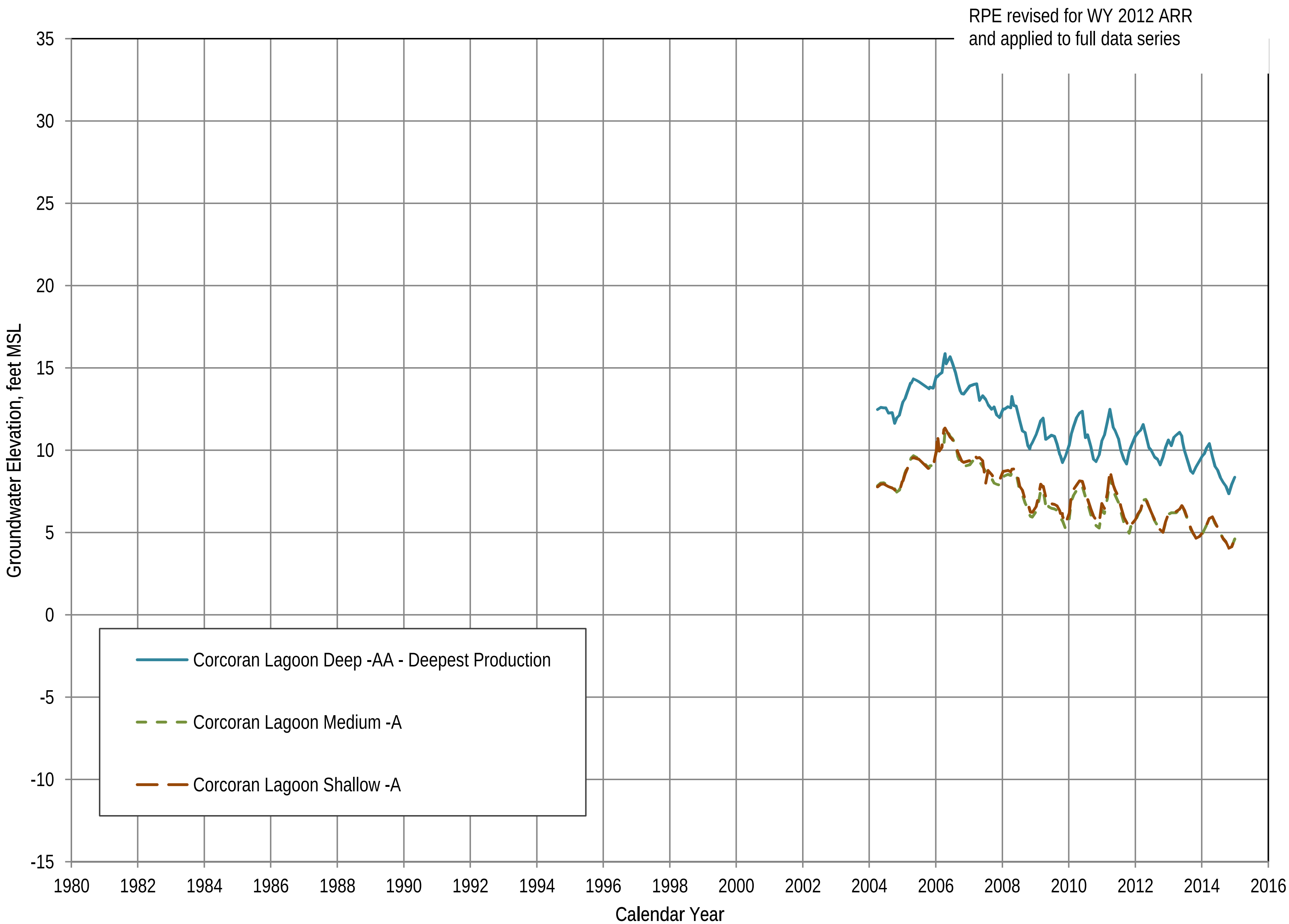
Hydrographs of SqCWD Monitoring Wells Adjacent to Production Wells

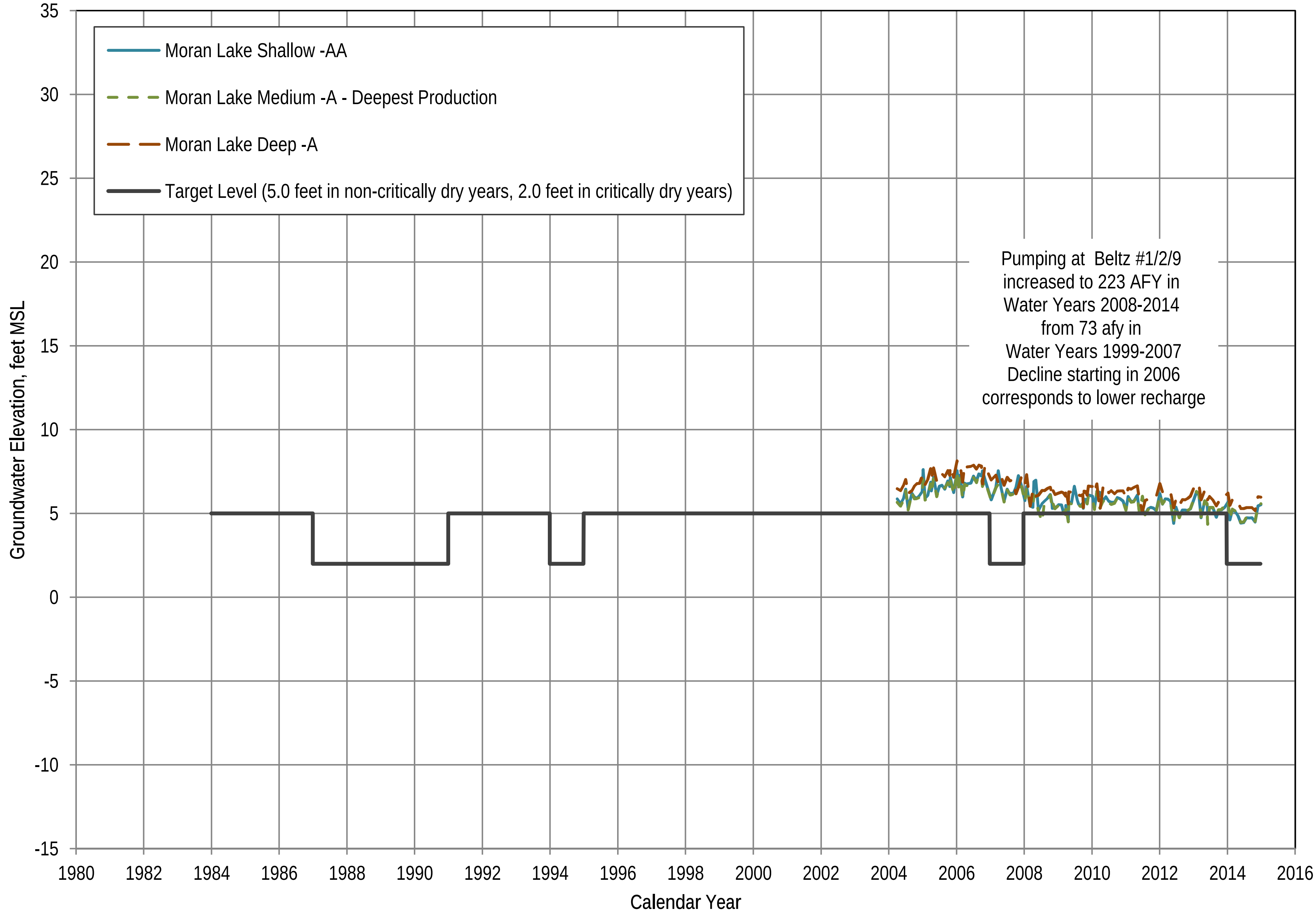

RPE revised for WY 2012 ARR
and applied to full data series
Groundwater Elevation, feet MSL
35
30
25
20
15
10
5
0
-5
-10
-15
1980
1981
1984
1985
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
Calendar Year
Garnet pumping for
WY 2010-2014
(132- 325 AFY)
5 lowest years since WY 1997
Garnet pumping increases from
265 AFY in WY 1997 to 530 AFY in WY 2004
SC-1A (A/B Units - Deepest Production)
SC-1B (B Unit)
Protective Level



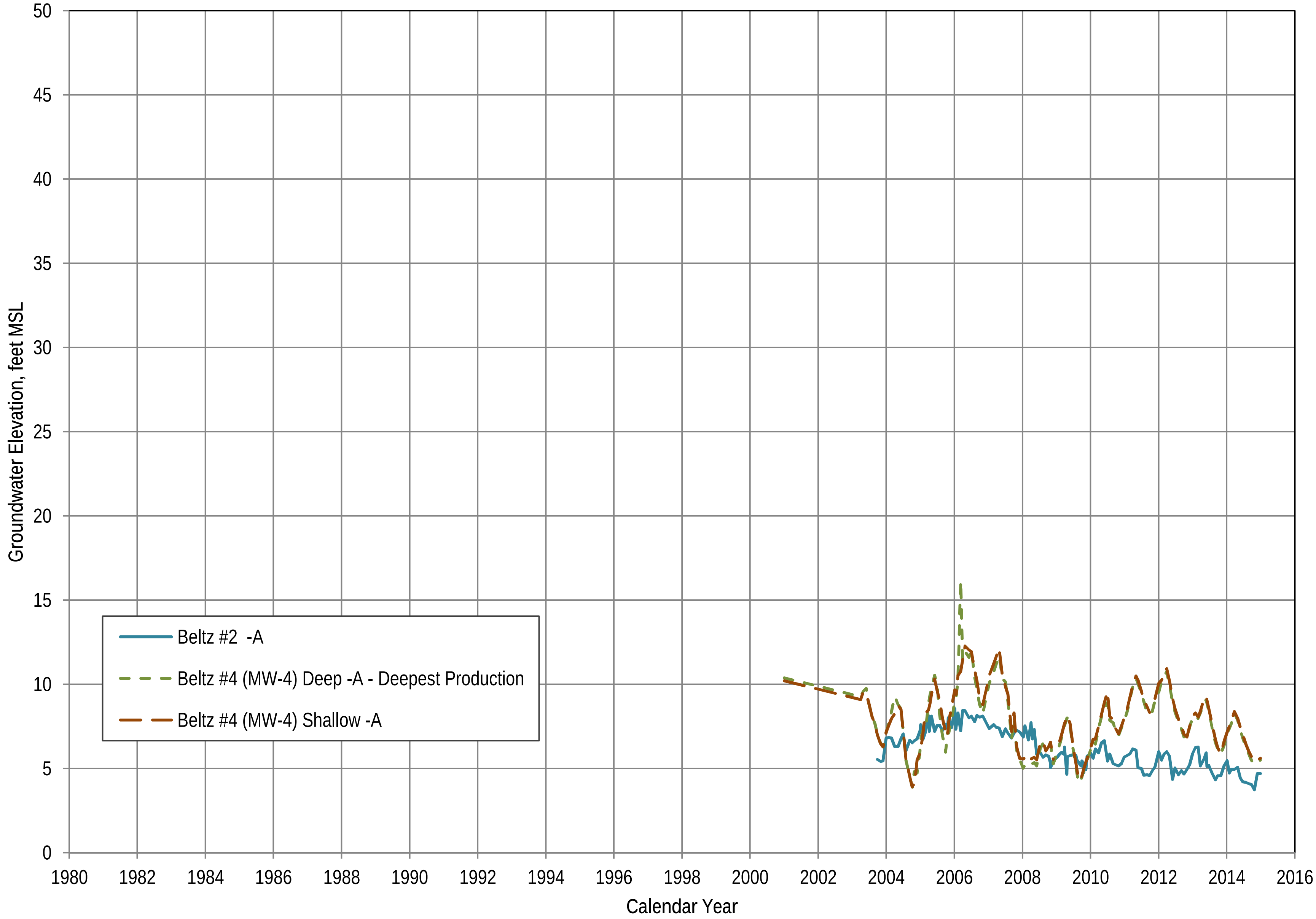
RPE revised for WY 2012 ARR
and applied to data series for
replacement wells installed in 2009
Groundwater Elevation, feet MSL
70
60
50
40
30
20
10
0
-10
-20
-30
Rosedale pumping for
WY 2009-2010 320 AFY vs.
WY 2011-2014 542 AFY
SC-3A (AA/A Units - Deepest Production)
SC-3B (B Unit)
SC-3C (B/BC Units)
Protective Level
1980
1981
1984
1985
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
Calendar Year
Wells replaced in 2009


120
100
80
60
40
20
0
-20
Groundwater Elevation, feet MSL
SC-5A (A Unit - Deepest Production)
SC-5B (B Unit)
SC-5C (BC Unit)
SC-5D (BC/DEF Units)
Protective Level
SC-5A,B,C replaced in 2003
SC-5RB,C have 10 feet screens
when original SC-5B,C had 169 and 165 feet screens
SC-5D destroyed in 2012
19 of 24 Pot Belly residences
removed from coastal wells in 2011
1980
1981
1984
1985
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
Calendar Year

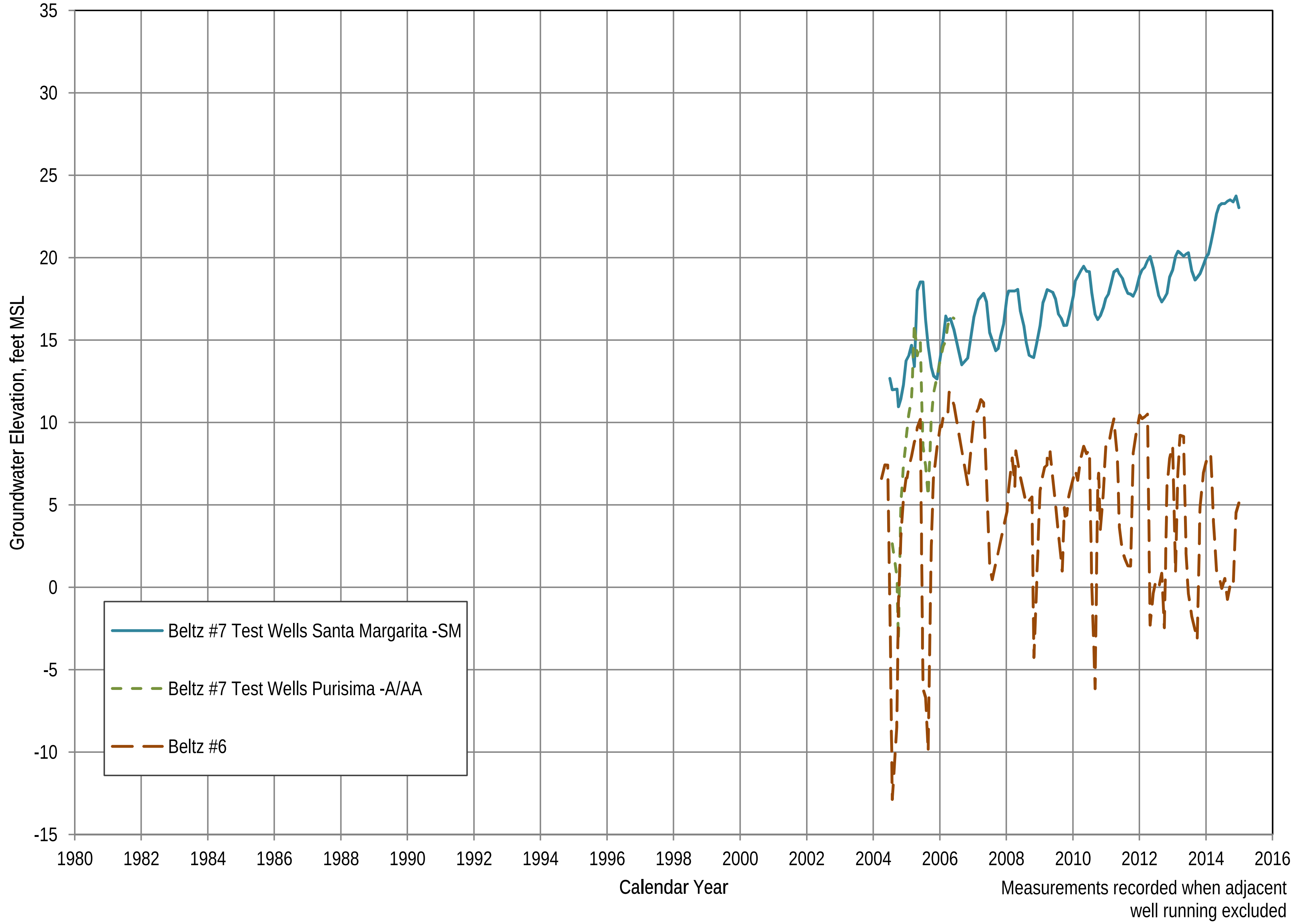

RPE revised for WY 2012 ARR
and applied to full data series
Groundwater Elevation, feet MSL
35
30
25
20
15
10
5
0
-5
-10
-15
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
Calendar Year
Corcoran Lagoon Deep -AA - Deepest Production
Corcoran Lagoon Medium -A
Corcoran Lagoon Shallow -A



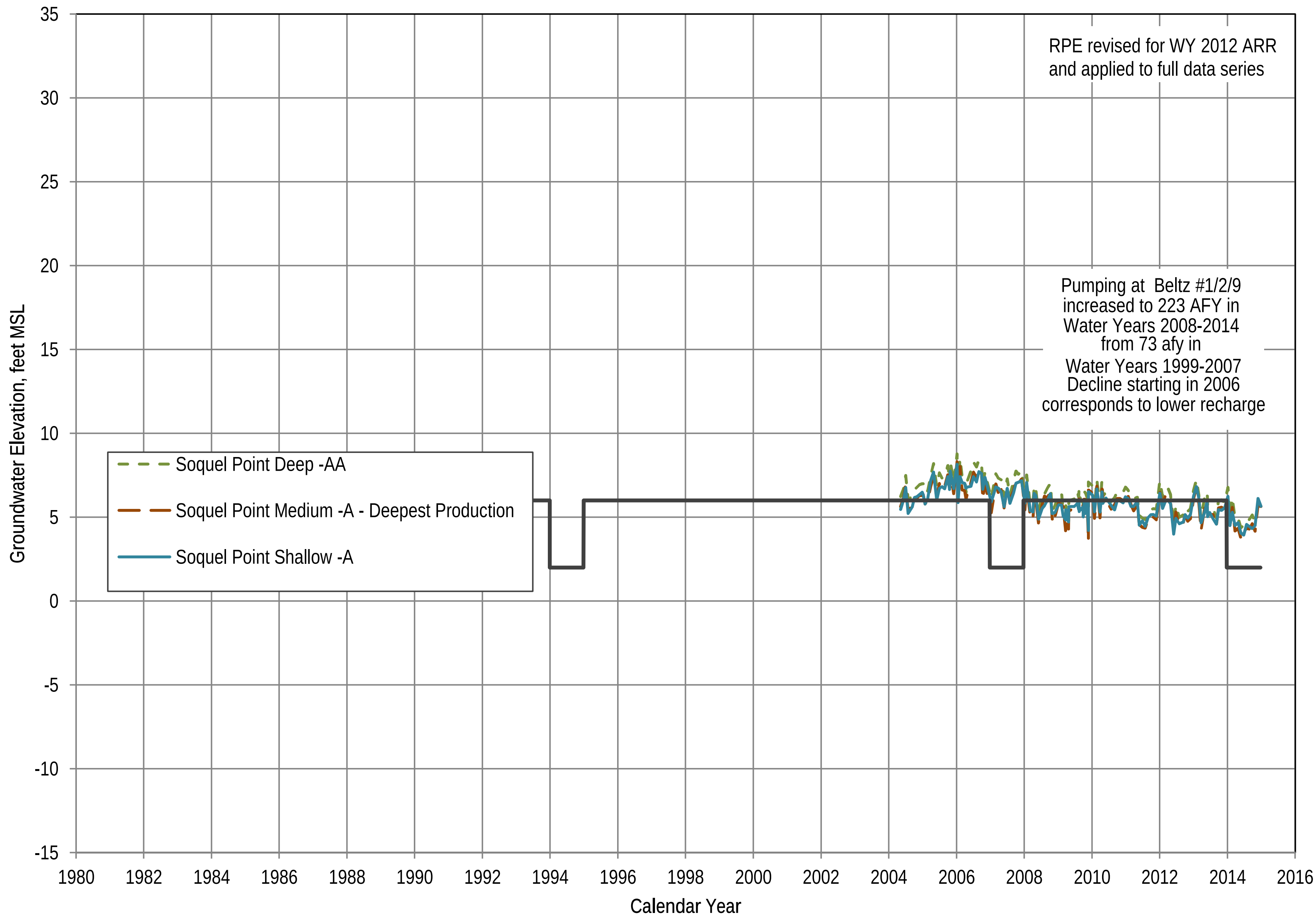
Moran Lake Shallow -AA
Moran Lake Medium -A - Deepest Production
Moran Lake Deep -A
Target Level (5.0 feet in non-critically dry years, 2.0 feet in critically dry years)
Pumping at Beltz #1/2/9 increased to 223 AFY in Water Years 2008-2014 from 73 afy in Water Years 1999-2007 Decline starting in 2006 corresponds to lower recharge
Groundwater Elevation, feet MSL
Calendar Year
35
30
25
20
15
10
5
0
-5
-10
-15
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016



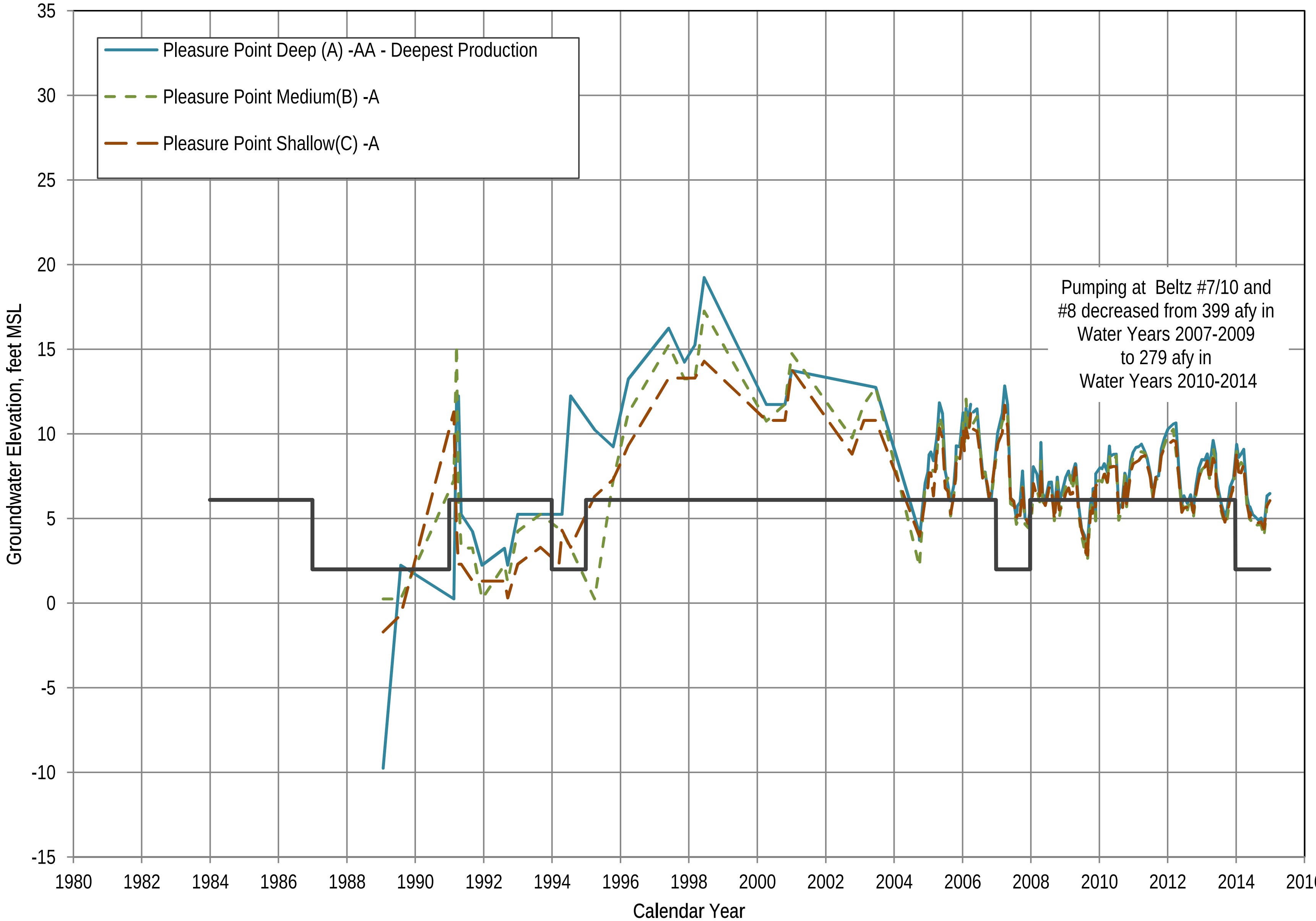
50
45
40
35
30
25
20
15
10
5
0
Groundwater Elevation, feet MSL
Beltz #2 -A
Beltz #4 (MW-4) Deep -A - Deepest Production
Beltz #4 (MW-4) Shallow -A
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
Calendar Year



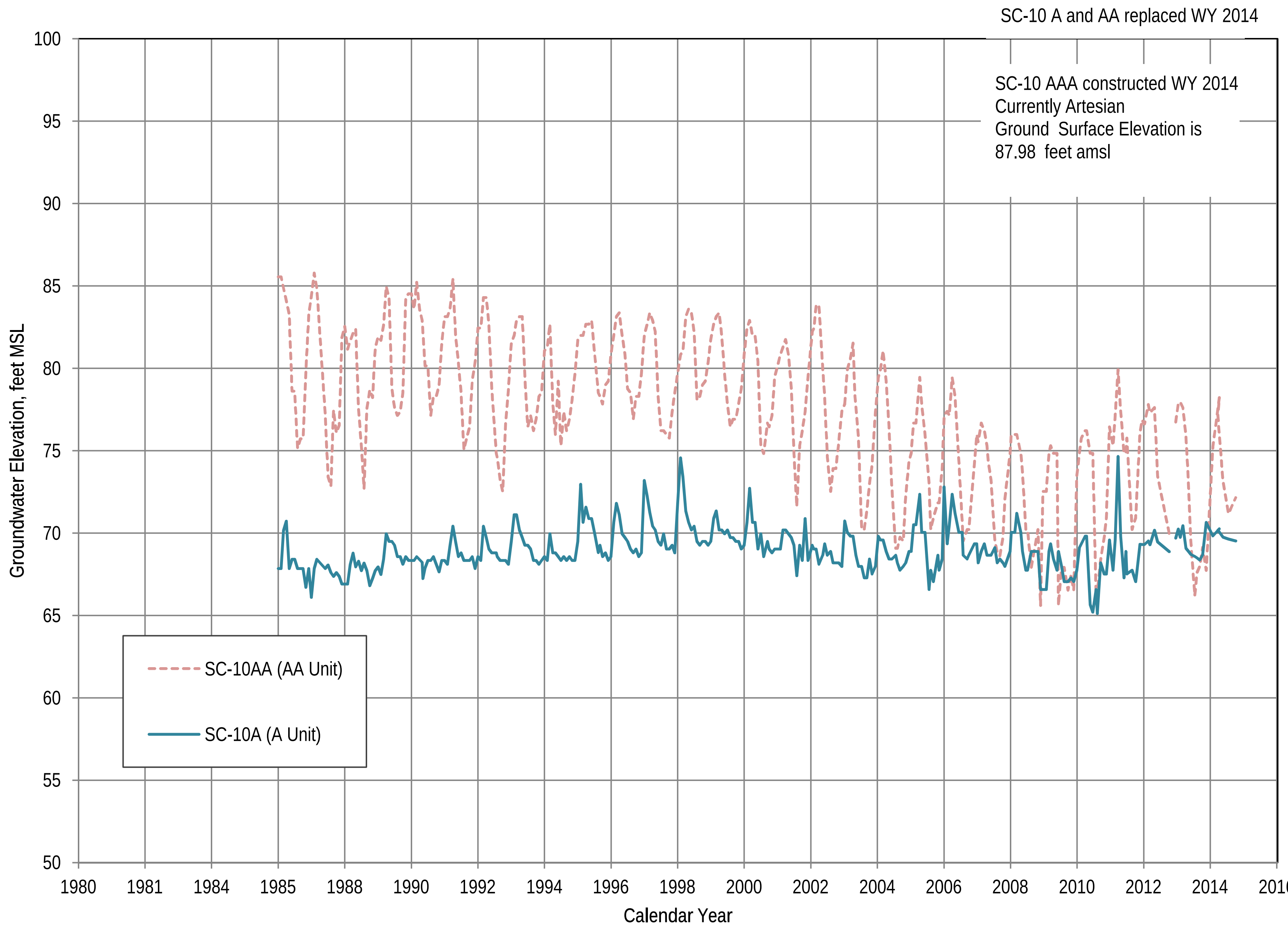
35
30
25
20
15
10
5
0
-5
-10
-15
Groundwater Elevation, feet MSL
Beltz #7 Test Wells Santa Margarita -SM
Beltz #7 Test Wells Purisima -A/AA
Beltz #6
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
Calendar Year
Measurements recorded when adjacent well running excluded

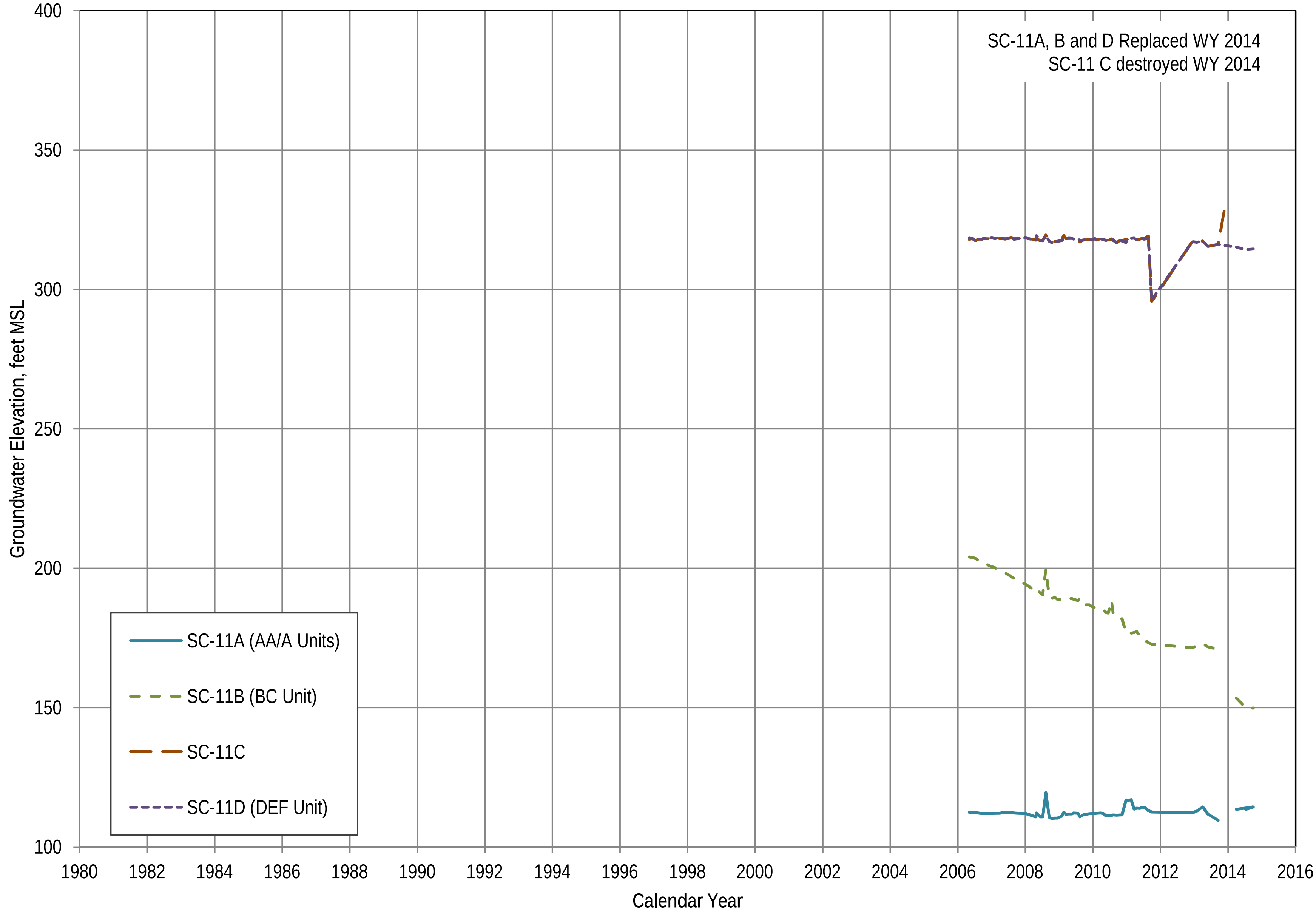


RPE revised for WY 2012 ARR
and applied to full data series
Pumping at Beltz #1/2/9
increased to 223 AFY in
Water Years 2008-2014
from 73 afy in
Water Years 1999-2007
Decline starting in 2006
corresponds to lower recharge
Soquel Point Deep -AA
Soquel Point Medium -A - Deepest Production
Soquel Point Shallow -A
Groundwater Elevation, feet MSL
Calendar Year
35
30
25
20
15
10
5
0
-5
-10
-15
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016

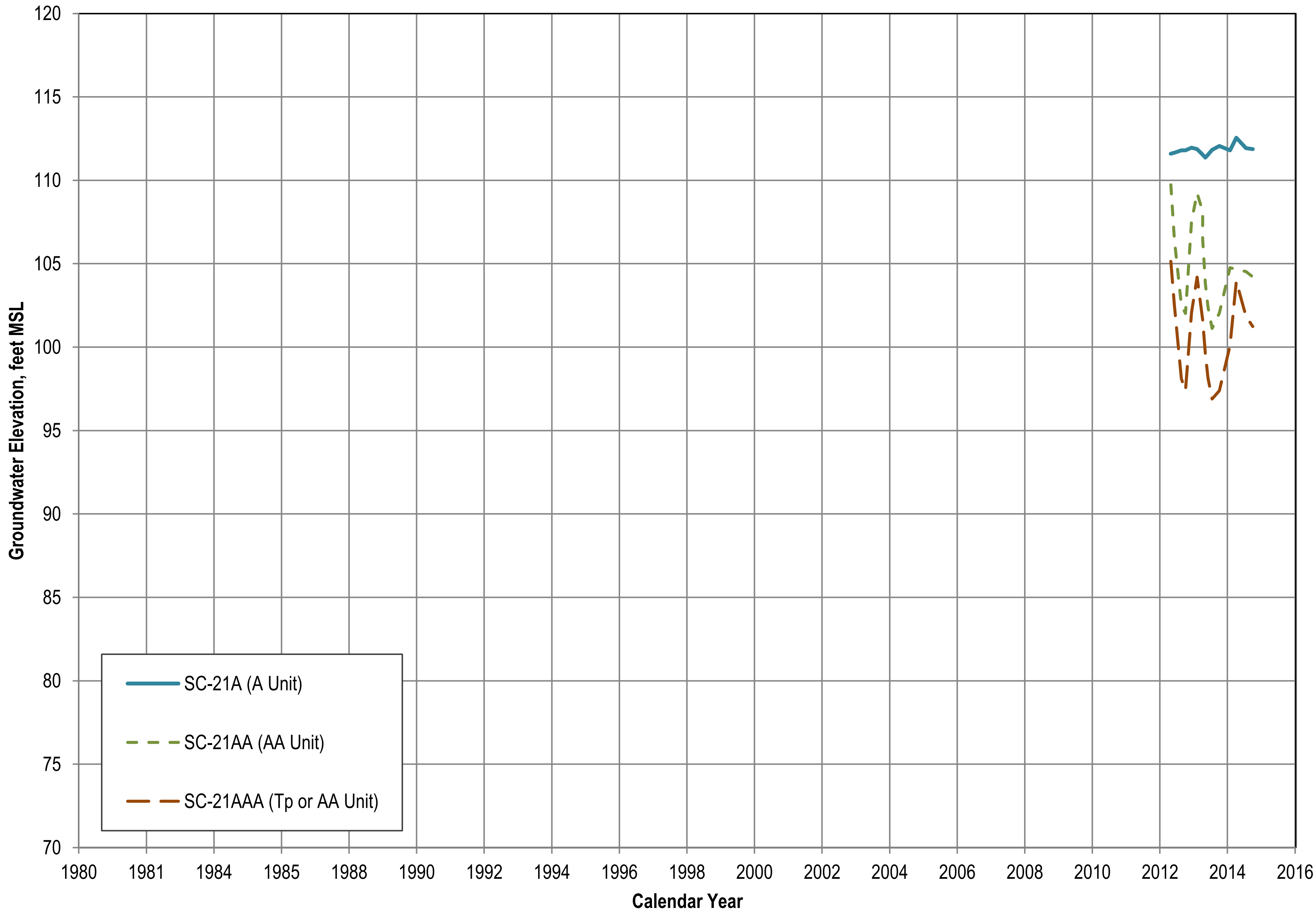


Pleasure Point Deep (A) -AA - Deepest Production
Pleasure Point Medium(B) -A
Pleasure Point Shallow(C) -A
Pumping at Beltz #7/10 and #8 decreased from 399 afy in Water Years 2007-2009 to 279 afy in Water Years 2010-2014
Groundwater Elevation, feet MSL
Calendar Year
35
30
25
20
15
10
5
0
-5
-10
-15
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016

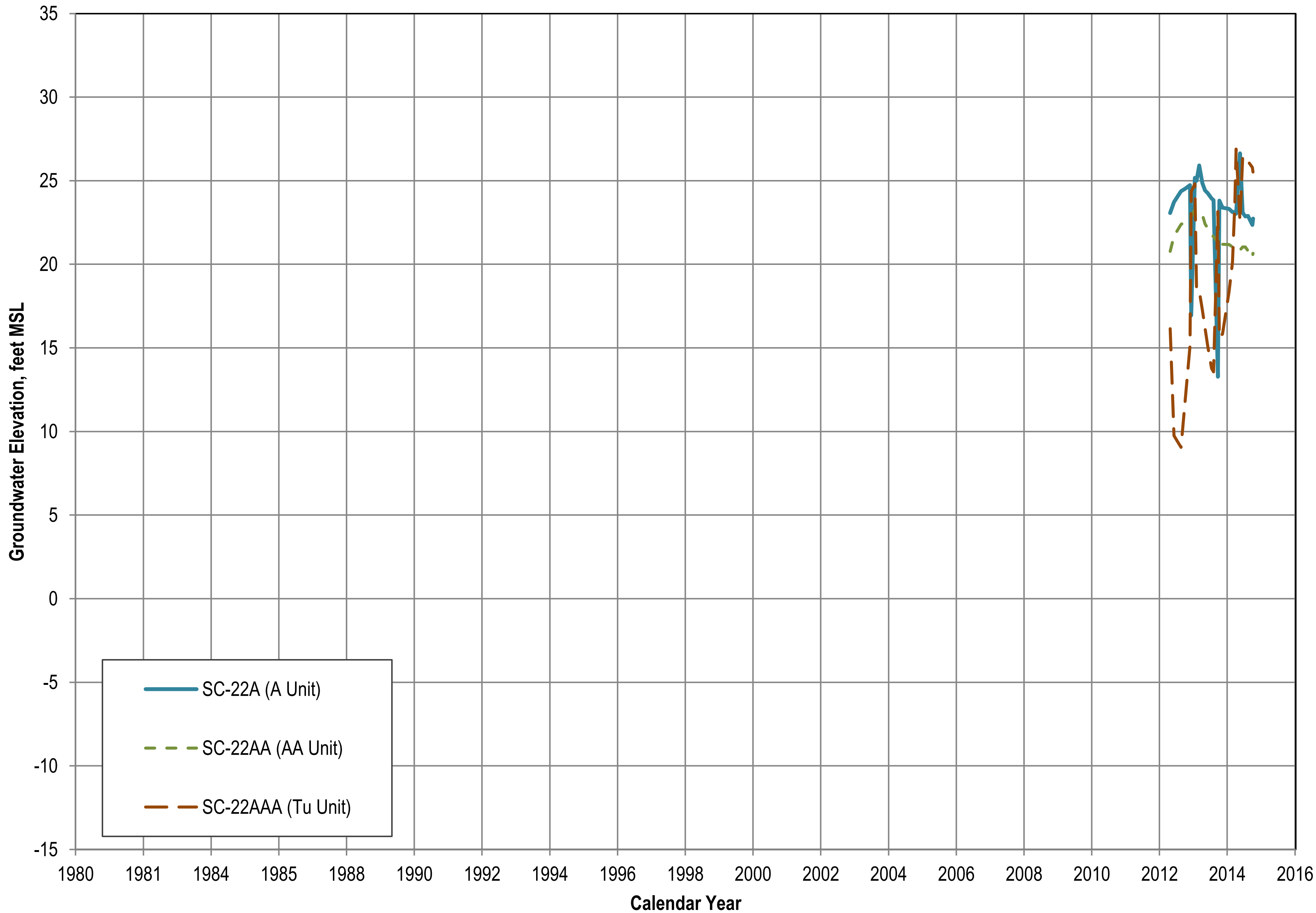

SC-10 A and AA replaced WY 2014
SC-10 AAA constructed WY 2014
Currently Artesian
Ground Surface Elevation is
87.98 feet amsl
Groundwater Elevation, feet MSL
Calendar Year
SC-10AA (AA Unit)
SC-10A (A Unit)
100
95
90
85
80
75
70
65
60
55
50
1980
1981
1984
1985
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016



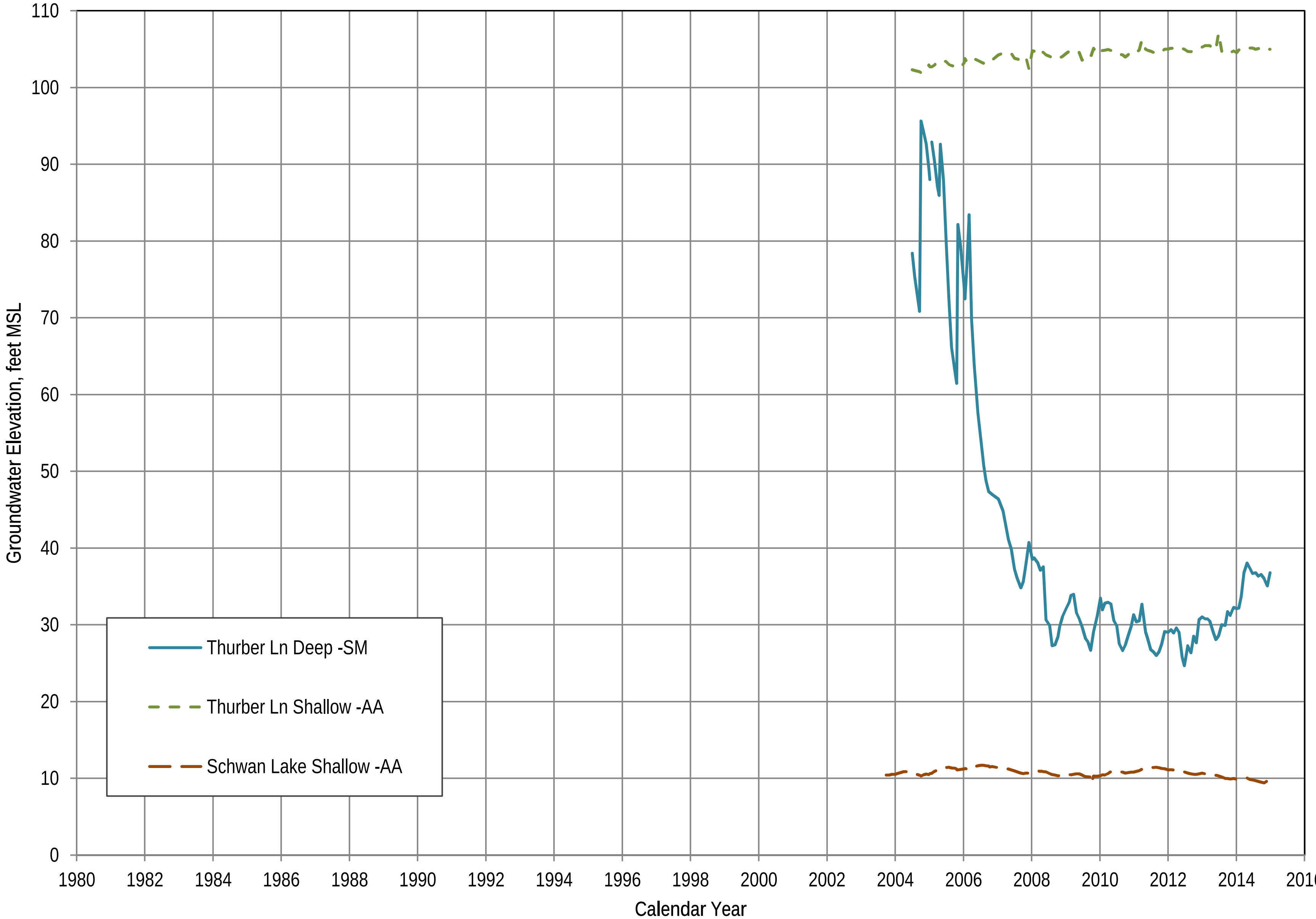
SC-11A, B and D Replaced WY 2014
SC-11 C destroyed WY 2014
Groundwater Elevation, feet MSL
400
350
300
250
200
150
100
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
Calendar Year
SC-11A (AA/A Units)
SC-11B (BC Unit)
SC-11C
SC-11D (DEF Unit)

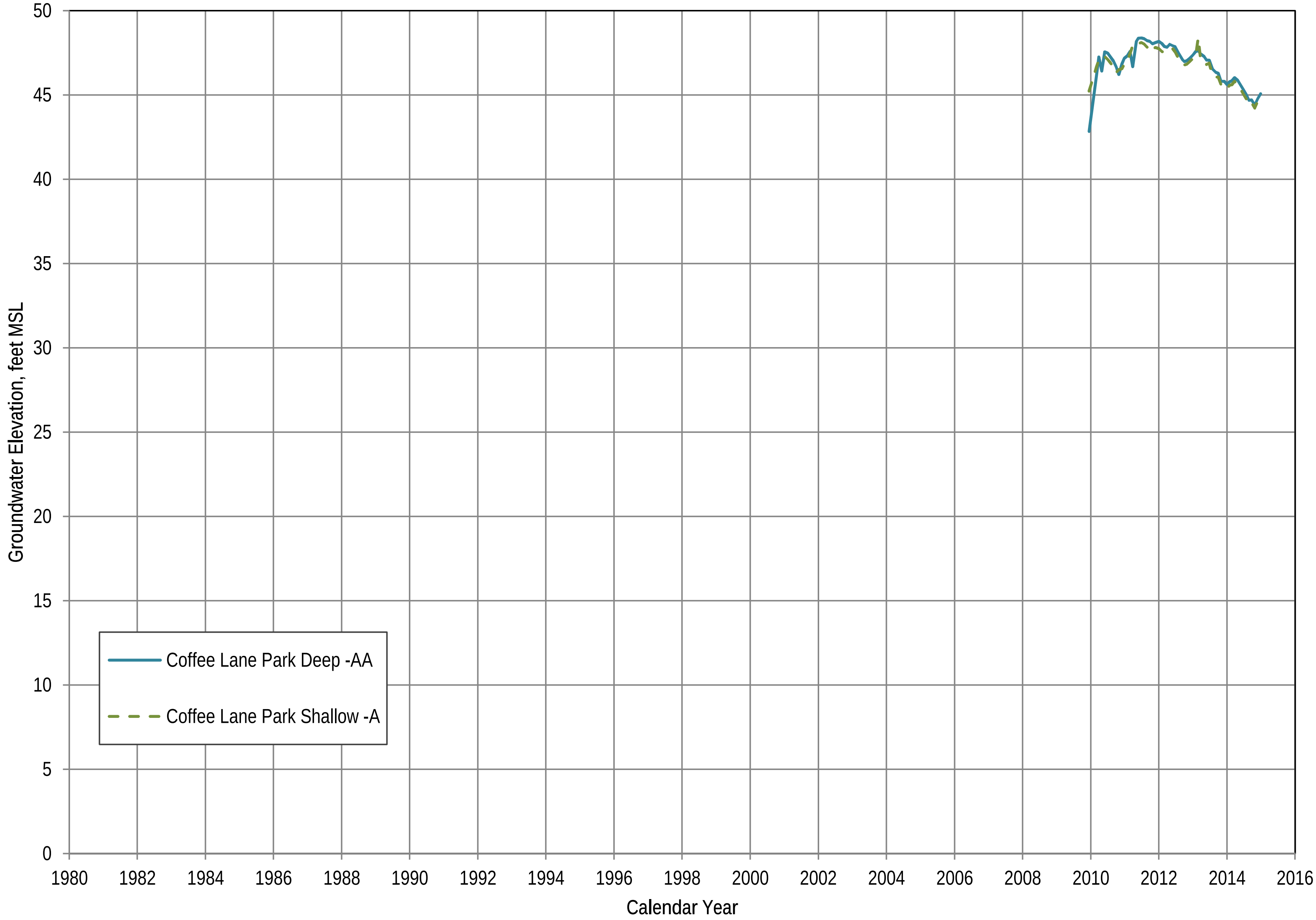


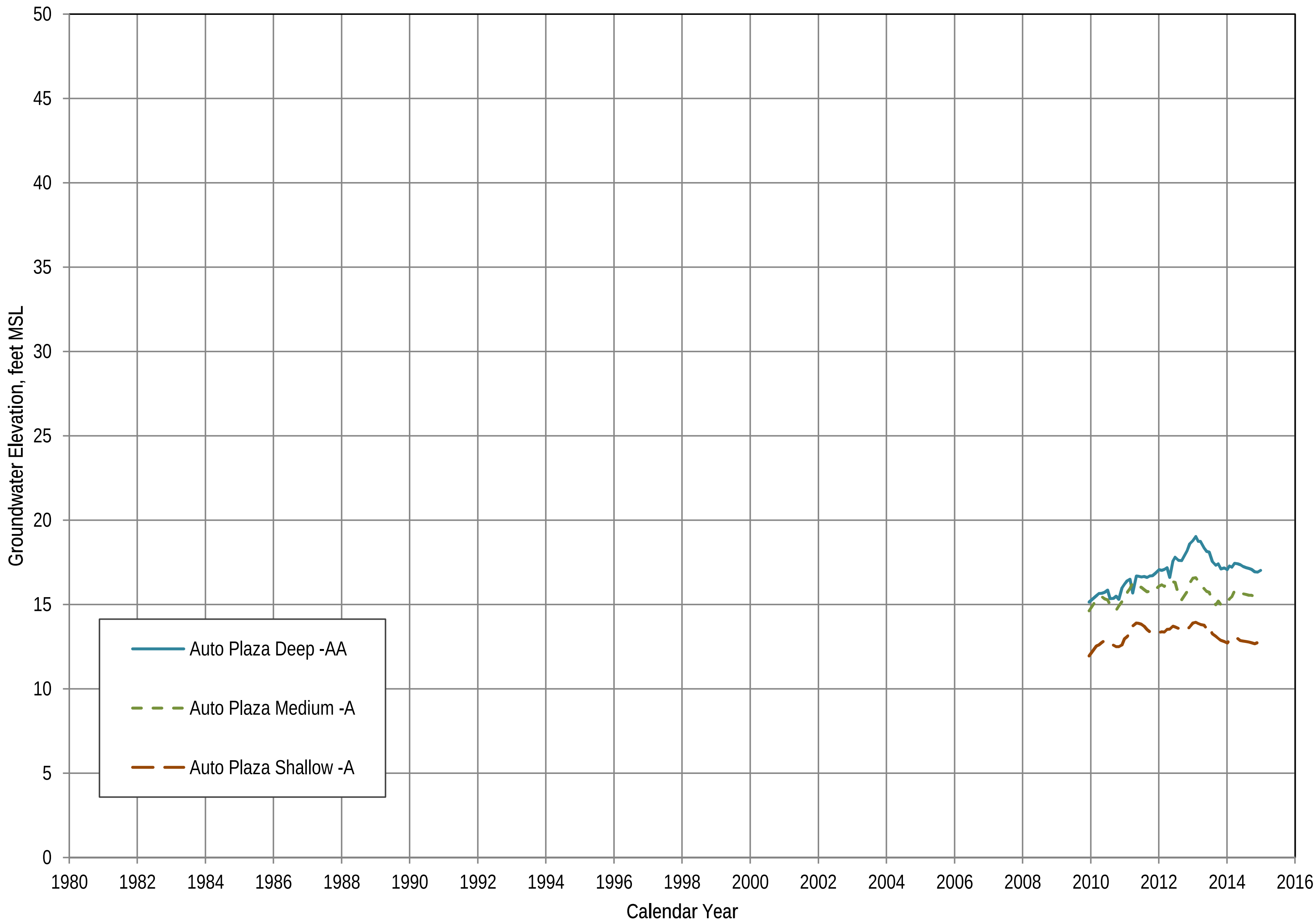
Groundwater Elevation, feet MSL
120
115
110
105
100
95
90
85
80
75
70
1980
1981
1984
1985
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
Calendar Year
SC-21A (A Unit)
SC-21AA (AA Unit)
SC-21AAA (Tp or AA Unit)



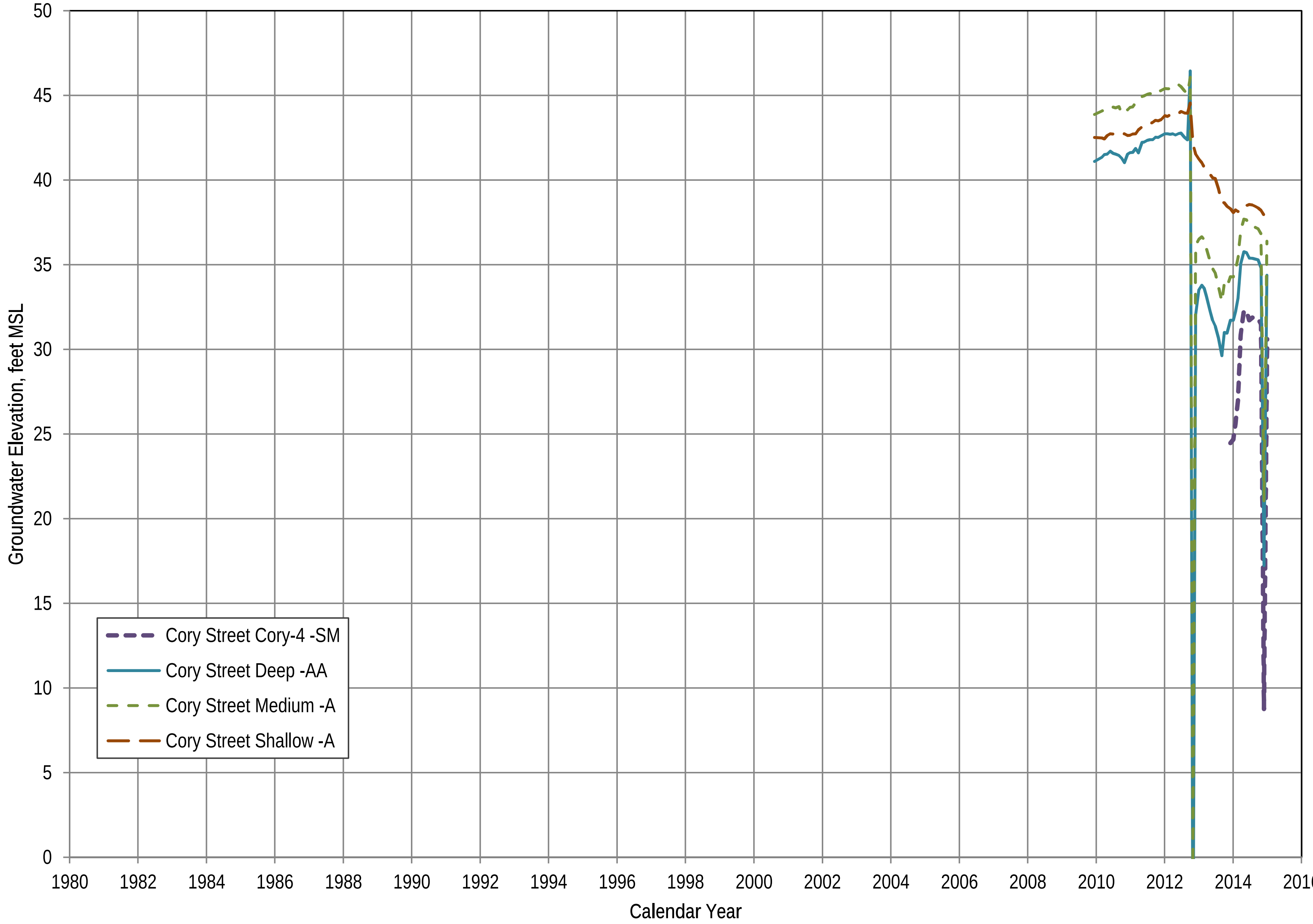
Groundwater Elevation, feet MSL
35
30
25
20
15
10
5
0
-5
-10
-15
1980
1981
1984
1985
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
Calendar Year
SC-22A (A Unit)
SC-22AA (AA Unit)
SC-22AAA (Tu Unit)

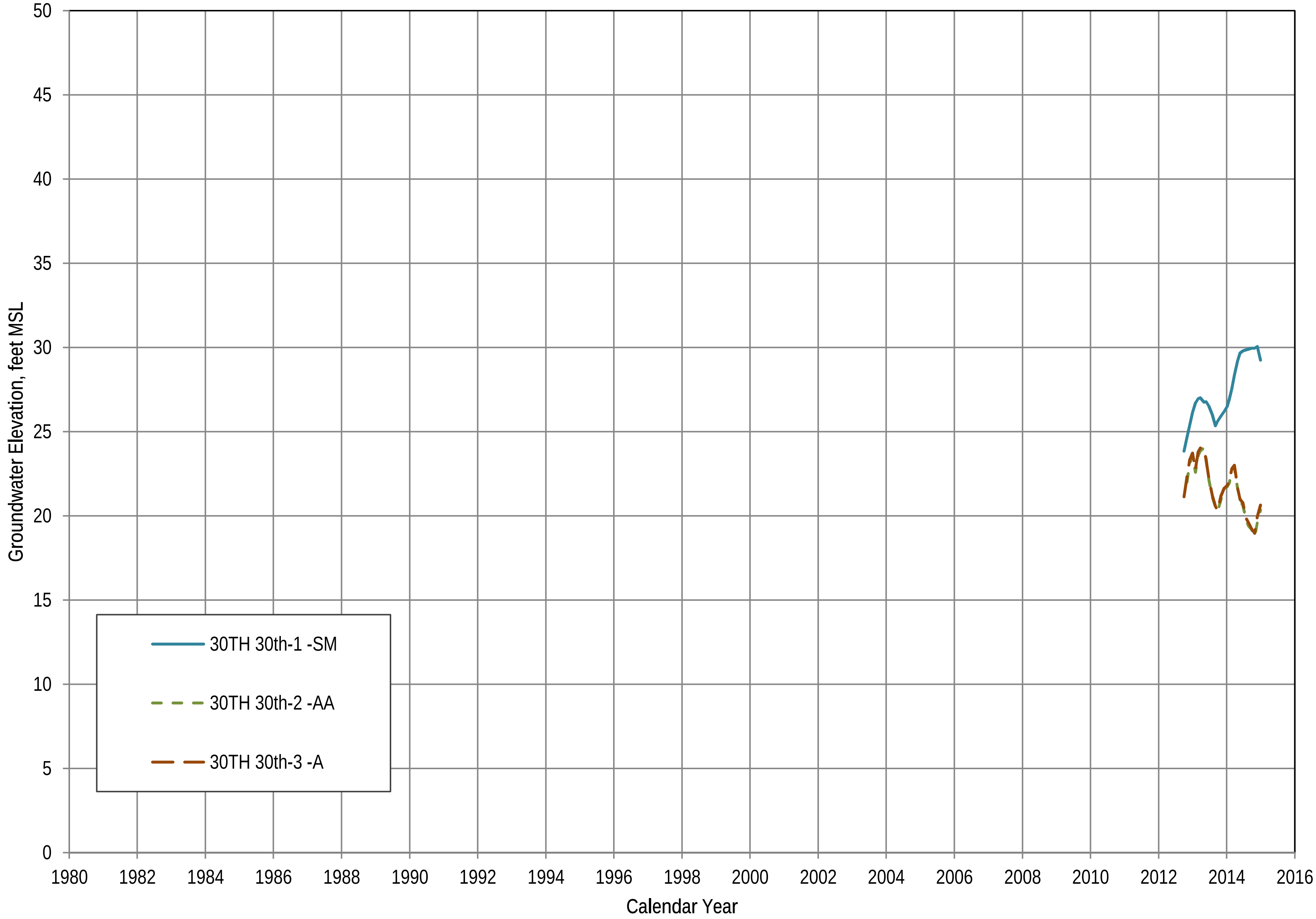

Groundwater Elevation, feet MSL
Calendar Year
Thurber Ln Deep -SM
Thurber Ln Shallow -AA
Schwan Lake Shallow -AA
0
10
20
30
40
50
60
70
80
90
100
110
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016


50
45
40
35
30
25
20
15
10
5
0
Groundwater Elevation, feet MSL
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
Calendar Year
Coffee Lane Park Deep -AA
Coffee Lane Park Shallow -A

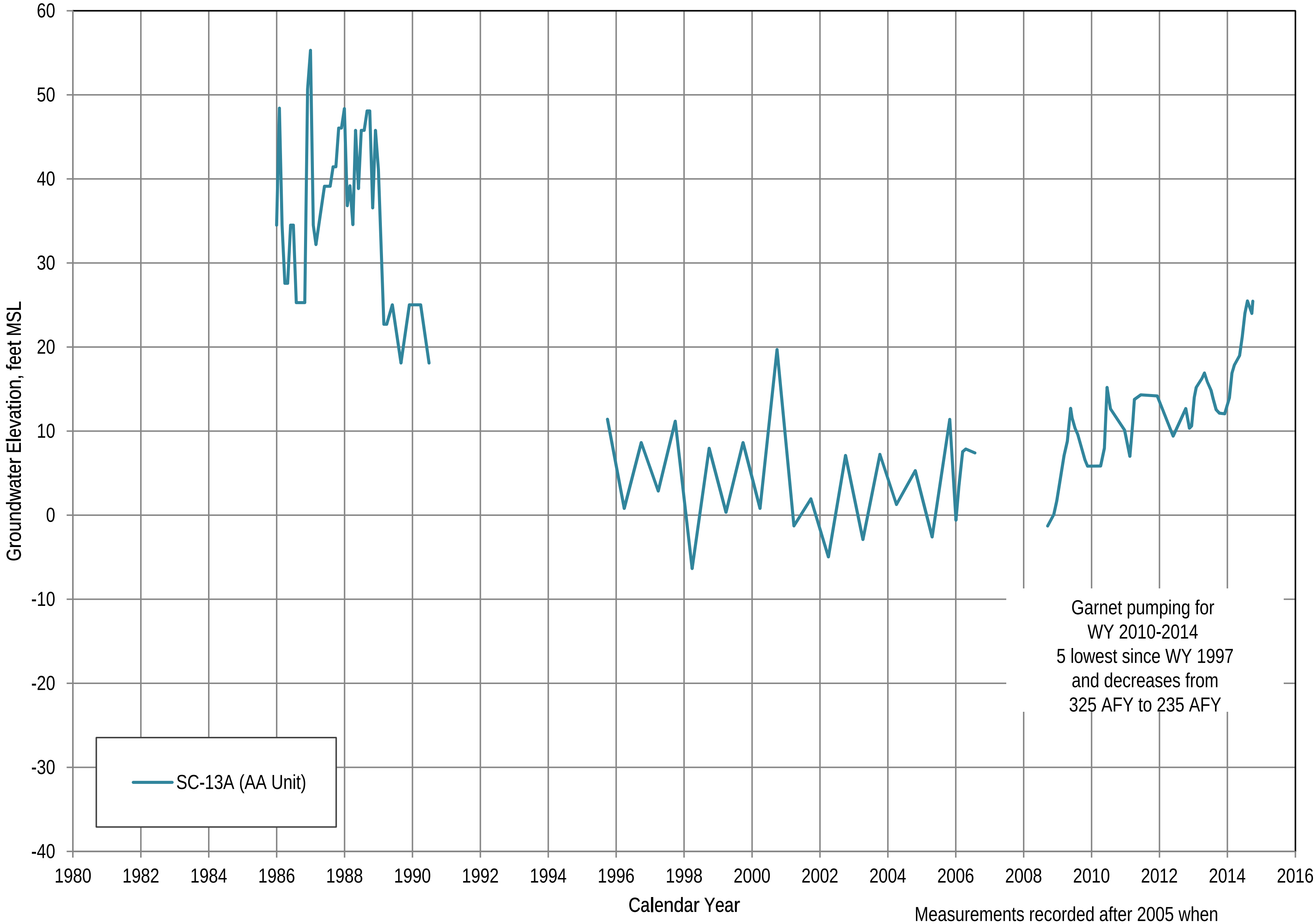


Groundwater Elevation, feet MSL
Calendar Year
0
5
10
15
20
25
30
35
40
45
50
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
Auto Plaza Deep -AA
Auto Plaza Medium -A
Auto Plaza Shallow -A

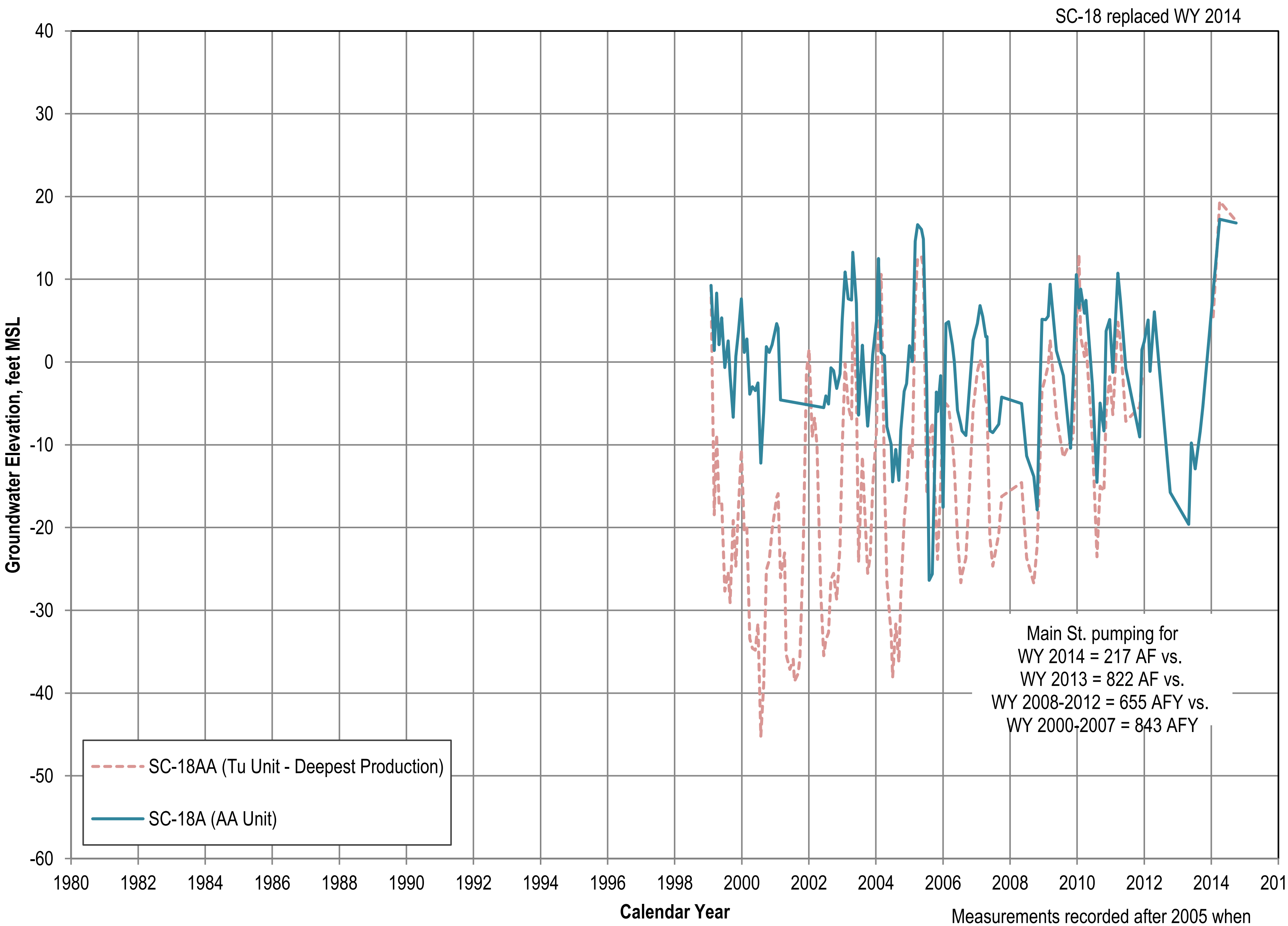

Groundwater Elevation, feet MSL
Calendar Year
Cory Street Cory-4 -SM
Cory Street Deep -AA
Cory Street Medium -A
Cory Street Shallow -A
0
5
10
15
20
25
30
35
40
45
50
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016



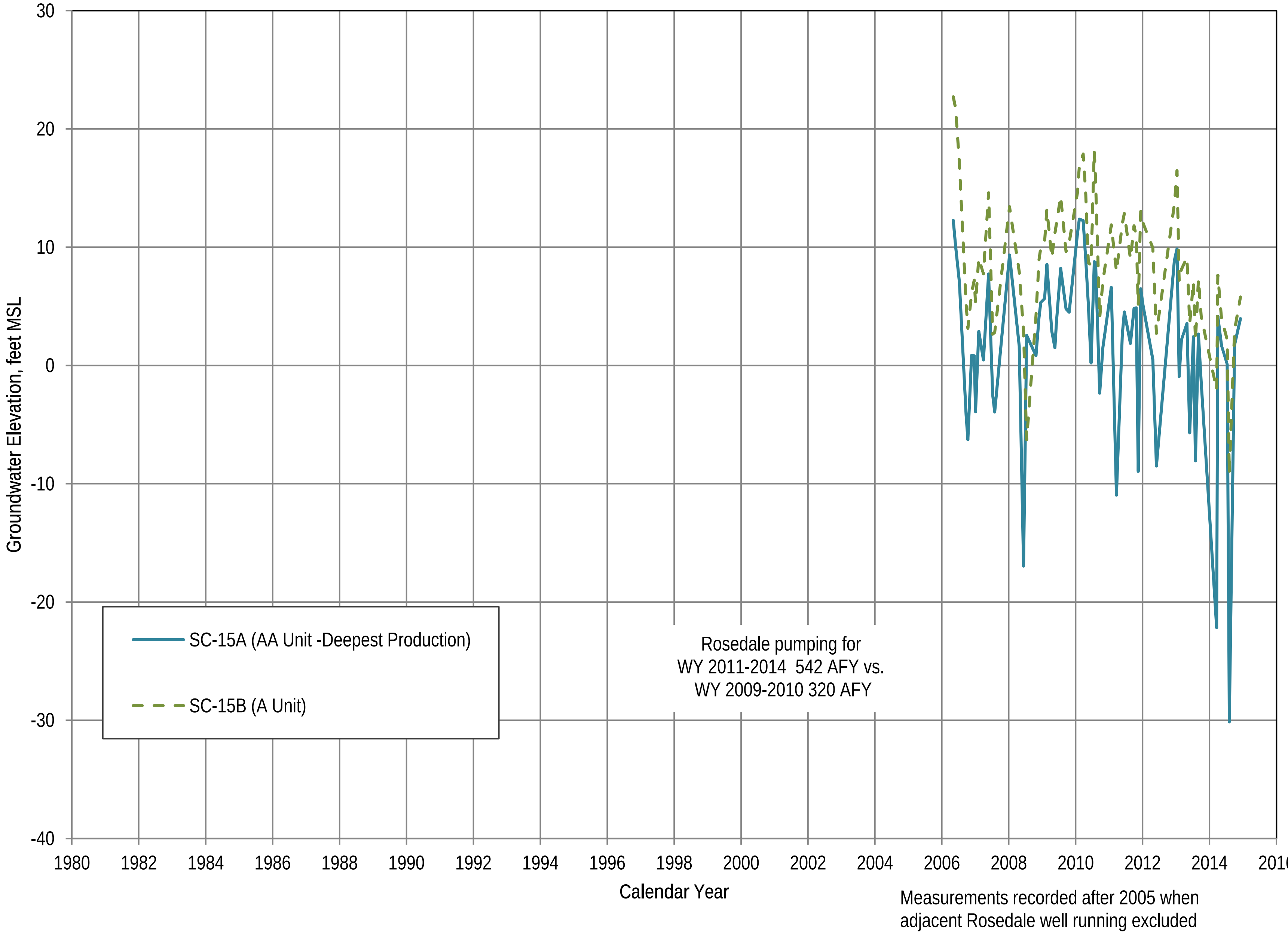
50
45
40
35
30
25
20
15
10
5
0
Groundwater Elevation, feet MSL
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
Calendar Year
30TH 30th-1 -SM
30TH 30th-2 -AA
30TH 30th-3 -A



Measurements recorded after 2005 when adjacent Garnet well running excluded



Measurements recorded after 2005 when adjacent Main St. well running excluded


30
20
10
0
-10
-20
-30
-40
Groundwater Elevation, feet MSL
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
Calendar Year
SC-15A (AA Unit -Deepest Production)
SC-15B (A Unit)
Rosedale pumping for
WY 2011-2014 542 AFY vs.
WY 2009-2010 320 AFY
Measurements recorded after 2005 when
adjacent Rosedale well running excluded

<u>**Chemographs and Single Well Hydrographs for Western Purisima Area**</u>

Graphs of SqCWD Coastal Monitoring Well Clusters

Graphs of City of Santa Cruz Coastal Monitoring Well Clusters

Graphs of SqCWD Inland Monitoring Well Clusters

Graphs of City of Santa Cruz Inland Monitoring Well Clusters

Graphs of SqCWD Production Wells and Monitoring Wells Adjacent to Production Wells

Trends shown on the hydrographs and chemographs are based on a linear fit to data in the specified time period.

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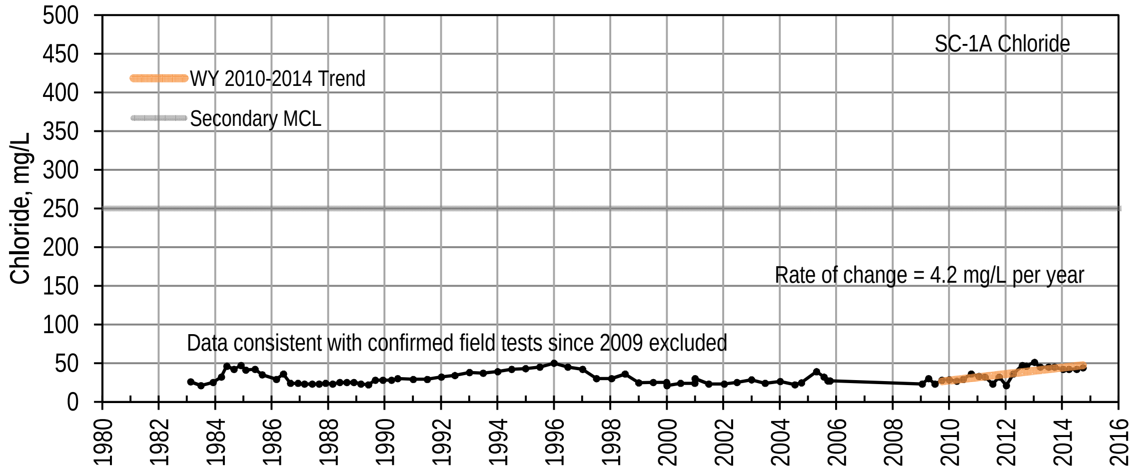
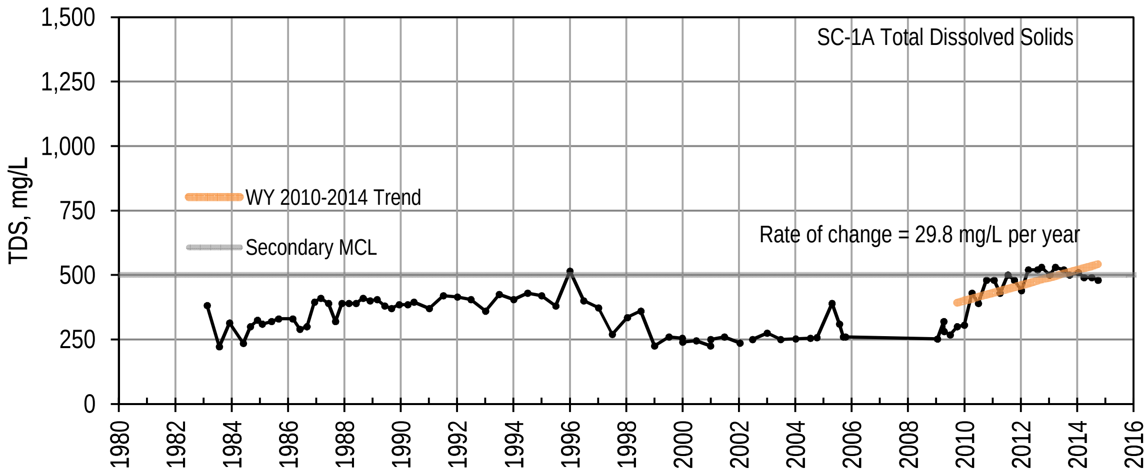
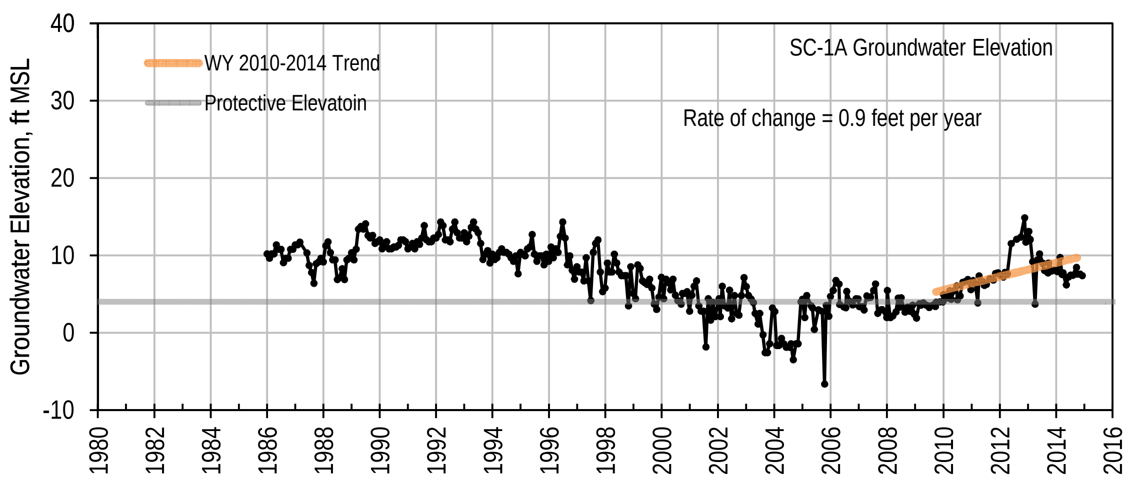
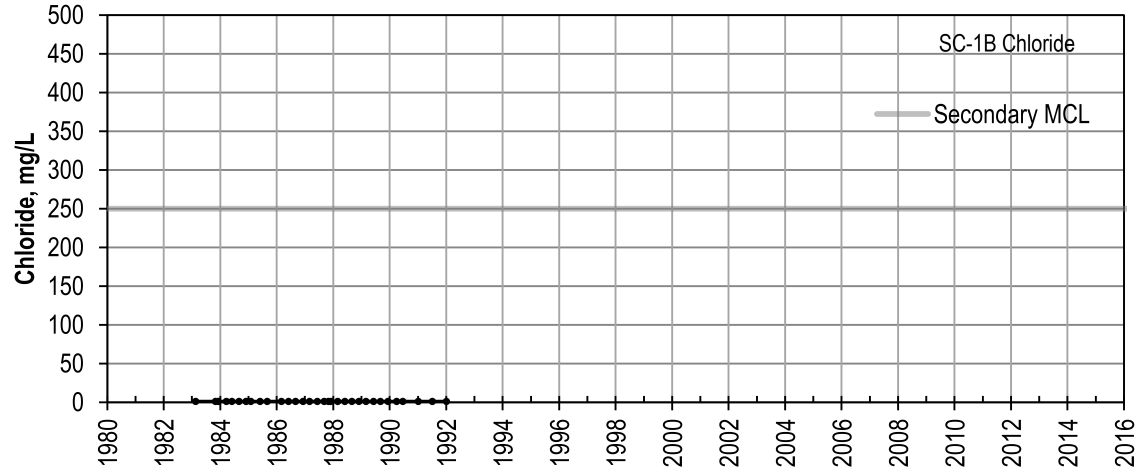
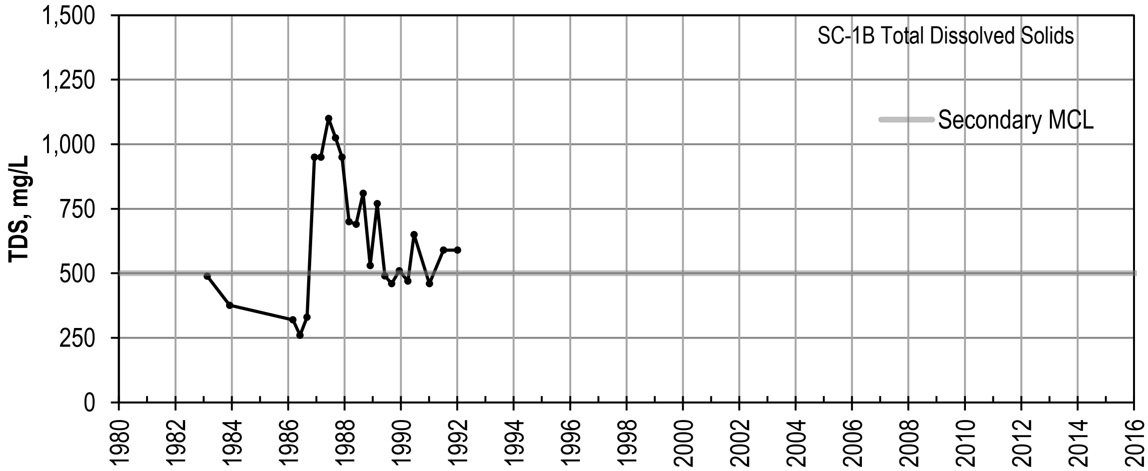

SC-1A Chloride
WY 2010-2014 Trend
Secondary MCL
Rate of change = 4.2 mg/L per year
Data consistent with confirmed field tests since 2009 excluded
Chloride, mg/L
500
450
400
350
300
250
200
150
100
50
0
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016


SC-1A Total Dissolved Solids
WY 2010-2014 Trend
Secondary MCL
Rate of change = 29.8 mg/L per year
TDS, mg/L
1,500
1,250
1,000
750
500
250
0
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016

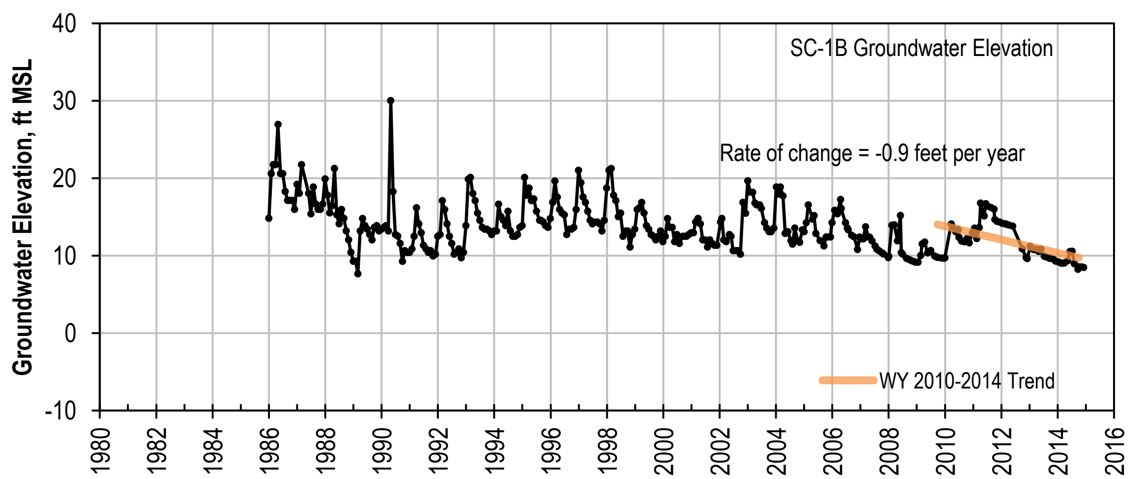

SC-1A Groundwater Elevation
WY 2010-2014 Trend
Protective Elevatoin
Rate of change = 0.9 feet per year
Groundwater Elevation, ft MSL
40
30
20
10
0
-10
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016



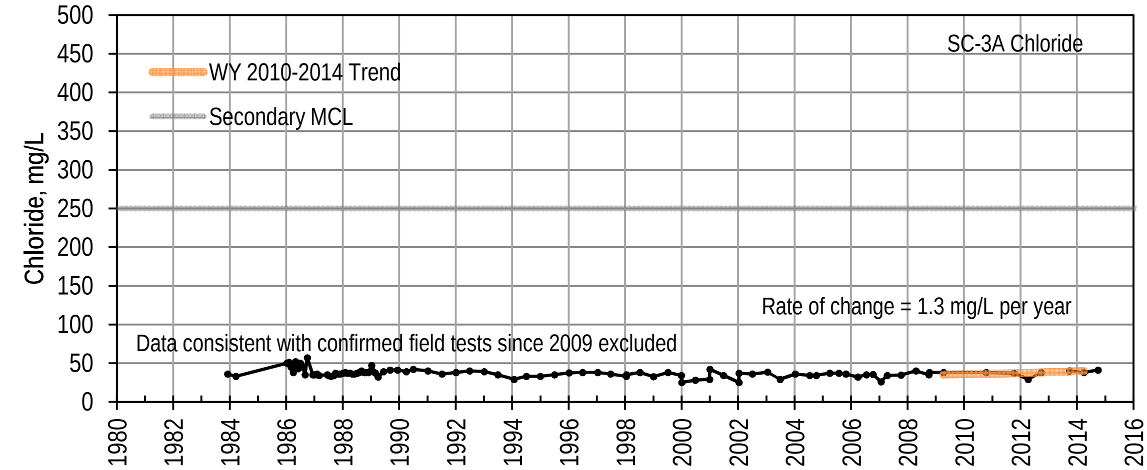
SC-1B Chloride
Secondary MCL
Chloride, mg/L

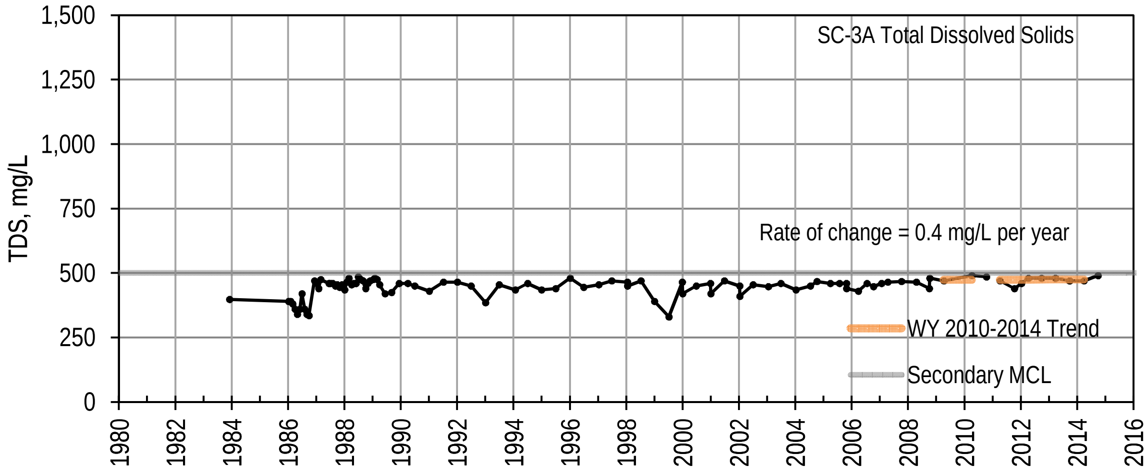


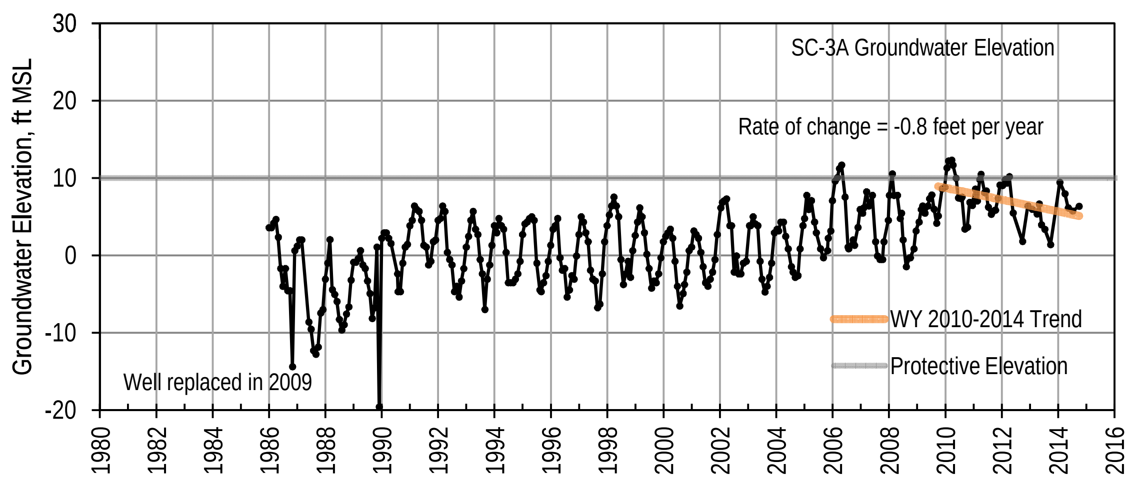
SC-1B Total Dissolved Solids
Secondary MCL
TDS, mg/L

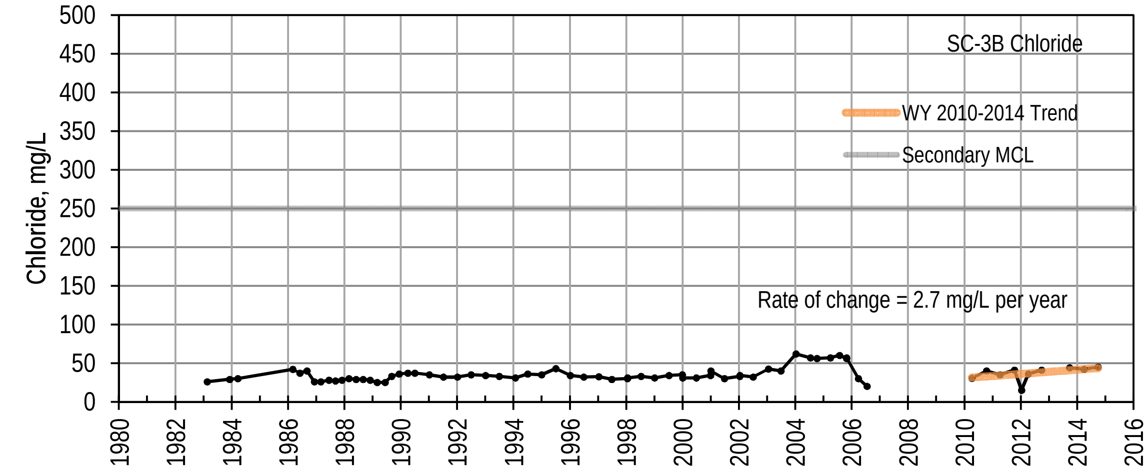


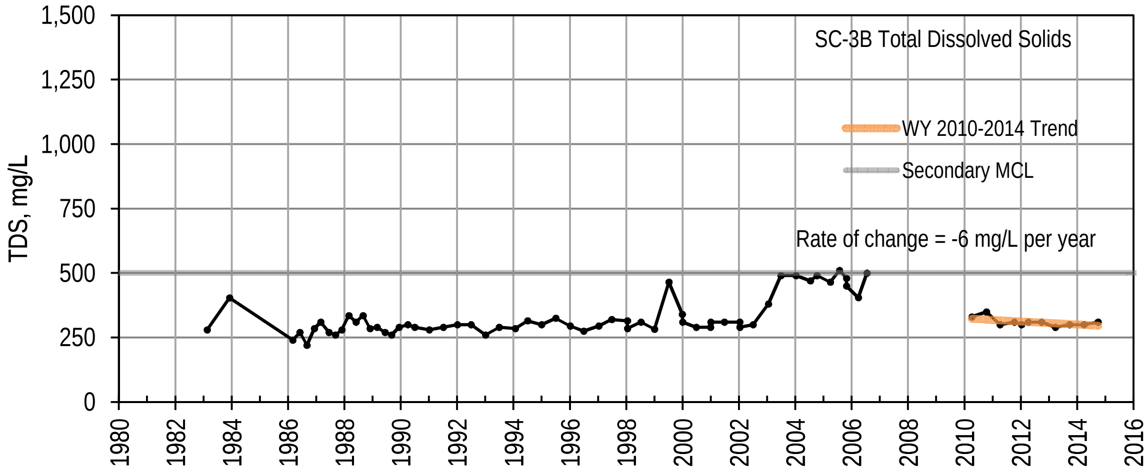
SC-1B Groundwater Elevation
Rate of change = -0.9 feet per year
WY 2010-2014 Trend
Groundwater Elevation, ft MSL

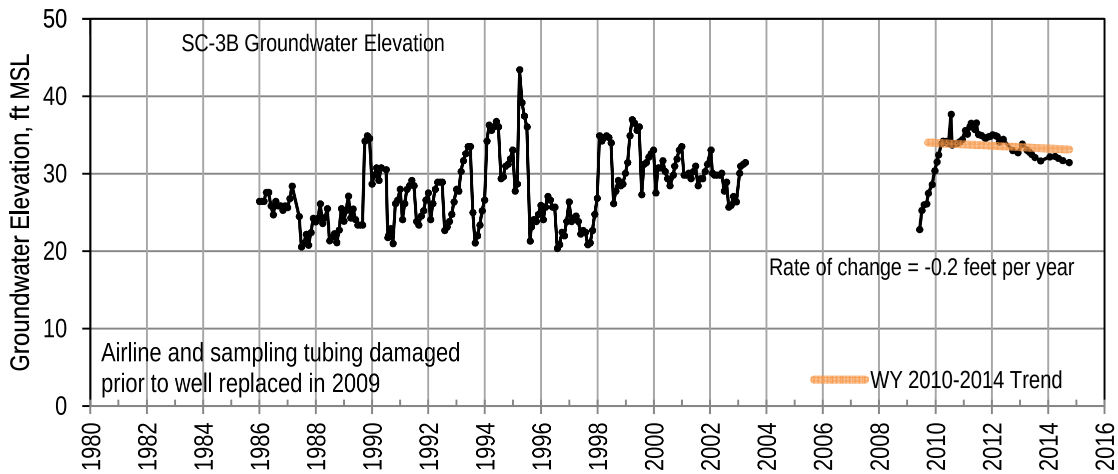

SC-3A Chloride
WY 2010-2014 Trend
Secondary MCL
Chloride, mg/L
Rate of change = 1.3 mg/L per year
Data consistent with confirmed field tests since 2009 excluded
500
450
400
350
300
250
200
150
100
50
0
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016

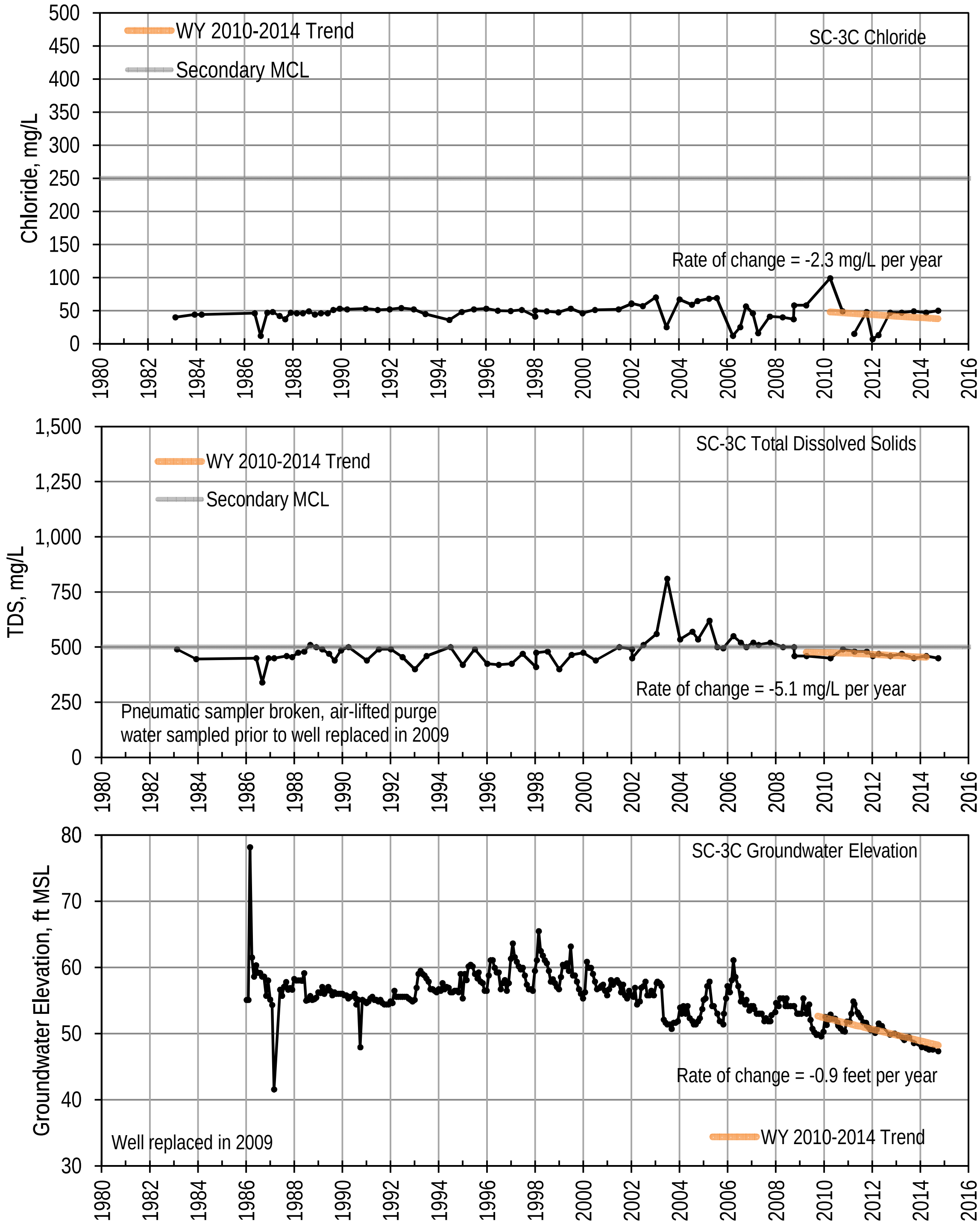

SC-3A Total Dissolved Solids
TDS, mg/L
Rate of change = 0.4 mg/L per year
WY 2010-2014 Trend
Secondary MCL
1,500
1,250
1,000
750
500
250
0
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016


SC-3A Groundwater Elevation
Groundwater Elevation, ft MSL
Rate of change = -0.8 feet per year
WY 2010-2014 Trend
Protective Elevation
Well replaced in 2009
30
20
10
0
-10
-20
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016

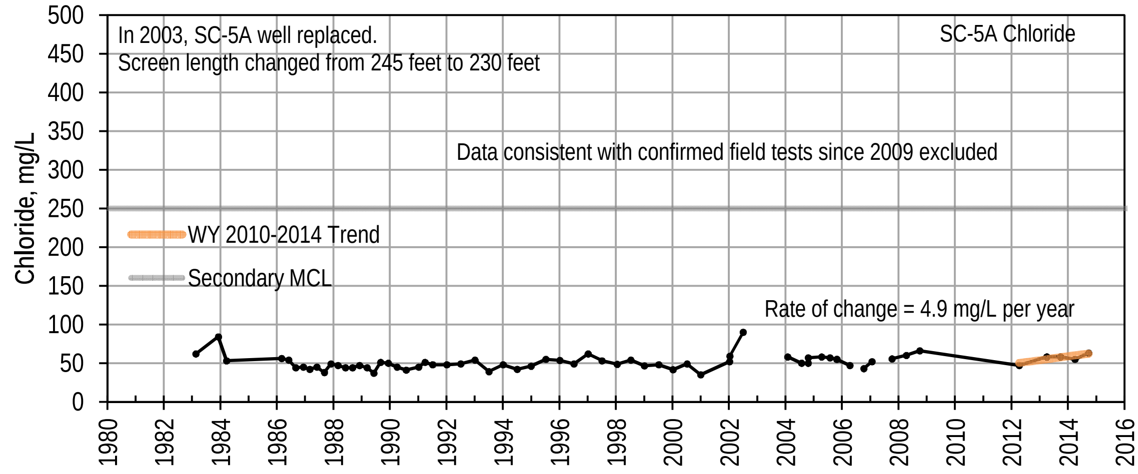

SC-3B Chloride
WY 2010-2014 Trend
Secondary MCL
Rate of change = 2.7 mg/L per year
Chloride, mg/L

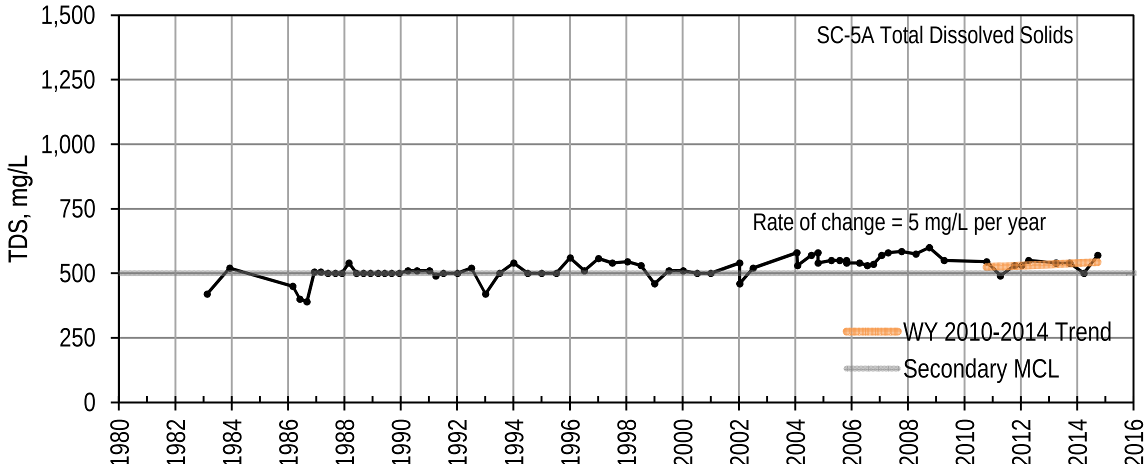

SC-3B Total Dissolved Solids
WY 2010-2014 Trend
Secondary MCL
Rate of change = -6 mg/L per year
TDS, mg/L

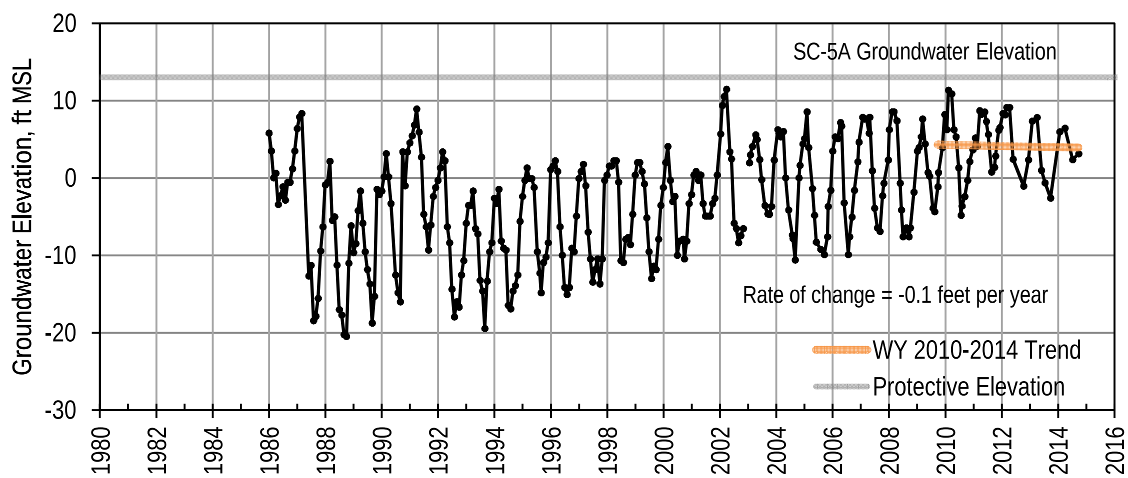

SC-3B Groundwater Elevation
Rate of change = -0.2 feet per year
Airline and sampling tubing damaged
prior to well replaced in 2009
WY 2010-2014 Trend
Groundwater Elevation, ft MSL

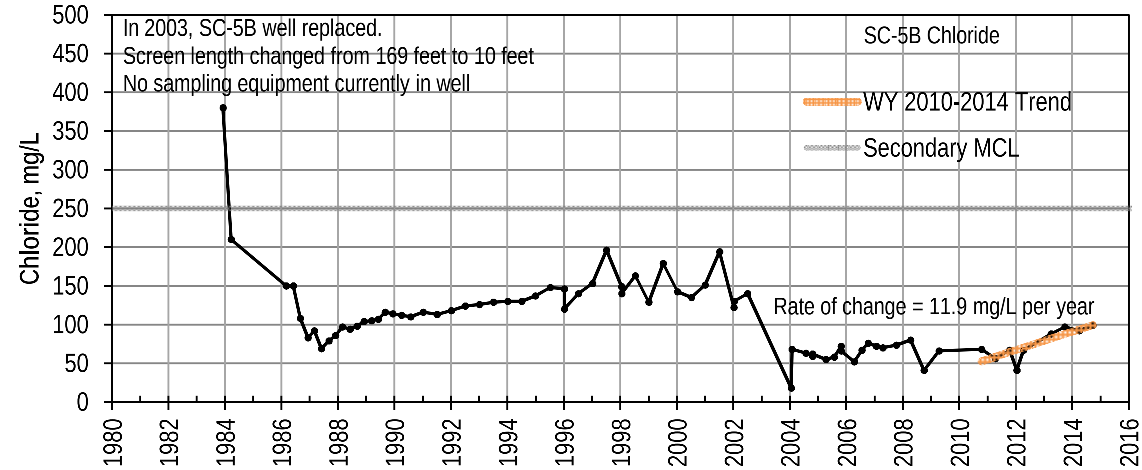


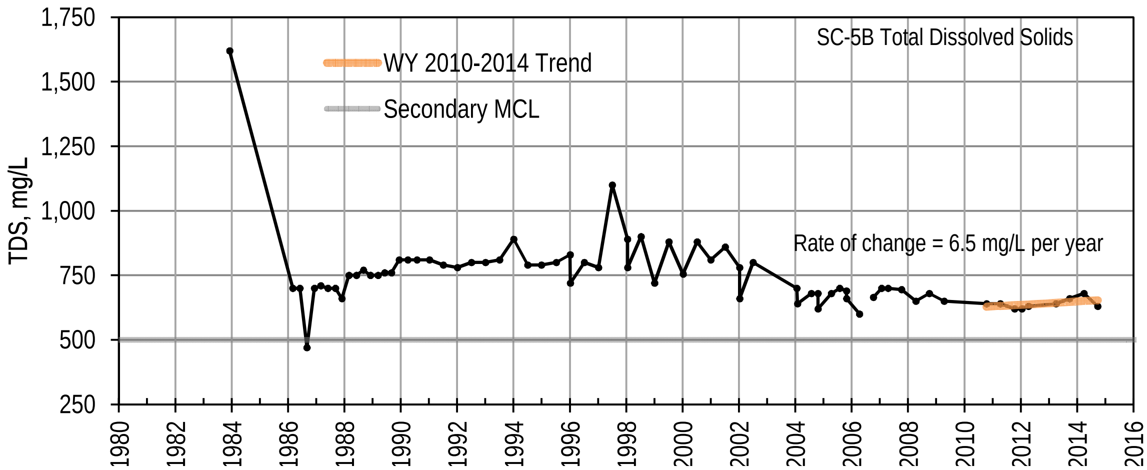
WY 2010-2014 Trend
Secondary MCL
SC-3C Chloride
Chloride, mg/L
Rate of change = -2.3 mg/L per year
SC-3C Total Dissolved Solids
TDS, mg/L
Rate of change = -5.1 mg/L per year
Pneumatic sampler broken, air-lifted purge
water sampled prior to well replaced in 2009
SC-3C Groundwater Elevation
Groundwater Elevation, ft MSL
Rate of change = -0.9 feet per year
Well replaced in 2009

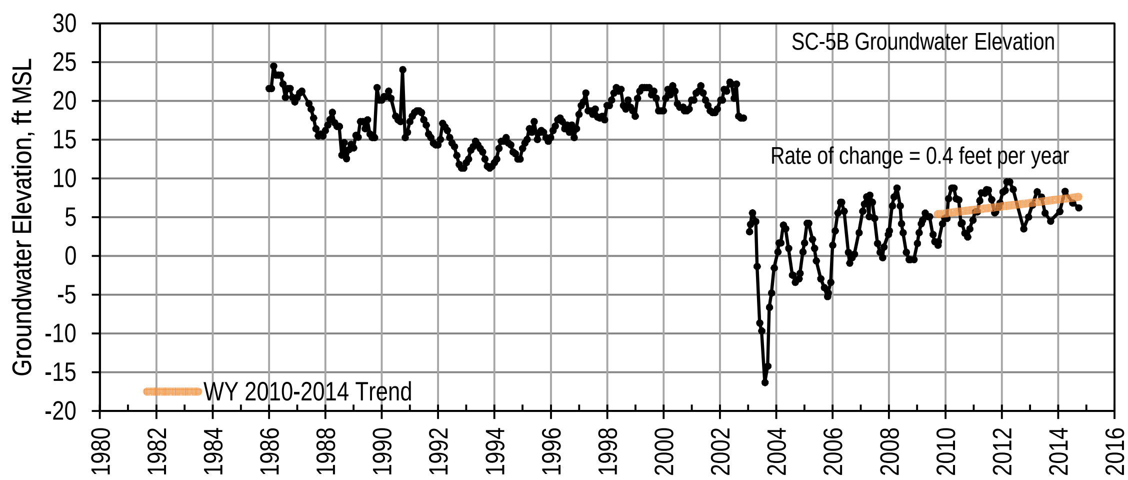

In 2003, SC-5A well replaced.
Screen length changed from 245 feet to 230 feet
SC-5A Chloride
Data consistent with confirmed field tests since 2009 excluded
WY 2010-2014 Trend
Secondary MCL
Rate of change = 4.9 mg/L per year
Chloride, mg/L

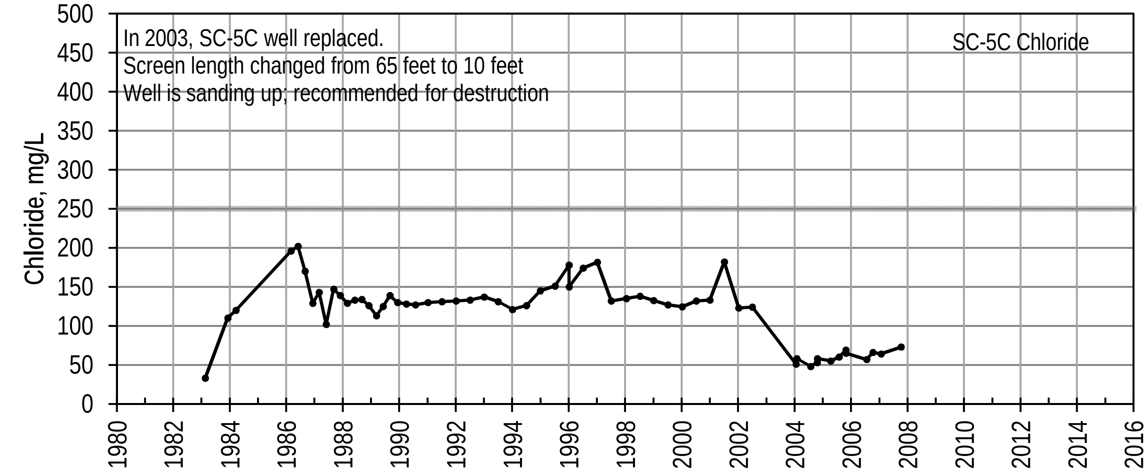

SC-5A Total Dissolved Solids
Rate of change = 5 mg/L per year
WY 2010-2014 Trend
Secondary MCL
TDS, mg/L

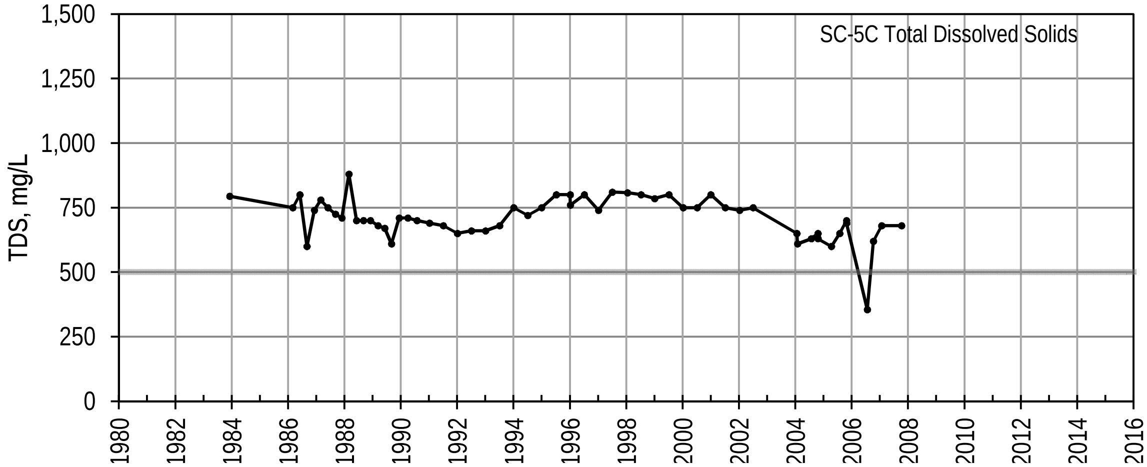

SC-5A Groundwater Elevation
Rate of change = -0.1 feet per year
WY 2010-2014 Trend
Protective Elevation
Groundwater Elevation, ft MSL

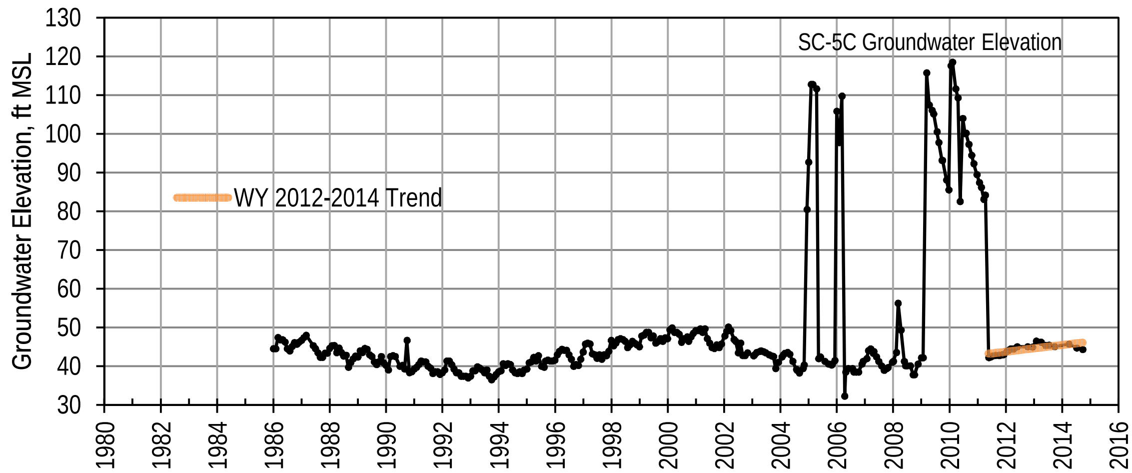

In 2003, SC-5B well replaced.
Screen length changed from 169 feet to 10 feet
No sampling equipment currently in well
SC-5B Chloride
WY 2010-2014 Trend
Secondary MCL
Rate of change = 11.9 mg/L per year
Chloride, mg/L

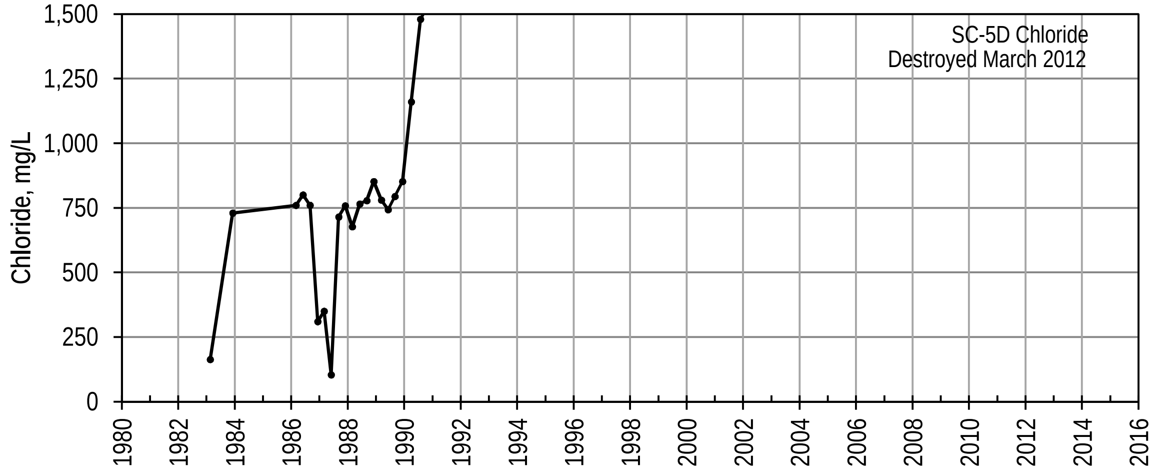

SC-5B Total Dissolved Solids
WY 2010-2014 Trend
Secondary MCL
Rate of change = 6.5 mg/L per year
TDS, mg/L

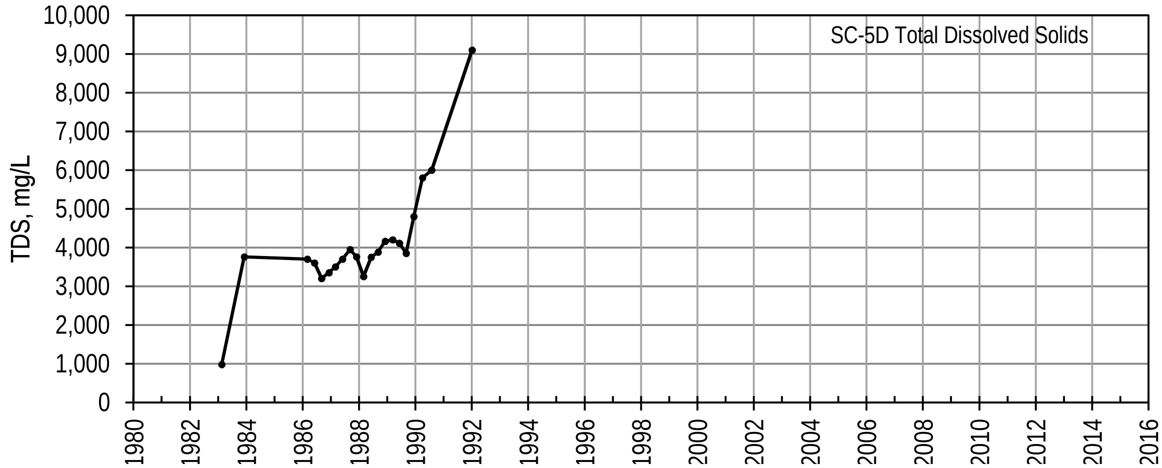

SC-5B Groundwater Elevation
Rate of change = 0.4 feet per year
WY 2010-2014 Trend
Groundwater Elevation, ft MSL

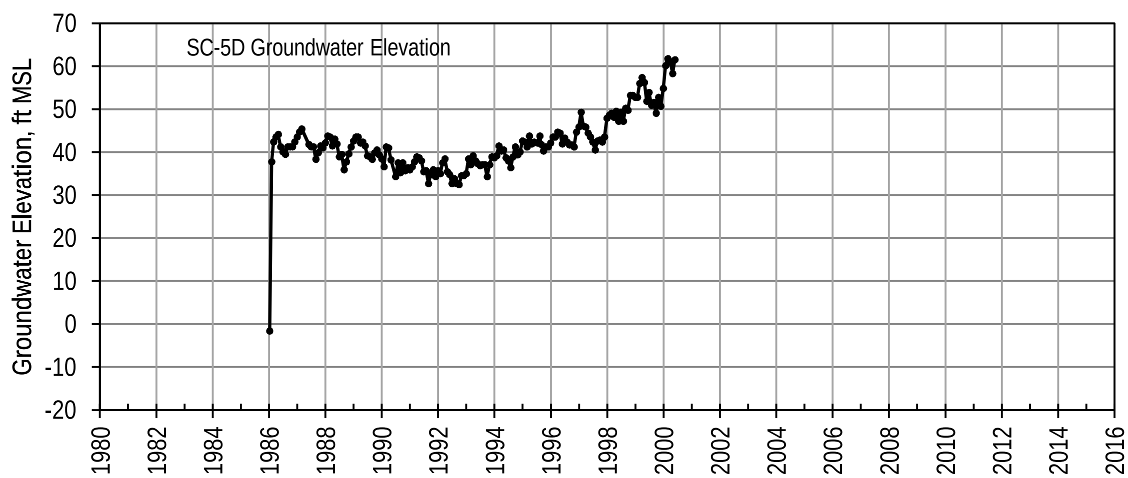

In 2003, SC-5C well replaced.
Screen length changed from 65 feet to 10 feet
Well is sanding up; recommended for destruction
SC-5C Chloride
Chloride, mg/L

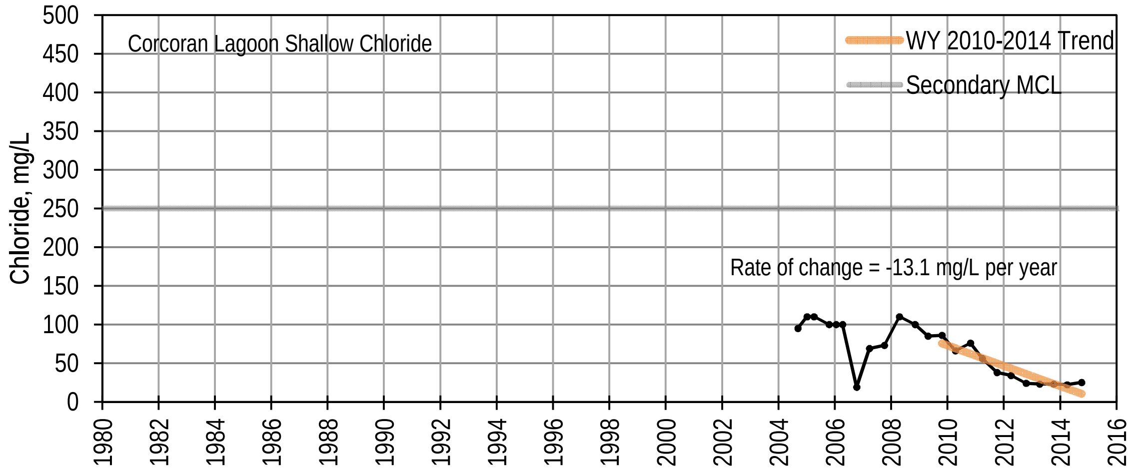

SC-5C Total Dissolved Solids
TDS, mg/L


SC-5C Groundwater Elevation
WY 2012-2014 Trend
Groundwater Elevation, ft MSL

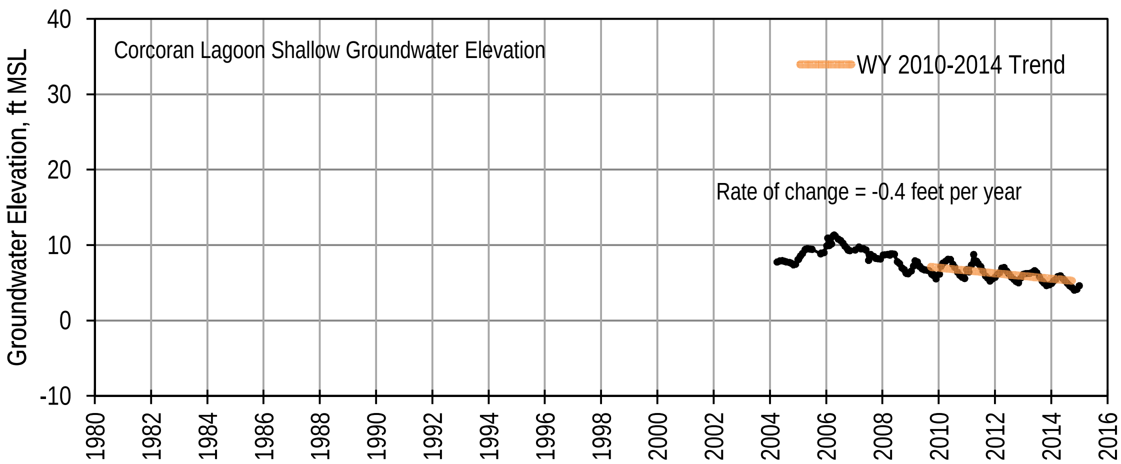

SC-5D Chloride
Destroyed March 2012
Chloride, mg/L
1,500
1,250
1,000
750
500
250
0
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016

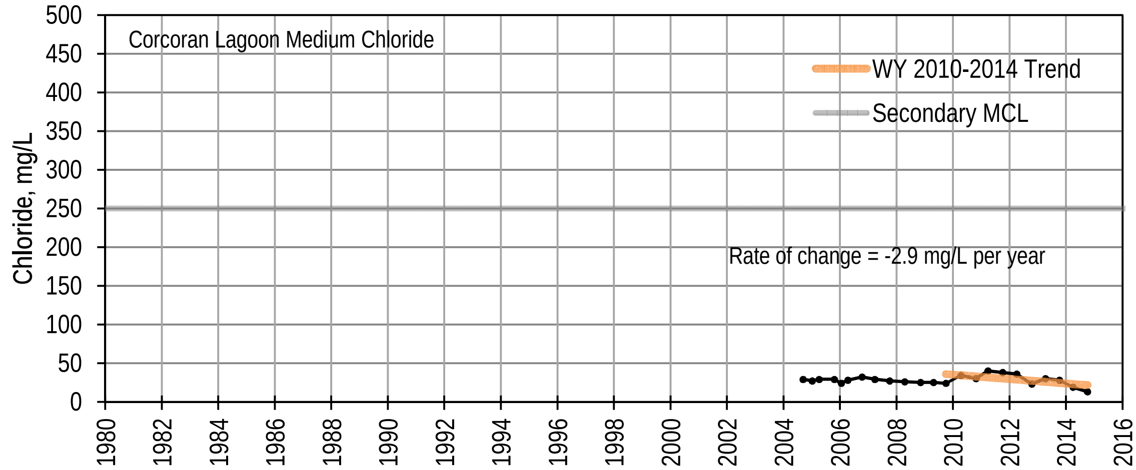

SC-5D Total Dissolved Solids
TDS, mg/L
10,000
9,000
8,000
7,000
6,000
5,000
4,000
3,000
2,000
1,000
0
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016

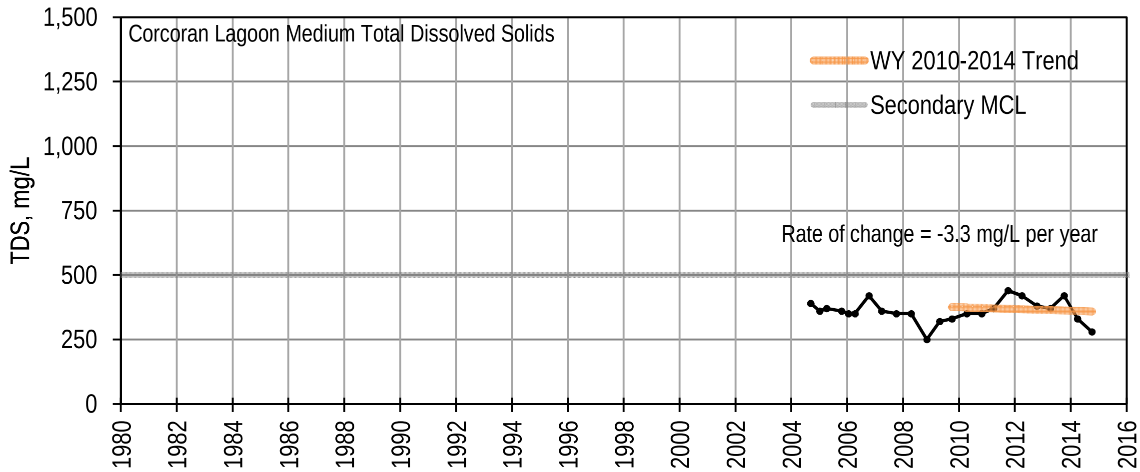

SC-5D Groundwater Elevation
Groundwater Elevation, ft MSL
70
60
50
40
30
20
10
0
-10
-20
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016

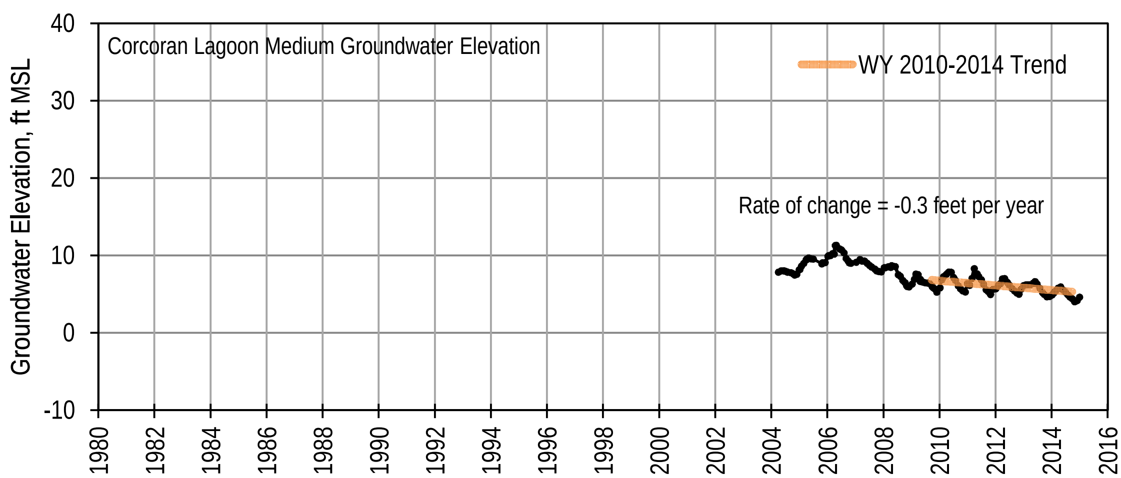

Corcoran Lagoon Shallow Chloride
WY 2010-2014 Trend
Secondary MCL
Rate of change = -13.1 mg/L per year
Chloride, mg/L
500
450
400
350
300
250
200
150
100
50
0
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016

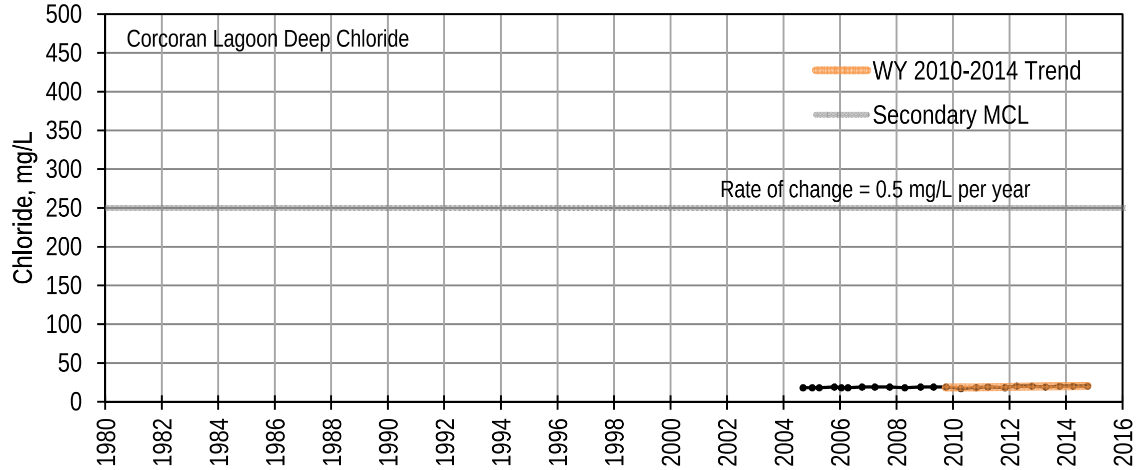

Corcoran Lagoon Shallow Total Dissolved Solids
WY 2010-2014 Trend
Secondary MCL
Rate of change = -53.6 mg/L per year
TDS, mg/L
1,500
1,250
1,000
750
500
250
0
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016

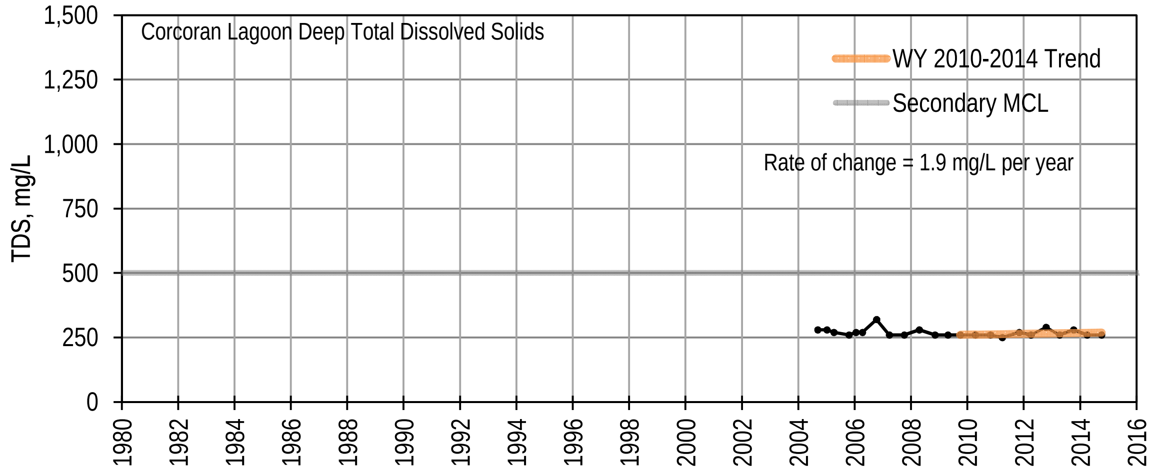

Corcoran Lagoon Shallow Groundwater Elevation
WY 2010-2014 Trend
Rate of change = -0.4 feet per year
Groundwater Elevation, ft MSL
40
30
20
10
0
-10
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016

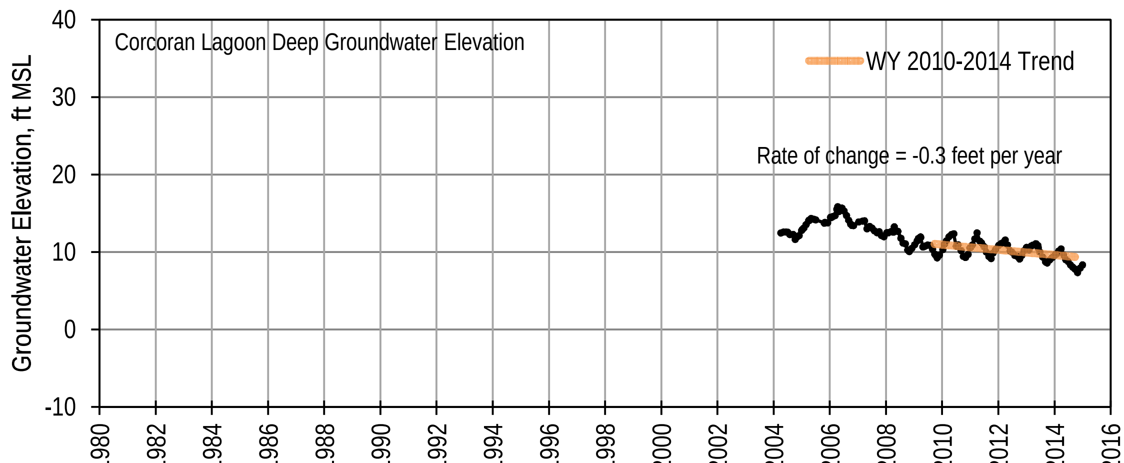

Corcoran Lagoon Medium Chloride
WY 2010-2014 Trend
Secondary MCL
Rate of change = -2.9 mg/L per year
Chloride, mg/L

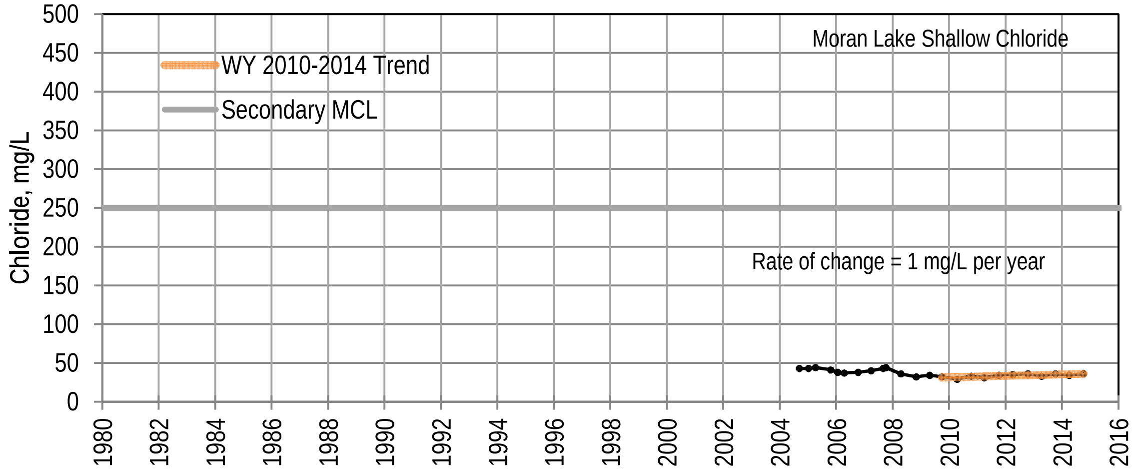

Corcoran Lagoon Medium Total Dissolved Solids
WY 2010-2014 Trend
Secondary MCL
Rate of change = -3.3 mg/L per year
TDS, mg/L

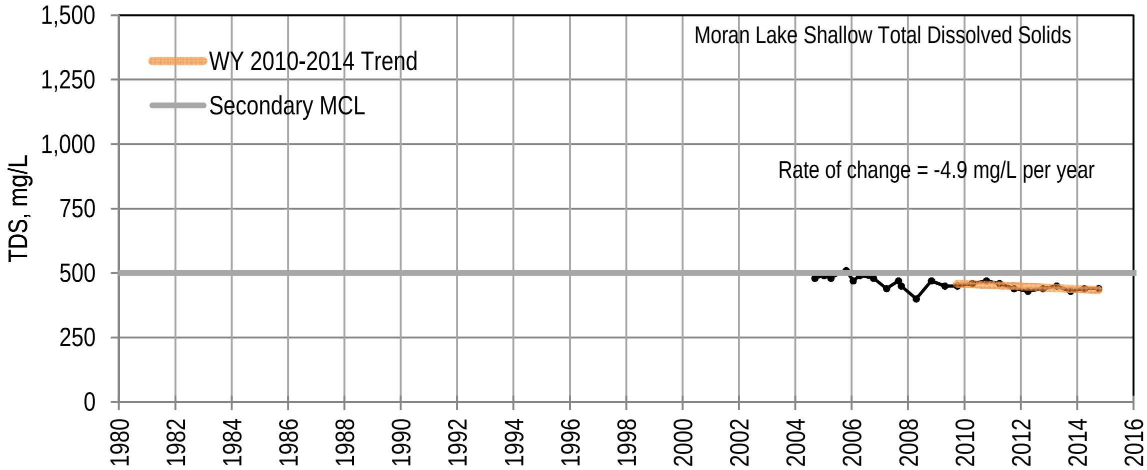

Corcoran Lagoon Medium Groundwater Elevation
WY 2010-2014 Trend
Rate of change = -0.3 feet per year
Groundwater Elevation, ft MSL

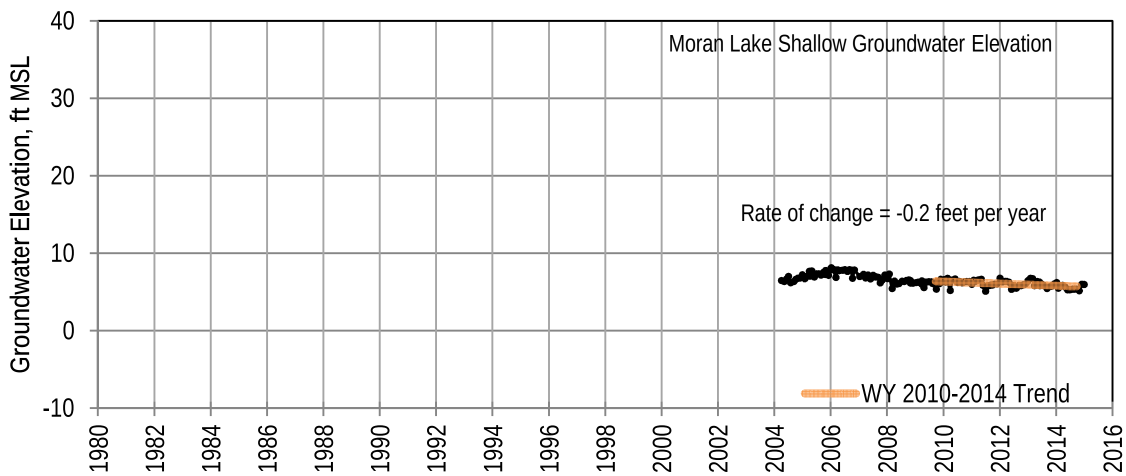

Corcoran Lagoon Deep Chloride
WY 2010-2014 Trend
Secondary MCL
Rate of change = 0.5 mg/L per year
Chloride, mg/L
500
450
400
350
300
250
200
150
100
50
0
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016

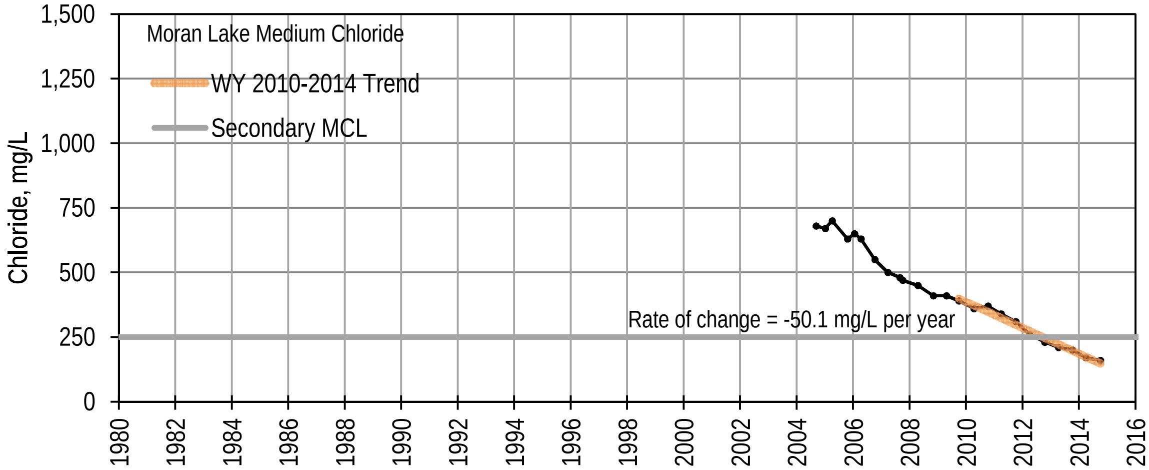

Corcoran Lagoon Deep Total Dissolved Solids
WY 2010-2014 Trend
Secondary MCL
Rate of change = 1.9 mg/L per year
TDS, mg/L
1,500
1,250
1,000
750
500
250
0
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016

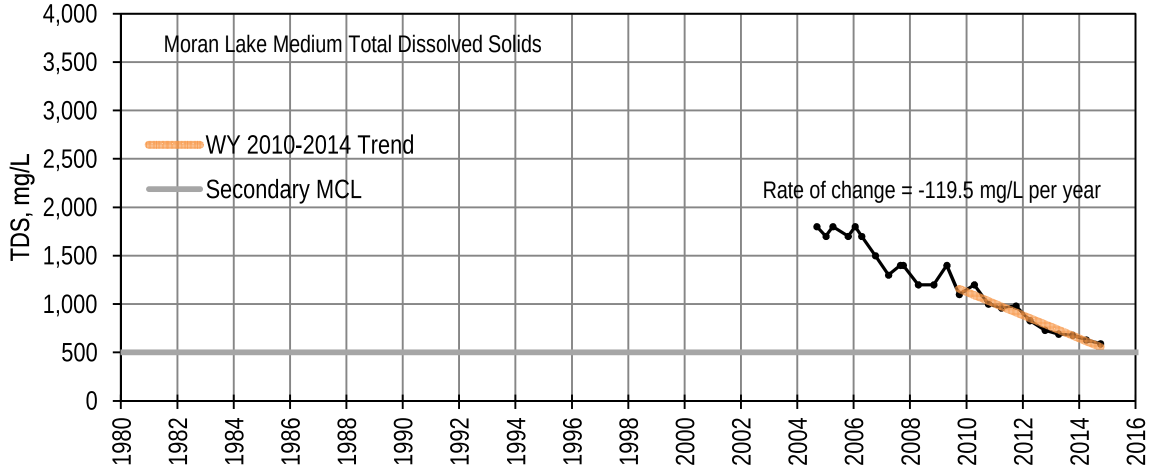

Corcoran Lagoon Deep Groundwater Elevation
WY 2010-2014 Trend
Rate of change = -0.3 feet per year
Groundwater Elevation, ft MSL
40
30
20
10
0
-10
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016

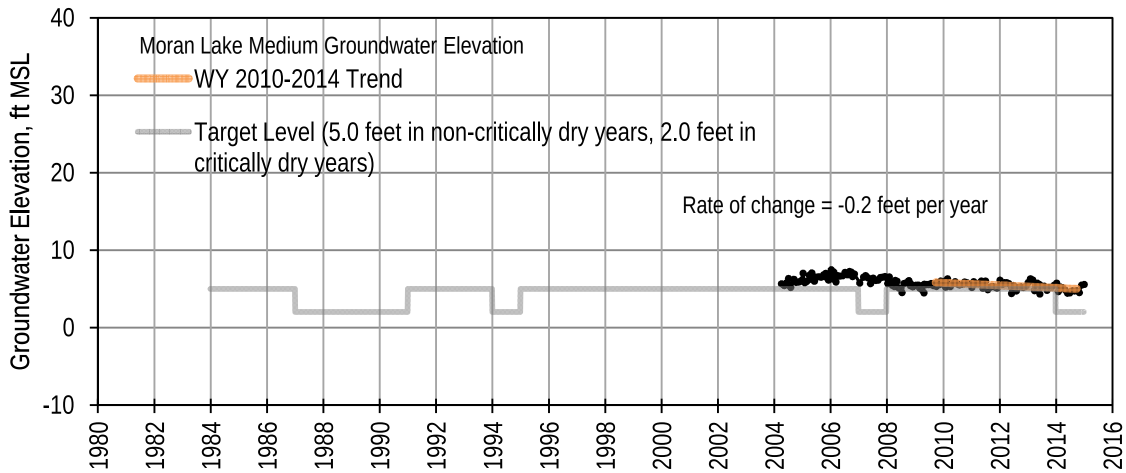

Moran Lake Shallow Chloride
WY 2010-2014 Trend
Secondary MCL
Rate of change = 1 mg/L per year
Chloride, mg/L
500
450
400
350
300
250
200
150
100
50
0
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016

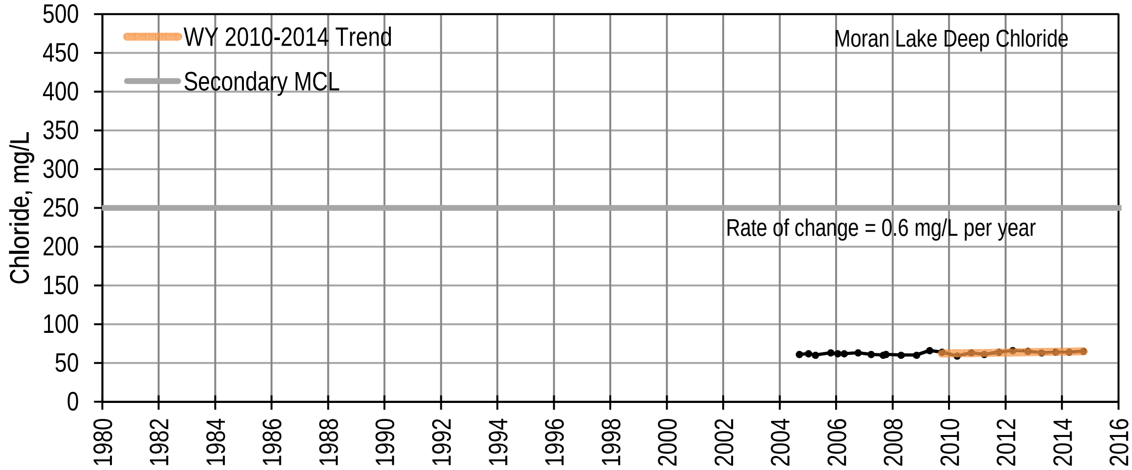

Moran Lake Shallow Total Dissolved Solids
WY 2010-2014 Trend
Secondary MCL
Rate of change = -4.9 mg/L per year
TDS, mg/L
1,500
1,250
1,000
750
500
250
0
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016

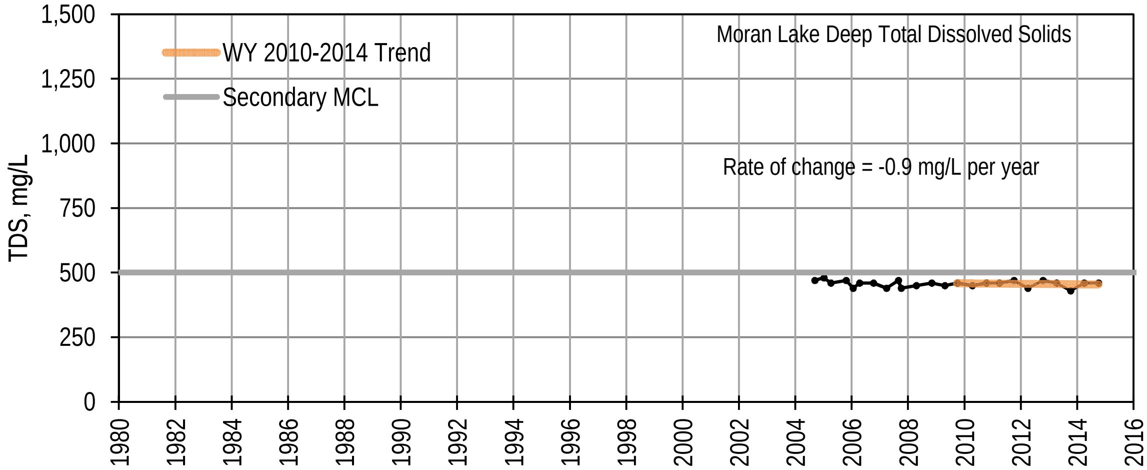

Moran Lake Shallow Groundwater Elevation
Rate of change = -0.2 feet per year
WY 2010-2014 Trend
Groundwater Elevation, ft MSL
40
30
20
10
0
-10
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016

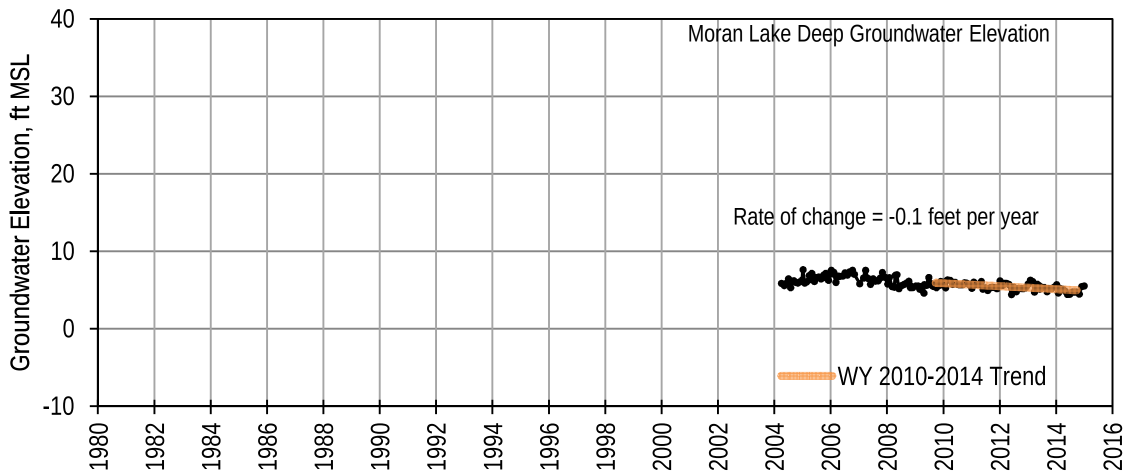

Moran Lake Medium Chloride
WY 2010-2014 Trend
Secondary MCL
Rate of change = -50.1 mg/L per year
Chloride, mg/L

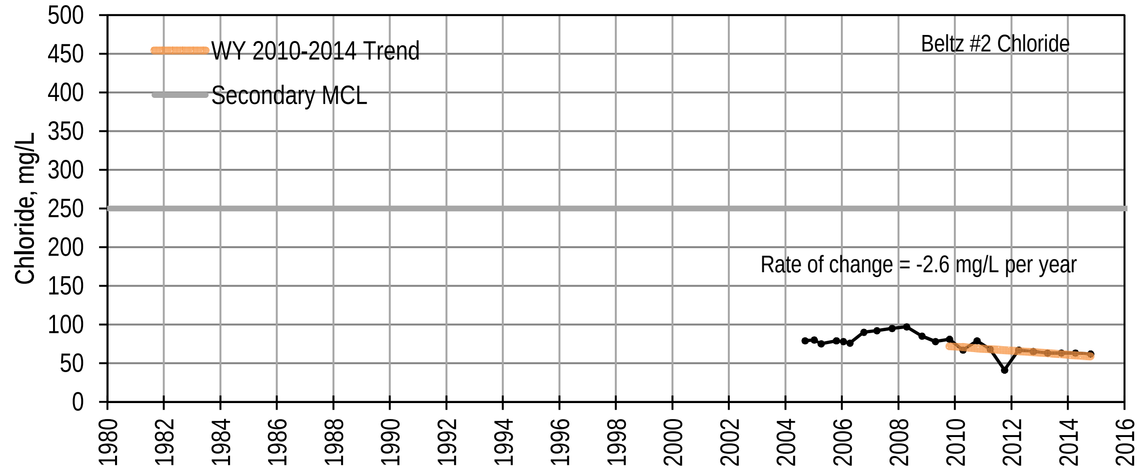

Moran Lake Medium Total Dissolved Solids
WY 2010-2014 Trend
Secondary MCL
Rate of change = -119.5 mg/L per year
TDS, mg/L

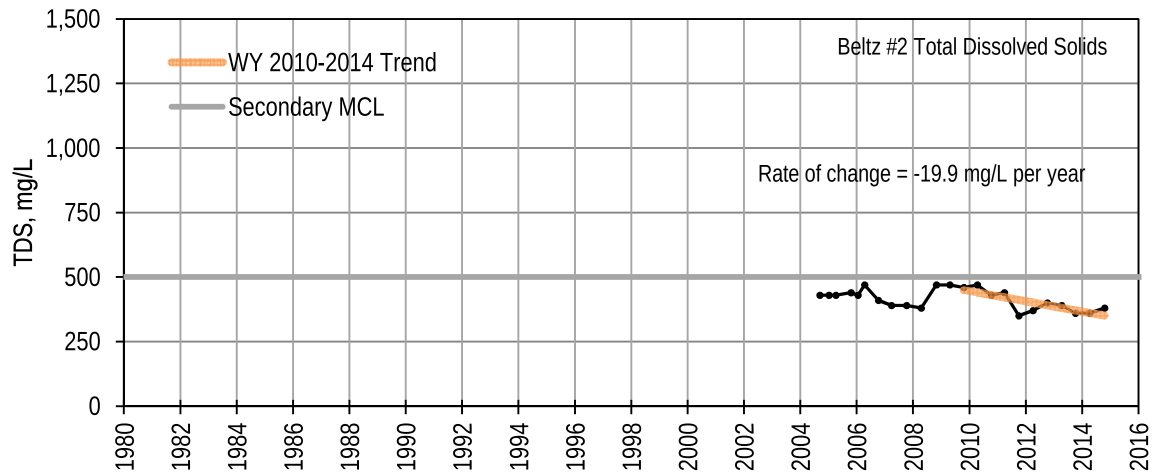

Moran Lake Medium Groundwater Elevation
WY 2010-2014 Trend
Target Level (5.0 feet in non-critically dry years, 2.0 feet in critically dry years)
Rate of change = -0.2 feet per year
Groundwater Elevation, ft MSL

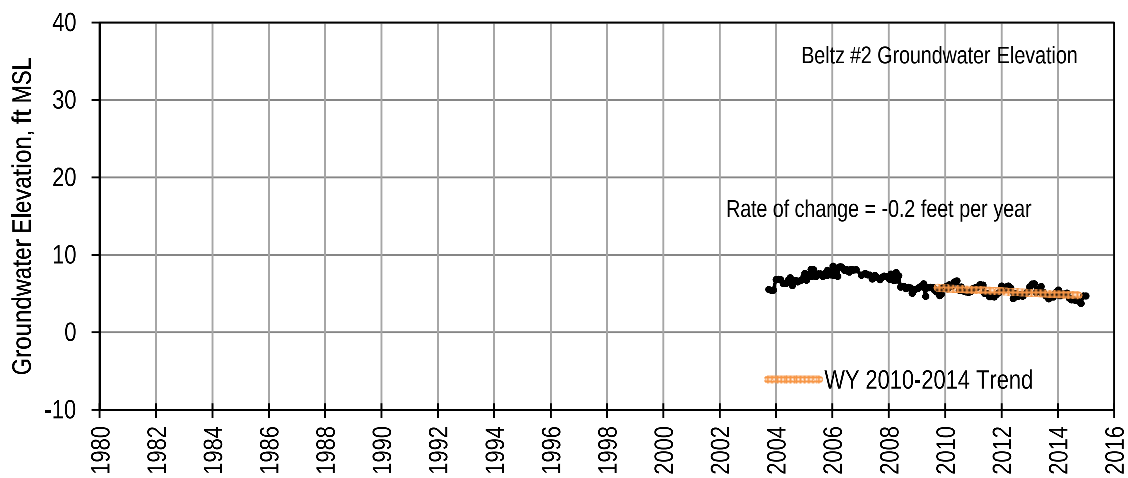

Moran Lake Deep Chloride
WY 2010-2014 Trend
Secondary MCL
Rate of change = 0.6 mg/L per year
Chloride, mg/L
500
450
400
350
300
250
200
150
100
50
0
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016

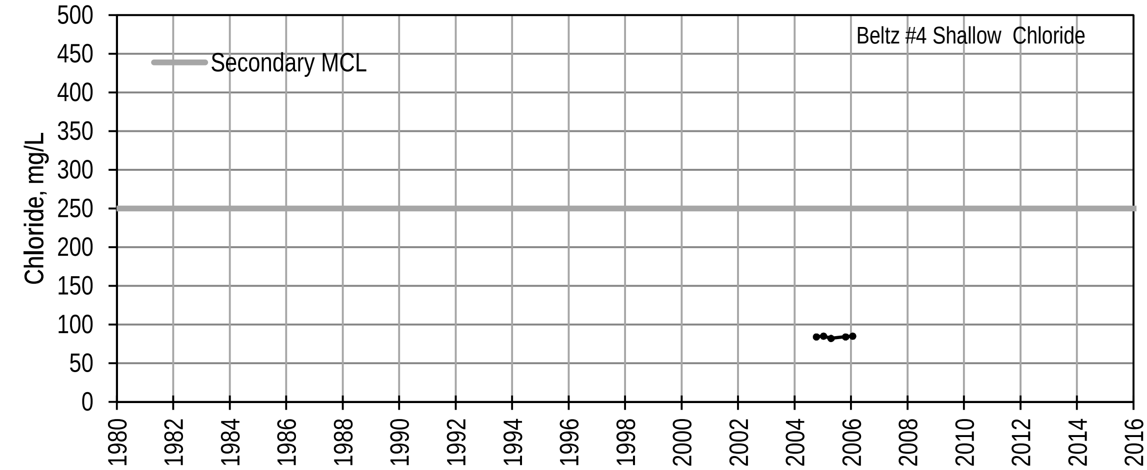

Moran Lake Deep Total Dissolved Solids
WY 2010-2014 Trend
Secondary MCL
Rate of change = -0.9 mg/L per year
TDS, mg/L
1,500
1,250
1,000
750
500
250
0
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016


Moran Lake Deep Groundwater Elevation
Rate of change = -0.1 feet per year
WY 2010-2014 Trend
Groundwater Elevation, ft MSL
40
30
20
10
0
-10
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016

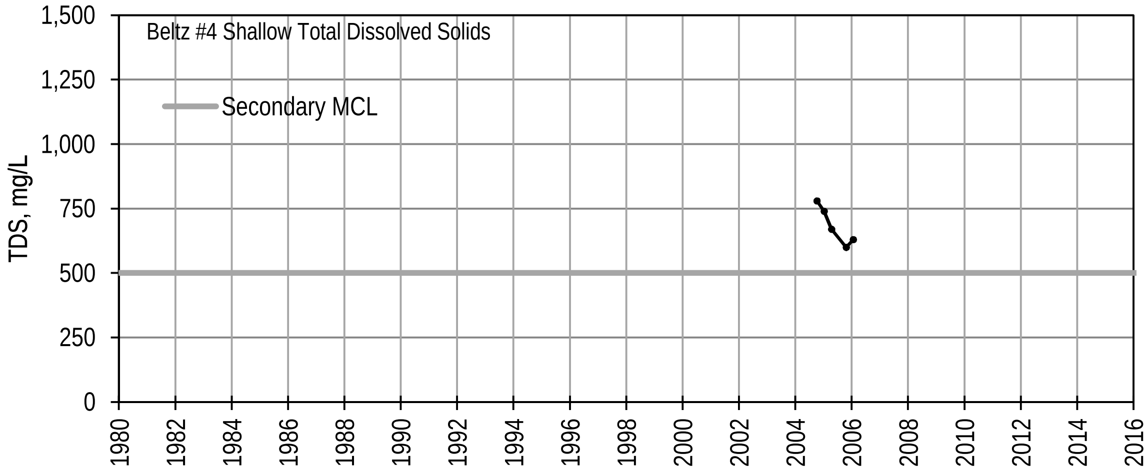

WY 2010-2014 Trend
Secondary MCL
Beltz #2 Chloride
Chloride, mg/L
Rate of change = -2.6 mg/L per year


WY 2010-2014 Trend
Secondary MCL
Beltz #2 Total Dissolved Solids
TDS, mg/L
Rate of change = -19.9 mg/L per year

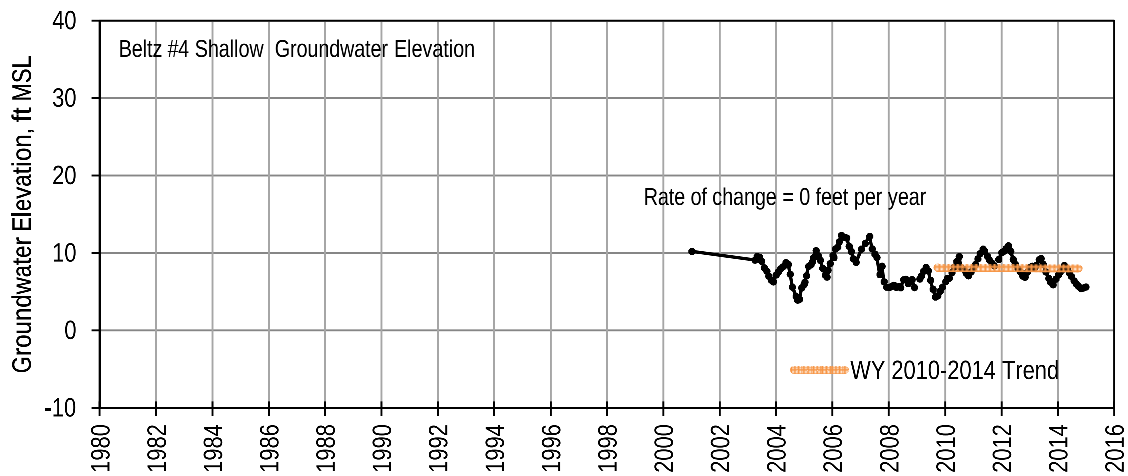

Beltz #2 Groundwater Elevation
Groundwater Elevation, ft MSL
Rate of change = -0.2 feet per year
WY 2010-2014 Trend



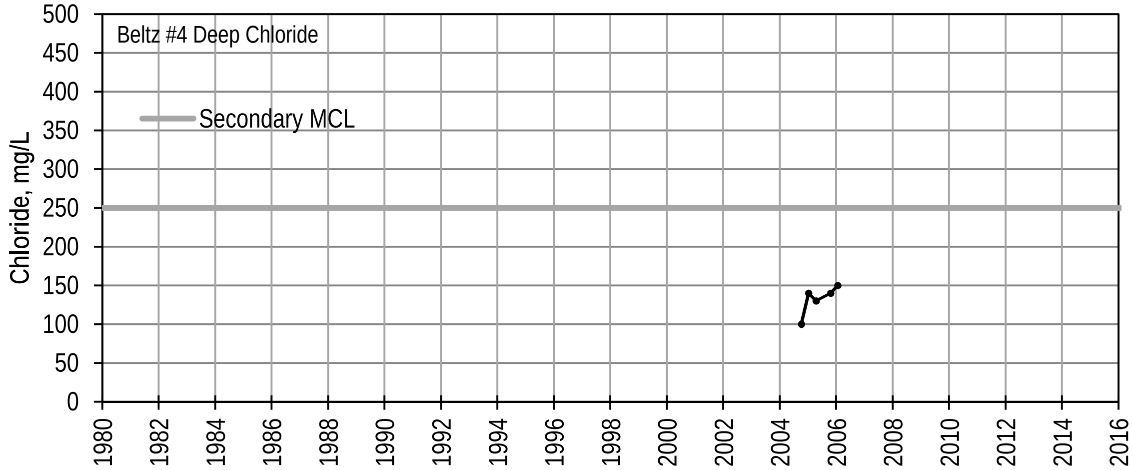
Beltz #4 Shallow Chloride
Secondary MCL
Chloride, mg/L
500
450
400
350
300
250
200
150
100
50
0
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016



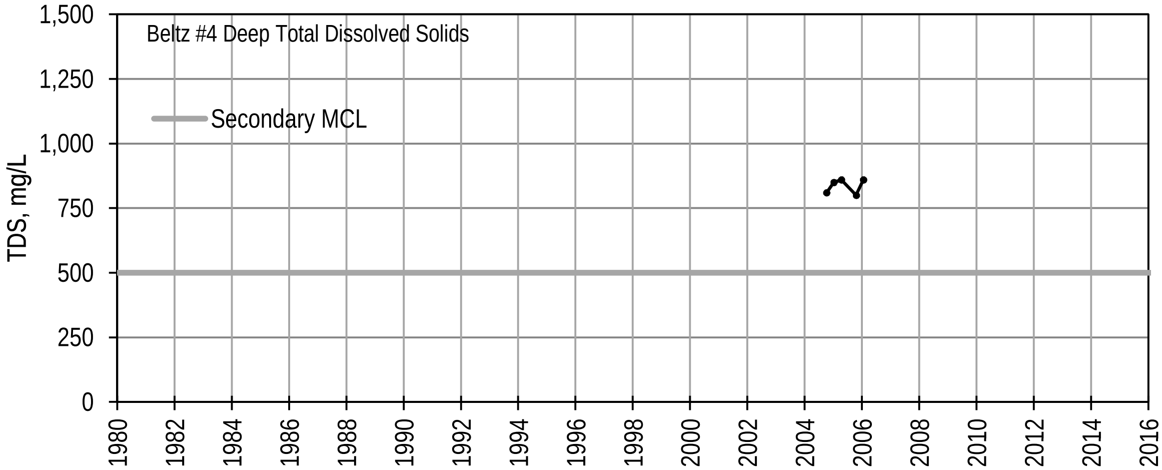
Beltz #4 Shallow Total Dissolved Solids
Secondary MCL
TDS, mg/L
1,500
1,250
1,000
750
500
250
0
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016



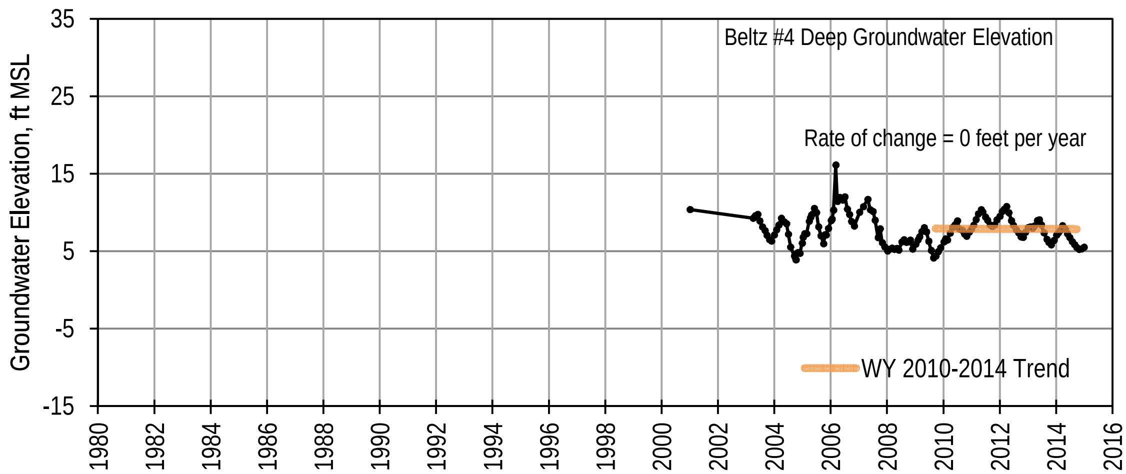
Beltz #4 Shallow Groundwater Elevation
Rate of change = 0 feet per year
WY 2010-2014 Trend
Groundwater Elevation, ft MSL
40
30
20
10
0
-10
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016



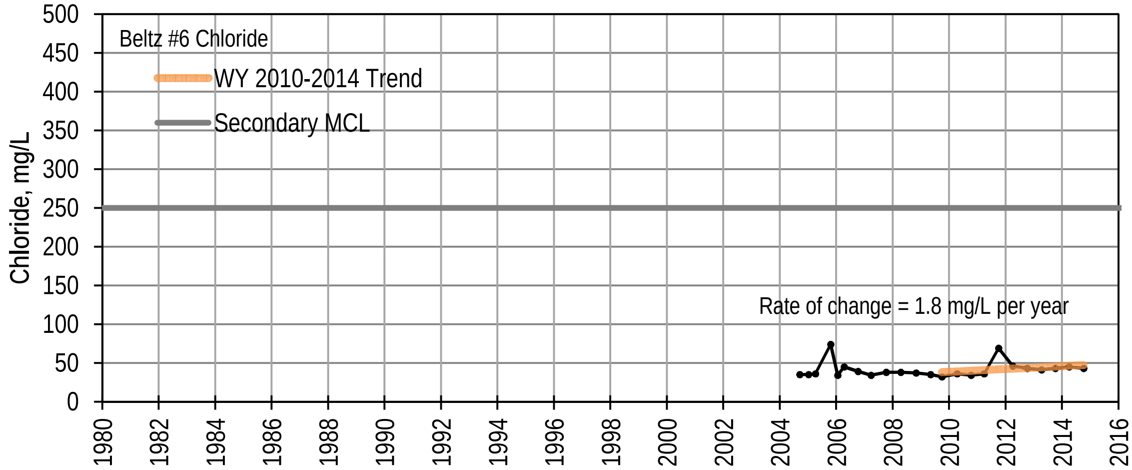
Beltz #4 Deep Chloride
Secondary MCL
Chloride, mg/L
500
450
400
350
300
250
200
150
100
50
0
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016

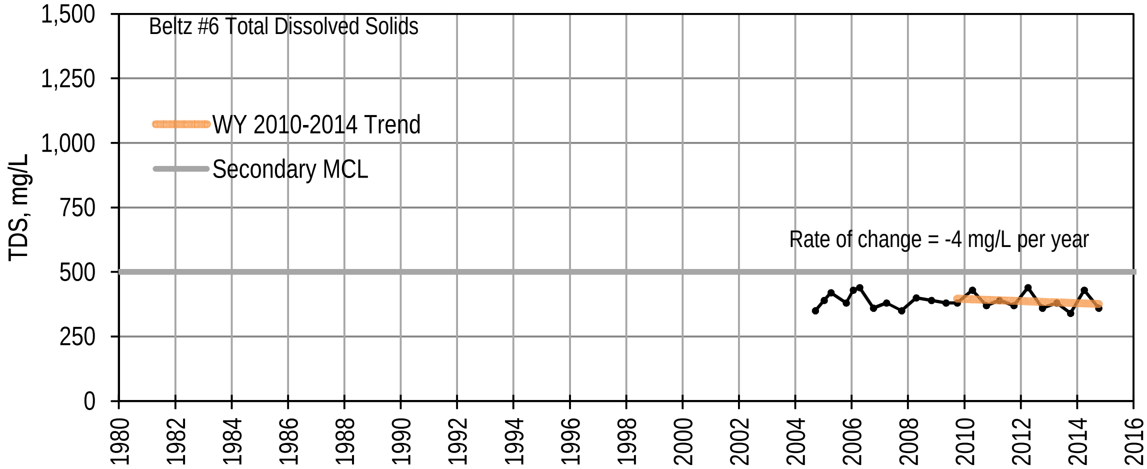


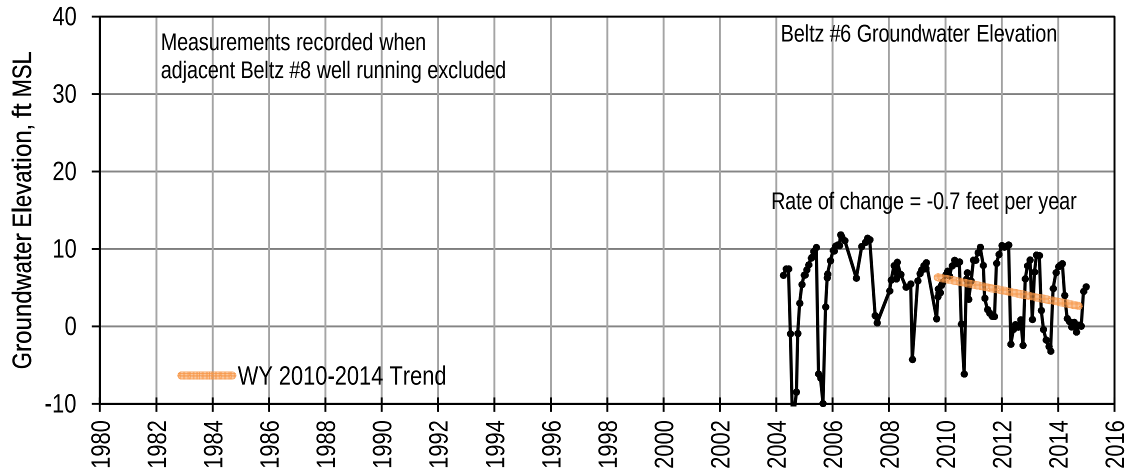
Beltz #4 Deep Total Dissolved Solids
Secondary MCL
TDS, mg/L
1,500
1,250
1,000
750
500
250
0
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016

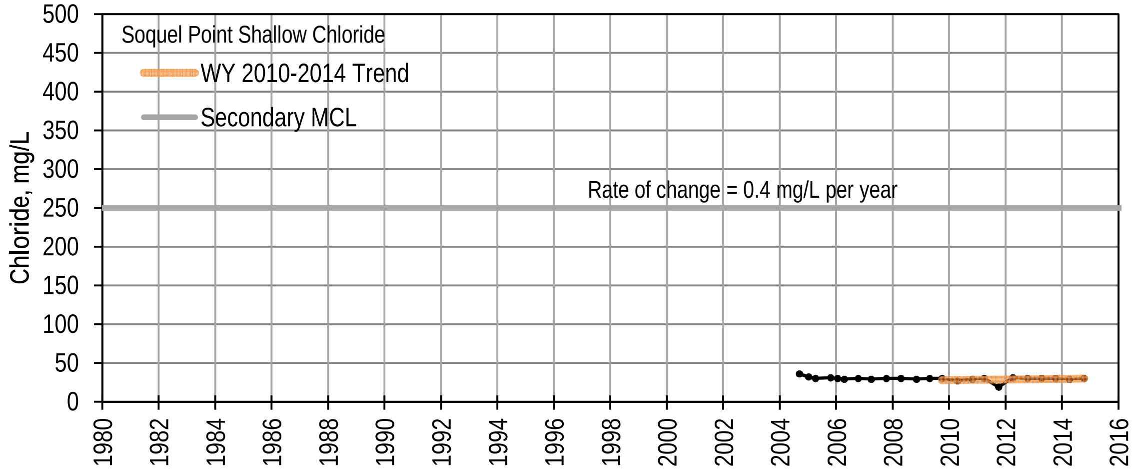


Beltz #4 Deep Groundwater Elevation
Rate of change = 0 feet per year
WY 2010-2014 Trend
Groundwater Elevation, ft MSL
35
25
15
5
-5
-15
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016

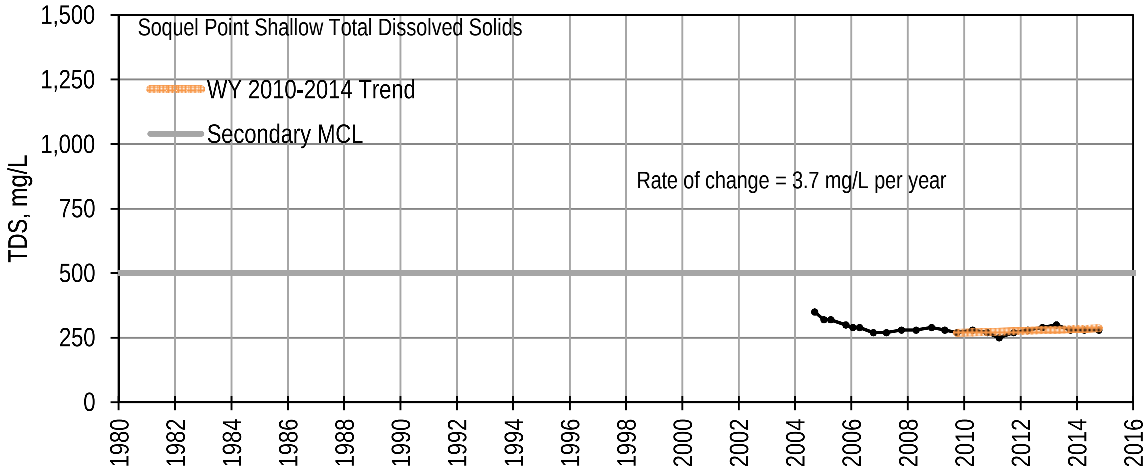

Beltz #6 Chloride
WY 2010-2014 Trend
Secondary MCL
Rate of change = 1.8 mg/L per year
Chloride, mg/L


Beltz #6 Total Dissolved Solids
WY 2010-2014 Trend
Secondary MCL
Rate of change = -4 mg/L per year
TDS, mg/L

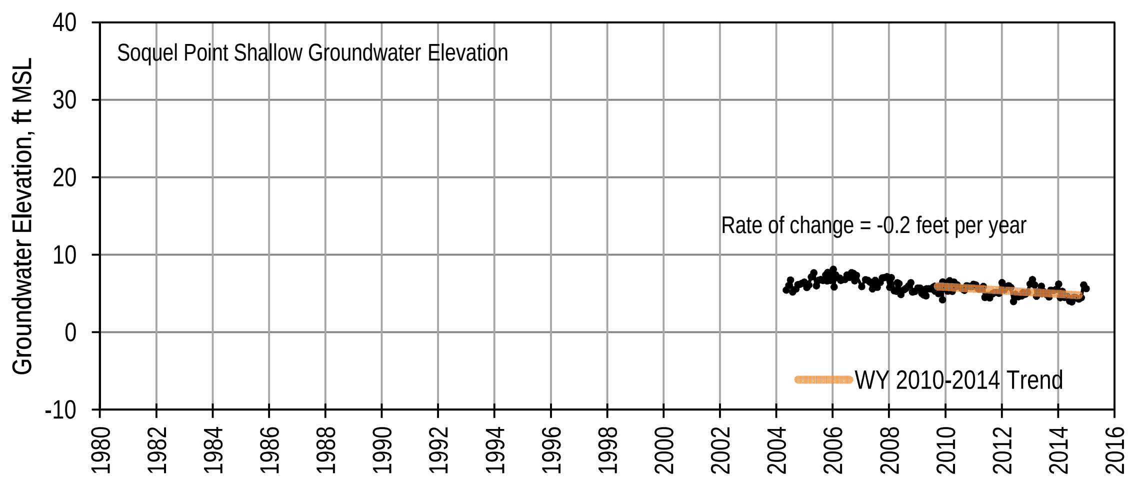

Measurements recorded when
adjacent Beltz #8 well running excluded
Beltz #6 Groundwater Elevation
Rate of change = -0.7 feet per year
WY 2010-2014 Trend
Groundwater Elevation, ft MSL



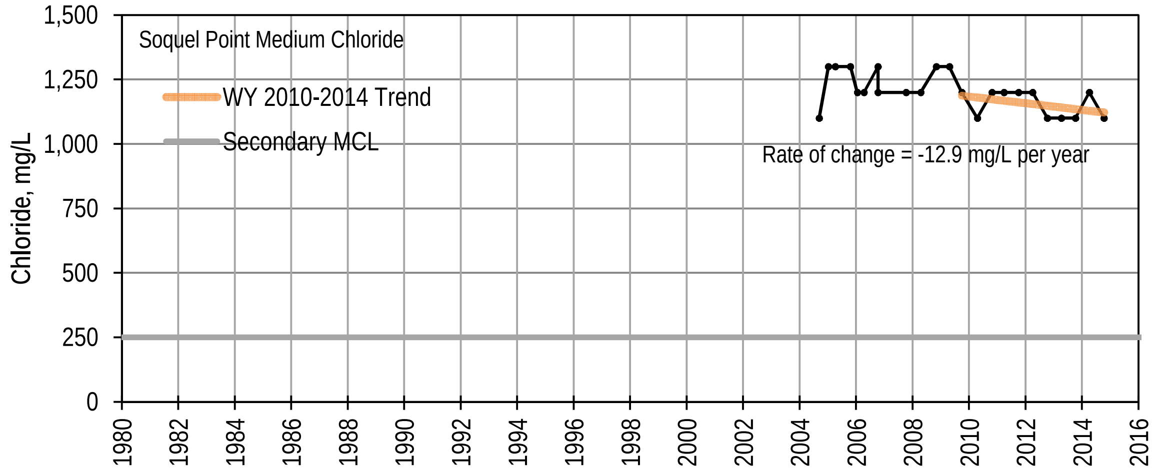
Soquel Point Shallow Chloride
WY 2010-2014 Trend
Secondary MCL
Rate of change = 0.4 mg/L per year
Chloride, mg/L

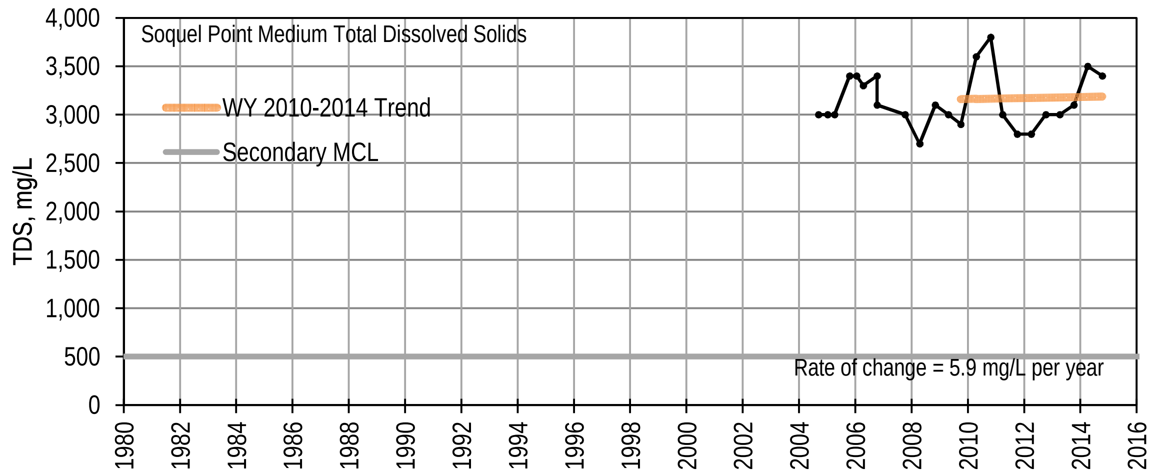


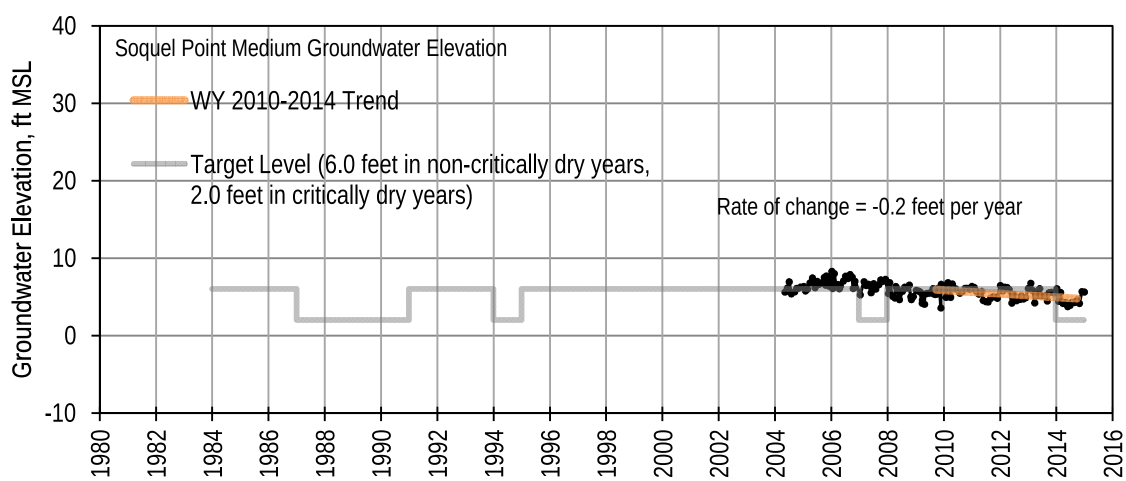
Soquel Point Shallow Total Dissolved Solids
WY 2010-2014 Trend
Secondary MCL
Rate of change = 3.7 mg/L per year
TDS, mg/L

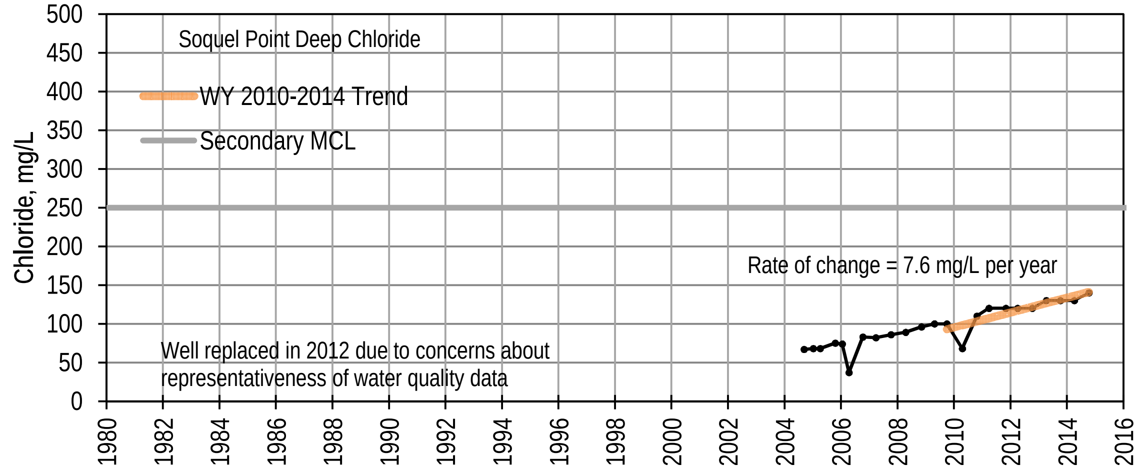


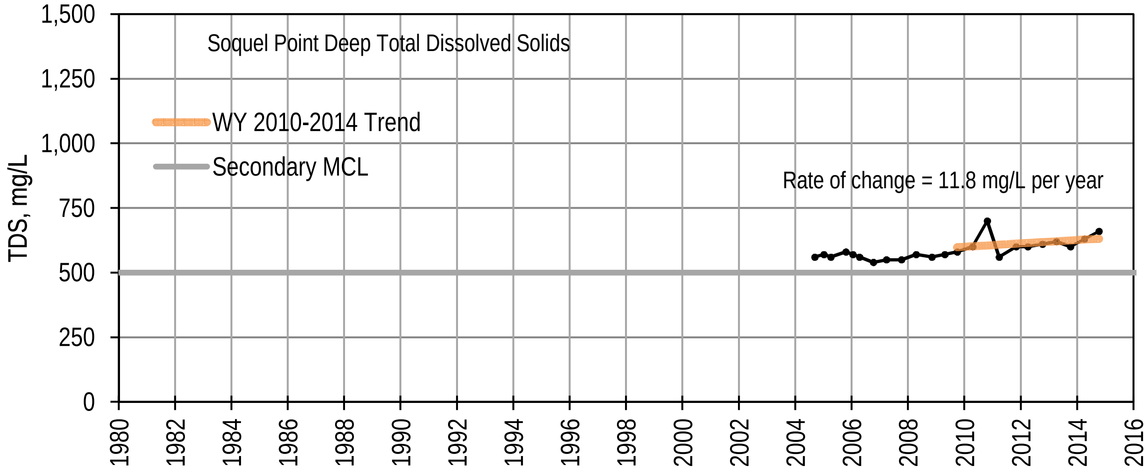
Soquel Point Shallow Groundwater Elevation
Rate of change = -0.2 feet per year
WY 2010-2014 Trend
Groundwater Elevation, ft MSL

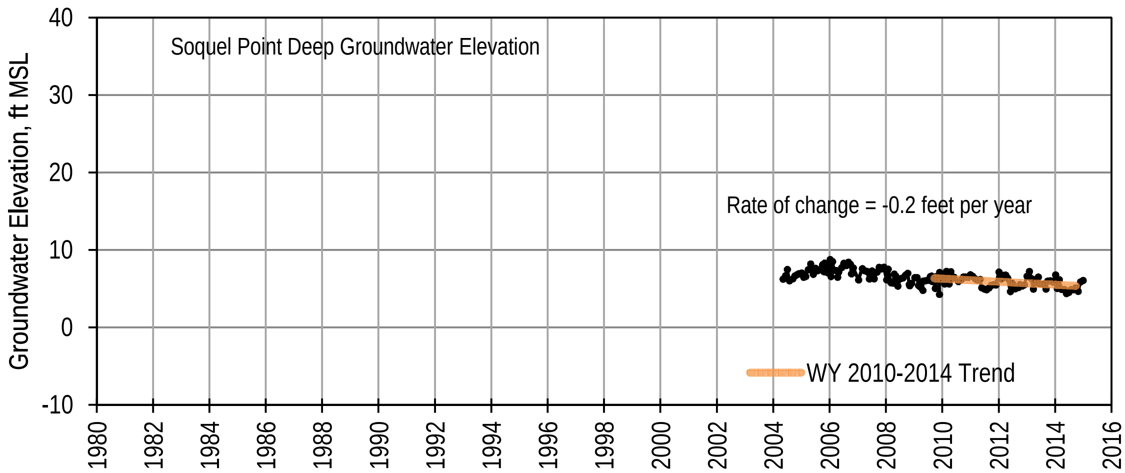

Soquel Point Medium Chloride
WY 2010-2014 Trend
Secondary MCL
Rate of change = -12.9 mg/L per year
Chloride, mg/L

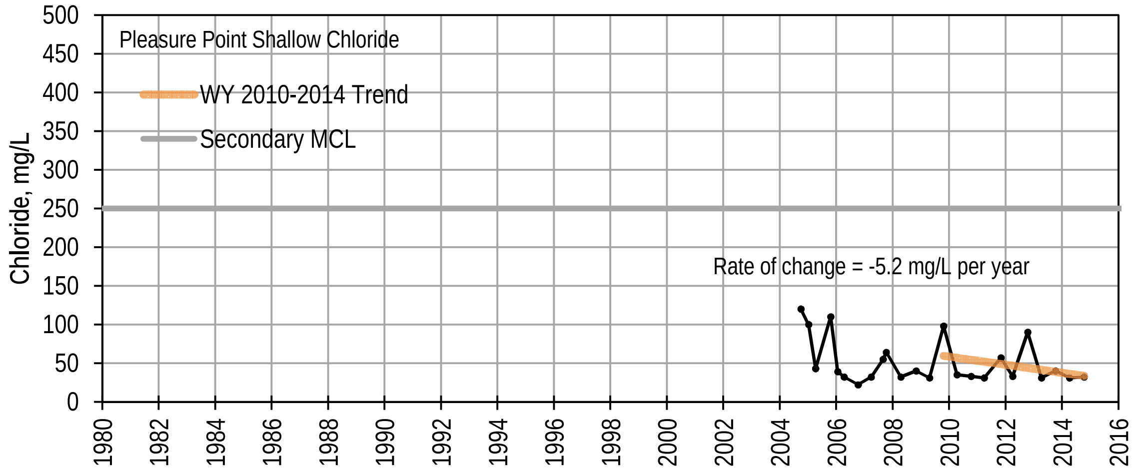

Soquel Point Medium Total Dissolved Solids
WY 2010-2014 Trend
Secondary MCL
Rate of change = 5.9 mg/L per year
TDS, mg/L

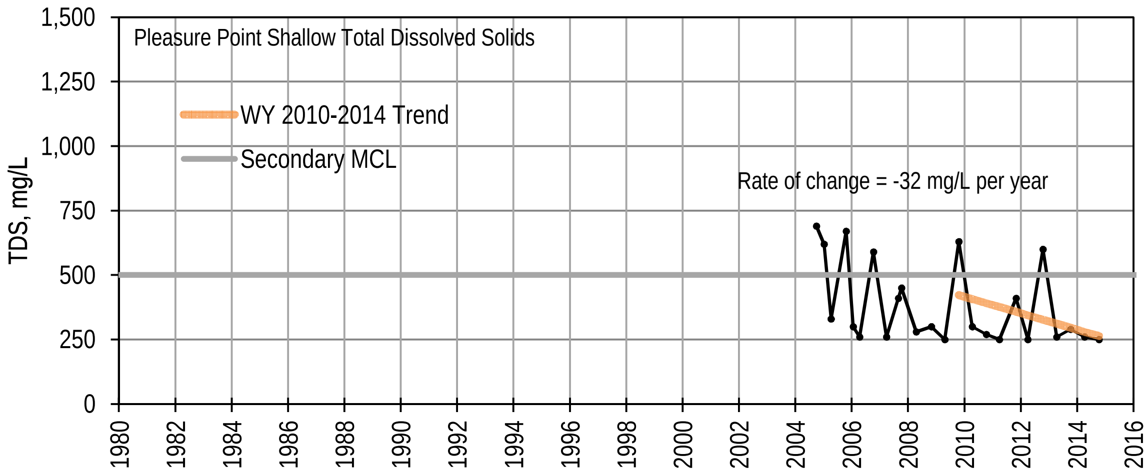

Soquel Point Medium Groundwater Elevation
WY 2010-2014 Trend
Target Level (6.0 feet in non-critically dry years,
2.0 feet in critically dry years)
Rate of change = -0.2 feet per year
Groundwater Elevation, ft MSL

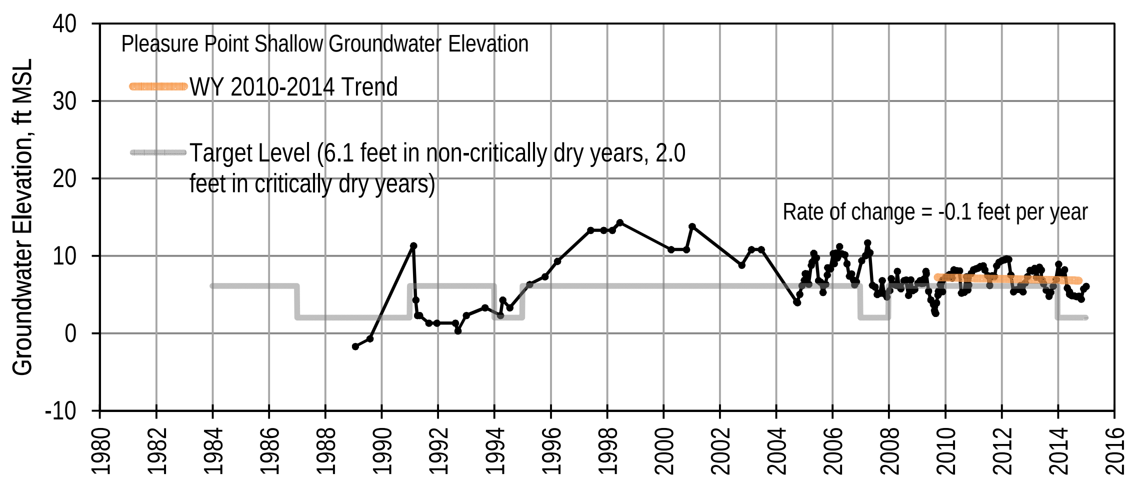

Soquel Point Deep Chloride
WY 2010-2014 Trend
Secondary MCL
Chloride, mg/L
Rate of change = 7.6 mg/L per year
Well replaced in 2012 due to concerns about
representativeness of water quality data
500
450
400
350
300
250
200
150
100
50
0
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016

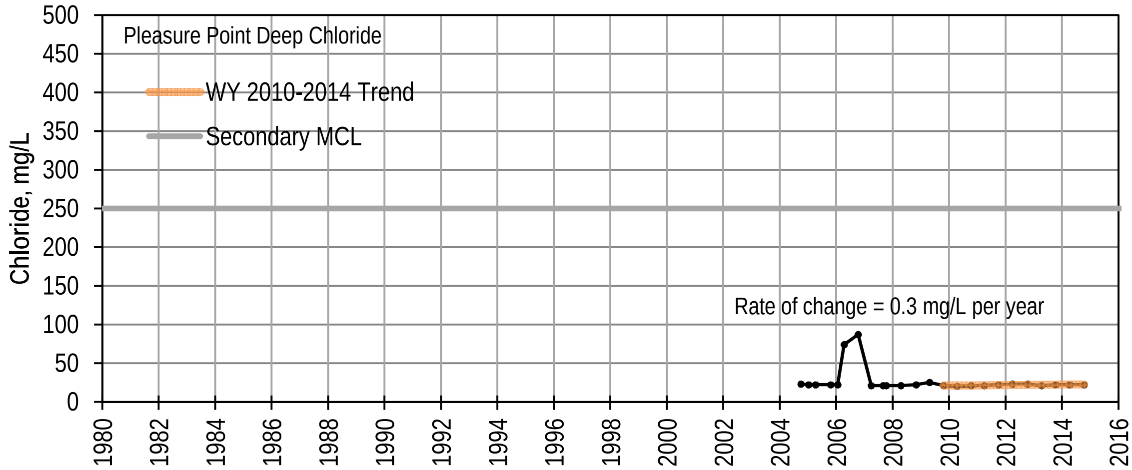

Soquel Point Deep Total Dissolved Solids
WY 2010-2014 Trend
Secondary MCL
TDS, mg/L
Rate of change = 11.8 mg/L per year
1,500
1,250
1,000
750
500
250
0
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016

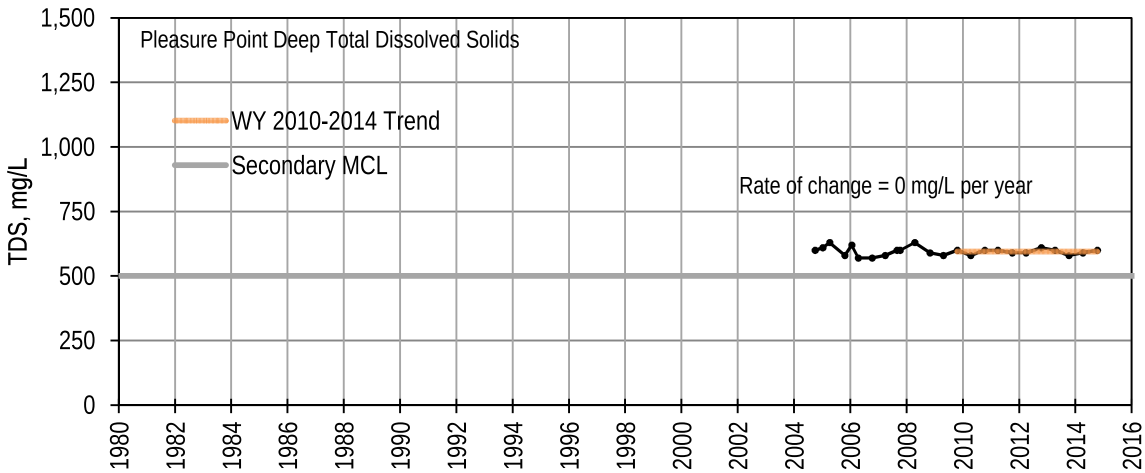

Soquel Point Deep Groundwater Elevation
Groundwater Elevation, ft MSL
Rate of change = -0.2 feet per year
WY 2010-2014 Trend
40
30
20
10
0
-10
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016

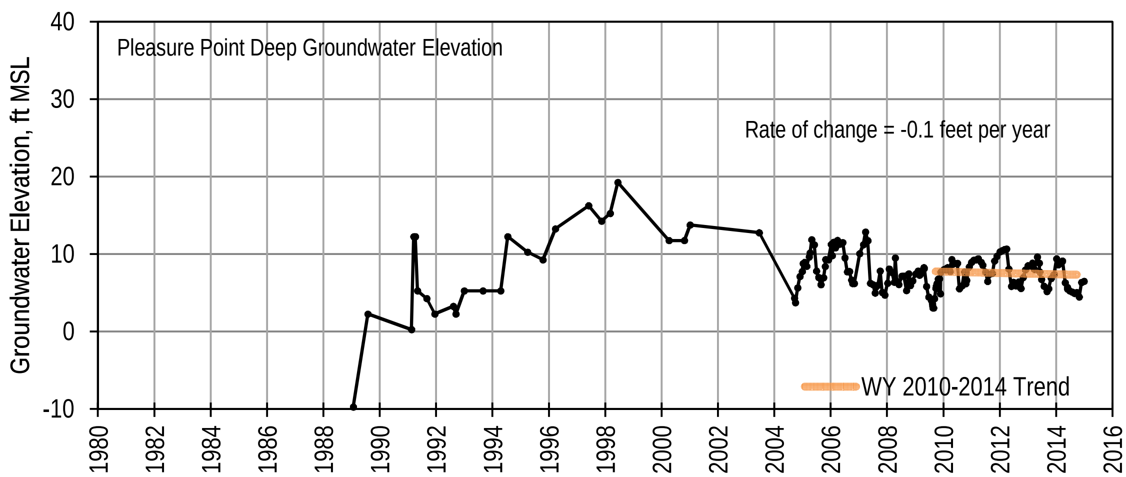

Pleasure Point Shallow Chloride
WY 2010-2014 Trend
Secondary MCL
Rate of change = -5.2 mg/L per year
Chloride, mg/L
0
50
100
150
200
250
300
350
400
450
500
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016


Pleasure Point Shallow Total Dissolved Solids
WY 2010-2014 Trend
Secondary MCL
Rate of change = -32 mg/L per year
TDS, mg/L
0
250
500
750
1,000
1,250
1,500
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016

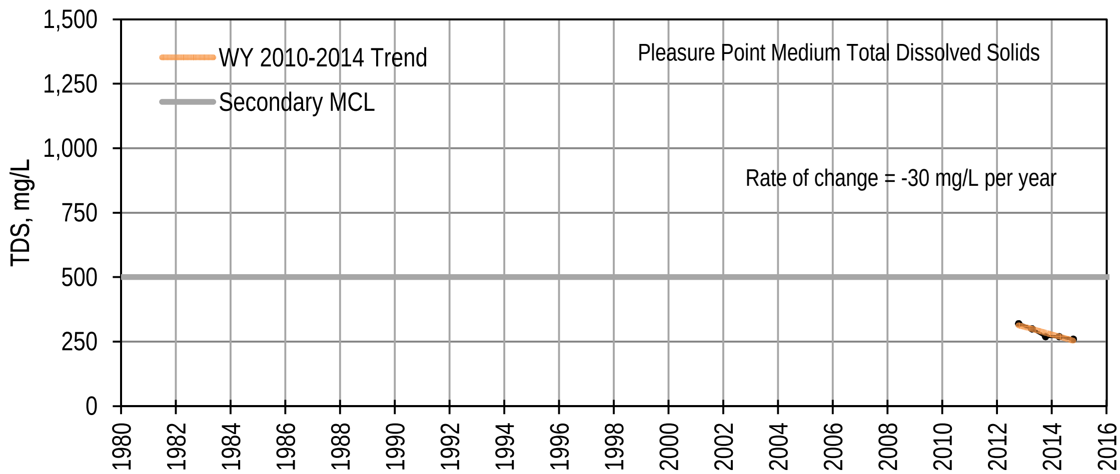

Pleasure Point Shallow Groundwater Elevation
WY 2010-2014 Trend
Target Level (6.1 feet in non-critically dry years, 2.0 feet in critically dry years)
Rate of change = -0.1 feet per year
Groundwater Elevation, ft MSL
-10
0
10
20
30
40
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016

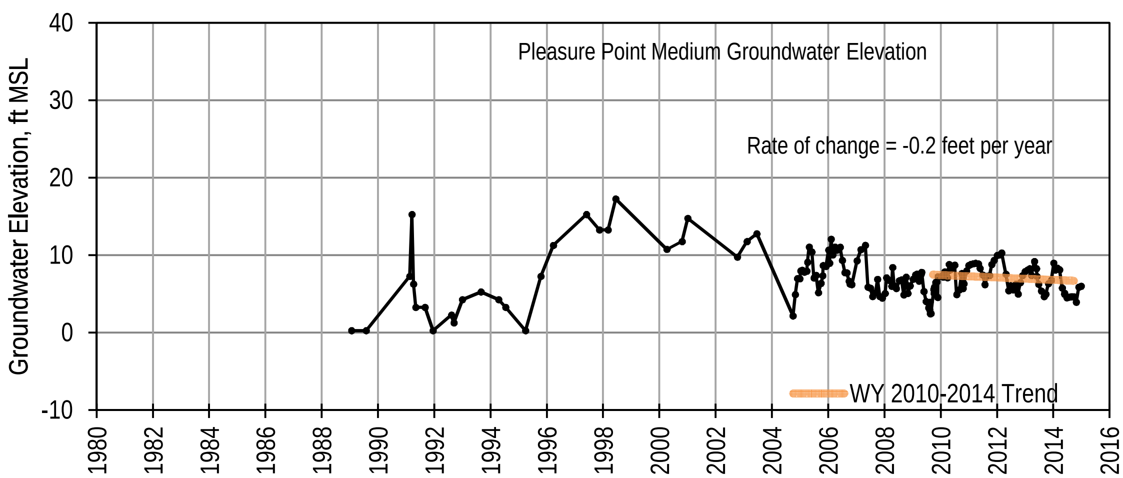

Pleasure Point Deep Chloride
WY 2010-2014 Trend
Secondary MCL
Chloride, mg/L
Rate of change = 0.3 mg/L per year
500
450
400
350
300
250
200
150
100
50
0
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016

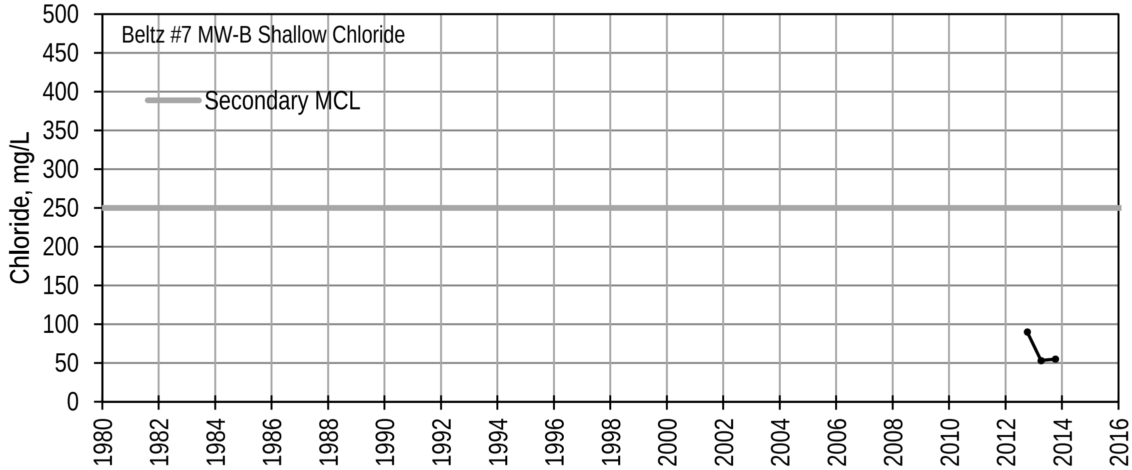

Pleasure Point Deep Total Dissolved Solids
WY 2010-2014 Trend
Secondary MCL
TDS, mg/L
Rate of change = 0 mg/L per year
1,500
1,250
1,000
750
500
250
0
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016

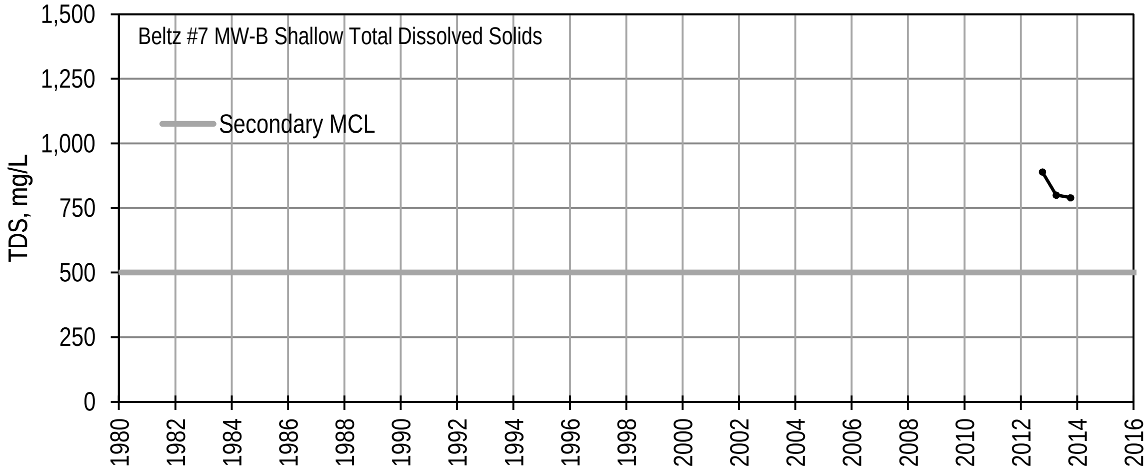

Pleasure Point Deep Groundwater Elevation
Rate of change = -0.1 feet per year
WY 2010-2014 Trend
Groundwater Elevation, ft MSL
40
30
20
10
0
-10
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016

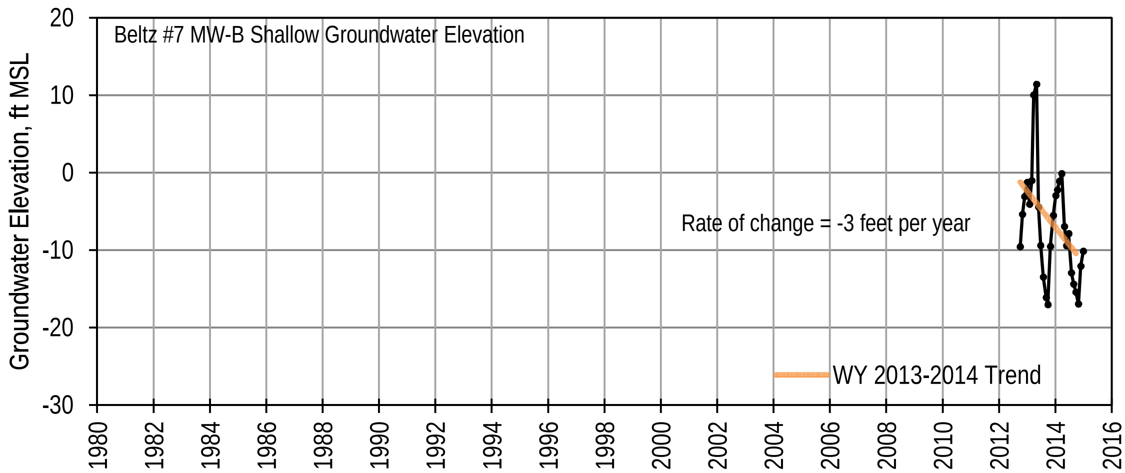

Pleasure Point Medium Chloride
WY 2010-2014 Trend
Secondary MCL
Rate of change = -2.8 mg/L per year
Chloride, mg/L
500
450
400
350
300
250
200
150
100
50
0
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016

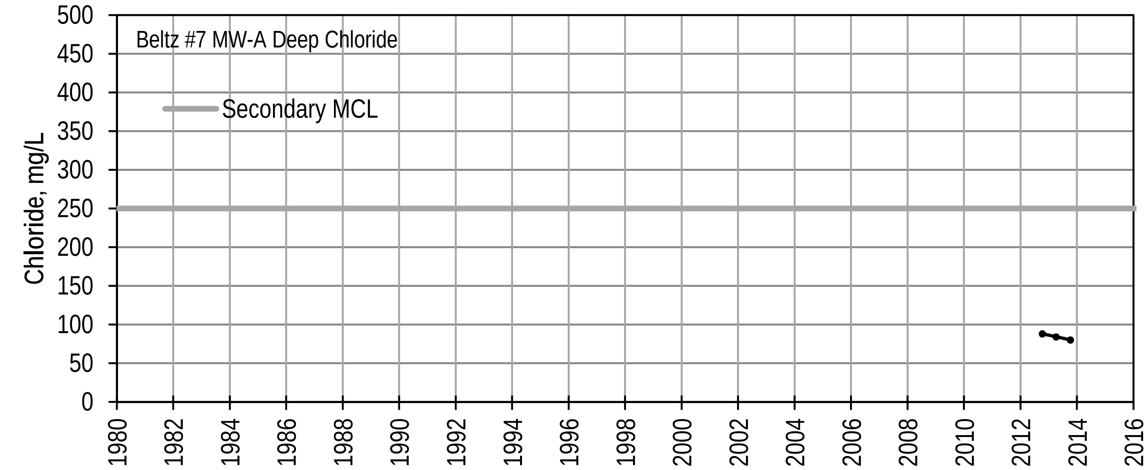

Pleasure Point Medium Total Dissolved Solids
WY 2010-2014 Trend
Secondary MCL
Rate of change = -30 mg/L per year
TDS, mg/L
1,500
1,250
1,000
750
500
250
0
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016

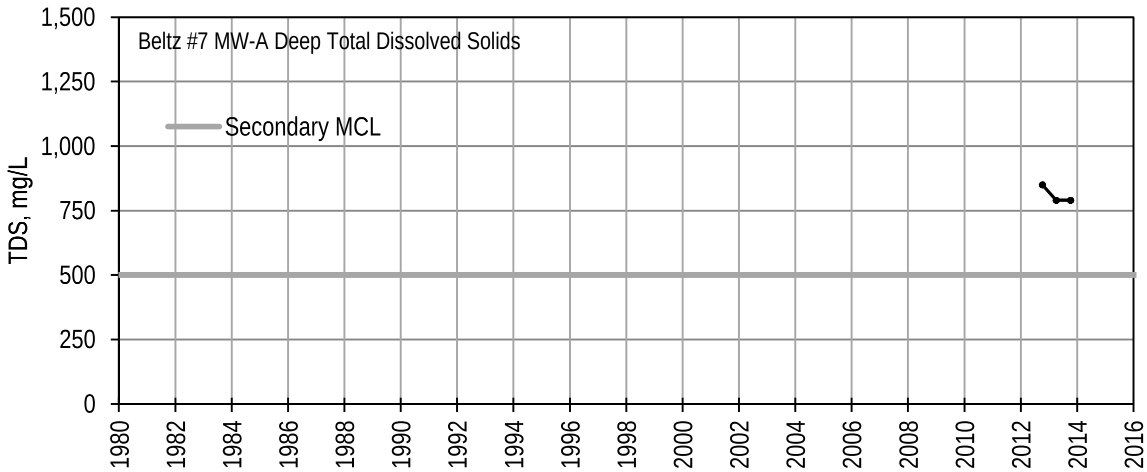

Pleasure Point Medium Groundwater Elevation
Rate of change = -0.2 feet per year
WY 2010-2014 Trend
Groundwater Elevation, ft MSL
40
30
20
10
0
-10
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016

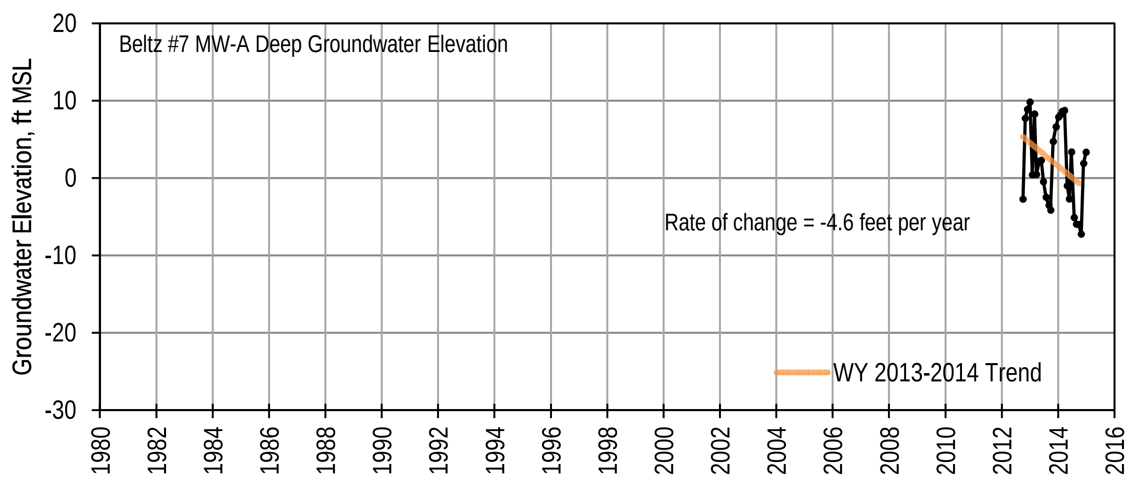

Beltz #7 MW-B Shallow Chloride
Secondary MCL
Chloride, mg/L
500
450
400
350
300
250
200
150
100
50
0
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016

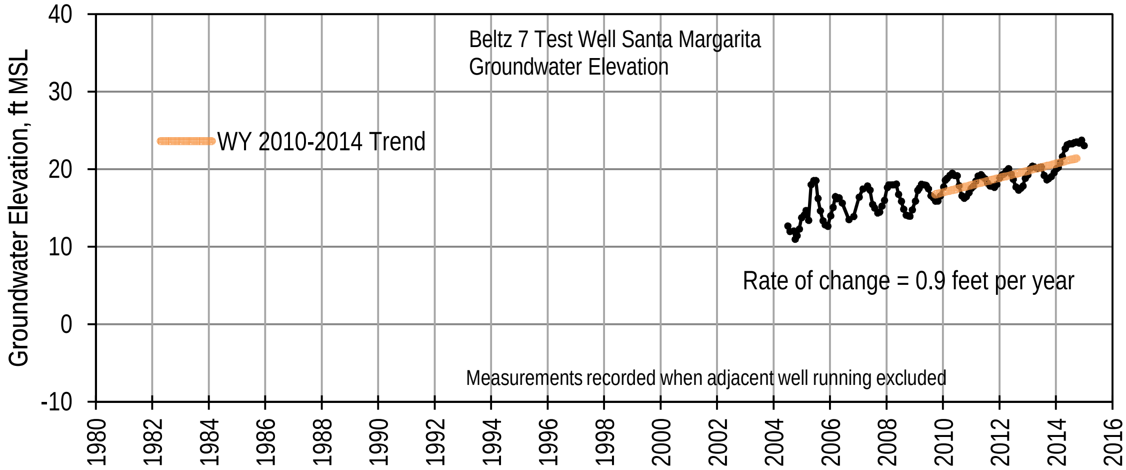

Beltz #7 MW-B Shallow Total Dissolved Solids
Secondary MCL
TDS, mg/L
1,500
1,250
1,000
750
500
250
0
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016


Beltz #7 MW-B Shallow Groundwater Elevation
Rate of change = -3 feet per year
WY 2013-2014 Trend
Groundwater Elevation, ft MSL
20
10
0
-10
-20
-30
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016

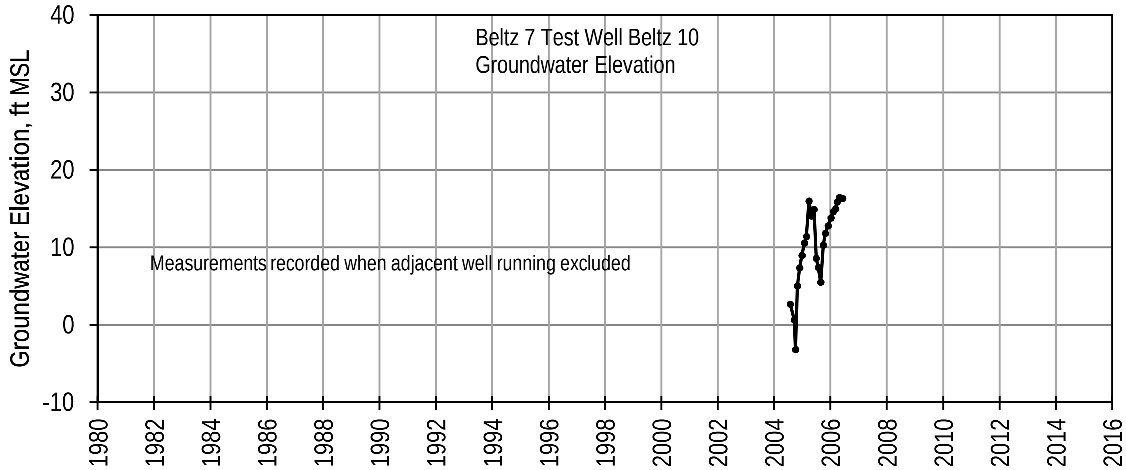

Beltz #7 MW-A Deep Chloride
Secondary MCL
Chloride, mg/L
500
450
400
350
300
250
200
150
100
50
0
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016


Beltz #7 MW-A Deep Total Dissolved Solids
Secondary MCL
TDS, mg/L
1,500
1,250
1,000
750
500
250
0
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016

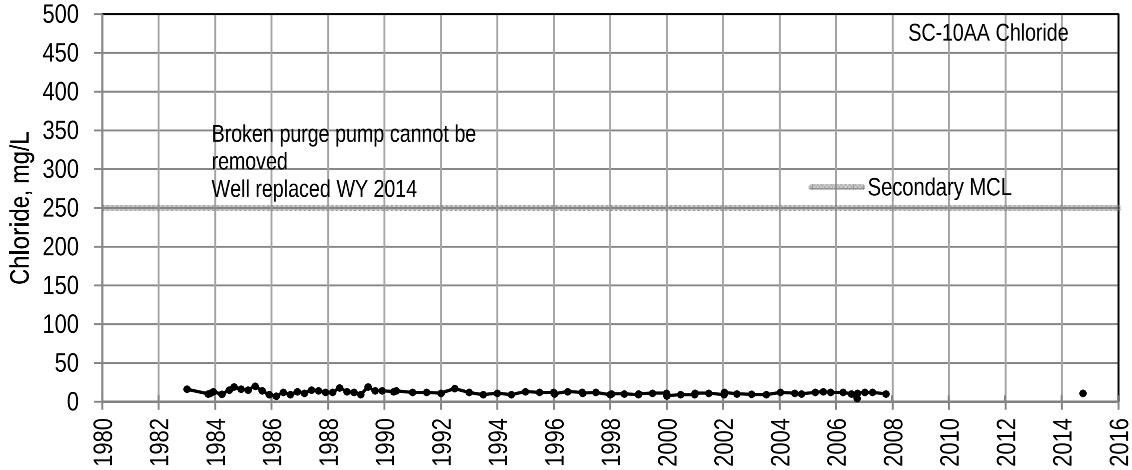

Beltz #7 MW-A Deep Groundwater Elevation
Rate of change = -4.6 feet per year
WY 2013-2014 Trend
Groundwater Elevation, ft MSL
20
10
0
-10
-20
-30
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016

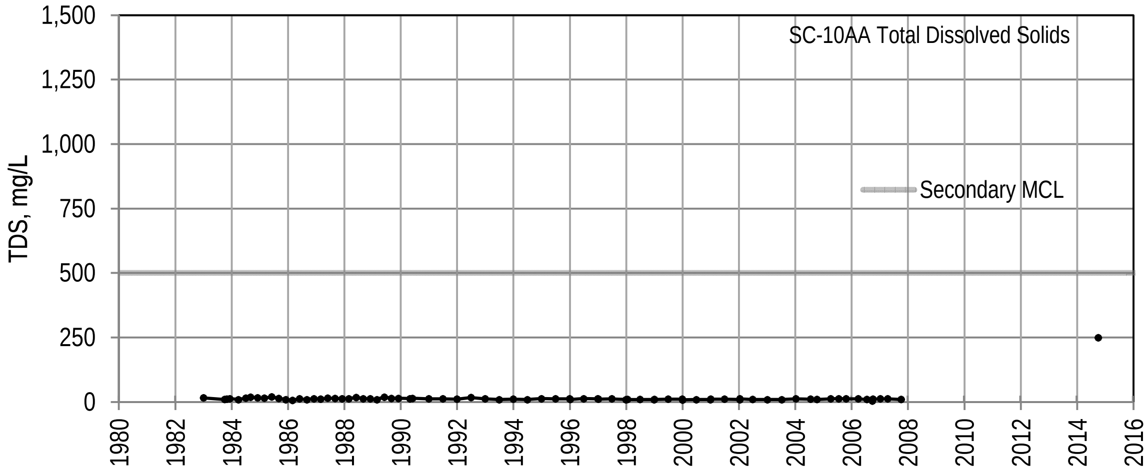


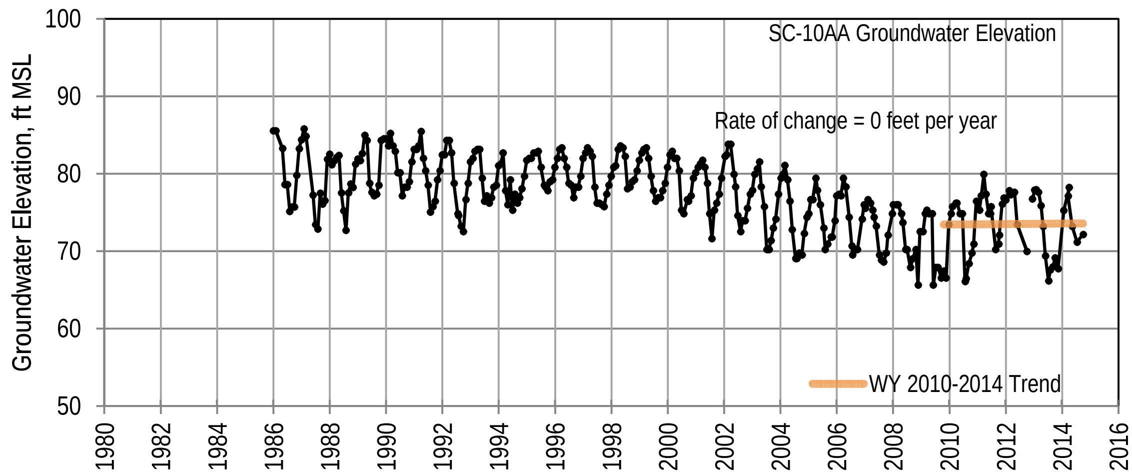
Beltz 7 Test Well Santa Margarita
Groundwater Elevation
WY 2010-2014 Trend
Rate of change = 0.9 feet per year
Measurements recorded when adjacent well running excluded
Groundwater Elevation, ft MSL
40
30
20
10
0
-10
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016

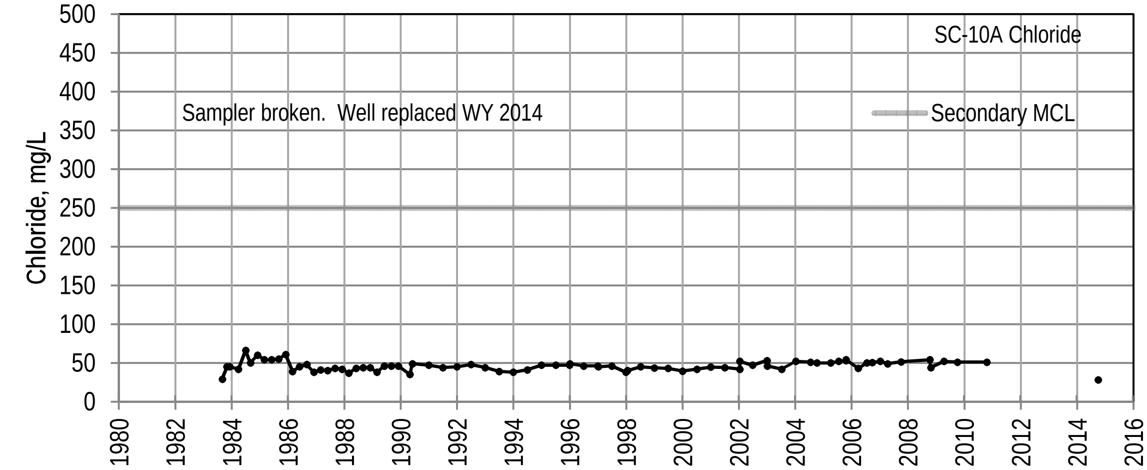


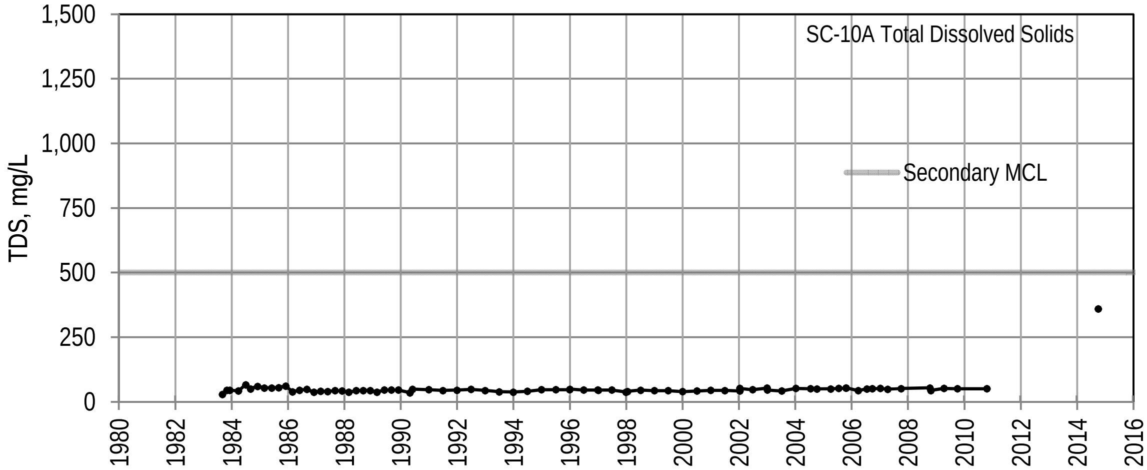
Beltz 7 Test Well Beltz 10
Groundwater Elevation
Measurements recorded when adjacent well running excluded
Groundwater Elevation, ft MSL
40
30
20
10
0
-10
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016

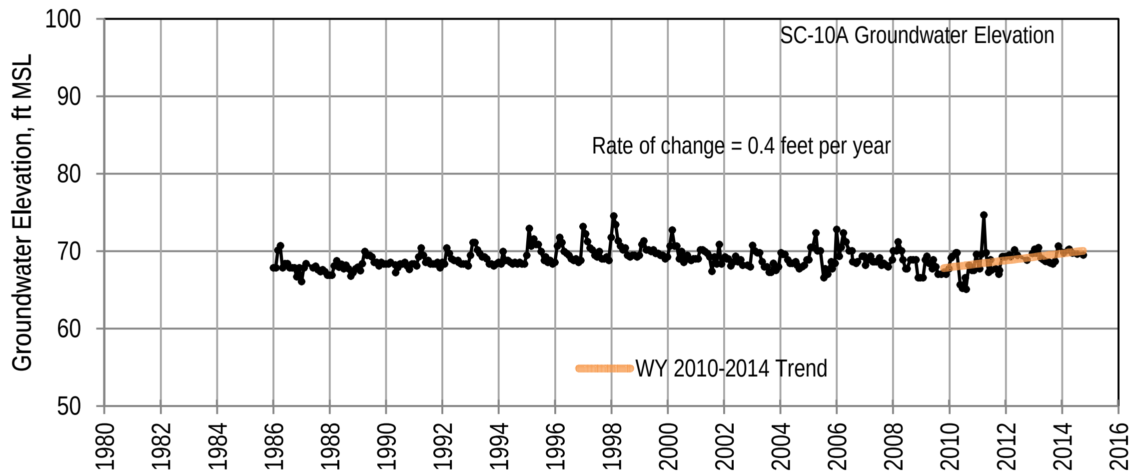

SC-10AA Chloride
Broken purge pump cannot be removed
Well replaced WY 2014
Secondary MCL
Chloride, mg/L
0
50
100
150
200
250
300
350
400
450
500
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016

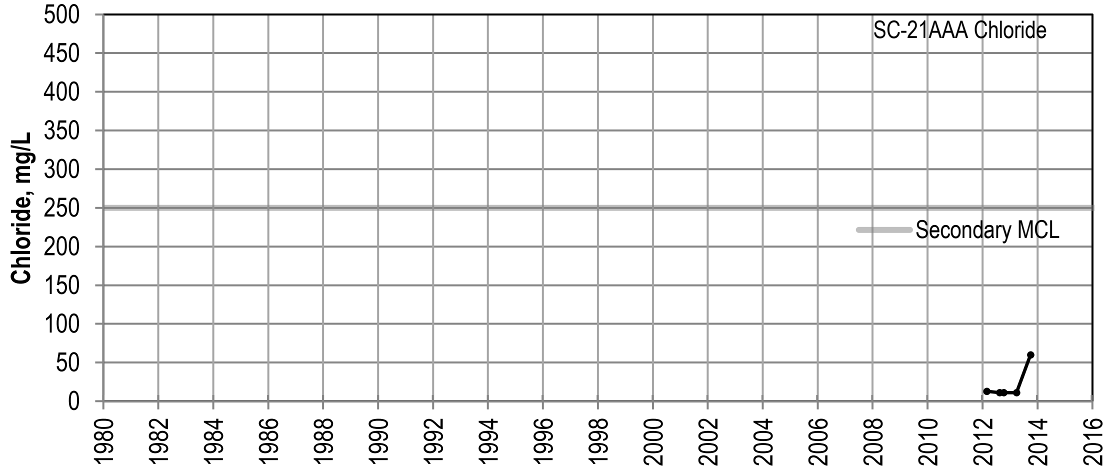

SC-10AA Total Dissolved Solids
Secondary MCL
TDS, mg/L
0
250
500
750
1,000
1,250
1,500
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016

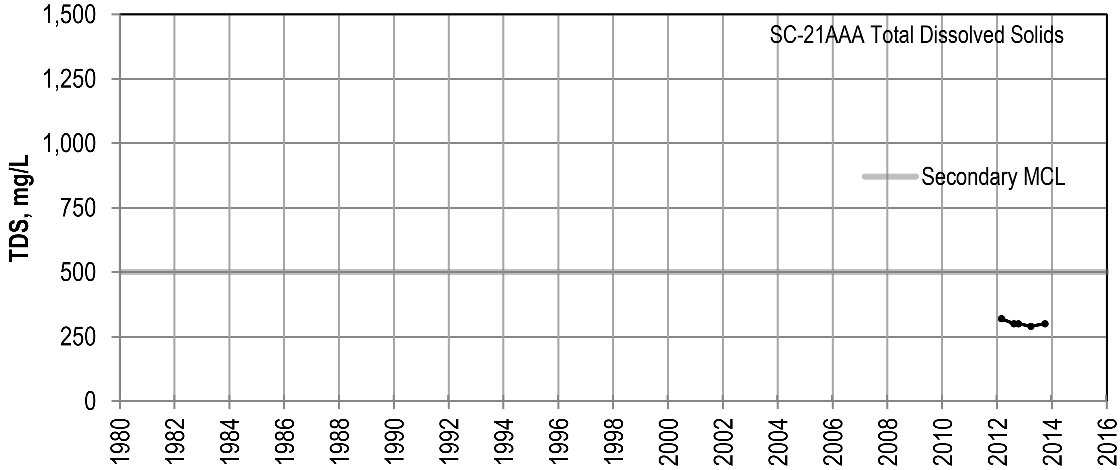

SC-10AA Groundwater Elevation
Rate of change = 0 feet per year
WY 2010-2014 Trend
Groundwater Elevation, ft MSL
50
60
70
80
90
100
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016

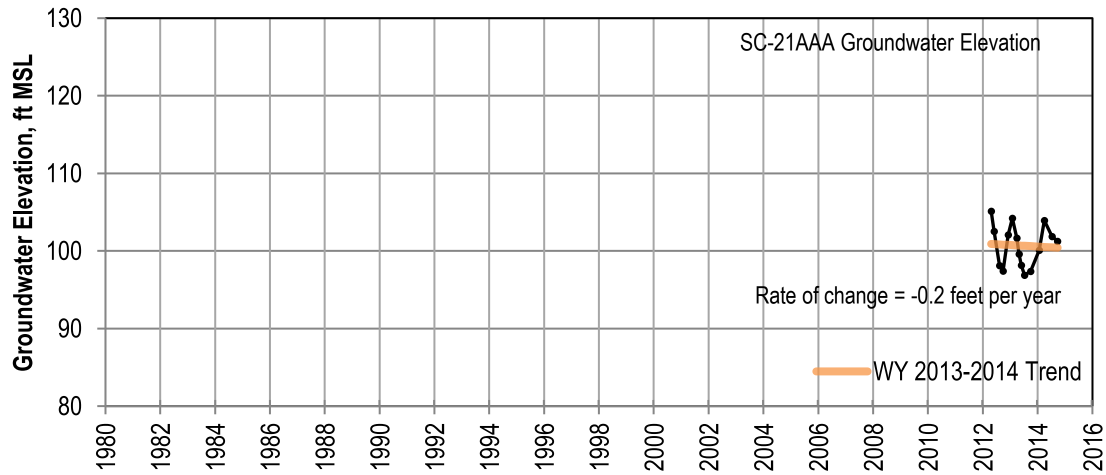

SC-10A Chloride
Sampler broken. Well replaced WY 2014
Secondary MCL
Chloride, mg/L

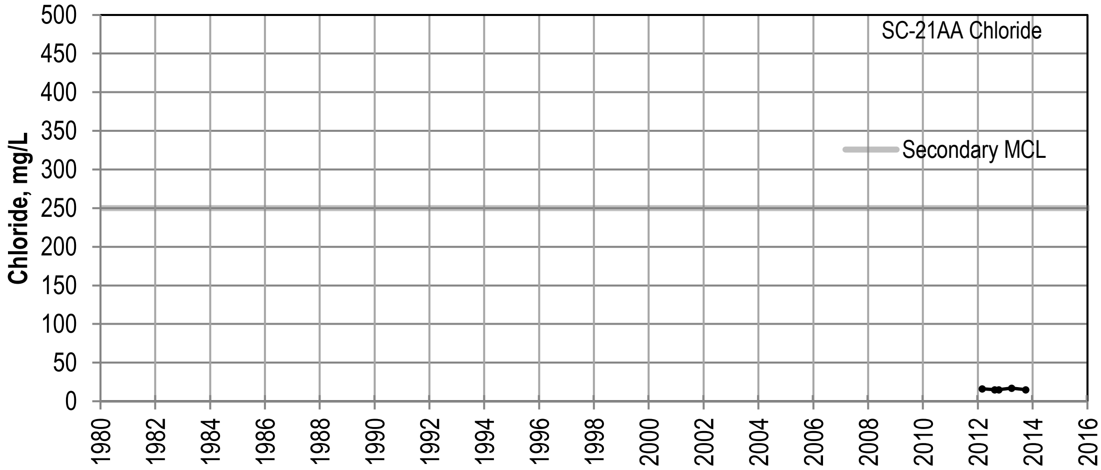

SC-10A Total Dissolved Solids
Secondary MCL
TDS, mg/L


SC-10A Groundwater Elevation
Rate of change = 0.4 feet per year
WY 2010-2014 Trend
Groundwater Elevation, ft MSL

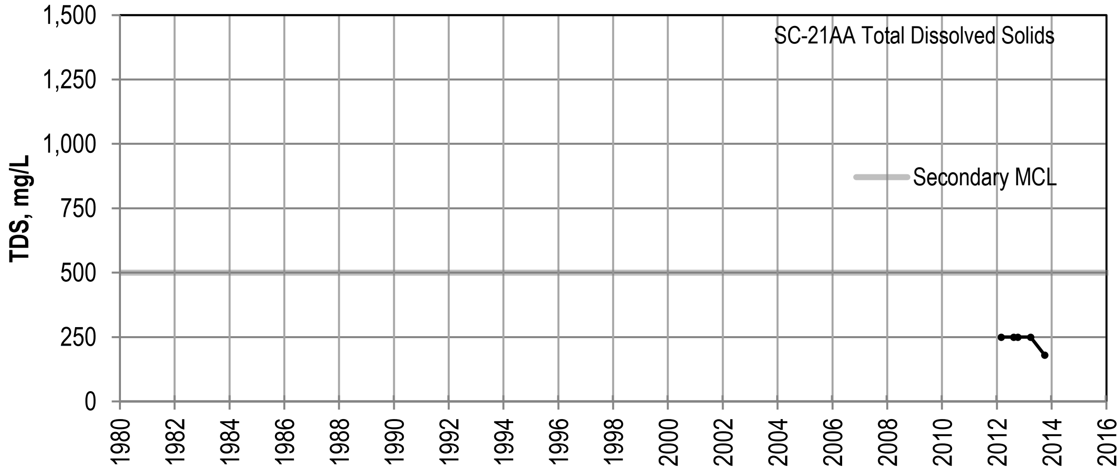

SC-21AAA Chloride
Secondary MCL
Chloride, mg/L


SC-21AAA Total Dissolved Solids
Secondary MCL
TDS, mg/L

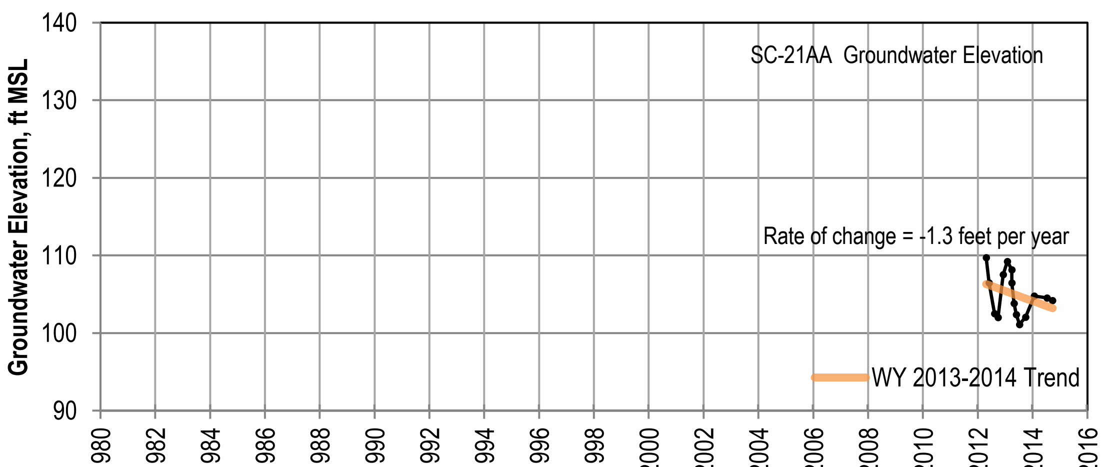

SC-21AAA Groundwater Elevation
Rate of change = -0.2 feet per year
WY 2013-2014 Trend
Groundwater Elevation, ft MSL



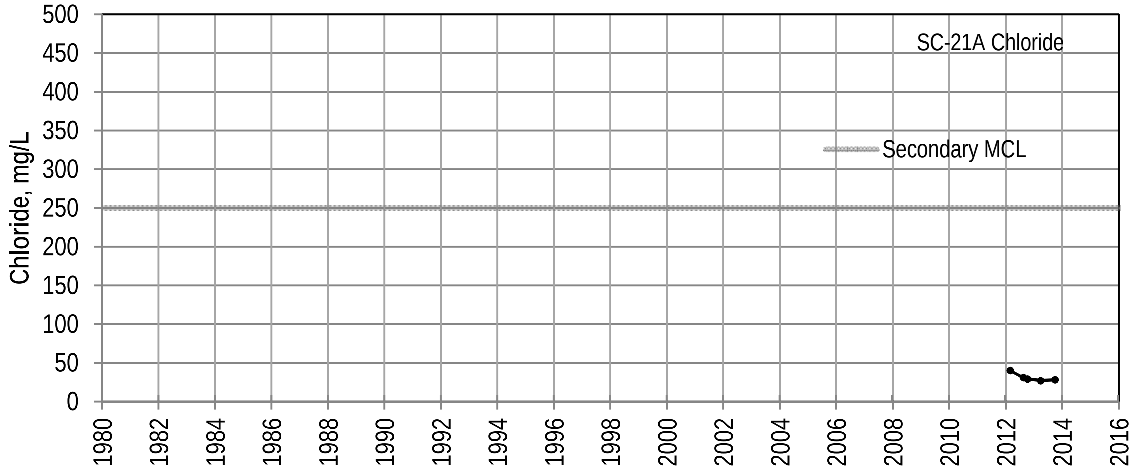
SC-21AA Chloride
Secondary MCL
Chloride, mg/L
500
450
400
350
300
250
200
150
100
50
0
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016

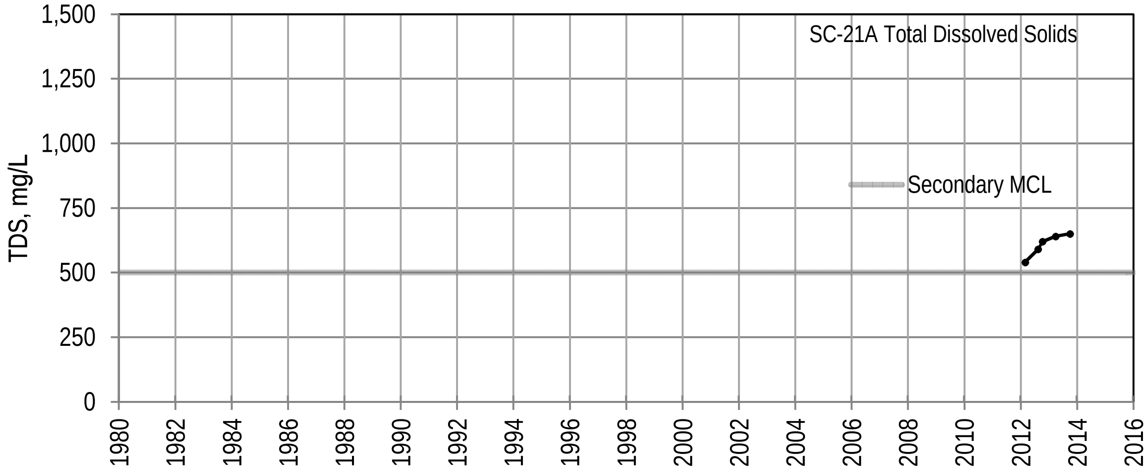


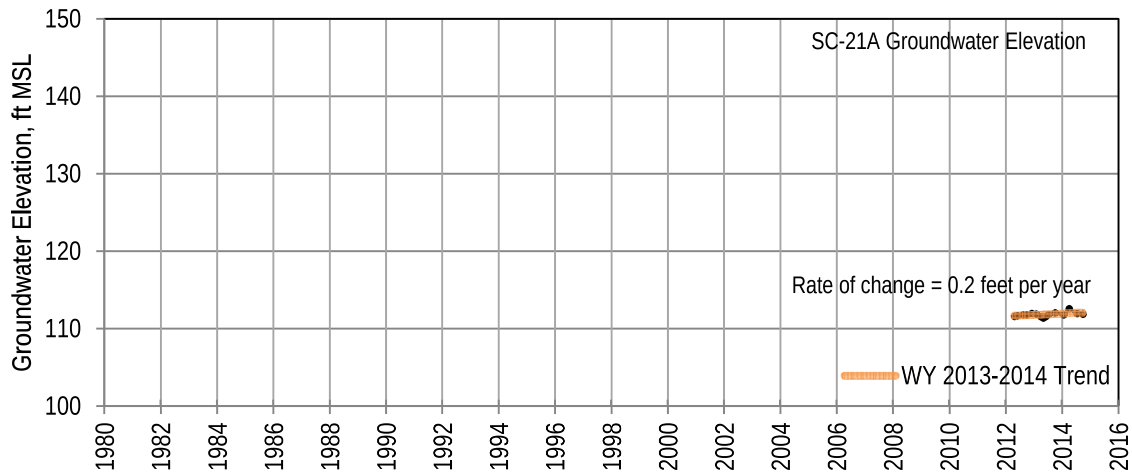
SC-21AA Total Dissolved Solids
Secondary MCL
TDS, mg/L
1,500
1,250
1,000
750
500
250
0
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016

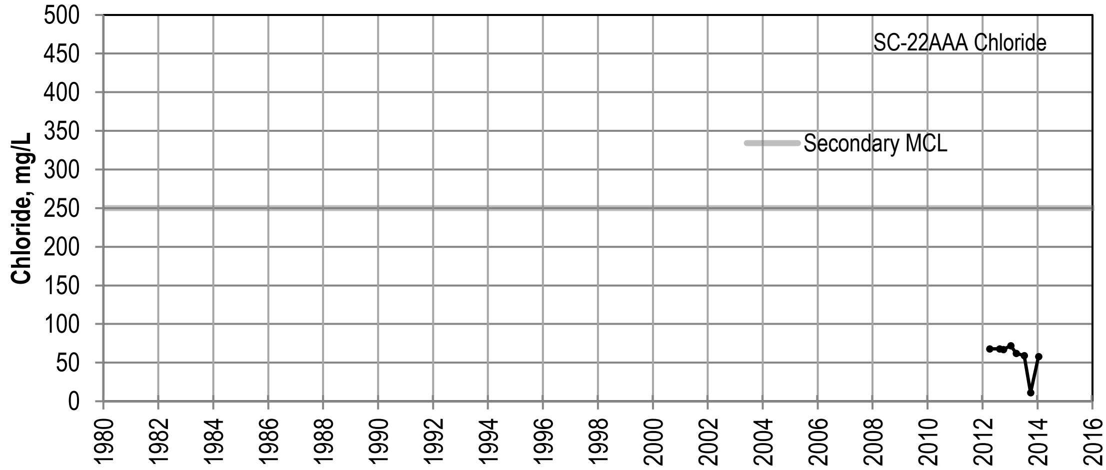


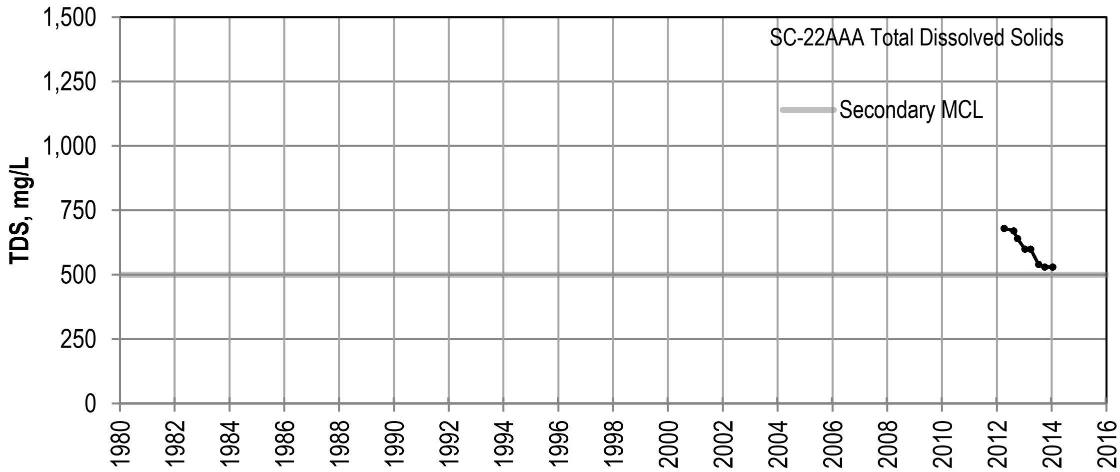
SC-21AA Groundwater Elevation
Rate of change = -1.3 feet per year
WY 2013-2014 Trend
Groundwater Elevation, ft MSL
140
130
120
110
100
90
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016

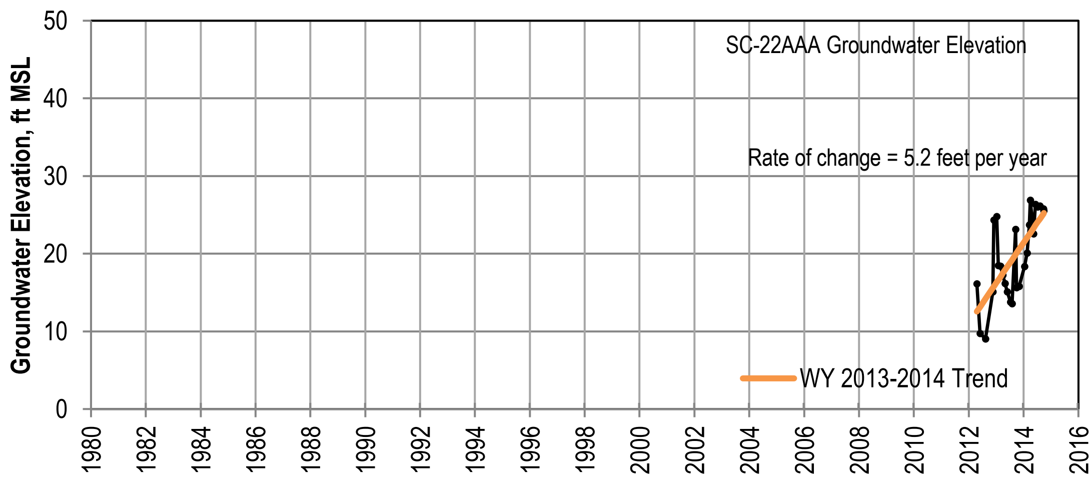

SC-21A Chloride
Secondary MCL
Chloride, mg/L
500
450
400
350
300
250
200
150
100
50
0
1980 1982 1984 1986 1988 1990 1992 1994 1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016

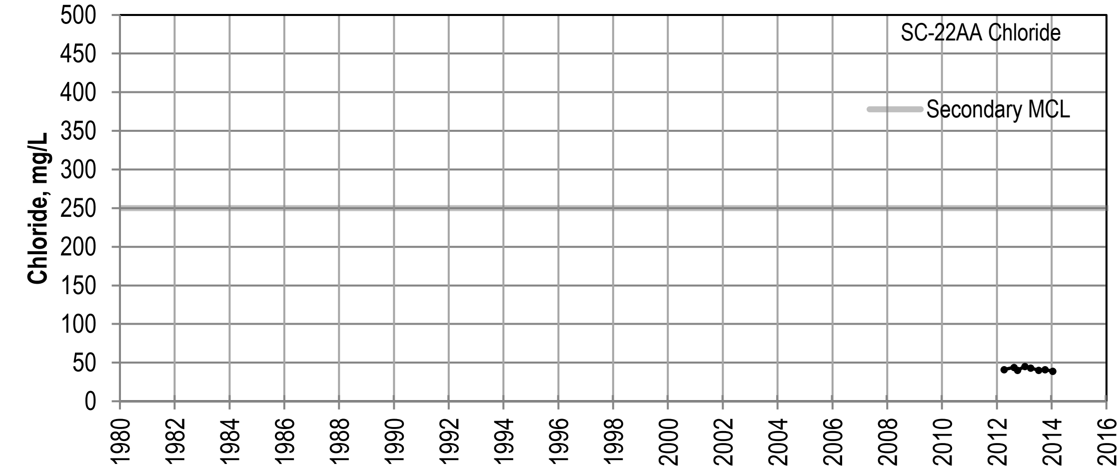

SC-21A Total Dissolved Solids
Secondary MCL
TDS, mg/L
1,500
1,250
1,000
750
500
250
0
1980 1982 1984 1986 1988 1990 1992 1994 1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016

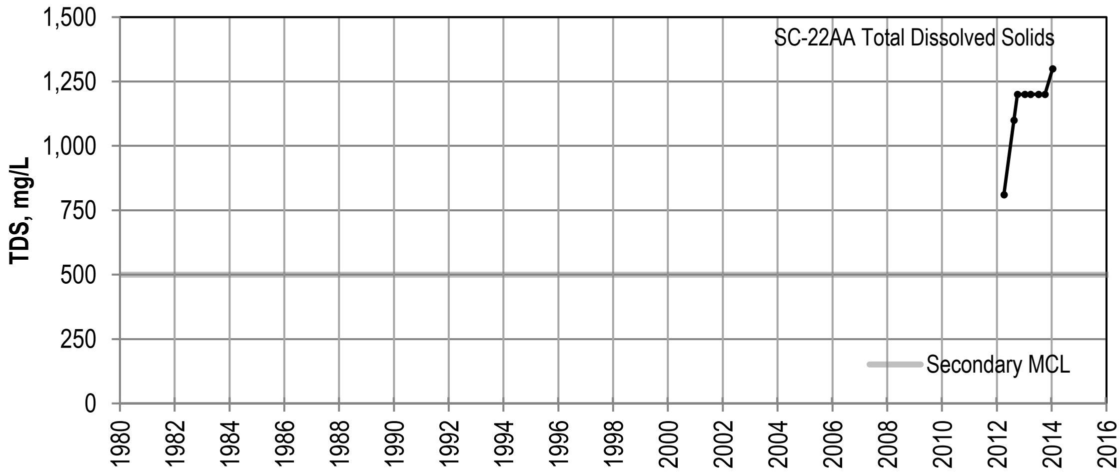

SC-21A Groundwater Elevation
Rate of change = 0.2 feet per year
WY 2013-2014 Trend
Groundwater Elevation, ft MSL
150
140
130
120
110
100
1980 1982 1984 1986 1988 1990 1992 1994 1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016

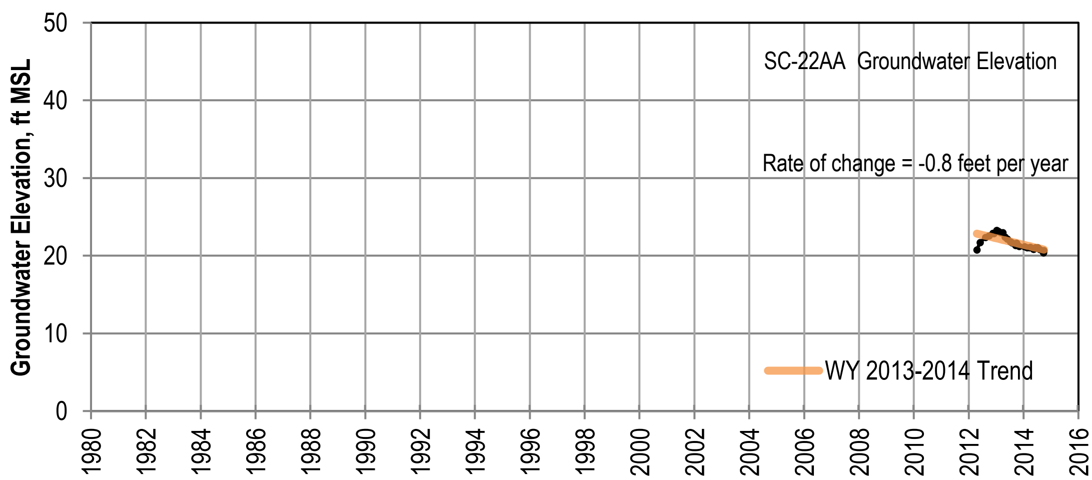

SC-22AAA Chloride
Secondary MCL
Chloride, mg/L
500
450
400
350
300
250
200
150
100
50
0
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016

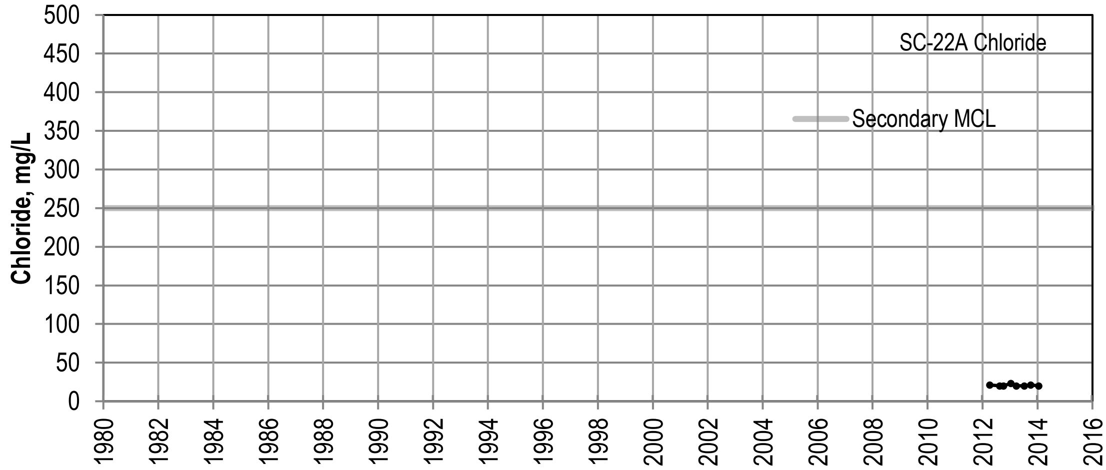

SC-22AAA Total Dissolved Solids
Secondary MCL
TDS, mg/L
1,500
1,250
1,000
750
500
250
0
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016

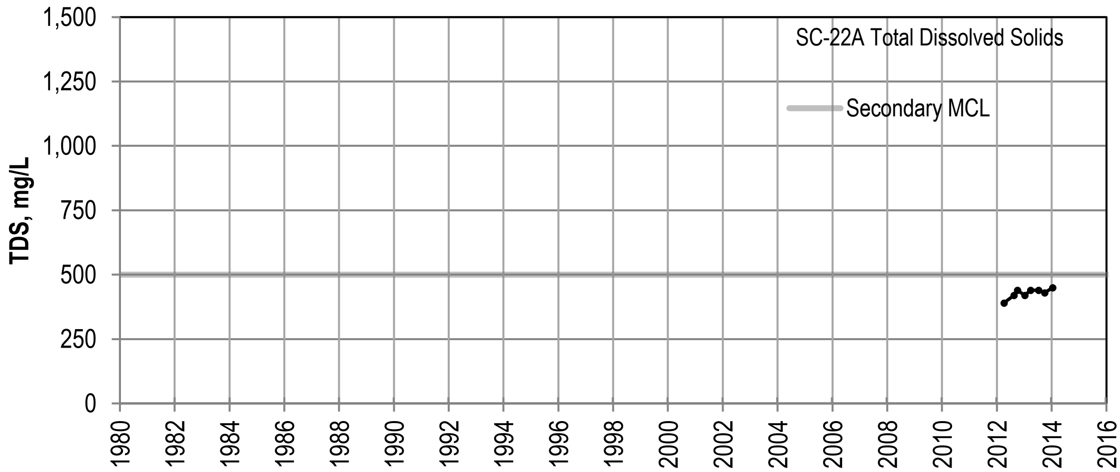

SC-22AAA Groundwater Elevation
Rate of change = 5.2 feet per year
WY 2013-2014 Trend
Groundwater Elevation, ft MSL
50
40
30
20
10
0
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016

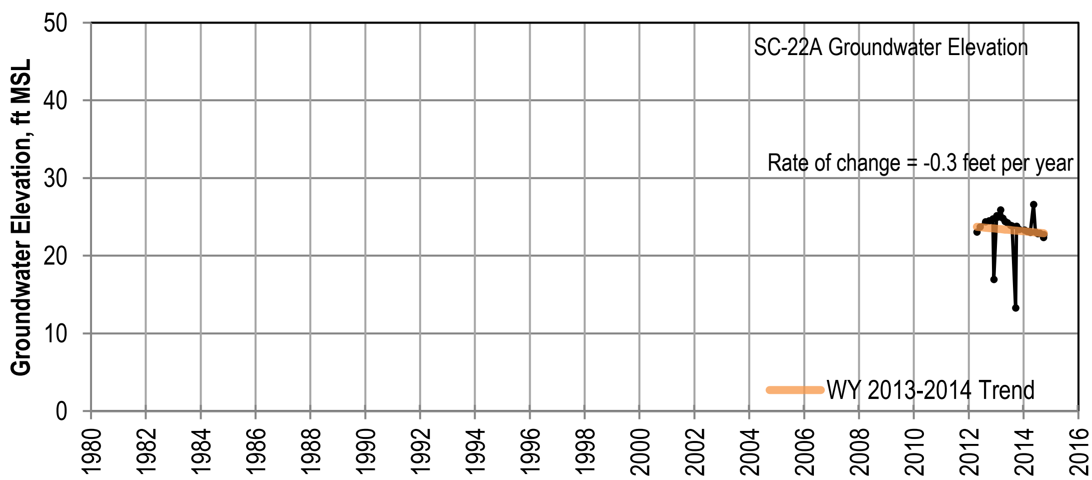

SC-22AA Chloride
Secondary MCL
Chloride, mg/L
0
50
100
150
200
250
300
350
400
450
500
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016

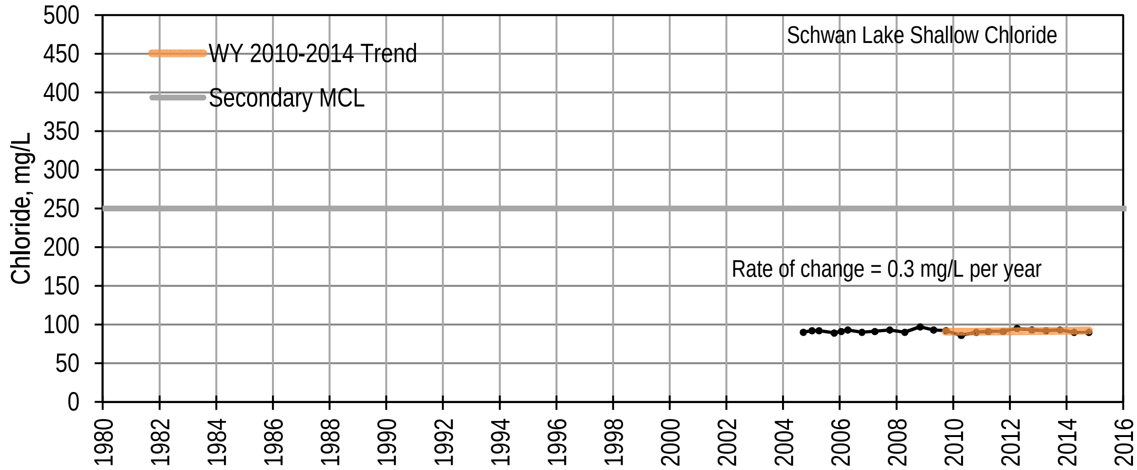

SC-22AA Total Dissolved Solids
Secondary MCL
TDS, mg/L
0
250
500
750
1,000
1,250
1,500
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016

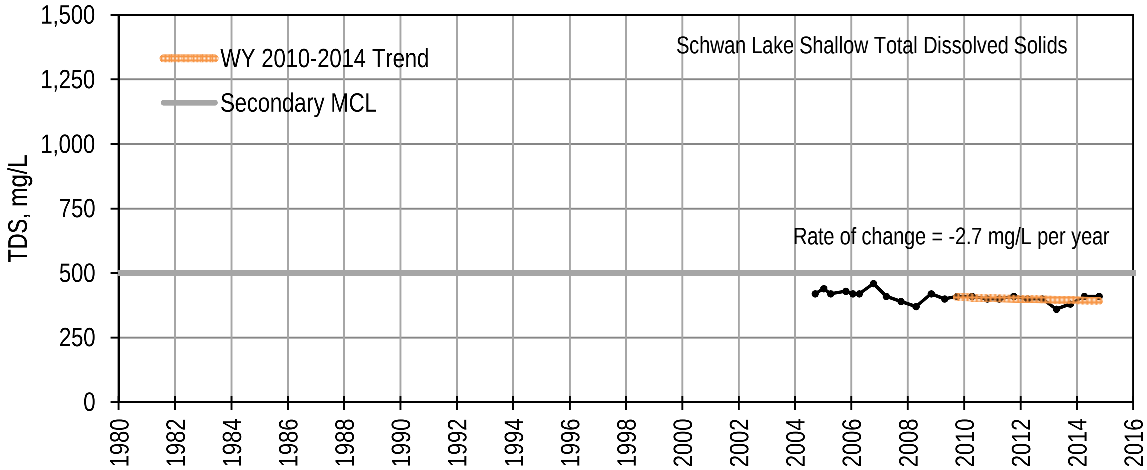

SC-22AA Groundwater Elevation
Rate of change = -0.8 feet per year
WY 2013-2014 Trend
Groundwater Elevation, ft MSL
0
10
20
30
40
50
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016

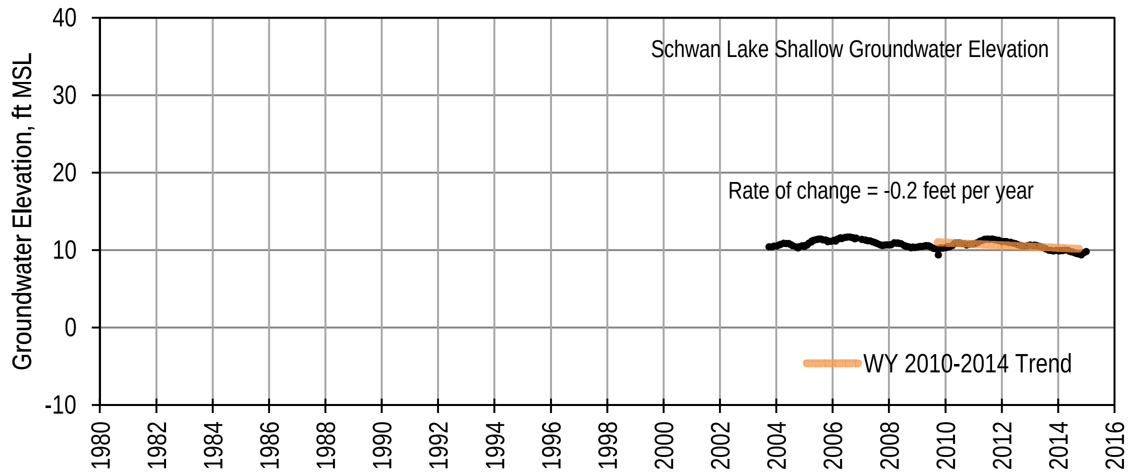

SC-22A Chloride
Secondary MCL
Chloride, mg/L

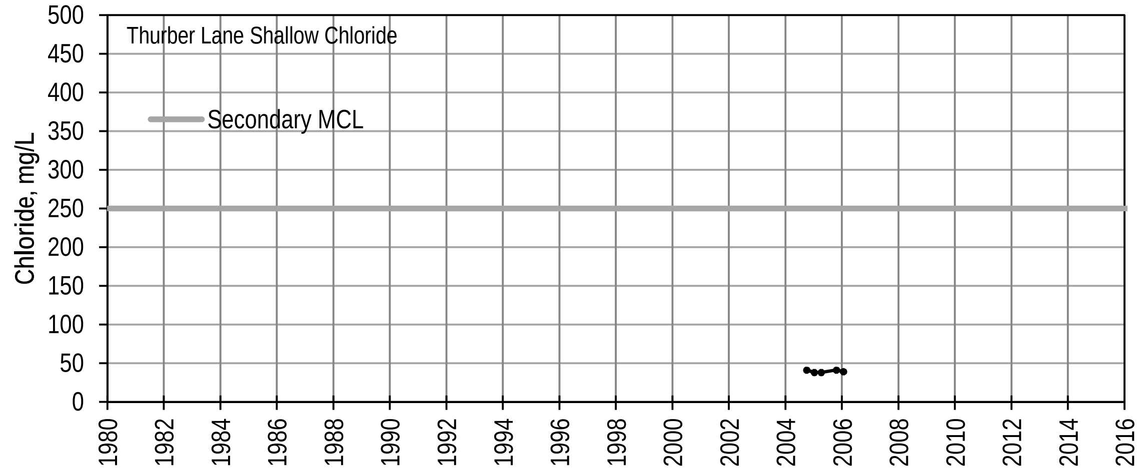

SC-22A Total Dissolved Solids
Secondary MCL
TDS, mg/L

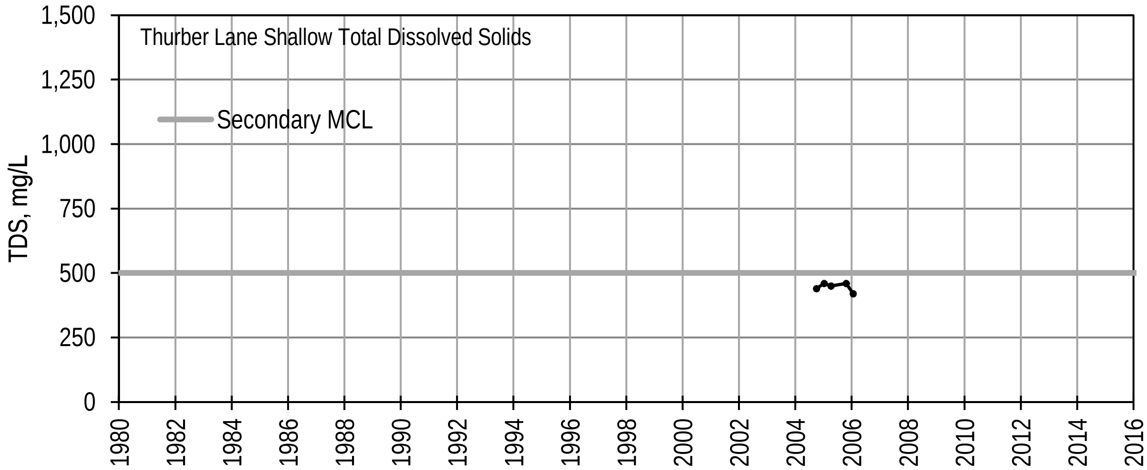

SC-22A Groundwater Elevation
Rate of change = -0.3 feet per year
WY 2013-2014 Trend
Groundwater Elevation, ft MSL

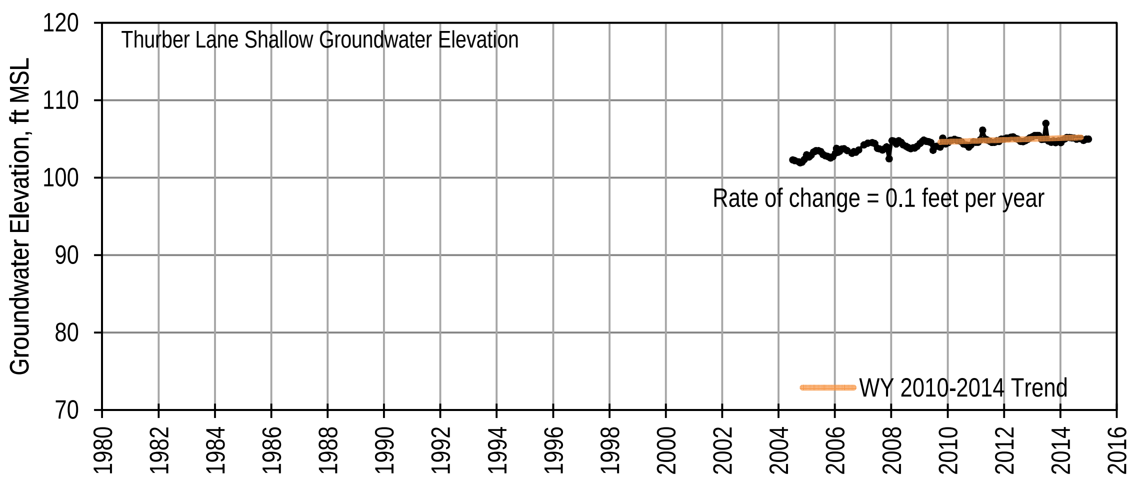

Schwan Lake Shallow Chloride
WY 2010-2014 Trend
Secondary MCL
Chloride, mg/L
Rate of change = 0.3 mg/L per year

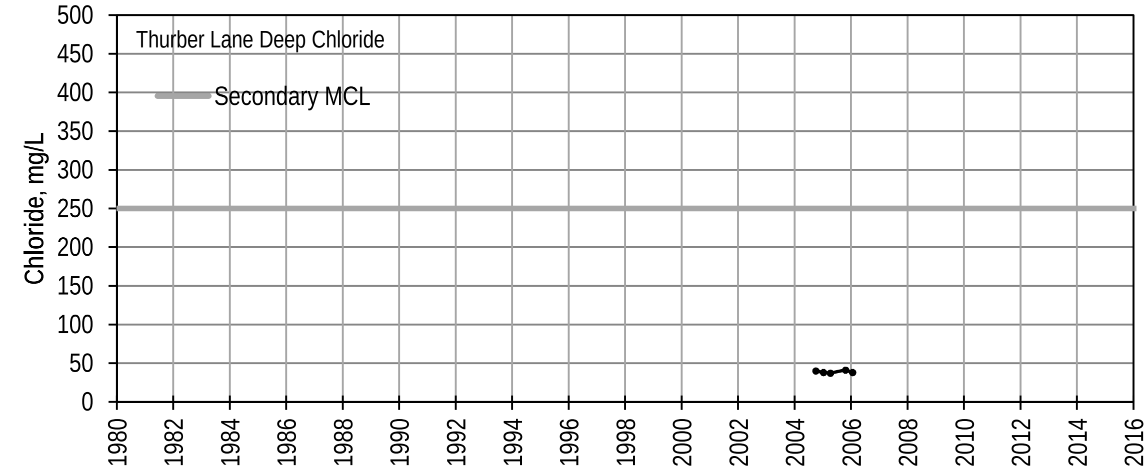

Schwan Lake Shallow Total Dissolved Solids
WY 2010-2014 Trend
Secondary MCL
TDS, mg/L
Rate of change = -2.7 mg/L per year

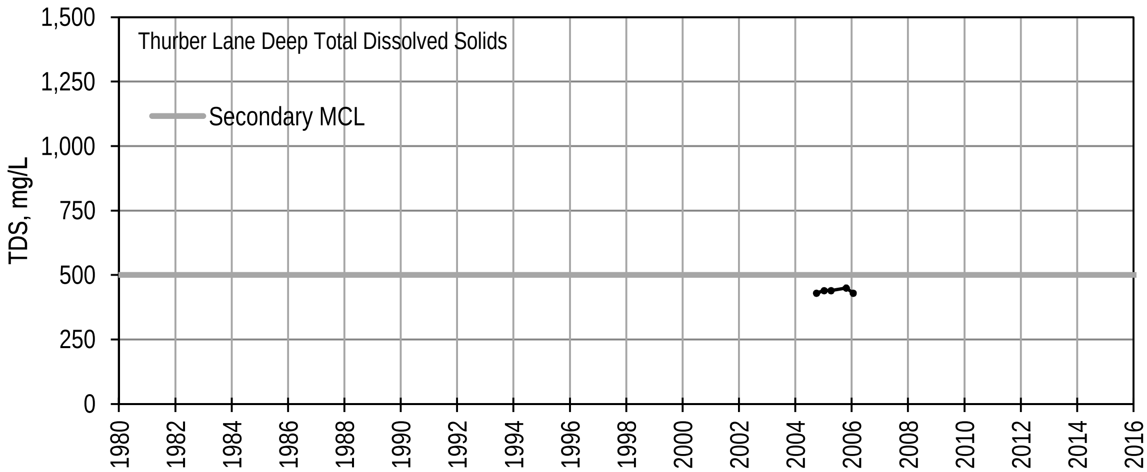

Schwan Lake Shallow Groundwater Elevation
Groundwater Elevation, ft MSL
Rate of change = -0.2 feet per year
WY 2010-2014 Trend

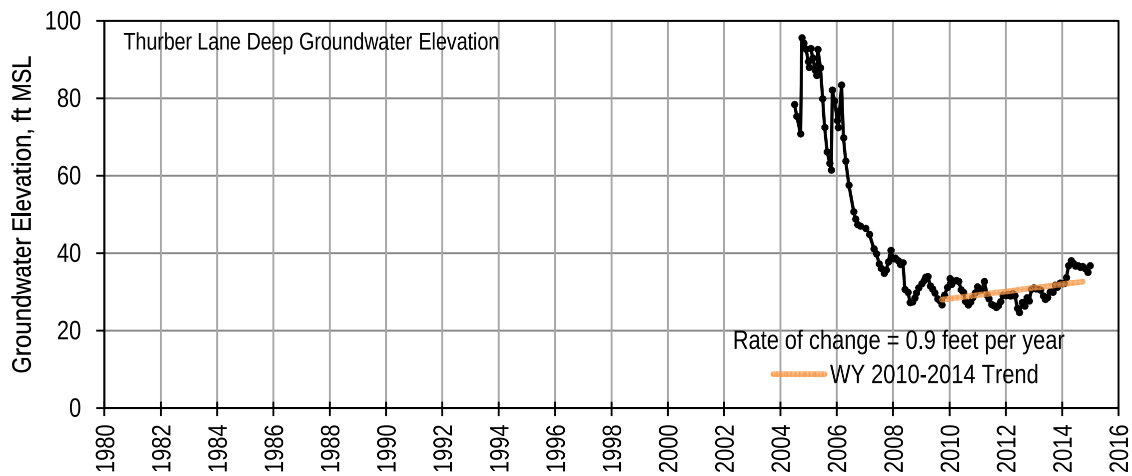

Thurber Lane Shallow Chloride
Secondary MCL
Chloride, mg/L
500
450
400
350
300
250
200
150
100
50
0
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016

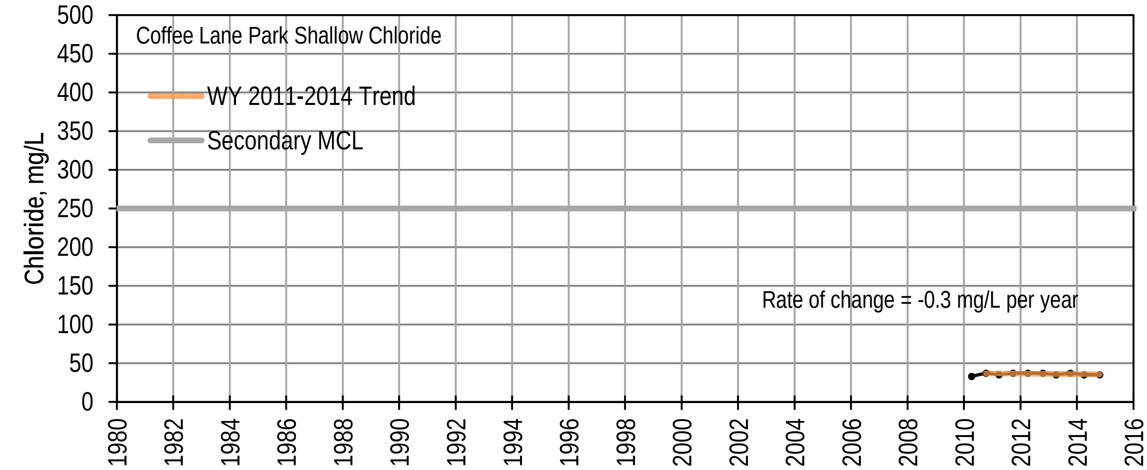

Thurber Lane Shallow Total Dissolved Solids
Secondary MCL
TDS, mg/L
1,500
1,250
1,000
750
500
250
0
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016

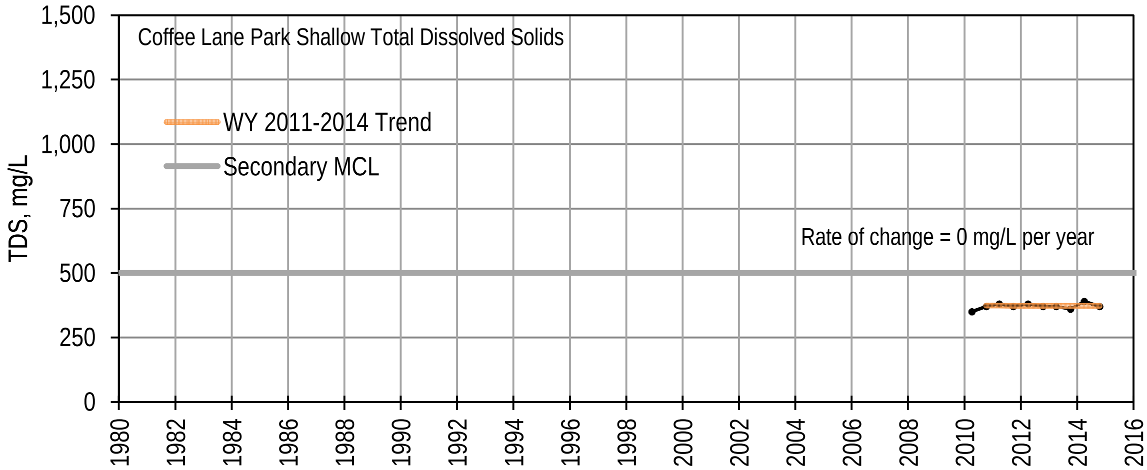

Thurber Lane Shallow Groundwater Elevation
Rate of change = 0.1 feet per year
WY 2010-2014 Trend
Groundwater Elevation, ft MSL
120
110
100
90
80
70
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016

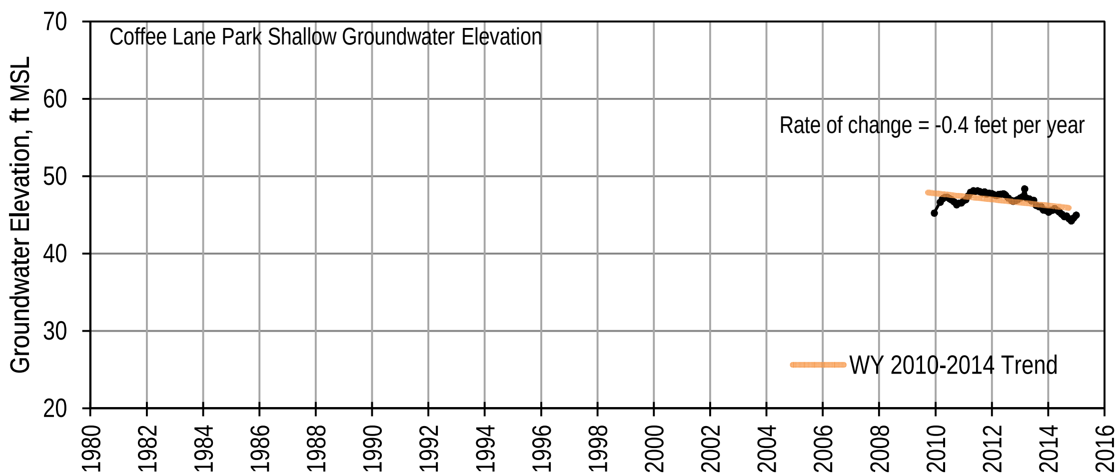

Thurber Lane Deep Chloride
Secondary MCL
Chloride, mg/L
500
450
400
350
300
250
200
150
100
50
0
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016

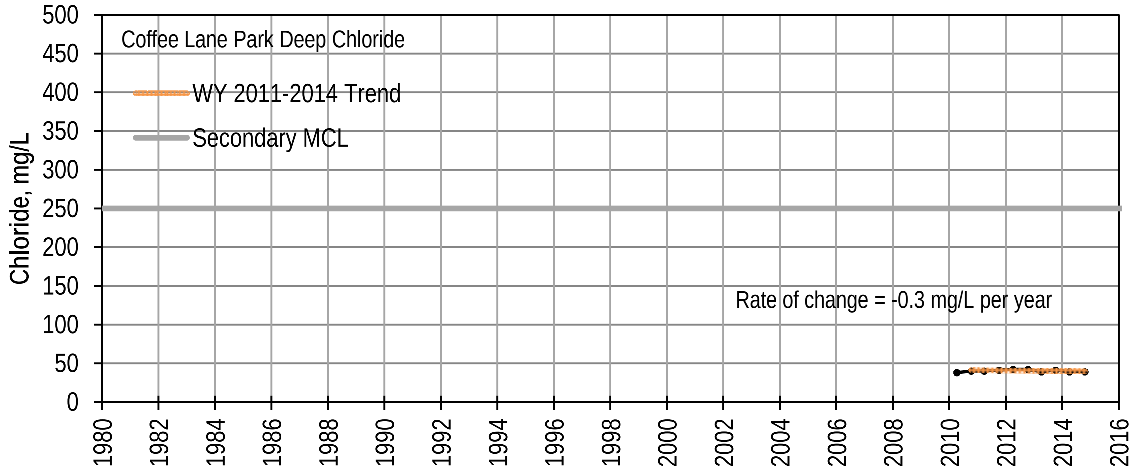

Thurber Lane Deep Total Dissolved Solids
Secondary MCL
TDS, mg/L
1,500
1,250
1,000
750
500
250
0
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016

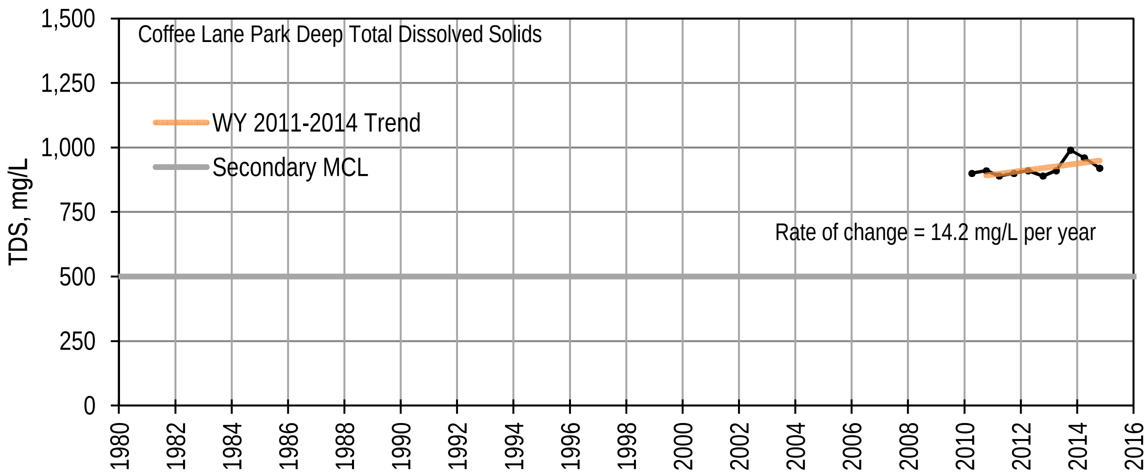

Thurber Lane Deep Groundwater Elevation
Groundwater Elevation, ft MSL
Rate of change = 0.9 feet per year
WY 2010-2014 Trend
100
80
60
40
20
0
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016

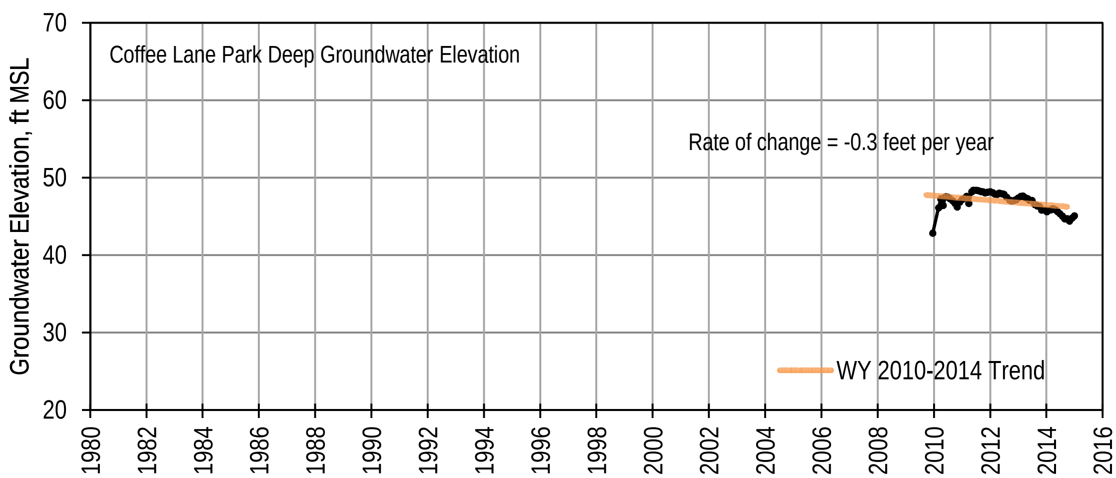

Coffee Lane Park Shallow Chloride
WY 2011-2014 Trend
Secondary MCL
Rate of change = -0.3 mg/L per year
Chloride, mg/L

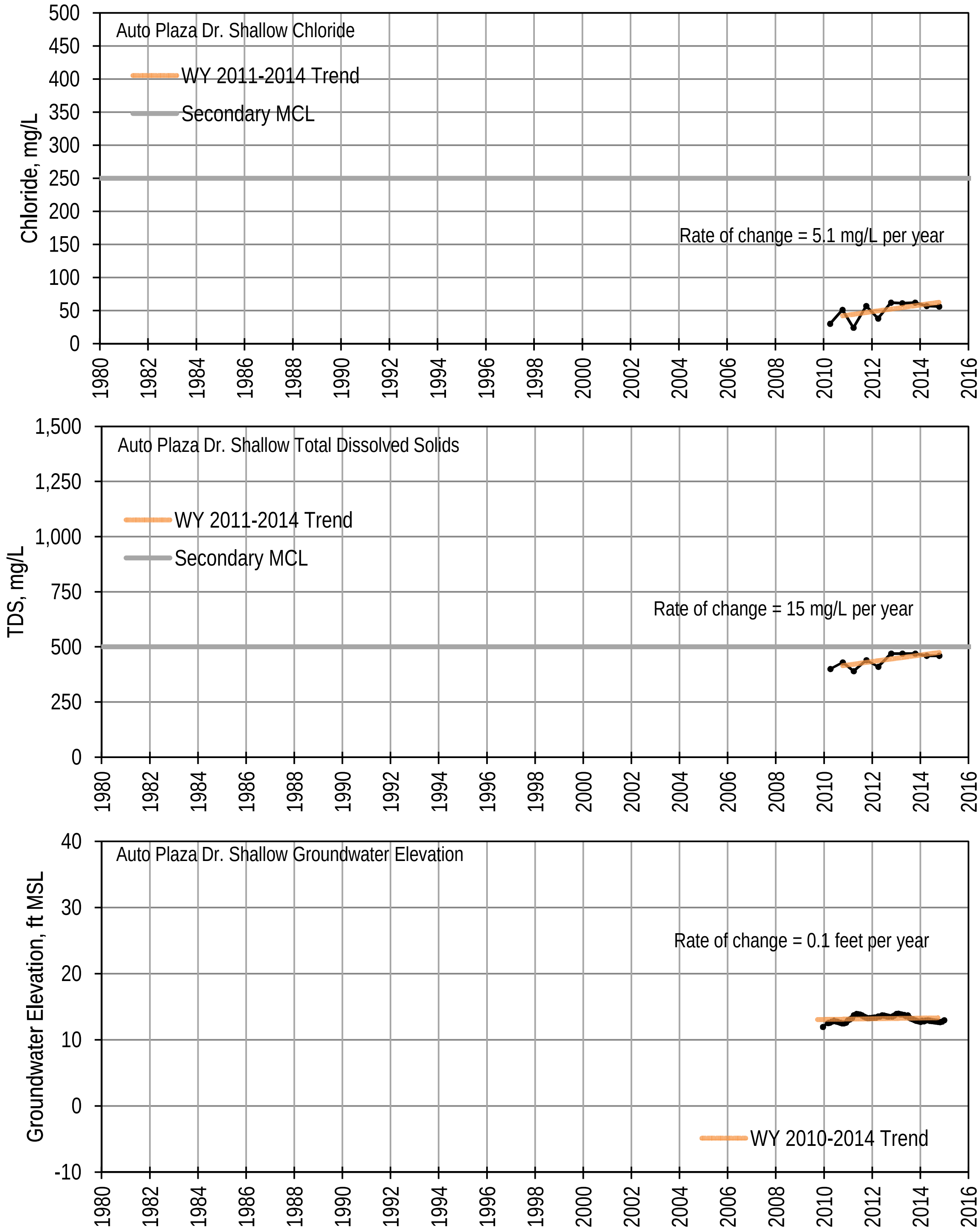

Coffee Lane Park Shallow Total Dissolved Solids
WY 2011-2014 Trend
Secondary MCL
Rate of change = 0 mg/L per year
TDS, mg/L

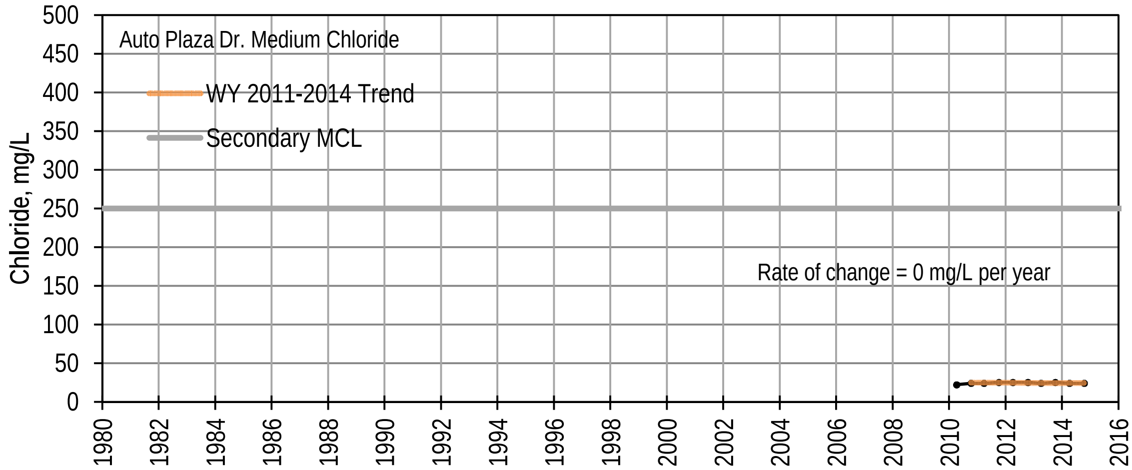

Coffee Lane Park Shallow Groundwater Elevation
Rate of change = -0.4 feet per year
WY 2010-2014 Trend
Groundwater Elevation, ft MSL

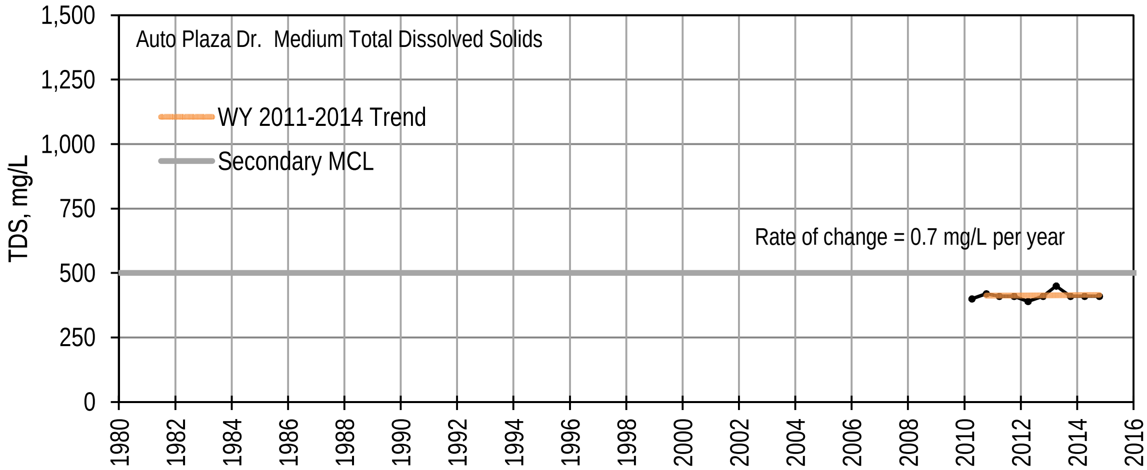

Coffee Lane Park Deep Chloride
WY 2011-2014 Trend
Secondary MCL
Rate of change = -0.3 mg/L per year
Chloride, mg/L

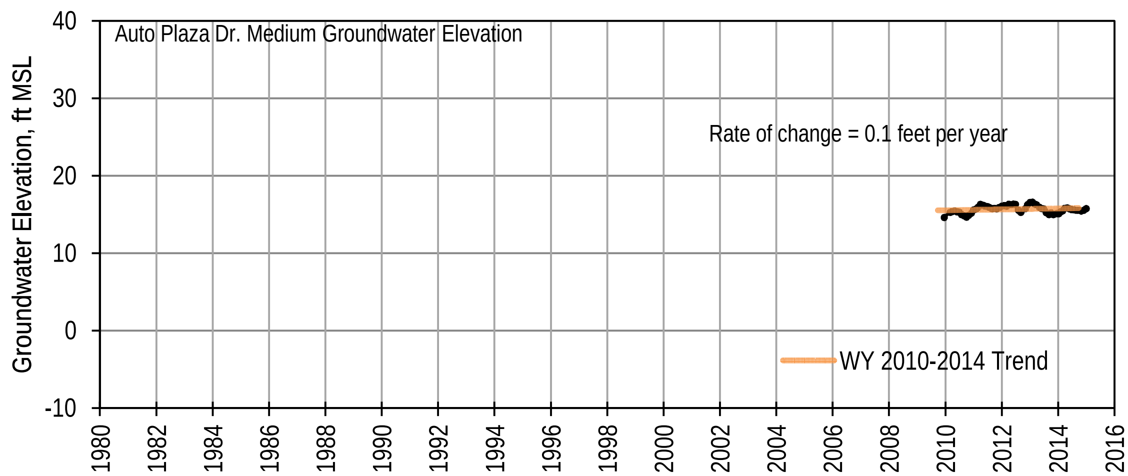

Coffee Lane Park Deep Total Dissolved Solids
WY 2011-2014 Trend
Secondary MCL
Rate of change = 14.2 mg/L per year
TDS, mg/L

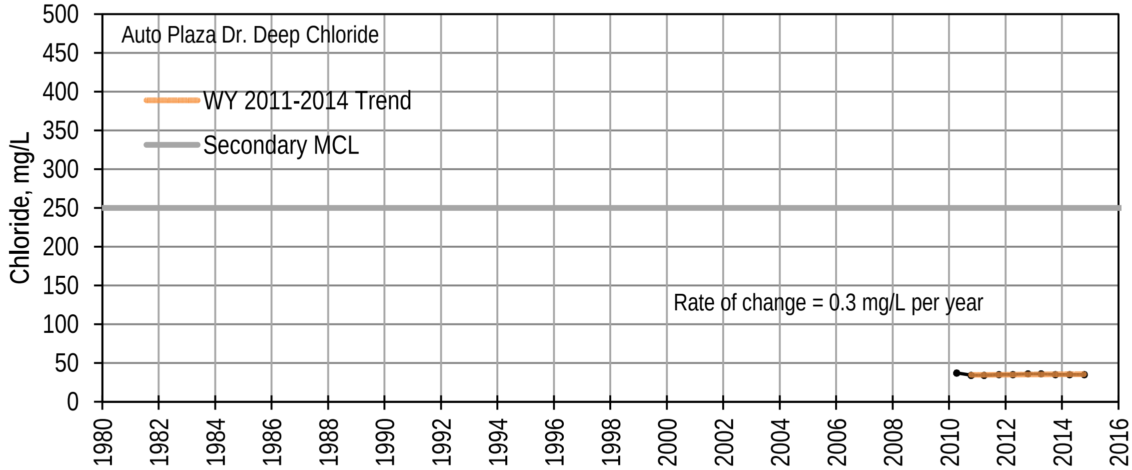

Coffee Lane Park Deep Groundwater Elevation
Rate of change = -0.3 feet per year
WY 2010-2014 Trend
Groundwater Elevation, ft MSL

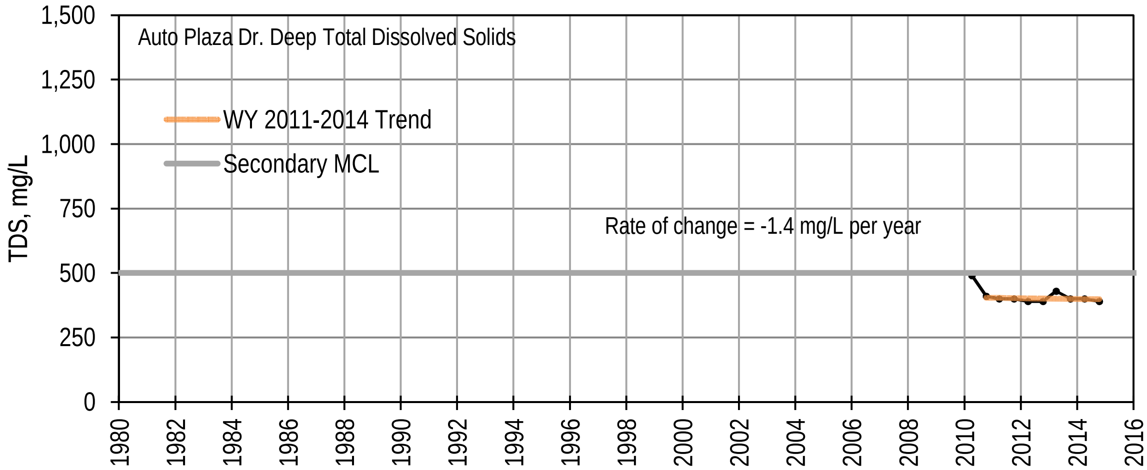

Auto Plaza Dr. Shallow Chloride
WY 2011-2014 Trend
Secondary MCL
Rate of change = 5.1 mg/L per year
Chloride, mg/L
500
450
400
350
300
250
200
150
100
50
0
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
Auto Plaza Dr. Shallow Total Dissolved Solids
WY 2011-2014 Trend
Secondary MCL
Rate of change = 15 mg/L per year
TDS, mg/L
1,500
1,250
1,000
750
500
250
0
Auto Plaza Dr. Shallow Groundwater Elevation
Rate of change = 0.1 feet per year
WY 2010-2014 Trend
Groundwater Elevation, ft MSL
40
30
20
10
0
-10

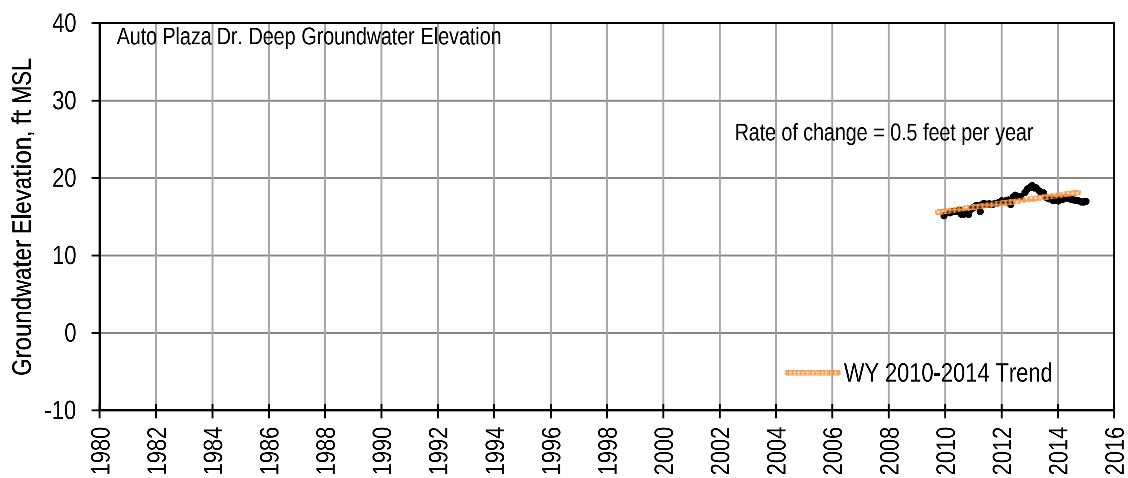

Auto Plaza Dr. Medium Chloride
WY 2011-2014 Trend
Secondary MCL
Rate of change = 0 mg/L per year
Chloride, mg/L

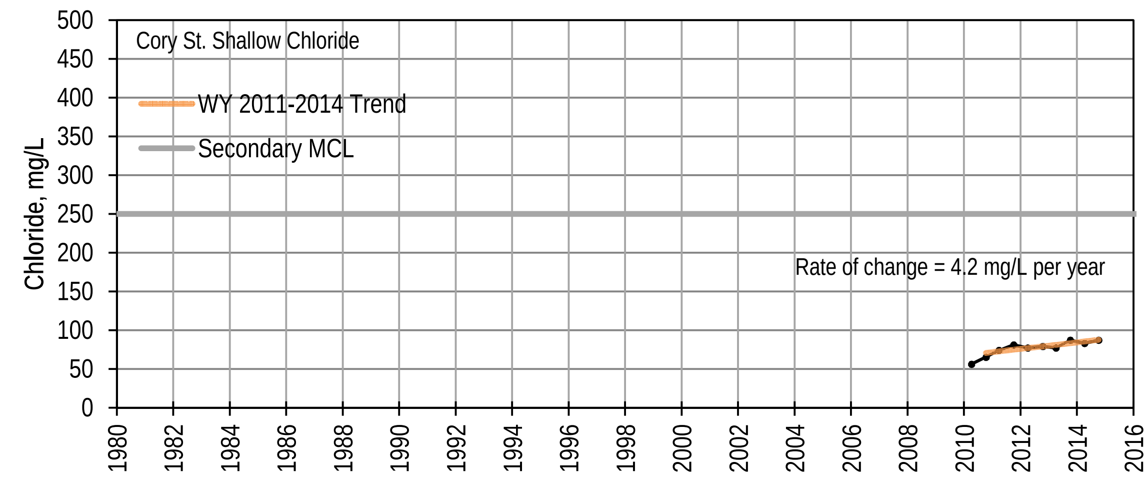

Auto Plaza Dr. Medium Total Dissolved Solids
WY 2011-2014 Trend
Secondary MCL
Rate of change = 0.7 mg/L per year
TDS, mg/L

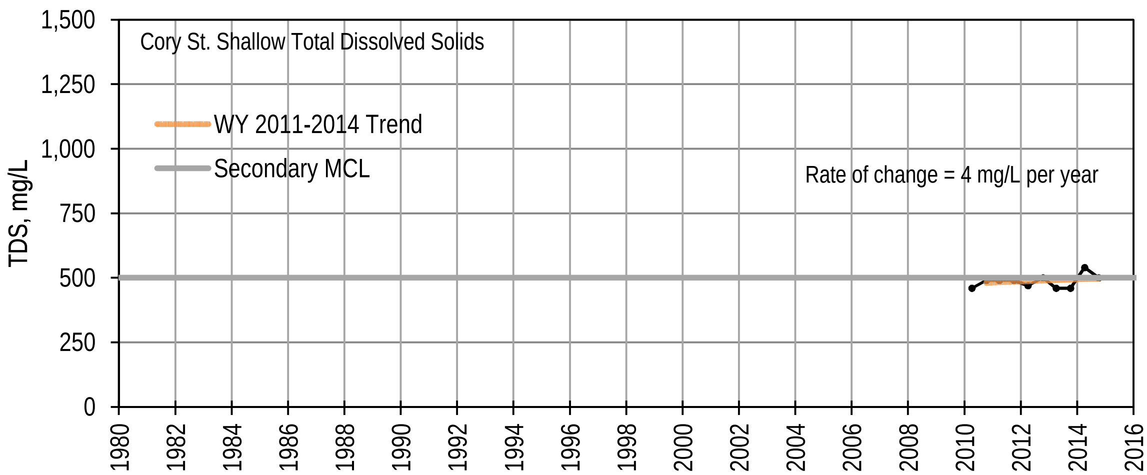

Auto Plaza Dr. Medium Groundwater Elevation
Rate of change = 0.1 feet per year
WY 2010-2014 Trend
Groundwater Elevation, ft MSL

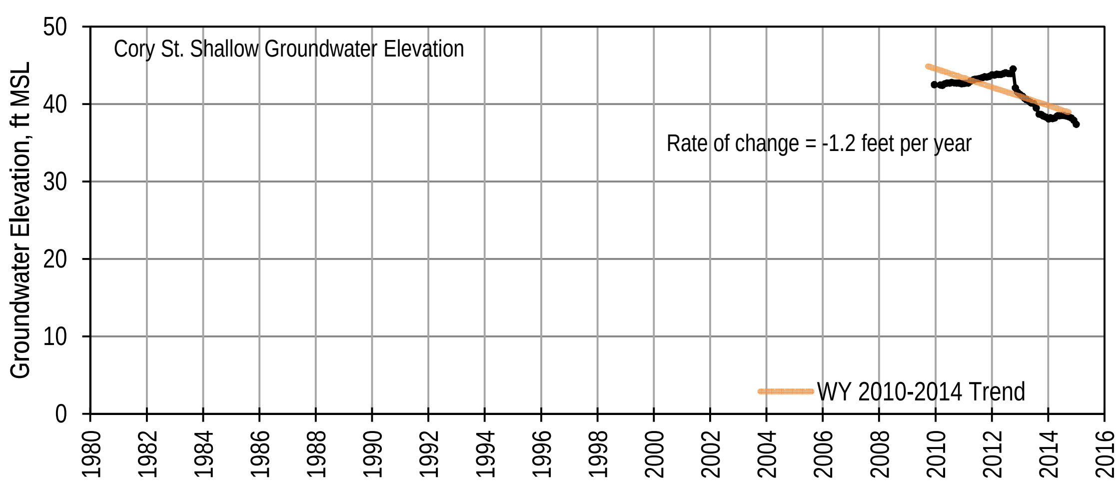

Auto Plaza Dr. Deep Chloride
WY 2011-2014 Trend
Secondary MCL
Rate of change = 0.3 mg/L per year
Chloride, mg/L
500
450
400
350
300
250
200
150
100
50
0
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016

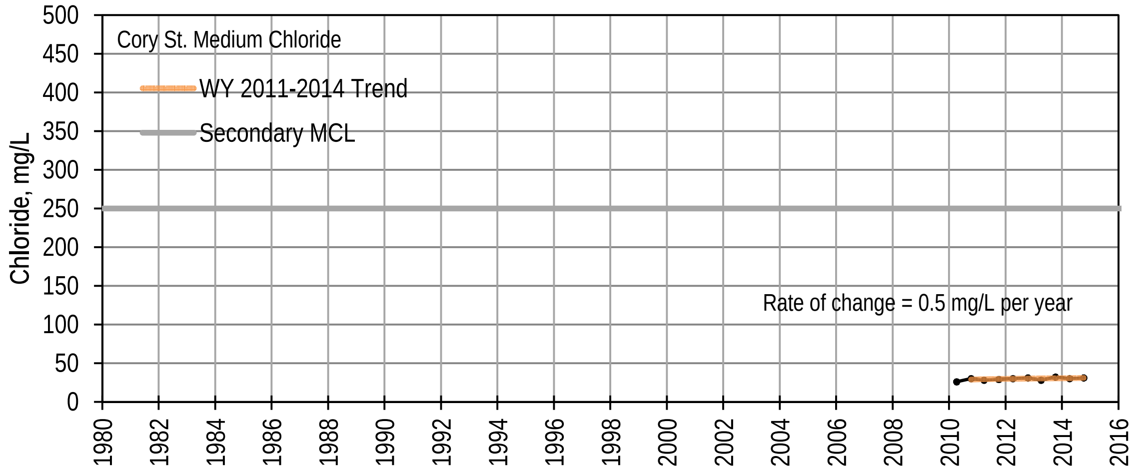

Auto Plaza Dr. Deep Total Dissolved Solids
WY 2011-2014 Trend
Secondary MCL
Rate of change = -1.4 mg/L per year
TDS, mg/L
1,500
1,250
1,000
750
500
250
0
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016

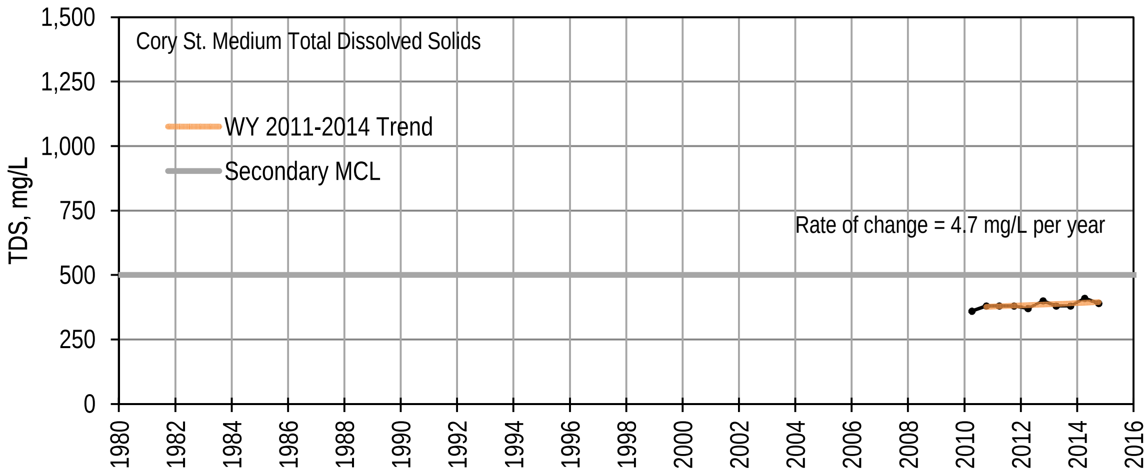

Auto Plaza Dr. Deep Groundwater Elevation
Rate of change = 0.5 feet per year
WY 2010-2014 Trend
Groundwater Elevation, ft MSL
40
30
20
10
0
-10
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016

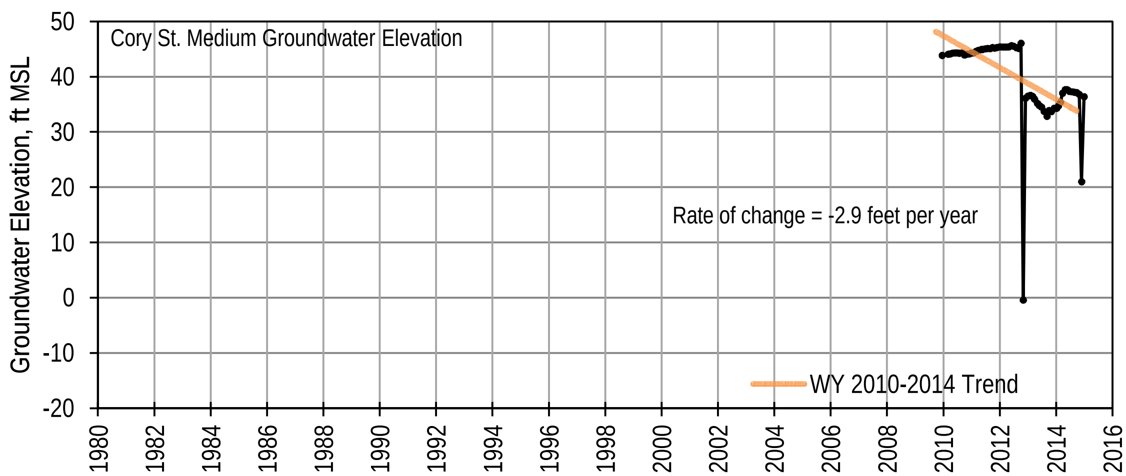

Cory St. Shallow Chloride
WY 2011-2014 Trend
Secondary MCL
Rate of change = 4.2 mg/L per year
Chloride, mg/L

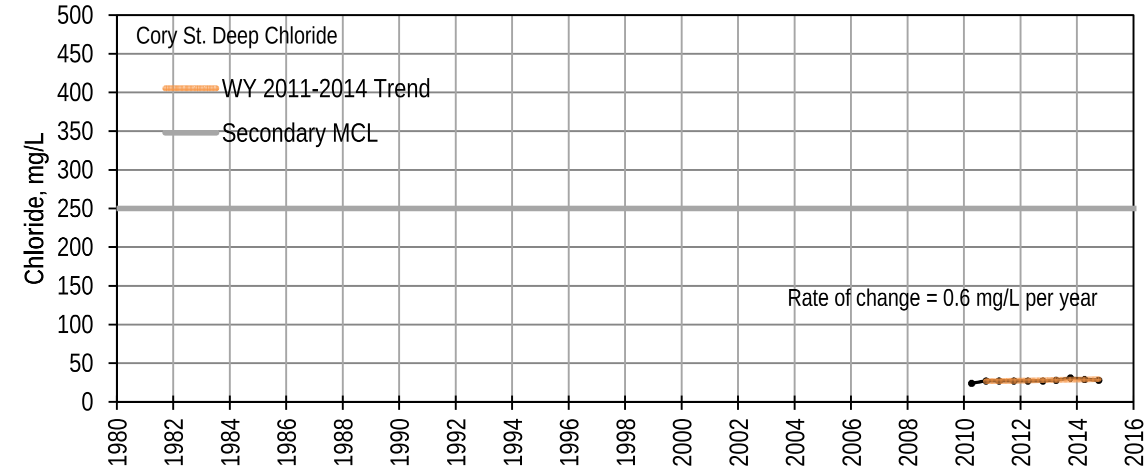

Cory St. Shallow Total Dissolved Solids
WY 2011-2014 Trend
Secondary MCL
Rate of change = 4 mg/L per year
TDS, mg/L

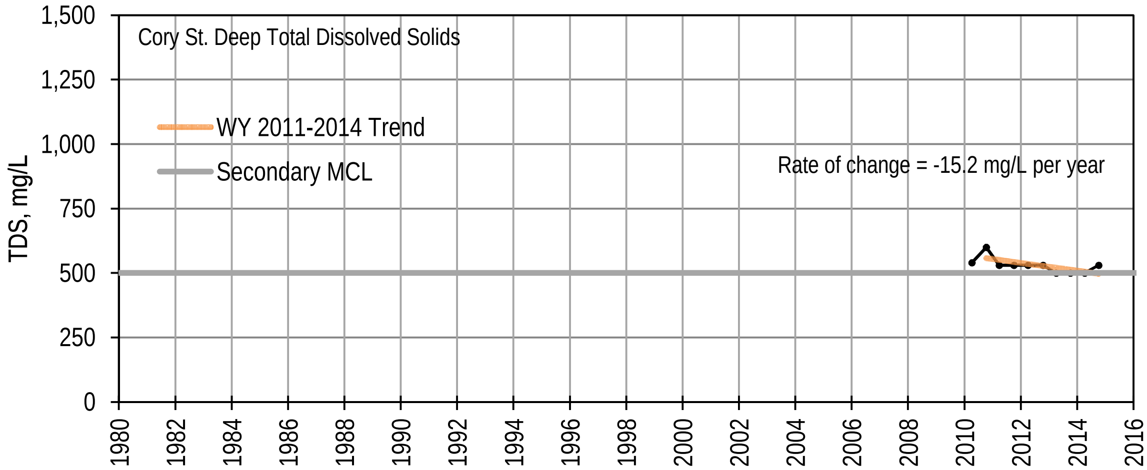

Cory St. Shallow Groundwater Elevation
Rate of change = -1.2 feet per year
WY 2010-2014 Trend
Groundwater Elevation, ft MSL

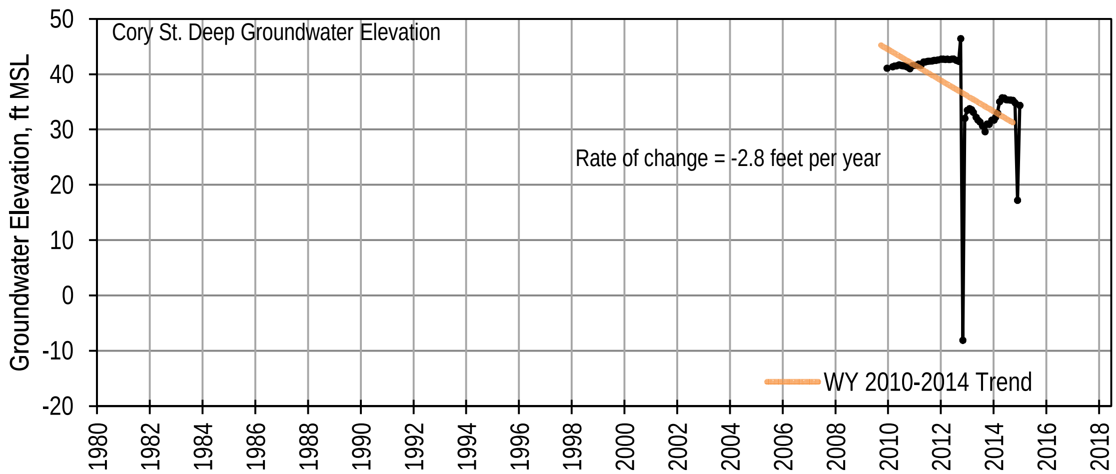

Cory St. Medium Chloride
WY 2011-2014 Trend
Secondary MCL
Rate of change = 0.5 mg/L per year
Chloride, mg/L
500
450
400
350
300
250
200
150
100
50
0
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016

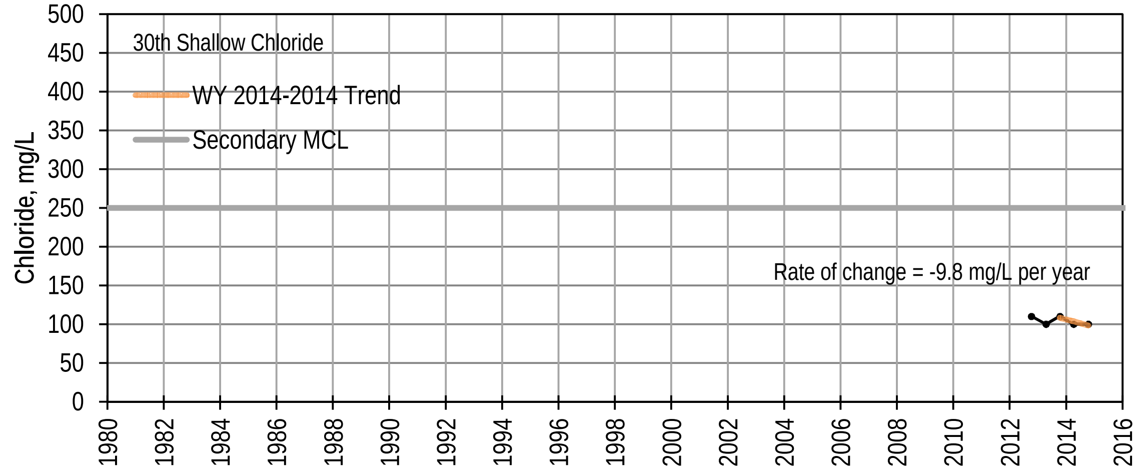

Cory St. Medium Total Dissolved Solids
WY 2011-2014 Trend
Secondary MCL
Rate of change = 4.7 mg/L per year
TDS, mg/L
1,500
1,250
1,000
750
500
250
0
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016

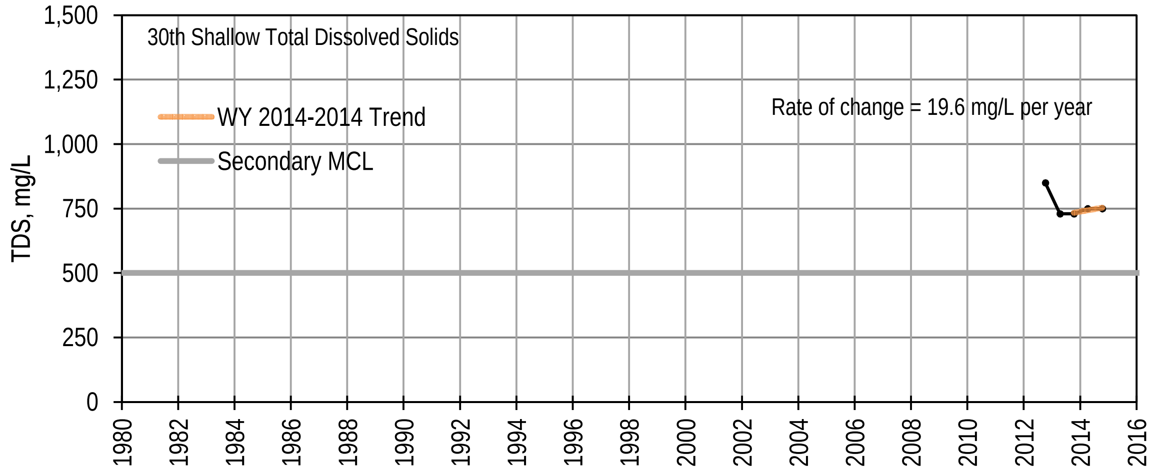

Cory St. Medium Groundwater Elevation
Rate of change = -2.9 feet per year
WY 2010-2014 Trend
Groundwater Elevation, ft MSL
50
40
30
20
10
0
-10
-20
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016

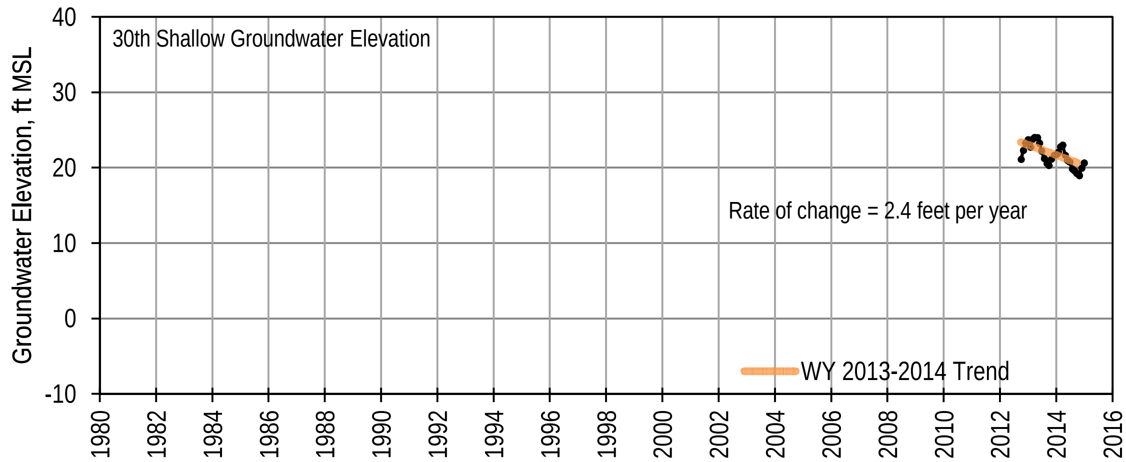

Cory St. Deep Chloride
WY 2011-2014 Trend
Secondary MCL
Rate of change = 0.6 mg/L per year
Chloride, mg/L

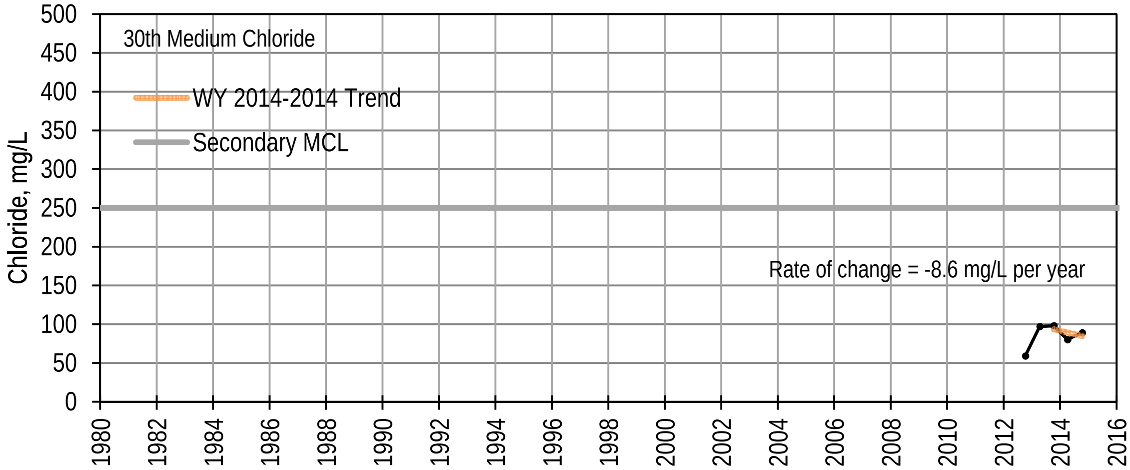

Cory St. Deep Total Dissolved Solids
WY 2011-2014 Trend
Secondary MCL
Rate of change = -15.2 mg/L per year
TDS, mg/L

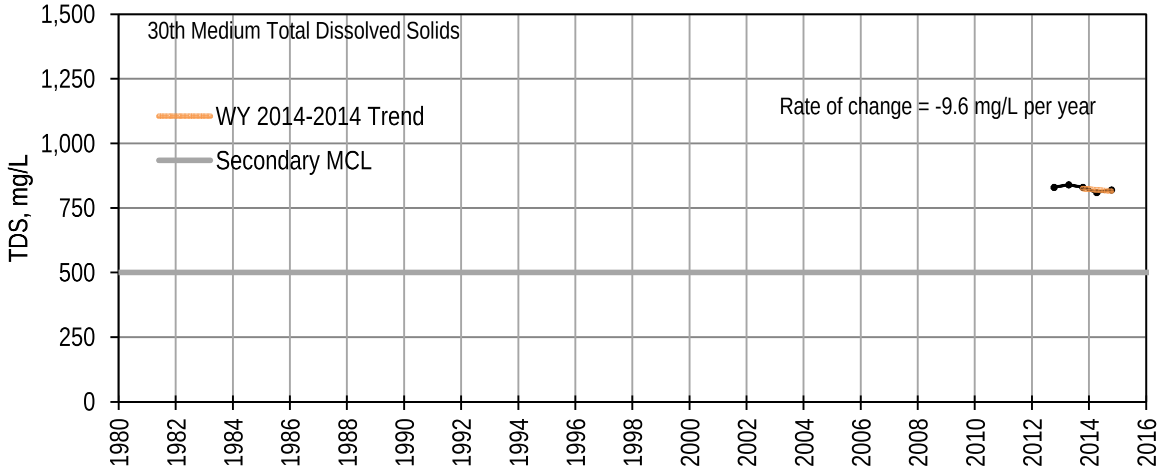

Cory St. Deep Groundwater Elevation
Rate of change = -2.8 feet per year
WY 2010-2014 Trend
Groundwater Elevation, ft MSL

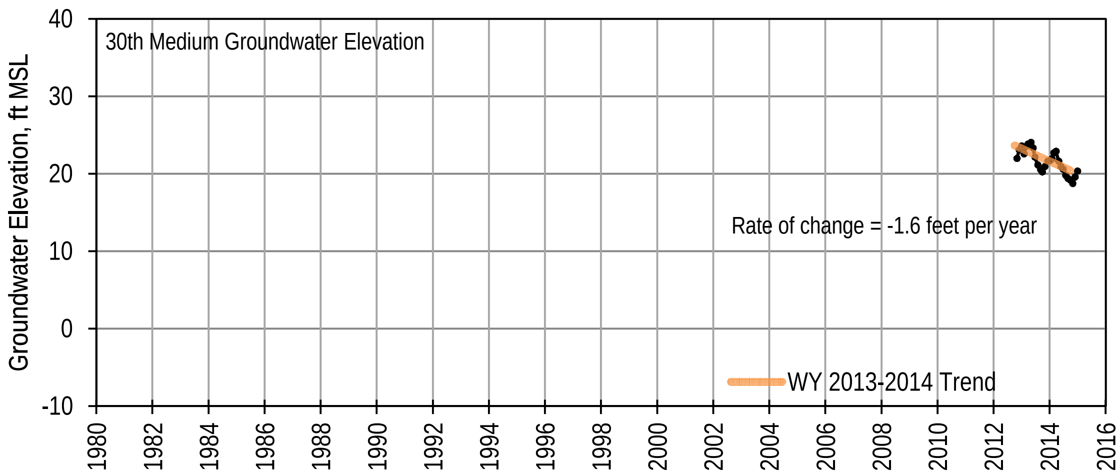

30th Shallow Chloride
WY 2014-2014 Trend
Secondary MCL
Chloride, mg/L
Rate of change = -9.8 mg/L per year
0
50
100
150
200
250
300
350
400
450
500
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016

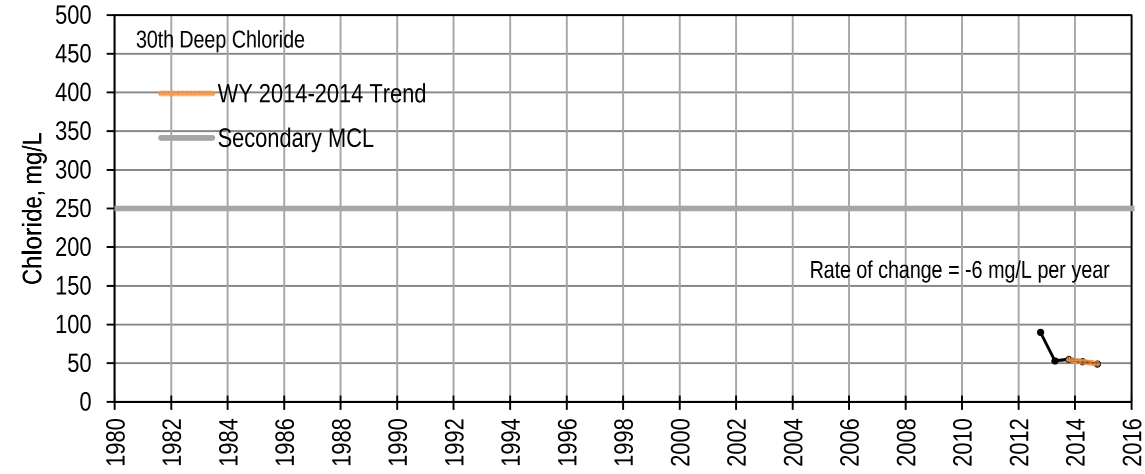

30th Shallow Total Dissolved Solids
WY 2014-2014 Trend
Secondary MCL
Rate of change = 19.6 mg/L per year
TDS, mg/L
0
250
500
750
1,000
1,250
1,500
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016


30th Shallow Groundwater Elevation
Groundwater Elevation, ft MSL
Rate of change = 2.4 feet per year
WY 2013-2014 Trend
-10
0
10
20
30
40
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016

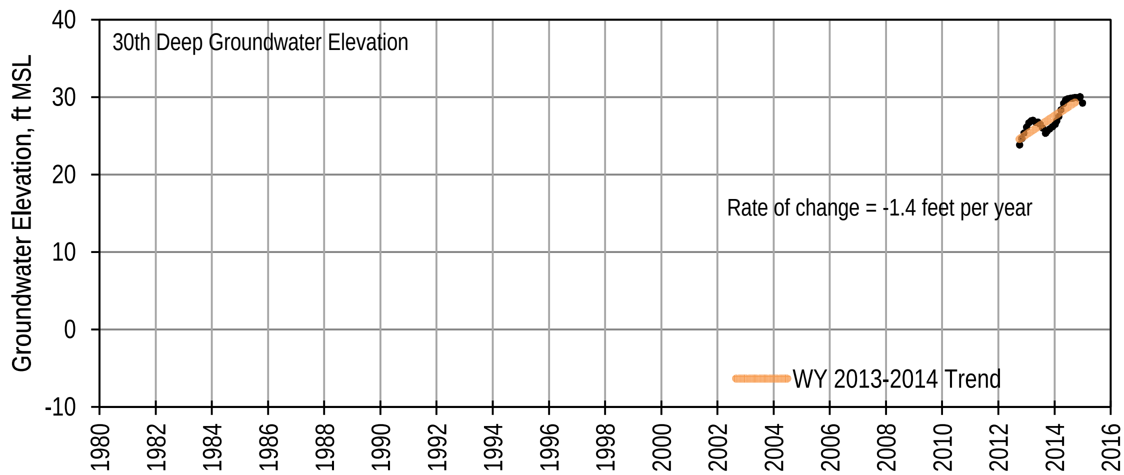

30th Medium Chloride
WY 2014-2014 Trend
Secondary MCL
Rate of change = -8.6 mg/L per year
Chloride, mg/L
500
450
400
350
300
250
200
150
100
50
0
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016

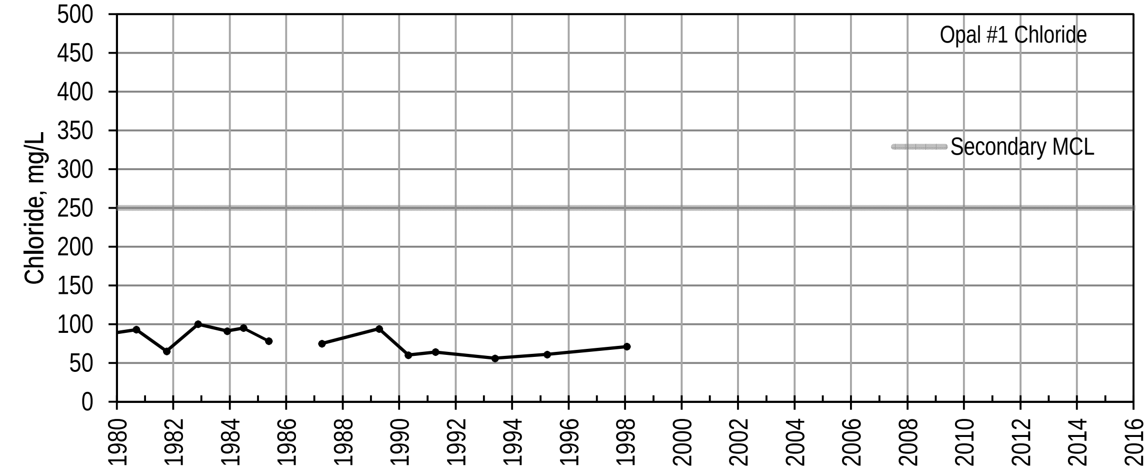

30th Medium Total Dissolved Solids
WY 2014-2014 Trend
Secondary MCL
Rate of change = -9.6 mg/L per year
TDS, mg/L
1,500
1,250
1,000
750
500
250
0
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016

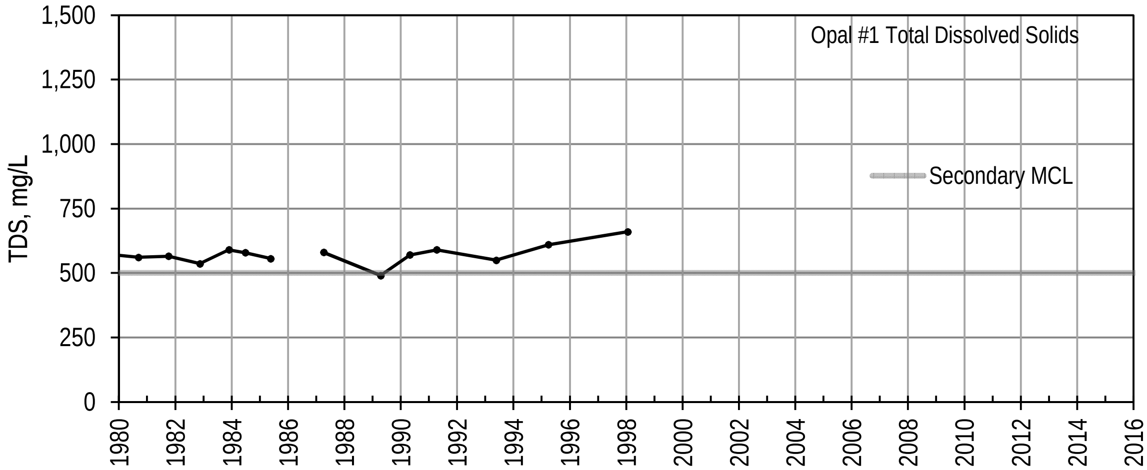

30th Medium Groundwater Elevation
Rate of change = -1.6 feet per year
WY 2013-2014 Trend
Groundwater Elevation, ft MSL
40
30
20
10
0
-10
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016

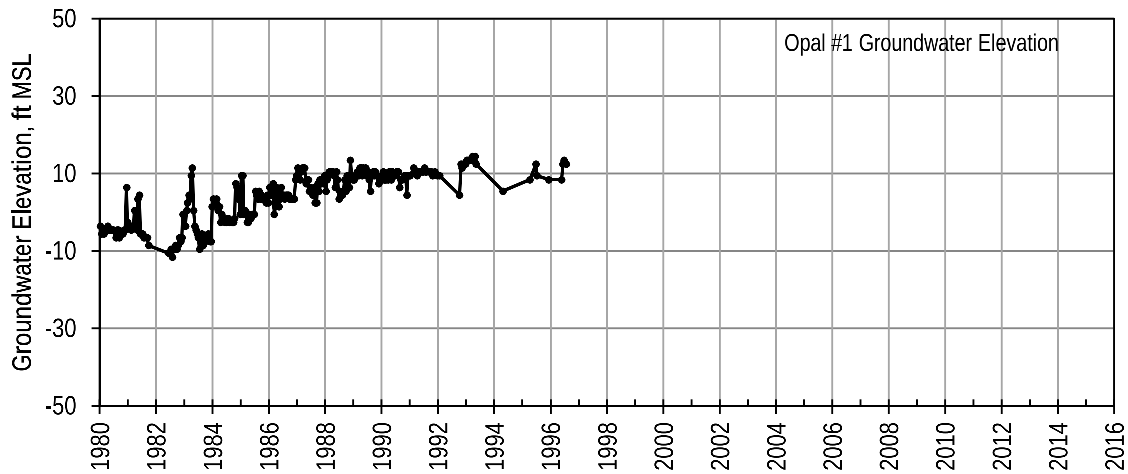

30th Deep Chloride
WY 2014-2014 Trend
Secondary MCL
Rate of change = -6 mg/L per year
Chloride, mg/L
500
450
400
350
300
250
200
150
100
50
0
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016

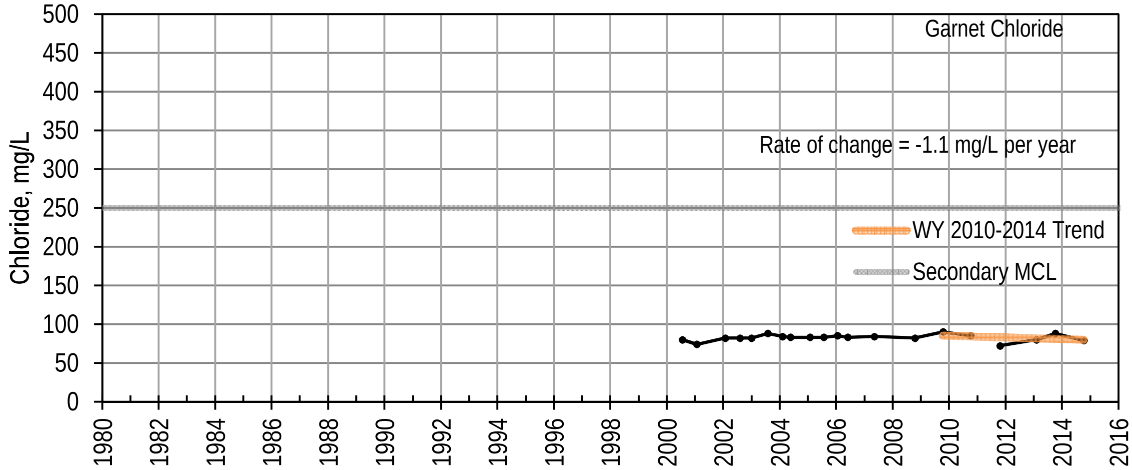

30th Deep Total Dissolved Solids
WY 2014-2014 Trend
Secondary MCL
Rate of change = -0.2 mg/L per year
TDS, mg/L
1,500
1,250
1,000
750
500
250
0
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016

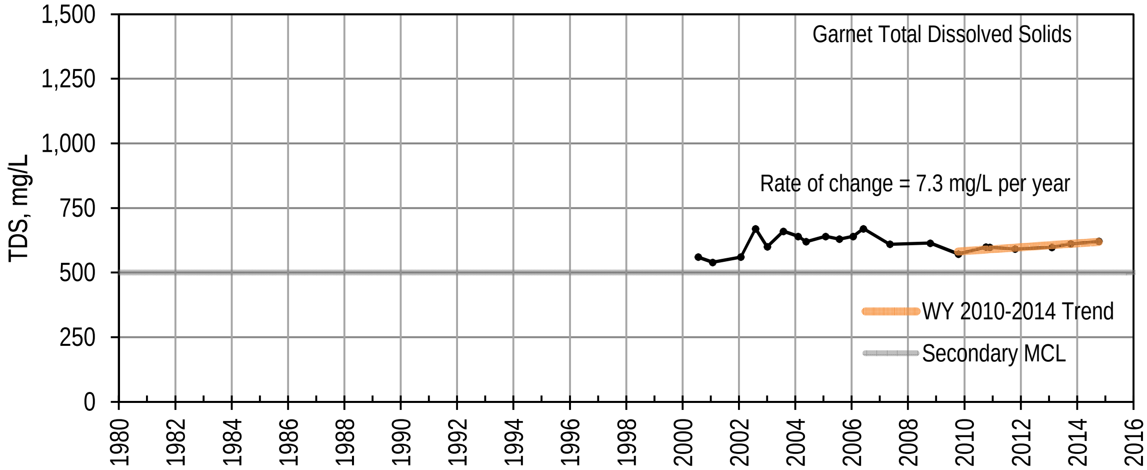

30th Deep Groundwater Elevation
Rate of change = -1.4 feet per year
WY 2013-2014 Trend
Groundwater Elevation, ft MSL
40
30
20
10
0
-10
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016

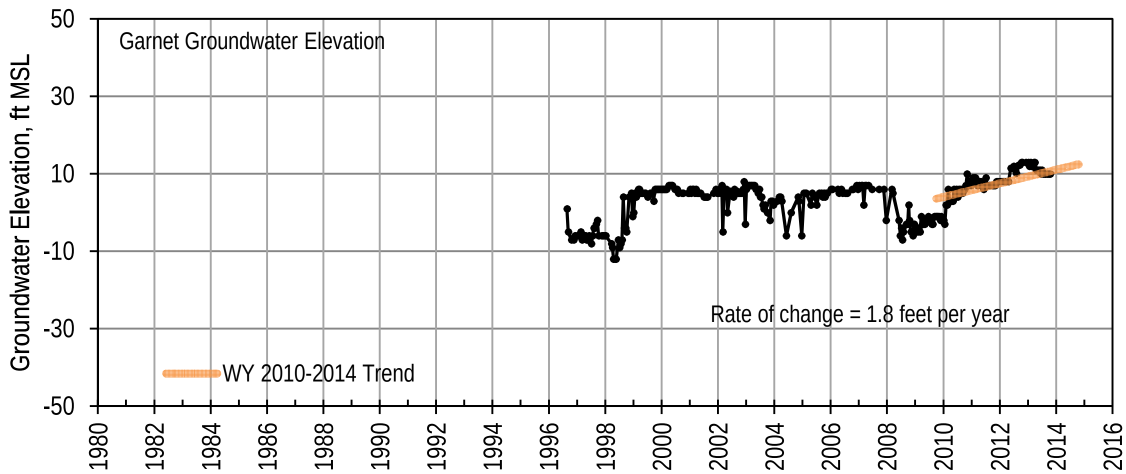

Opal #1 Chloride
Secondary MCL
Chloride, mg/L
500
450
400
350
300
250
200
150
100
50
0
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016


Opal #1 Total Dissolved Solids
Secondary MCL
TDS, mg/L
1,500
1,250
1,000
750
500
250
0
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016

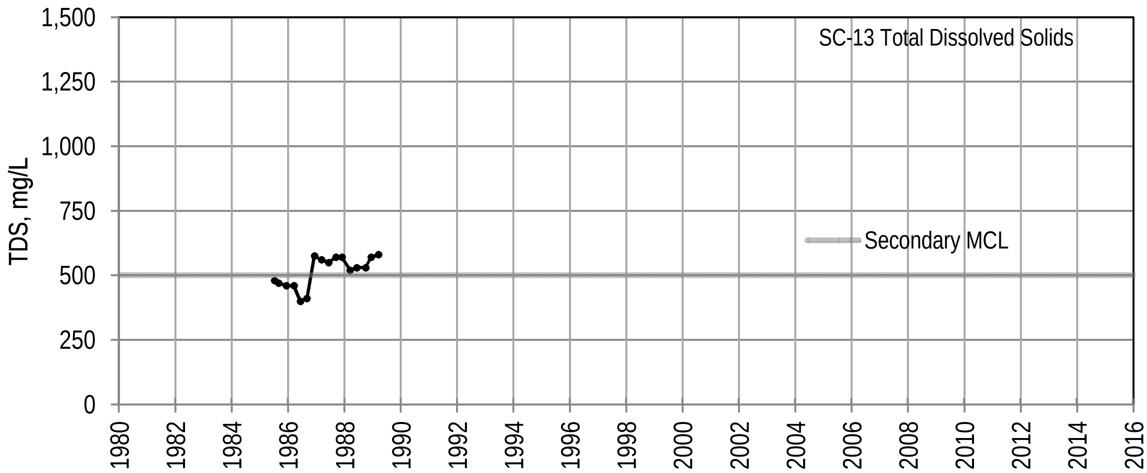

Opal #1 Groundwater Elevation
Groundwater Elevation, ft MSL
50
30
10
-10
-30
-50
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016

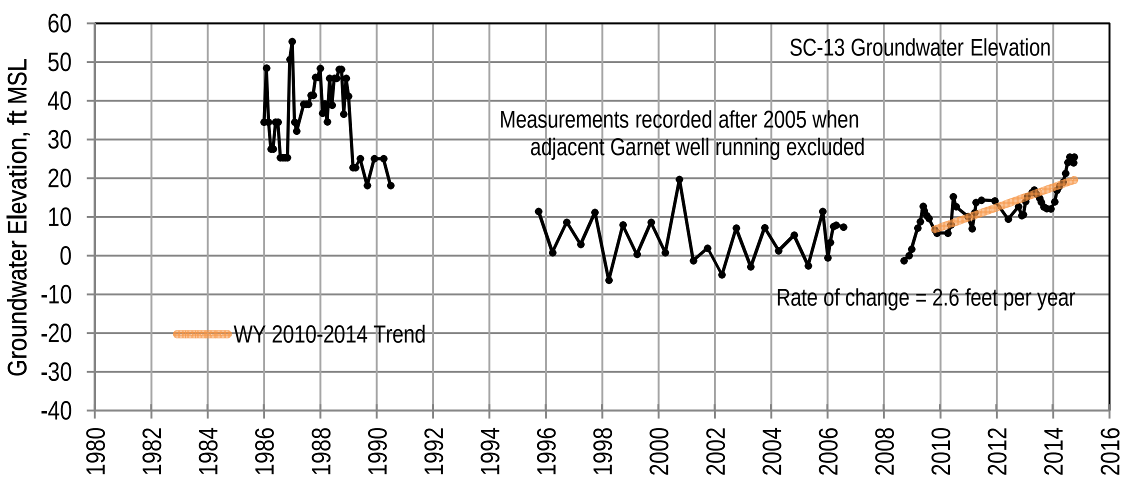

Garnet Chloride
Rate of change = -1.1 mg/L per year
WY 2010-2014 Trend
Secondary MCL
Chloride, mg/L
500
450
400
350
300
250
200
150
100
50
0
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016

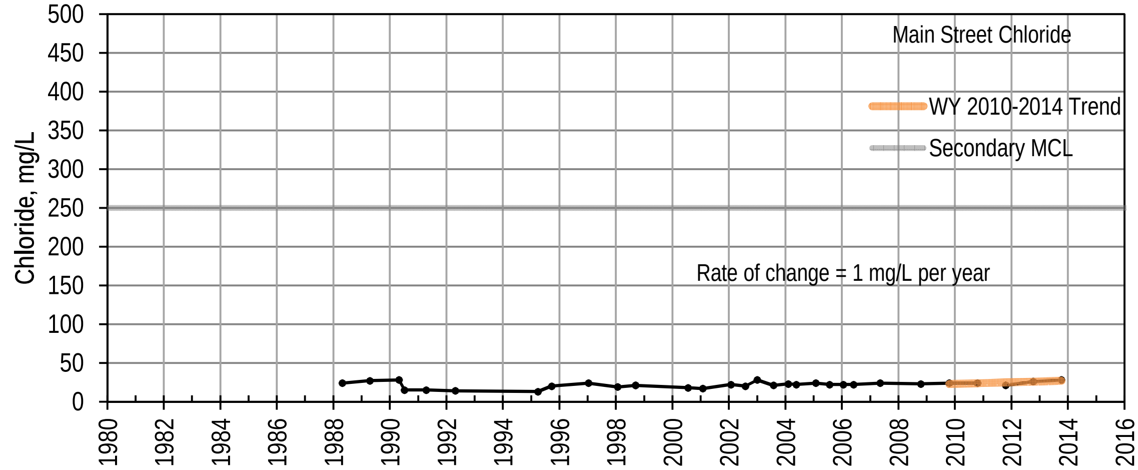

Garnet Total Dissolved Solids
Rate of change = 7.3 mg/L per year
WY 2010-2014 Trend
Secondary MCL
TDS, mg/L
1,500
1,250
1,000
750
500
250
0
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016

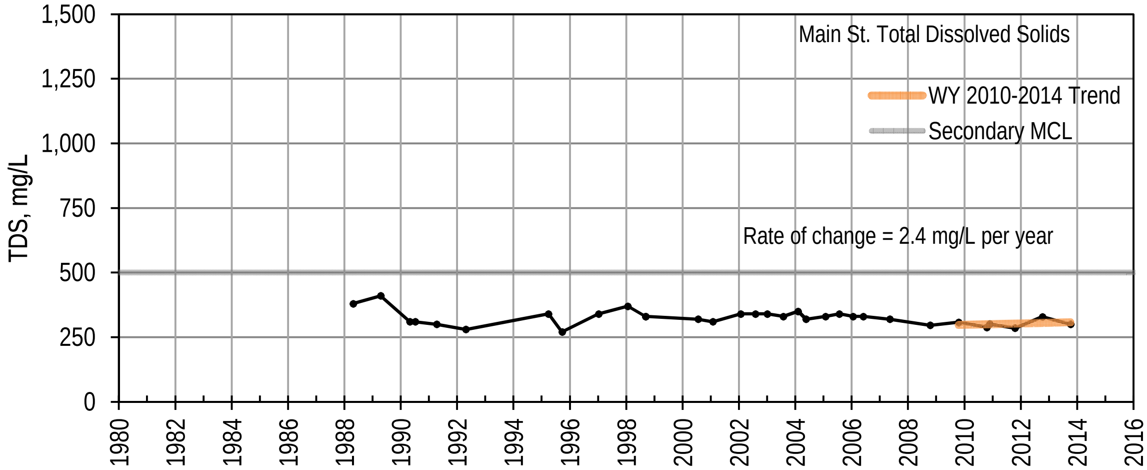

Garnet Groundwater Elevation
Rate of change = 1.8 feet per year
WY 2010-2014 Trend
Groundwater Elevation, ft MSL
50
30
10
-10
-30
-50
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016

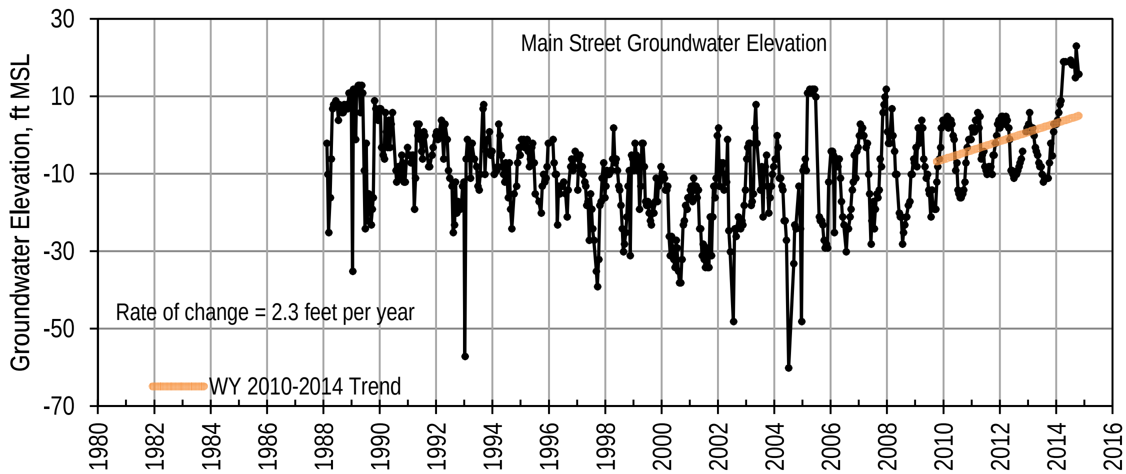

SC-13 Chloride
Secondary MCL
Chloride, mg/L
500
450
400
350
300
250
200
150
100
50
0
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016

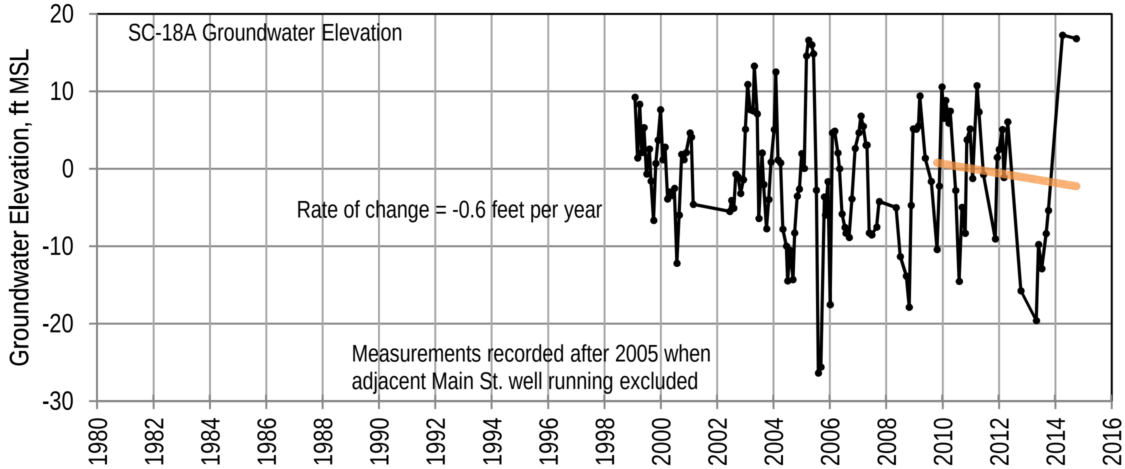

SC-13 Total Dissolved Solids
Secondary MCL
TDS, mg/L
1,500
1,250
1,000
750
500
250
0
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016

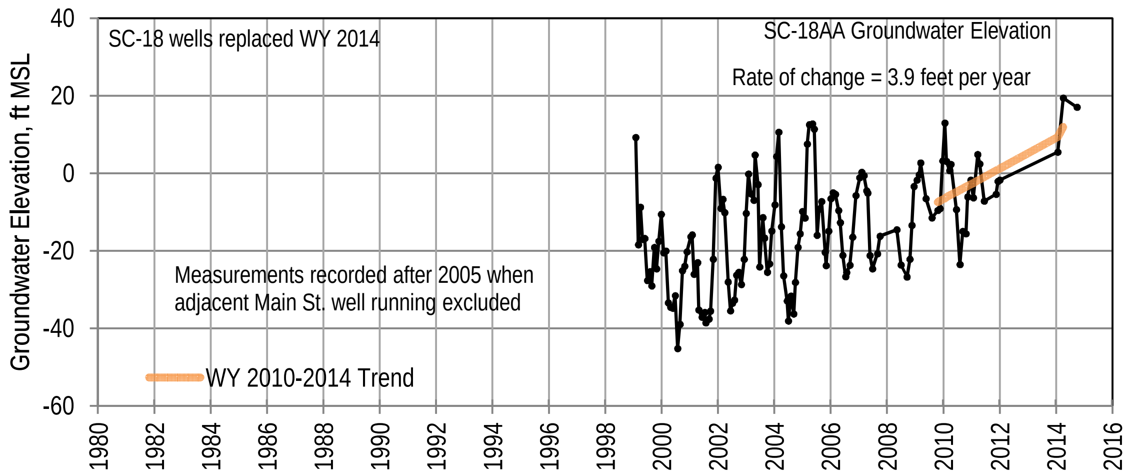

SC-13 Groundwater Elevation
Measurements recorded after 2005 when
adjacent Garnet well running excluded
Rate of change = 2.6 feet per year
WY 2010-2014 Trend
Groundwater Elevation, ft MSL
60
50
40
30
20
10
0
-10
-20
-30
-40
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016

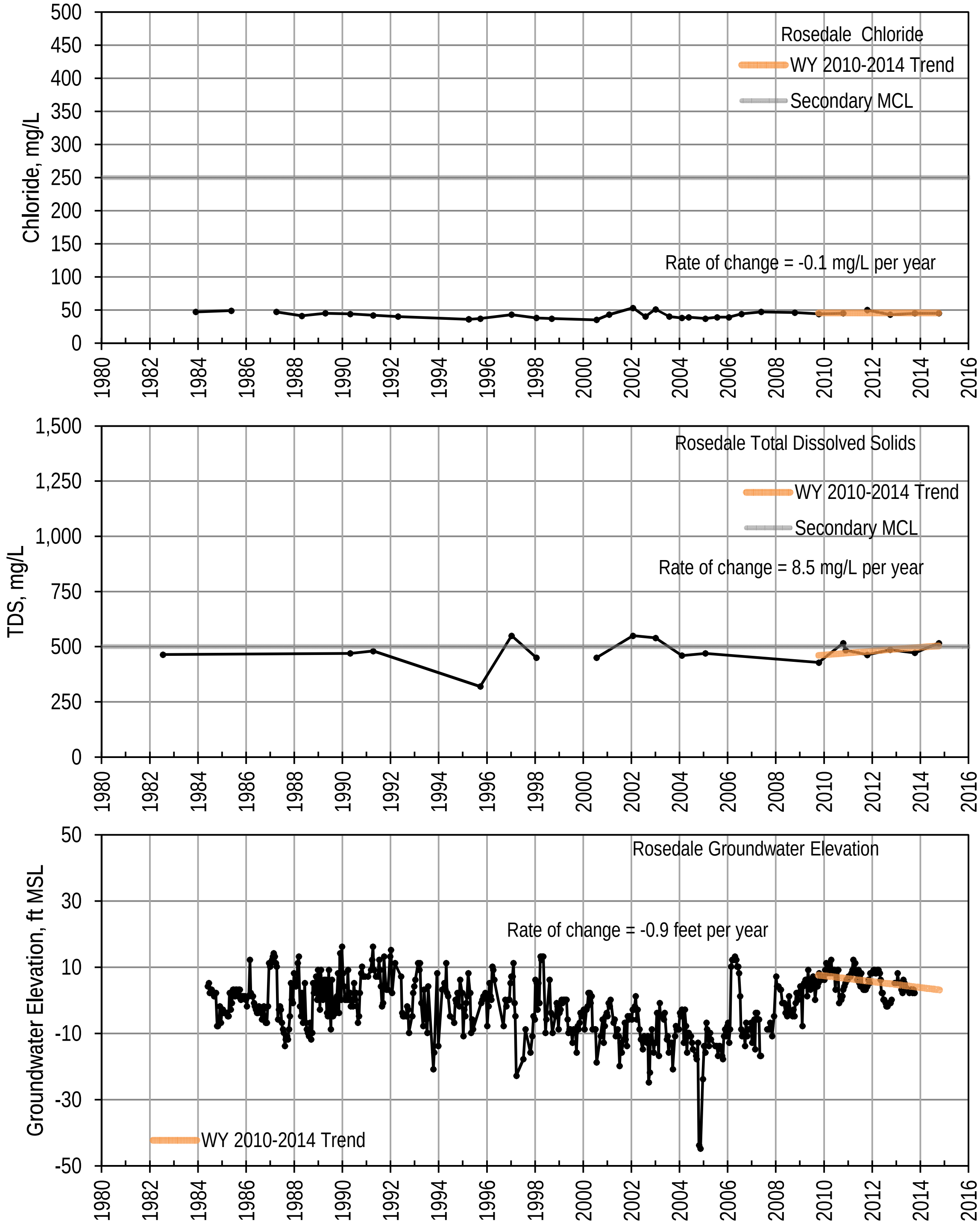

Main Street Chloride
WY 2010-2014 Trend
Secondary MCL
Rate of change = 1 mg/L per year
Chloride, mg/L
500
450
400
350
300
250
200
150
100
50
0
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016

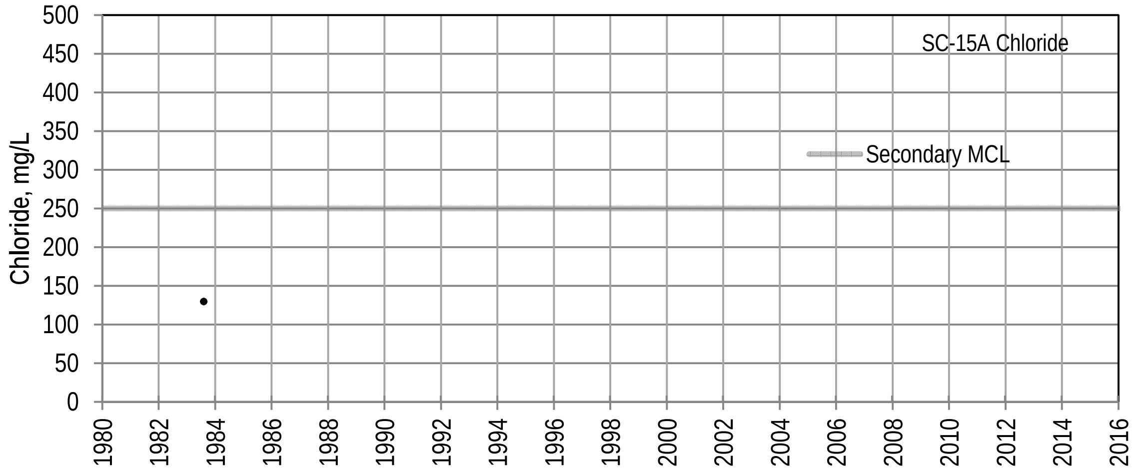

Main St. Total Dissolved Solids
WY 2010-2014 Trend
Secondary MCL
Rate of change = 2.4 mg/L per year
TDS, mg/L
1,500
1,250
1,000
750
500
250
0
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016

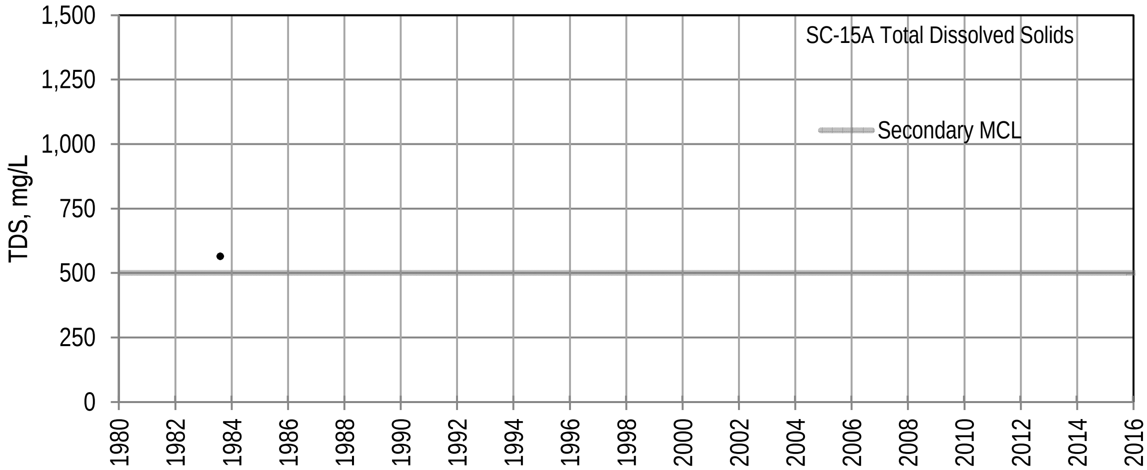

Main Street Groundwater Elevation
Rate of change = 2.3 feet per year
WY 2010-2014 Trend
Groundwater Elevation, ft MSL
30
10
-10
-30
-50
-70
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016

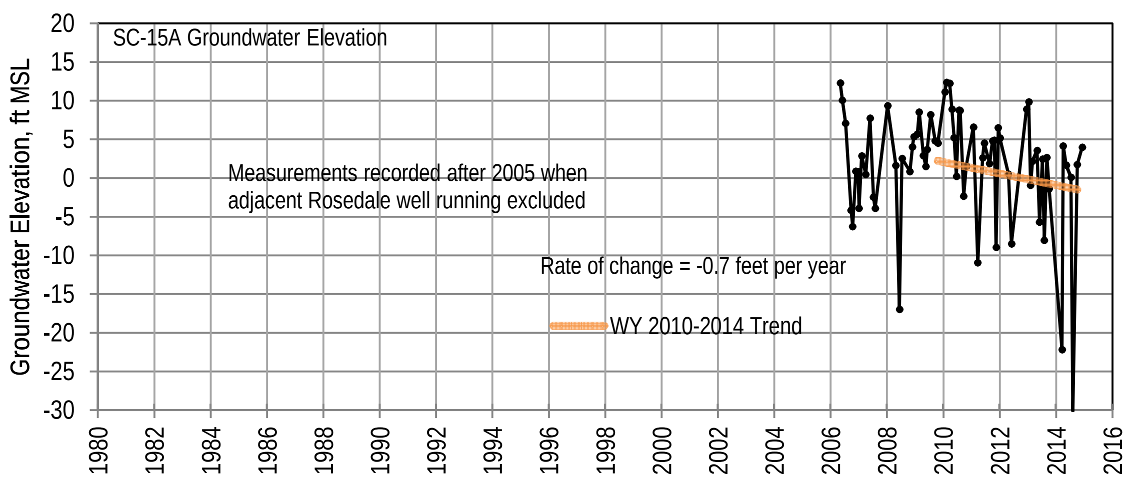

SC-18A Groundwater Elevation
Rate of change = -0.6 feet per year
Measurements recorded after 2005 when
adjacent Main St. well running excluded
Groundwater Elevation, ft MSL
20
10
0
-10
-20
-30
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016

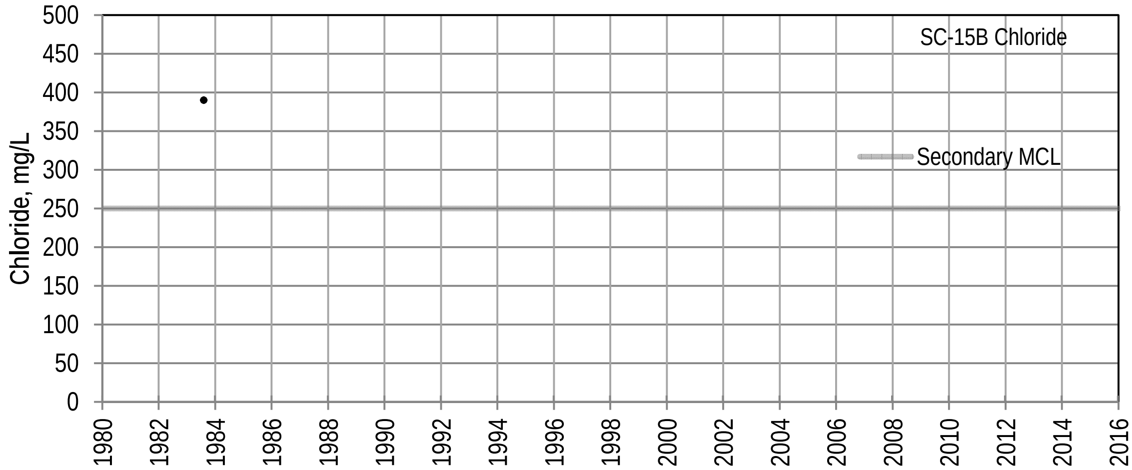

SC-18 wells replaced WY 2014
SC-18AA Groundwater Elevation
Rate of change = 3.9 feet per year
Measurements recorded after 2005 when
adjacent Main St. well running excluded
WY 2010-2014 Trend
Groundwater Elevation, ft MSL
40
20
0
-20
-40
-60
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016

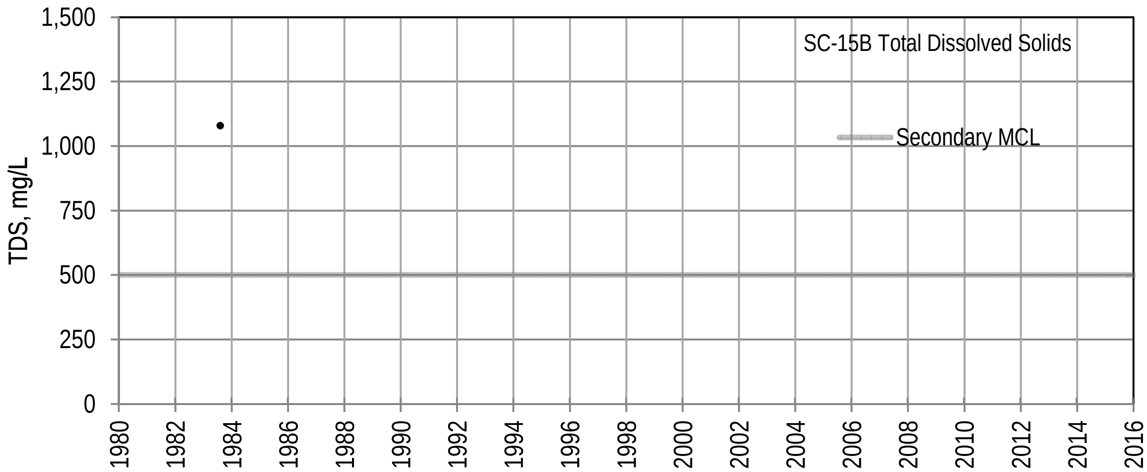

Rosedale Chloride
WY 2010-2014 Trend
Secondary MCL
Rate of change = -0.1 mg/L per year
Chloride, mg/L
Rosedale Total Dissolved Solids
WY 2010-2014 Trend
Secondary MCL
Rate of change = 8.5 mg/L per year
TDS, mg/L
Rosedale Groundwater Elevation
Rate of change = -0.9 feet per year
WY 2010-2014 Trend
Groundwater Elevation, ft MSL

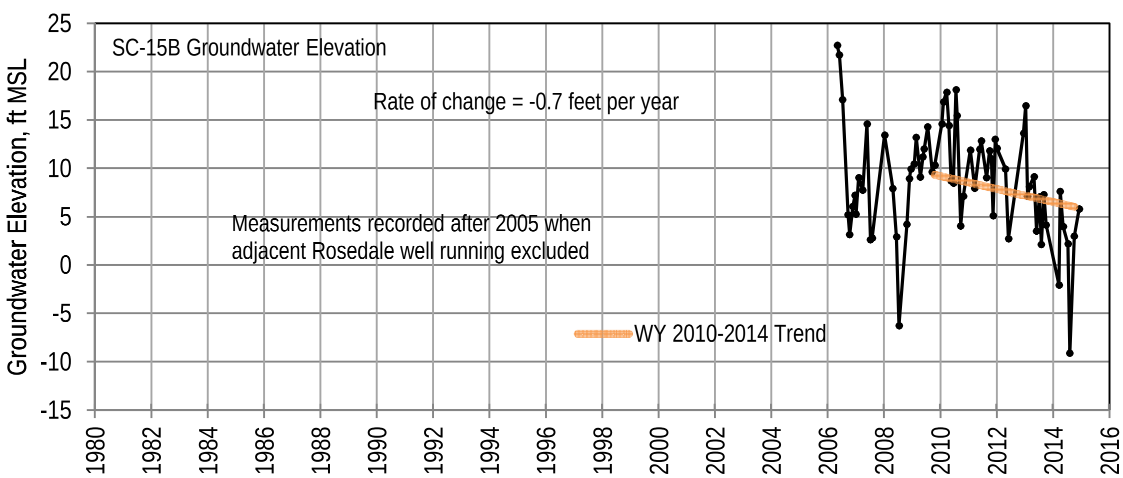

SC-15A Chloride
Secondary MCL
Chloride, mg/L
500
450
400
350
300
250
200
150
100
50
0
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016

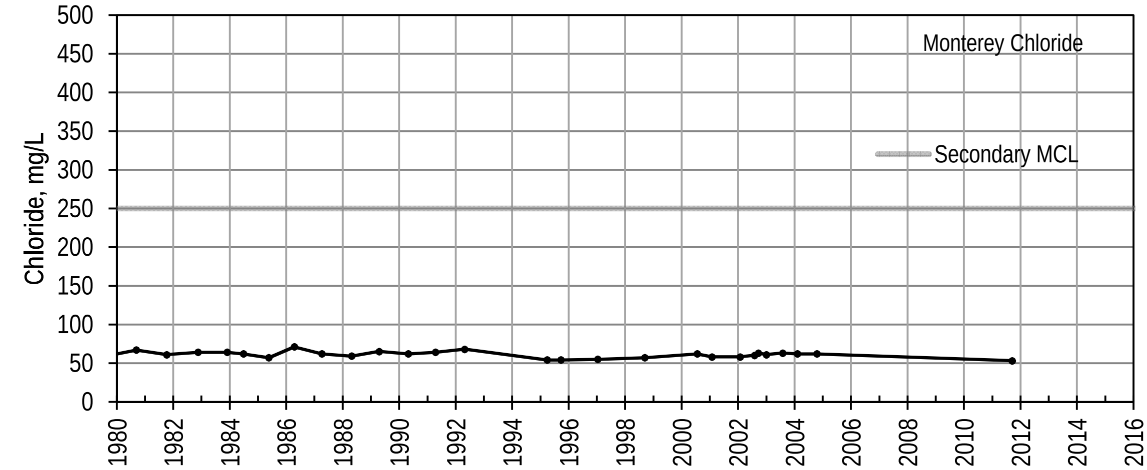

SC-15A Total Dissolved Solids
Secondary MCL
TDS, mg/L
1,500
1,250
1,000
750
500
250
0
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016

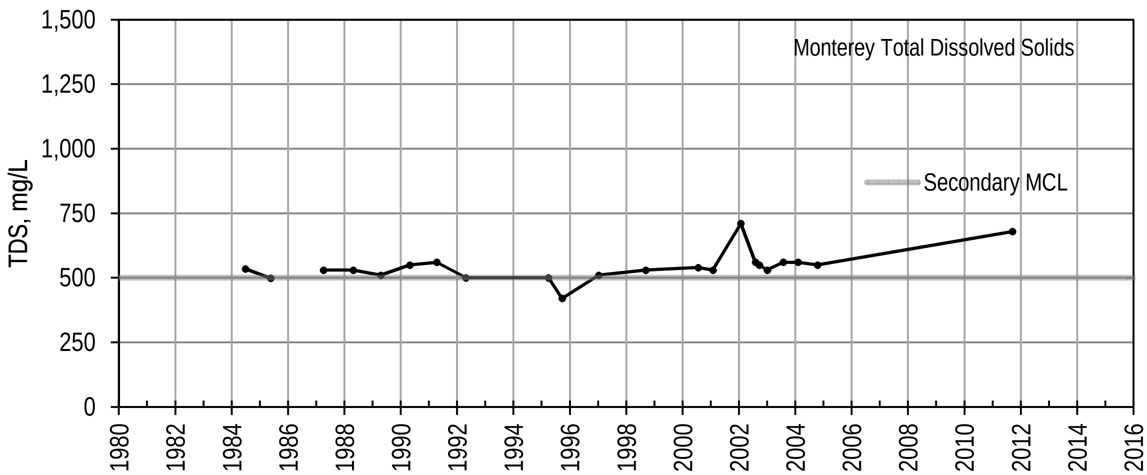

SC-15A Groundwater Elevation
Measurements recorded after 2005 when
adjacent Rosedale well running excluded
Rate of change = -0.7 feet per year
WY 2010-2014 Trend
Groundwater Elevation, ft MSL
20
15
10
5
0
-5
-10
-15
-20
-25
-30
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016

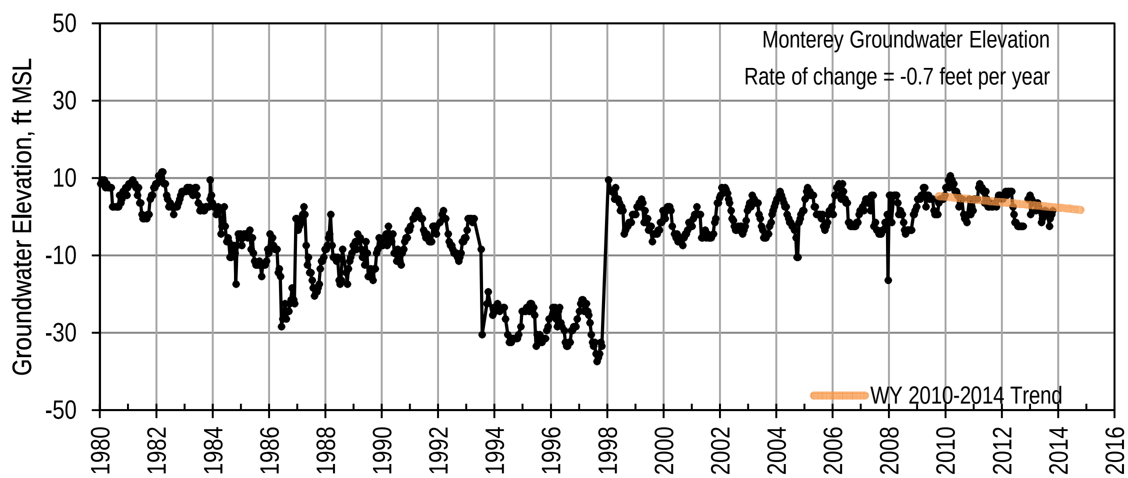

SC-15B Chloride
Secondary MCL
Chloride, mg/L

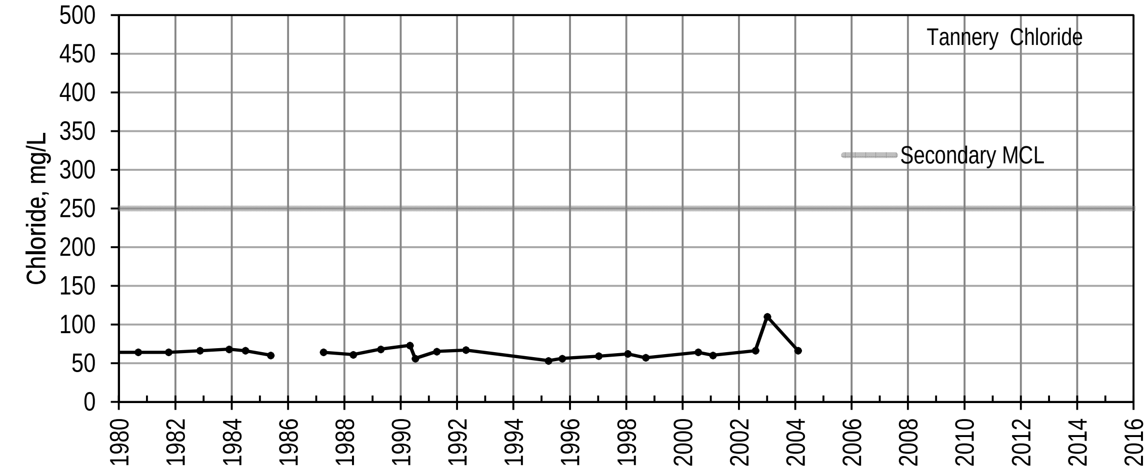

SC-15B Total Dissolved Solids
Secondary MCL
TDS, mg/L

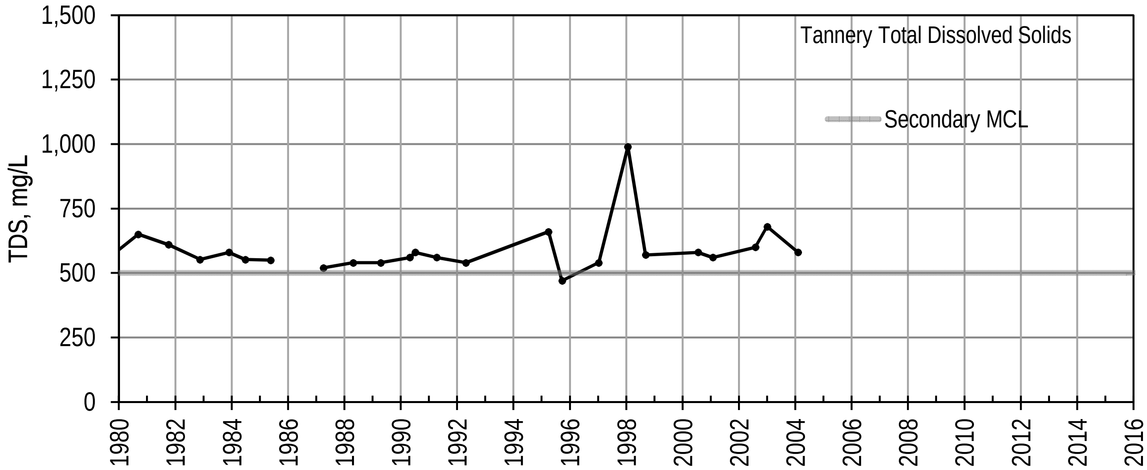

SC-15B Groundwater Elevation
Rate of change = -0.7 feet per year
Measurements recorded after 2005 when adjacent Rosedale well running excluded
WY 2010-2014 Trend
Groundwater Elevation, ft MSL

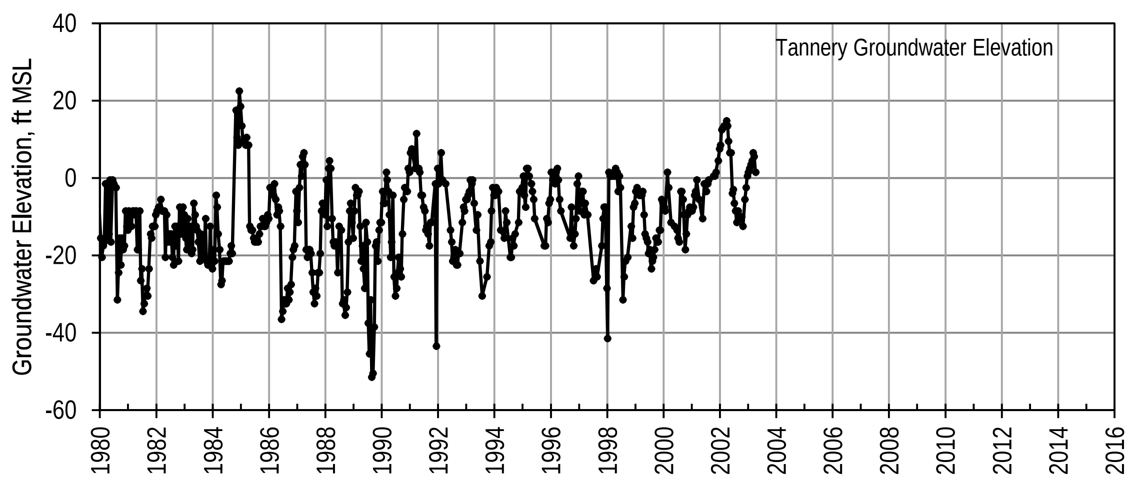

Monterey Chloride
Secondary MCL
Chloride, mg/L
500
450
400
350
300
250
200
150
100
50
0
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016

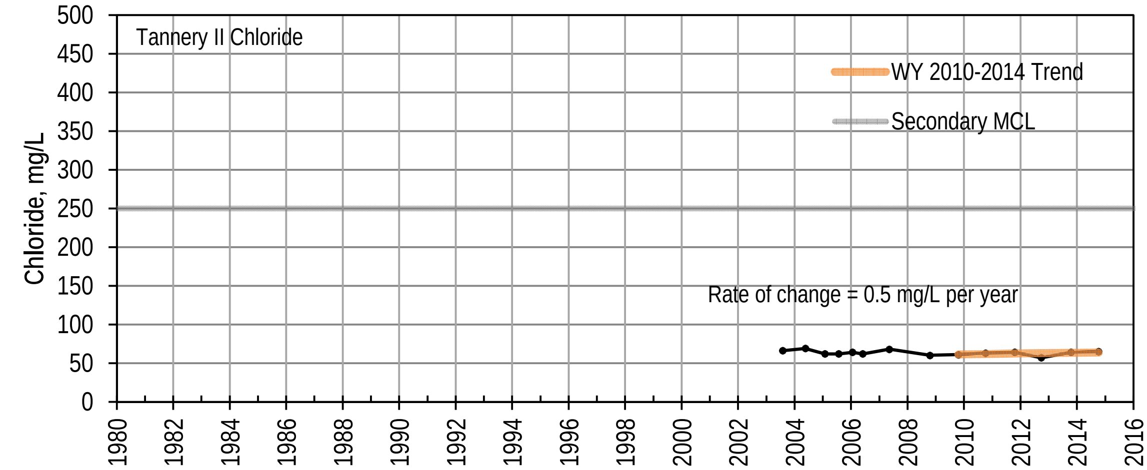

Monterey Total Dissolved Solids
Secondary MCL
TDS, mg/L
1,500
1,250
1,000
750
500
250
0
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016

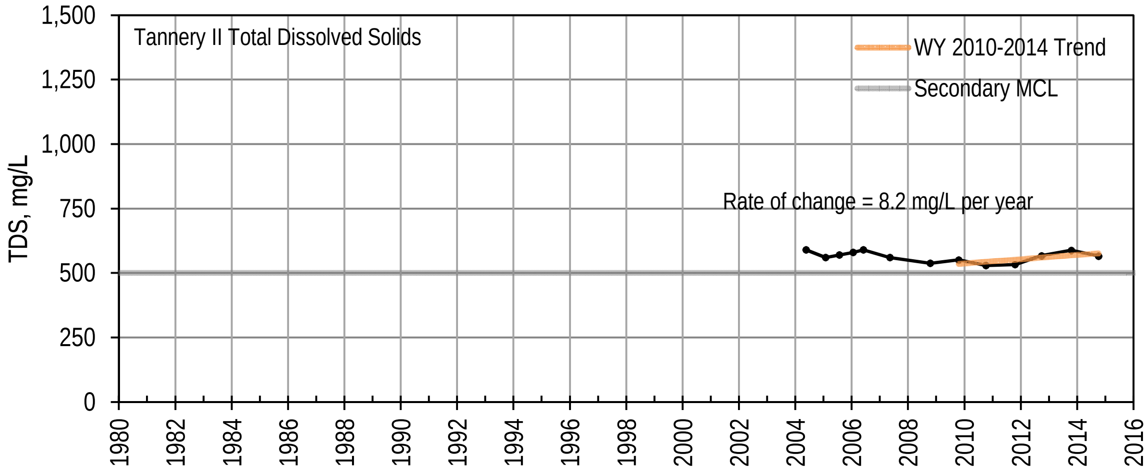

Monterey Groundwater Elevation
Rate of change = -0.7 feet per year
WY 2010-2014 Trend
Groundwater Elevation, ft MSL
50
30
10
-10
-30
-50
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016

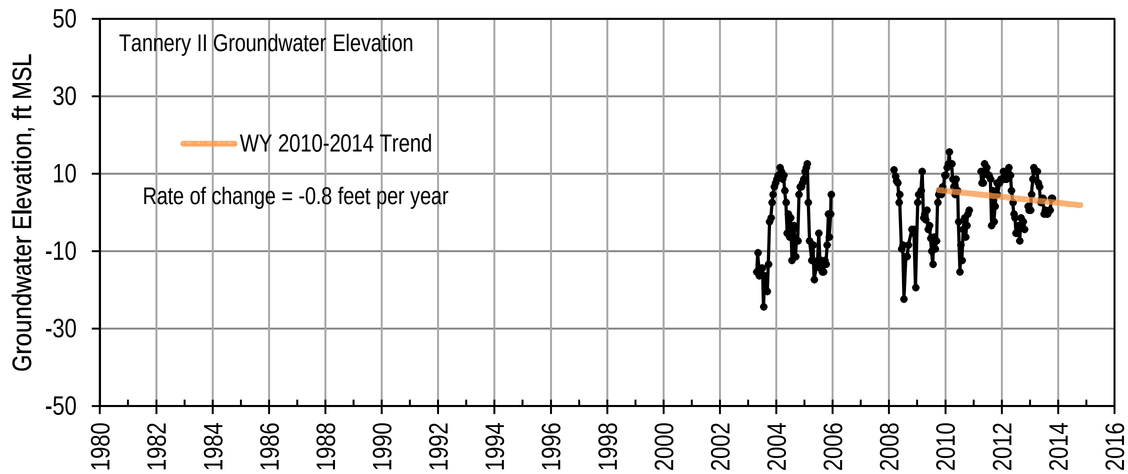

Tannery Chloride
Secondary MCL
Chloride, mg/L
0
50
100
150
200
250
300
350
400
450
500
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016

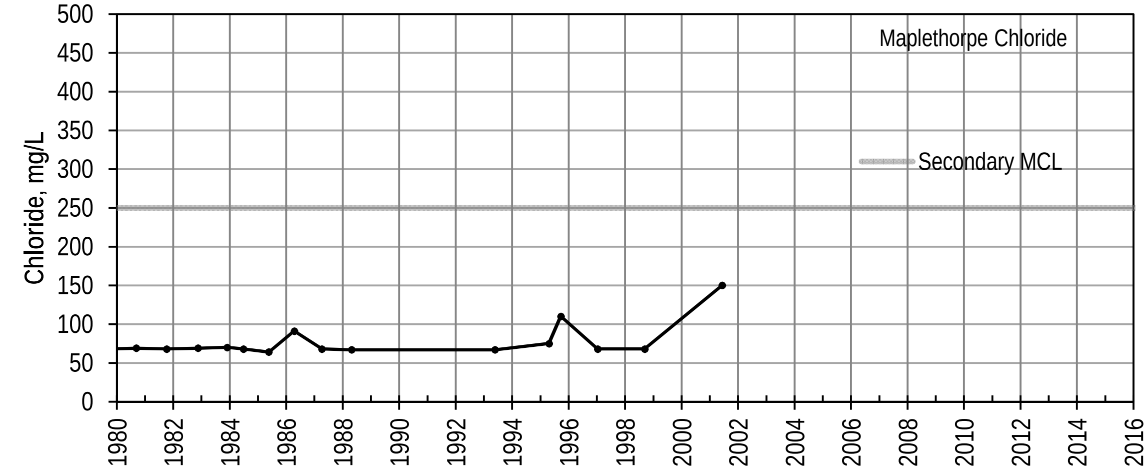

Tannery Total Dissolved Solids
Secondary MCL
TDS, mg/L
0
250
500
750
1,000
1,250
1,500
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016

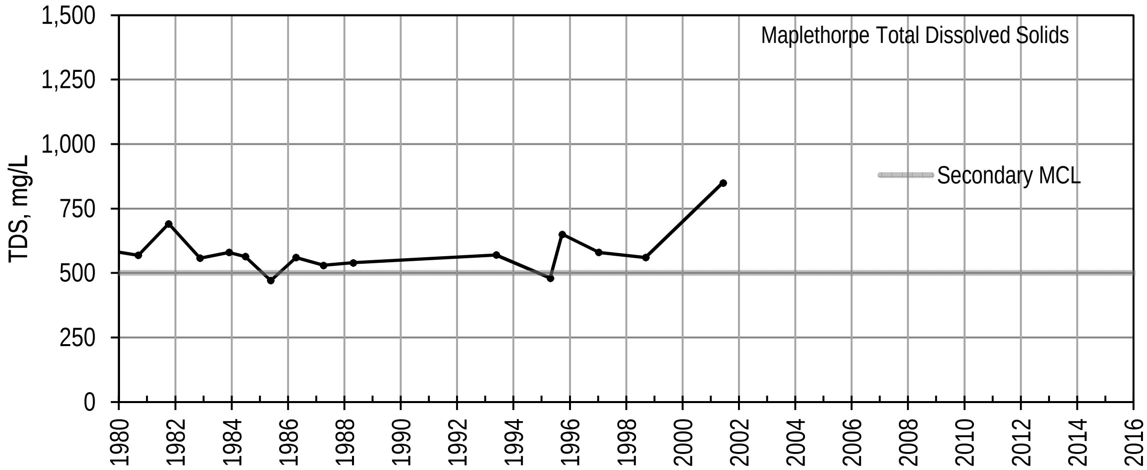

Tannery Groundwater Elevation
Groundwater Elevation, ft MSL
-60
-40
-20
0
20
40
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016

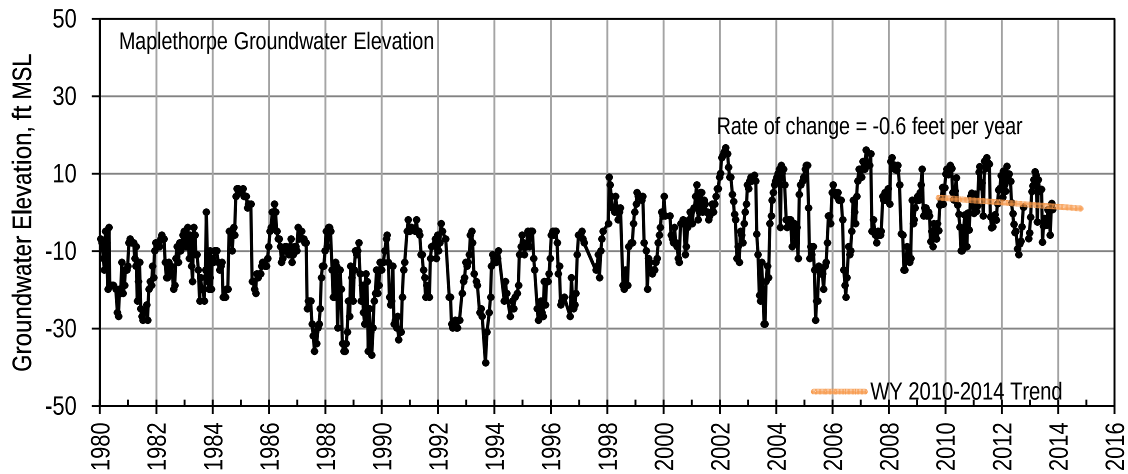

Tannery II Chloride
WY 2010-2014 Trend
Secondary MCL
Rate of change = 0.5 mg/L per year
Chloride, mg/L


Tannery II Total Dissolved Solids
WY 2010-2014 Trend
Secondary MCL
Rate of change = 8.2 mg/L per year
TDS, mg/L


Tannery II Groundwater Elevation
WY 2010-2014 Trend
Rate of change = -0.8 feet per year
Groundwater Elevation, ft MSL


Maplethorpe Chloride
Secondary MCL
Chloride, mg/L


Maplethorpe Total Dissolved Solids
Secondary MCL
TDS, mg/L


Maplethorpe Groundwater Elevation
Rate of change = -0.6 feet per year
WY 2010-2014 Trend
Groundwater Elevation, ft MSL

SECTION 4 – WATER YEAR 2014 AQUIFER CONDITIONS FOR CENTRAL PURISIMA AREA (BC/DEF-UNITS)

This section presents groundwater level and water quality conditions for Water Year 2014 in the central portion of the Soquel-Aptos area where the primary production aquifers are the Purisima BC-unit and the Purisima DEF-unit.

4.1 SQCWD SERVICE AREA II PRODUCTION

In the central portion of the Soquel-Aptos area, groundwater is produced for municipal purposes by SqCWD in Service Area II. SqCWD's Service Area II production was 817 acre-feet in Water Year 2014, the fifth lowest annual total since service area totals have been recorded from Water Year 1984, but represents an increase from each of the previous four years. . Production in Service Area II over the last seven years has been below the historical average. Figure 4-1 shows the production in Service Area II by water year. Figure 4-1 also shows the production by well in Service Area II grouped by aquifer unit. Combined pumping at the wells grouped as BC-unit wells (Estates, Ledyard, and Madeline) was 430 acre-feet, which is an increase following the lowest annual amount pumped since Water Year 1986 in Water Years 2010-2013. Combined pumping at the wells grouped as DEF-unit wells (Aptos Creek and T. Hopkins) was 330 acre-feet, which represents an increase from Water Year 2013. Water Year 2014 pumping in Service Area II was approximately 28% of SqCWD's revised estimate of the post-recovery pumping yield in the Purisima area (HydroMetrics WRI, 2012).

Located in Service Area II, Cabrillo College reported pumping 75 acre-feet in 2014, less than the previous report of 95 acre-feet for 2009.

4.2 GROUNDWATER LEVEL CONDITIONS AND TRENDS

SqCWD has established protective groundwater elevations in coastal monitoring wells to protect the Purisima BC-unit and DEF-unit in the central portion of the Soquel-Aptos area from seawater intrusion. Cross-sectional models were used to estimate groundwater elevations that result in the freshwater-salt water interface in the productive aquifer unit being seaward of the coast over the long term (HydroMetrics LLC, 2009b).

Average coastal groundwater levels in the SqCWD's BC-unit and DEF-unit monitoring wells remained below protective elevations in Water Year 2014, as shown in Table 4-1.

Figure 4-2 shows the hydrographs for the logger data for SC-9C and SC-8D used to calculate annual averages. Hydrographs for all wells in the SC-9 and SC-8 clusters follow at the end of this section. The hydrographs show that groundwater levels at wells SC-9C and SC-8D have been below protective elevations for most of the data record, and remained below protective elevations in Water Year 2014.

Table 4-1 (2013): Comparison of Water Year 2014 Coastal Groundwater Levels with Protective Elevations

Well	Location	Unit	Minimum Groundwater Elevation (feet msl)[1]	Maximum Groundwater Elevation (feet msl)	Average Groundwater Elevation (feet msl)	Protective Elevation (feet msl)
SC-9C[2]	Seacliff	BC	-11.3	-4.0	-7.9	10
SC-8D[2]	Aptos Creek	DEF	2.2	6.6	4.5	10

[1] msl = mean sea level

[2] Based on logger data for the full water year.

Table 4-2 summarizes the important groundwater level trends by monitoring well. Recently declining groundwater elevations in certain wells may reflect the increased pumping at the Ledyard, T. Hopkins, and Aptos Creek wells in Water Year 2014 compared to recent years. Logger data for coastal wells SC-8D and SC-9C (

Figure 4-2) show a slight recovery of 2-3 feet during the summer and fall when typical seasonal pattern is a groundwater decline. This may be related to lower pumping overall in the Purisima during these seasons compared to previous years though those reductions did not occur in Service Area II.

Hydrographs for multiple completions of these wells follow at the end of this section. Hydrographs for multiple completions of monitoring wells adjacent to production wells, and static groundwater levels in groups of production wells are also included following this section.

Hydrographs for single wells including production wells are included with chemographs. These hydrographs show trend lines for Water Years 2010-2014, a period when production in the Central Purisima area was generally decreasing and below historical averages.

Contour maps of groundwater elevations in Spring and Fall 2014 for the Purisima BC-unit are shown in Figure 4-3 and Figure 4-3. Figure 4-3 shows that the Spring 2014 pumping depression in the BC-unit was below sea level, with below sea level groundwater levels extending to the coast. Figure 4-4 shows a depression of similar magnitude during the Fall, with some extension of the below sea level groundwater elevations along the coast. The figures show groundwater flows from all directions including from the Bay towards the pumping depression in the BC-unit. Compared to Water Year 2013, Spring Water Year 2014 shows deeper groundwater depressions while Fall Water Year 2014 shows smaller groundwater depressions.

Table 4-2 (2014): Summary of Groundwater Level Trends in Central Purisima Area

Category	Well	Groundwater Level Trend Description	Notes
SqCWD Coastal Monitoring BC and DEF-unit Wells	SC-9C	Overall upward trend since WY 2008; recent ~10 foot decline through WY 2014	Some increased pumping at Ledyard in WY 2014
	SC-8D	Overall upward trend since WY 2008; recent ~5 foot decline through WY 2014	Some increased pumping at Aptos Creek and T. Hopkins in WY 2014
	SC-8B	Overall upward trend since WY 2008; recent ~10 foot decline through WY 2014	BC-unit shows deeper drawdown than DEF-unit (SC-8D) even though more pumping in DEF unit nearby
SqCWD Shallow Monitoring Coastal Wells	SC-9E	Generally steady since WY 2010	Increasing rainfall WY 2008-2011, but lower rainfall in WY 2012-2014
	SC-8F	Rise of ~4 feet since WY 2006; slight upward trend since WY 2010	Well replaced in 2012, data consistent with previous data
SqCWD Inland BC Unit Monitoring Well	SC-19	>30 feet rise since installation in WY 2007; recent ~15 foot decline through WY 2014	Low precipitation in WY 2012-2014

4.3 Water Quality Conditions and Trends

The most significant groundwater quality threat in the Soquel-Aptos basin is seawater intrusion. As discussed above, groundwater levels remain below protective elevations in the BC and DEF-units. As a result, there is ongoing risk of seawater intrusion into the productive units of the central Purisima area.

Observed Total Dissolved Solids (TDS) and chloride concentrations do not suggest any seawater intrusion impacting SqCWD's production wells in the Purisima BC and DEF-units. Observed TDS and chloride concentrations in SqCWD's monitoring wells in the BC and DEF-units also do not indicate incipient seawater intrusion. Recent chloride concentrations in both production and monitoring wells are at 100 mg/L or less, while the maximum contaminant limit (MCL) for chlorides is 250 mg/L. Chemographs for SqCWD wells in the area are included following this section.

Well SC-8F, completed in the shallow F-unit, was sanded up to 100 feet and was replaced in 2012. Water quality data prior to the replacement from 2007 are not reliable. The chloride concentration from the replacement well was 40 mg/L in Water Year 2014.

Water pumped from the Purisima formation continues to be treated for iron and manganese to meet drinking water standards. In Water Year 2014, color and turbidity were also reduced during treatment to meet drinking water standards.

In Water Year 2014, the Aptos Creek and T. Hopkins wells had detections of arsenic that ranged from 2.1 to 3.1 μg/L, below the MCL of 10 μg/L for arsenic. Water from these wells is treated to reduce arsenic concentrations below 0.7-3.1 μg/L, with an average of 2.1 μg/L.

4.4 STATE OF THE AQUIFER SUMMARY

Seawater intrusion has not been detected in most of the Central Purisima area. However, the productive Purisima BC and DEF-units remain at risk for seawater intrusion as coastal groundwater levels remain well below protective elevations. Due to historically low production in Water Years 2009 through 2014, groundwater levels in the Purisima BC and DEF-units showed recovery over recent annual periods. However, some reversals of these trends were observed in Water Year 2014, which may be associated with increased pumping at some production wells during the water year. There was evidence of partial recovery in the late summer and fall. An extended period of low production will be required for the basin to recover to a level where it is protected against the risk for seawater intrusion.

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SECTION 4 – WATER YEAR 2013 AQUIFER CONDITIONS FOR CENTRAL PURISIMA AREA (BC/DEF-UNITS)

This section presents groundwater level and water quality conditions for Water Year 2013 in the central portion of the Soquel-Aptos area where the primary production aquifers are the Purisima BC-unit and the Purisima DEF-unit.

4.1 SQCWD SERVICE AREA II PRODUCTION

In the central portion of the Soquel-Aptos area, groundwater is produced for municipal purposes by SqCWD in Service Area II. SqCWD’s Service Area II production was 597 acre-feet in Water Year 2012, the lowest annual total since service area totals have been recorded from Water Year 1984, and the sixth consecutive year of production decreases. Production in Service Area II in seven of the last eight years has been below the historical average. Figure 4-1 shows the production in Service Area II by water year. Figure 4-1 also shows the production by well in Service Area II grouped by aquifer unit. Combined pumping at the wells grouped as BC-unit wells (Estates, Ledyard, and Madeline) was 354 acre-feet, the lowest annual amount since Water Year 1986. Combined pumping at the wells grouped as DEF-unit wells (Aptos Creek and T. Hopkins) was 243 acre-feet, the second lowest amount since Water Year 1990. Water Year 2013 pumping in Service Area II was approximately 21% of SqCWD's revised estimate of the post-recovery pumping yield in the Purisima area (HydroMetrics WRI, 2012).

4.2 GROUNDWATER LEVEL CONDITIONS AND TRENDS

SqCWD has established protective groundwater elevations in coastal monitoring wells to protect the Purisima BC-unit and DEF-unit in the central portion of the Soquel-Aptos area from seawater intrusion. Cross-sectional models were used to estimate groundwater elevations that result in the freshwater-salt water interface in the productive aquifer unit being seaward of the coast over the long term (HydroMetrics LLC, 2009b).

Average coastal groundwater levels in the SqCWD's BC-unit and DEF-unit monitoring wells remained below protective elevations in Water Year 2013, as shown in Table 4-1. Although the maximum groundwater level at SC-8D was above the protective elevation in Water Year 2013, average groundwater levels must be at or above the protective elevation to protect the productive aquifer against seawater intrusion. Hydrographs for wells in the SC-9 and SC-8 clusters follow at the end of this section. The hydrographs show that groundwater levels at wells SC-9C and SC-8D have been below protective elevations for most of the data record, and remained below protective elevations in Water Year 2013.

Table 4-1 (2013): Comparison of Water Year 2013 Coastal Groundwater Levels with Protective Elevations

Well	Location	Unit	Minimum Groundwater Elevation[1] (feet msl)[2]	Maximum Groundwater Elevation (feet msl)	Average Groundwater Elevation (feet msl)	Protective Elevation (feet msl)
SC-9C	Seacliff	BC	-13.8	-0.1	-6.3	10
SC-8D	Aptos Creek	DEF	0.4	10.6	6.2	10

[1] Bi-monthly data from October, December, February, April, June, and July.

[2] msl = mean sea level

Table 4-2 summarizes the important groundwater level trends by monitoring well. There were no substantial changes to trends in Water Year 2013.

Hydrographs for multiple completions of these wells follow at the end of this section. Hydrographs for multiple completions of monitoring wells adjacent to production wells, and static groundwater levels in groups of production wells are also included following this section.

Hydrographs for single wells including production wells are included with chemographs. These hydrographs show trend lines for Water Years 2009-2013, a period when production in the Central Purisima area was decreasing and below historical averages.

Contour maps of groundwater elevations in Spring and Fall 2013 for the Purisima BC-unit are shown in Figure 4-2 and Figure 4-3. Figure 4-2 shows that the Spring 2013 pumping depression in the BC-unit was below sea level, with below sea level groundwater levels extending to the coast. Figure 4-3 shows the below sea level pumping depression deepened in the fall at some locations, and extended to more of the coast than in the spring. The figures show groundwater flows from all directions including from the Bay towards the pumping depression in the BC-unit. The pumping depressions were less extensive than the previous year.

Table 4-2 (2013): Summary of Groundwater Level Trends in Central Purisima Area

Category	Well	Groundwater Level Trend Description	Notes
SqCWD Coastal Monitoring BC and DEF-unit Wells	SC-9C	Rise WY 2008-2013	Reduced pumping at Estates, Ledyard, and Madeline WY 2009-2013
	SC-8D	Rise WY 2008-2013	Reduced pumping at Aptos Creek and T. Hopkins WY 2008-2013
	SC-8B	Rise WY 2008-2013 in BC-unit and ~ 10 feet below SC-8D	Deeper drawdown from BC-unit pumping even though more nearby DEF pumping
SqCWD Shallow Monitoring Coastal Wells	SC-9E	Rise of 2 feet WY 2010 in overlying interval of DEF-unit then stable	Increasing rainfall WY 2008-2011, but lower rainfall in WY 2012-2013
	SC-8F	Rise of ~4 feet since Water Year 2006	Well replaced in 2012, data consistent with previous data
SqCWD Inland BC Unit Monitoring Well	SC-19	30+ feet rise since installation in WY 2007,	Increasing rainfall since WY 2007 with lower rainfall in WY 2012-2013

4.3 WATER QUALITY CONDITIONS AND TRENDS

The most significant groundwater quality threat in the Soquel-Aptos basin is seawater intrusion. As discussed above, groundwater levels remain below protective elevations in the BC and DEF-units. As a result, there is ongoing risk of seawater intrusion into the productive units of the central Purisima area.

Observed Total Dissolved Solids (TDS) and chloride concentrations do not suggest any seawater intrusion impacting SqCWD's production wells in the Purisima BC and DEF-units. Observed TDS and chloride concentrations in SqCWD's monitoring wells in the BC and DEF-units also do not indicate incipient seawater intrusion. Recent chloride concentrations in both production and monitoring wells are at 100 mg/L or less, while the maximum contaminant limit (MCL) for chlorides is 250 mg/L. Chemographs for SqCWD wells in the area are included following this section.

Well SC-8F, completed in the shallow F-unit, was sanded up to 100 feet and was replaced in 2012. Water quality data prior to the replacement from 2007 are not reliable. The chloride concentration from the replacement well was 38 mg/L in Water Year 2013.

Water pumped from the Purisima formation continues to be treated for iron and manganese to meet drinking water standards. In Water Year 2013, color and turbidity were also reduced during treatment to meet drinking water standards.

In 2013, the Aptos Creek and T. Hopkins wells had detections of arsenic that ranged from 1.6-3.1 μg/L, below the MCL of 10 μg/L for arsenic. Water from these wells is treated to reduce arsenic concentrations below 0.7-3.1 μg/L, with an average of 2.1 μg/L.

4.4 STATE OF THE AQUIFER SUMMARY

Seawater intrusion has not been detected in most of the Central Purisima area. However, the productive Purisima BC and DEF-units remain at risk for seawater intrusion as coastal groundwater levels remain well below protective elevations. Due to historically low production in Water Years 2009 through 2013, groundwater levels in the Purisima BC and DEF-units showed recovery over the last four years. A longer period of low production will be required to recover the basin to be protected against the risk for seawater intrusion.

SECTION 4 – WATER YEAR 2012 AQUIFER CONDITIONS FOR CENTRAL PURISIMA AREA (BC/DEF-UNITS)

This section presents groundwater level and water quality conditions for Water Year 2012 in the central portion of the Soquel-Aptos area where the primary production aquifers are the Purisima BC-unit and the Purisima DEF-unit.

4.1 SQCWD SERVICE AREA II PRODUCTION

In the central portion of the Soquel-Aptos area, groundwater is produced for municipal purposes by SqCWD in Service Area II. SqCWD's Service Area II production was 676 acre-feet in Water Year 2012, the lowest annual total since service area totals have been recorded from Water Year 1984, and the fifth consecutive year of production decreases. Production in Service Area II over the last seven years has been below the historical average. Figure 4-1 shows the production in Service Area II by water year. Figure 4-1 also shows the production by well in Service Area II grouped by aquifer unit. Combined pumping at the wells grouped as BC-unit wells (Estates, Ledyard, and Madeline) was 425 acre-feet, the lowest annual amount since Water Year 1986. Combined pumping at the wells grouped as DEF-unit wells (Aptos Creek and T. Hopkins) was 251 acre-feet, the second lowest amount since Water Year 1990. Water Year 2012 pumping in Service Area II was approximately 24% of SqCWD's revised estimate of the post-recovery pumping yield in the Purisima area (HydroMetrics WRI, 2012).

4.2 GROUNDWATER LEVEL CONDITIONS AND TRENDS

SqCWD has established protective groundwater elevations in coastal monitoring wells to protect the Purisima BC-unit and DEF-unit in the central portion of the Soquel-Aptos area from seawater intrusion. Cross-sectional models were used to estimate groundwater elevations that result in the freshwater-salt water interface in the productive aquifer unit being seaward of the coast over the long term (HydroMetrics LLC, 2009b).

Coastal groundwater levels in the SqCWD's BC-unit and DEF-unit monitoring wells remained below protective elevations in Water Year 2012, as shown in Table 4-1. Hydrographs for wells in the SC-9 and SC-8 clusters follow at the end of this section. The hydrographs show that groundwater levels at wells SC-9C and SC-8D have been below protective elevations for most of the data record, and remained below protective elevations in Water Year 2012.

Table 4-1 (2012): Comparison of Water Year 2012 Coastal Groundwater Levels with Protective Elevations

Well	Location	Unit	Minimum Groundwater Elevation (feet msl)[1]	Maximum Groundwater Elevation (feet msl)	Average Groundwater Elevation (feet msl)	Protective Elevation (feet msl)
SC-9C	Seacliff	BC	-21.9	-4.7	-12.1	10
SC-8D	Aptos Creek	DEF	-0.7	5.3	2.7	10

[1] msl = mean sea level

Groundwater levels show increasing trends over the last 5 years at SqCWD's coastal monitoring wells completed in the BC and DEF-units. In Water Year 2008, groundwater levels at wells SC-9B/C and SC-8D were close to historical lows. The increasing trend since that time has likely been due to reduced pumping at nearby SqCWD production wells.

Groundwater levels in the BC-unit are lower than groundwater levels in the DEF-units. This separation has occurred in the Aptos Creek area since Water Year 2004 even though the pumping at the Aptos Creek and T. Hopkins wells is mostly derived from the DEF-unit. This would suggest that drawdown caused by production wells in the BC-unit spreads farther laterally than drawdown in the DEF-unit.

Groundwater levels in shallower coastal monitoring wells in the DEF-unit declined slightly after Water Year 2006 and have been relatively stable since declining. This decline in the shallow interval of the DEF-unit may reflect a reduction in basin storage correlated with less precipitation. There has been a rise in these groundwater levels in Water Years 2010 to 2012.

Table 4-2 summarizes the important groundwater level trends by monitoring well. Hydrographs for multiple completions of these wells follow at the end of this section. Hydrographs for multiple completions of monitoring wells adjacent to production wells, and static groundwater levels in groups of production wells are also included following this section.

Hydrographs for single wells including production wells are included with chemographs. These hydrographs show trend lines for Water Years 2008-2012, a period when production in the Central Purisima area was decreasing and below historical averages.

Contour maps of groundwater elevations in Spring and Fall 2012 for the Purisima BC-unit are shown in Figure 4-2 and Figure 4-3. Figure 4-2 shows that the Spring 2012 pumping depression in the BC-unit was below sea level, with below sea level groundwater levels extending to the coast. Figure 4-3 shows the below sea level pumping depression deepened in the fall at some locations, and extended to more of the coast than in the spring. The pumping depressions were less deep in Spring 2012 than the previous spring, but more deep inland while less deep towards the coast in Fall 2012 than the previous year.

Table 4-2 (2012): Summary of Groundwater Level Trends in Central Purisima Area

Category	Well	Groundwater Level Trend Description	Notes
SqCWD Coastal Monitoring BC and DEF-unit Wells	SC-9C	Rise WY 2008-2012	Reduced pumping at Estates WY 2009-2012
	SC-8D	Rise WY 2008-2012, but steady from WY 2011-2012	Reduced pumping at Aptos Creek and T. Hopkins WY 2008-2012
	SC-8B	Rise WY 2008-2012 in BC-unit and > 10 feet below SC-8D	Deeper drawdown from BC-unit pumping
SqCWD Shallow Monitoring Coastal Wells	SC-9E	Rise of 2 feet WY 2010 in overlying interval of DEF-unit then slight decline	Increasing rainfall WY 2008-2011, but lower rainfall in WY 2012
	SC-8F	Rise of ~4 feet since Water Year 2006	Well replaced in 2012, data consistent with previous data
SqCWD Inland BC Unit Monitoring Well	SC-19	~~30 feet rise since installation in WY 2007, but steady from WY 2011-2012	Increasing rainfall since WY 2007 with lower rainfall in WY 2012

4.3 WATER QUALITY CONDITIONS AND TRENDS

The most significant groundwater quality threat in the Soquel-Aptos basin is seawater intrusion. As discussed above, groundwater levels remain below protective elevations in the BC and DEF-units. As a result, there is ongoing risk of seawater intrusion into the productive units of the central Purisima area.

Observed Total Dissolved Solids (TDS) and chloride concentrations do not suggest any seawater intrusion impacting SqCWD's production wells in the Purisima BC and DEF-units. Observed TDS and chloride concentrations in SqCWD's monitoring wells in the BC and DEF-units also do not indicate incipient seawater intrusion. Recent chloride concentrations in both production and monitoring wells are at 100 mg/L or less, while the maximum contaminant limit (MCL) for chlorides is 250 mg/L. Chemographs for SqCWD wells in the area are included following this section.

Well SC-8F, completed in the shallow F-unit, was sanded up to 100 feet and was replaced in 2012. Water quality data prior to the replacement from 2007 are not reliable. The chloride concentration from the replacement well ranged between 36.5 and 43 mg/L in 2012.

Water pumped from the Purisima formation continues to be treated for iron and manganese to meet drinking water standards. In Water Year 2012, color and turbidity were also reduced during treatment to meet drinking water standards.

In Water Years 2009 through 2012, the Aptos Creek and T. Hopkins wells had detections of arsenic that ranged from 1.9-4.8 μg/L, below the MCL of 10 μg/L for arsenic. Water from these wells is treated to reduce arsenic concentrations below 1.1-3.1 μg/L, with an average of 1.9 μg/L.

4.4 STATE OF THE AQUIFER SUMMARY

Seawater intrusion has not been detected in most of the Central Purisima area. However, the productive Purisima BC and DEF-units remain at risk for seawater intrusion as coastal groundwater levels remain well below protective elevations. Due to historically low production in Water Years 2009 through 2012, groundwater levels in the Purisima BC and DEF-units showed recovery over the last three years. A longer period of low production will be required to recover the basin to be protected against the risk for seawater intrusion.

SECTION 4 – WATER YEAR 2011 AQUIFER CONDITIONS FOR CENTRAL PURISIMA AREA (BC/DEF-UNITS)

This section presents groundwater level and water quality conditions for Water Year 2011 in the central portion of the Soquel-Aptos area where the primary production aquifers are the Purisima BC-unit and the Purisima DEF-unit.

4.1 SqCWD Service Area II Production

In the central portion of the Soquel-Aptos area, groundwater is produced for municipal purposes by SqCWD in Service Area II. SqCWD’s Service Area II production was 801 acre-feet in Water Year 2011, the lowest annual total since Water Year 1986 and the fourth consecutive year of production decreases. Production in Service Area II over the last six years has been below the historical average. Figure 4-1 shows the production in Service Area II by water year. Figure 4-1 also shows the production by well in Service Area II grouped by aquifer unit. Combined pumping at the wells grouped as BC-unit wells (Estates, Ledyard, and Madeline) was 495 acre-feet, the lowest annual amount since Water Year 1986. Combined pumping at the wells grouped as DEF-unit wells (Aptos Creek and T. Hopkins) was 306 acre-feet, the third lowest amount since Water Year 1990. Water Year 2010 pumping in Service Area II was approximately 29% of SqCWD's revised estimate of the post-recovery pumping yield in the Purisima area (HydroMetrics WRI, 2012).

4.2 Groundwater Level Conditions and Trends

SqCWD has established protective groundwater elevations in coastal monitoring wells to protect the Purisima BC-unit and DEF-unit in the central portion of the Soquel-Aptos area from seawater intrusion. Cross-sectional models were used to estimate groundwater elevations that result in the freshwater-salt water interface in the productive aquifer unit being seaward of the coast over the long term (HydroMetrics LLC, 2009b).

Coastal groundwater levels in the SqCWD's BC-unit and DEF-unit monitoring wells remained below protective elevations in Water Year 2011, as shown in Table 4-1. Hydrographs for wells in the SC-9 and SC-8 clusters follow at the end of this section. The hydrographs show that groundwater levels at wells SC-9B, SC-9C, and SC-8D have been below protective elevations for most of the data record, and remained below protective elevations in Water Year 2011.

Table 4-1 (2011): Comparison of Water Year 2011 Coastal Groundwater Levels with Protective Elevations

Well	Location	Unit	Minimum Groundwater Elevation (feet msl)[1]	Maximum Groundwater Elevation (feet msl)	Protective Elevation (feet msl)
SC-9B	Seacliff	B/BC	-14.4	-5.2	10
SC-9C		BC	-21.9	-9.4	
SC-8D	Aptos Creek	DEF	-3.5	8.5	10

[1] msl = mean sea level

Groundwater levels show increasing trends over the last 4 years at SqCWD's coastal monitoring wells completed in the BC and DEF-units. Four years ago, groundwater levels at wells SC-9B/C and SC-8D were close to historical lows. The increasing trend since that time has likely been due to reduced pumping at nearby SqCWD production wells.

Groundwater levels in the BC-unit are lower than groundwater levels in the DEF-units. This separation has occurred in the Aptos Creek area since Water Year 2004 even though the pumping at the Aptos Creek and T. Hopkins wells is mostly derived from the DEF-unit. This would suggest that drawdown caused by production wells in the BC-unit spreads farther laterally than drawdown in the DEF-unit.

Groundwater levels in shallower coastal monitoring wells in the DEF-unit declined slightly after Water Year 2006 and have been relatively stable since declining. This decline in the shallow interval of the DEF-unit may reflect a reduction in basin storage correlated with less precipitation. There has been a slight rise in these groundwater levels in Water Years 2010 and 2011, coinciding with increased precipitation.

Table 4-2 summarizes the important groundwater level trends by monitoring well. Hydrographs for multiple completions of these wells follow at the end of this section. Hydrographs for multiple completions of monitoring wells adjacent to production wells, and static groundwater levels in groups of production wells are also included following this section.

Hydrographs for single wells including production wells are included with chemographs. These hydrographs show trend lines for Water Years 2007-2011, a period when production in the Central Purisima area was decreasing and below historical averages.

Contour maps of groundwater elevations in Spring and Fall 2011 for the Purisima BC-unit are shown in Figure 4-2 and Figure 4-3. Figure 4-2 shows that the Spring 2011 pumping depression in the BC-unit was below sea level, with below sea level groundwater levels extending to the coast. Figure 4-3 shows the below sea level pumping depression deepened in the fall at some locations, and extended to more of the coast than in the spring. The pumping depressions were less deep in 2011 than the previous year.

Table 4-2 (2011): Summary of Groundwater Level Trends in Central Purisima Area

Category	Well	Groundwater Level Trend Description	Notes
SqCWD Coastal Monitoring BC and DEF-unit Wells	SC-9B/C	Rise WY 2008-2011	Reduced pumping at Estates WY 2009-2011
	SC-8D	Rise WY 2008-2011	Reduced pumping at Aptos Creek and T. Hopkins WY 2008-2011
	SC-8B	Rise WY 2008-2011 in BC-unit and > 10 feet below SC-8D	Deeper drawdown from BC-unit pumping
SqCWD Shallow Monitoring Coastal Wells	SC-9E SC-8E	Rise of 1.5 feet since WY 2008-2009 in overlying interval of DEF-unit after 1-2 foot drop WY 2007	Increasing precipitation since WY 2007
	SC-8F	Unreliable data	Well filled up to a depth of 106 feet from original 200 feet depth
SqCWD Inland BC Unit Monitoring Well	SC-19	10+ feet rise since installation in WY 2007	Increasing precipitation since WY 2007

4.3 WATER QUALITY CONDITIONS AND TRENDS

The most significant groundwater quality threat in the Soquel-Aptos basin is seawater intrusion. As discussed above, groundwater levels remain below protective elevations in the BC and DEF-units. As a result, there is ongoing risk of seawater intrusion into the productive units of the central Purisima area.

Observed Total Dissolved Solids (TDS) and chloride concentrations do not suggest any seawater intrusion impacting SqCWD's production wells in the Purisima BC and DEF-units. Observed TDS and chloride concentrations in SqCWD's monitoring wells in the BC and DEF-units also do not indicate incipient seawater intrusion. Recent chloride concentrations in both production and monitoring wells are at 100 mg/L or less, while the maximum contaminant limit (MCL) for chlorides is 250 mg/L. Chemographs for SqCWD wells in the area are included following this section.

Chloride concentrations in well SC-8F, completed in the shallow F-unit, were approximately 3,000 mg/L starting in Water Year 2007. Data from this well, however, are not reliable. The well was sanded up to 100 feet and was replaced in 2012. The chloride concentration from the replacement well was 43 mg/L.

Water pumped from the Purisima formation continues to be treated for iron and manganese to meet drinking water standards. In Water Year 2011, color and turbidity were also reduced during treatment to meet drinking water standards.

In Water Years 2009 through 2011, the Aptos Creek and T. Hopkins wells had detections of arsenic that ranged from 1.9-4.7 μg/L, below the MCL of 10 μg/L for arsenic. Water from these wells is treated to reduce arsenic concentrations below 1.1-3.0 μg/L, with an average of 2.0 μg/L.

4.4 STATE OF THE AQUIFER SUMMARY

Seawater intrusion has not been detected in most of the Central Purisima area. However, the productive Purisima BC and DEF-units remain at risk for seawater intrusion as coastal groundwater levels remain well below protective elevations. Due to historically low production in Water Years 2009 through 2011, groundwater levels in the Purisima BC and DEF-units showed recovery over the last two years. A longer period of low production will be required to recover the basin to be protected against the risk for seawater intrusion.

SECTION 4 – WATER YEAR 2010
AQUIFER CONDITIONS FOR CENTRAL PURISIMA AREA (BC/DEF-UNITS)

This section presents groundwater level and water quality conditions for Water Year 2010 in the central portion of the Soquel-Aptos area where the primary production aquifers are the Purisima BC-unit and the Purisima DEF-unit.

4.1 SqCWD SERVICE AREA II PRODUCTION

In the central portion of the Soquel-Aptos area, groundwater is produced for municipal purposes by SqCWD in Service Area II. SqCWD's Service Area II production was 814 acre-feet in Water Year 2010, the lowest annual amount since Water Year 1986. Production in Service Area II over the last 5 years has been below the historical average. Figure 4-1 shows the production in Service Area II by Water Year. Figure 4-1 also shows the production by well in Service Area II grouped by aquifer unit. Combined pumping at the wells grouped as BC-unit wells (Estates, Ledyard, and Madeline) was 511 acre-feet. This was higher than the previous year, but lower than every other year since Water Year 1986. Combined pumping at the wells grouped as DEF-unit wells (Aptos Creek and T. Hopkins) was 303 acre-feet, the second lowest amount since Water Year 1990, partly because the T. Hopkins well was out of service for over two months. Water Year 2010 pumping in Service Area II was approximately 33% of SqCWD's revised estimate of its share of the annual sustainable yield in the Purisima area (HydroMetrics LLC, 2009c).

4.2 GROUNDWATER LEVEL CONDITIONS AND TRENDS

SqCWD has established protective groundwater elevations in coastal monitoring wells to protect the Purisima BC-unit and DEF-unit in the central portion of the Soquel-Aptos area from seawater intrusion. Cross-sectional models were used to estimate groundwater elevations that result in the freshwater-salt water interface in the productive aquifer unit being seaward of the coast over the long term (HydroMetrics LLC, 2009b).

Coastal groundwater levels in the SqCWD's BC-unit and DEF-unit monitoring wells remained below protective elevations in Water Year 2010, as shown in Table 4-1. Hydrographs for wells in the SC-9 and SC-8 clusters follow at the end of this section. The hydrographs show that groundwater levels at wells SC-9B, SC-9C and SC-8D have been below protective elevations for most of the data record, and remained below protective elevations in Water Year 2010.

Table 4-1 (2010): Comparison of Water Year 2010 Coastal Groundwater Levels with Protective Elevations

Well	Location	Unit	Minimum Groundwater Elevation (feet msl)[1]	Maximum Groundwater Elevation (feet msl)	Protective Elevation (feet msl)
SC-9B	Seacliff	B/BC	-20.4	-8.4	10
SC-9C		BC	-29.3	-13.1	
SC-8D	Aptos Creek	DEF	-7.1	3.5	10

[1] mean sea level

In general, groundwater levels show increasing trends over the last 3 years at SqCWD's coastal monitoring wells completed in the BC and DEF-units. Three years ago, groundwater levels at wells SC-9B/C and SC-8D were close to historical lows. The increasing trend since that time has likely been due to reduced pumping at nearby SqCWD production wells.

Groundwater levels in the BC-unit are lower than groundwater levels in the DEF-units. This separation has occurred in the Aptos Creek area since Water Year 2004 even though the pumping at the Aptos Creek and T. Hopkins wells is mostly derived from the DEF-unit. This would suggest that drawdown caused by production wells in the BC-unit spreads farther laterally than drawdown in the DEF-unit.

Groundwater levels in shallower coastal monitoring wells in the DEF-unit declined slightly after Water Year 2006 and have been relatively stable since declining. This decline in the shallow interval of the DEF-unit may reflect a reduction in basin storage correlated with less precipitation.

Table 4-2 summarizes the important groundwater level trends by monitoring well. Hydrographs for multiple completions of these wells follow at the end of this section. Hydrographs for multiple completions of monitoring wells adjacent to production wells, and static groundwater levels in groups of production wells are also included following this section.

Hydrographs for single wells including production wells are included with chemographs. These hydrographs show trendlines for Water Years 2005-2010 when municipal production for the basin has been at or below pumping goals in the Groundwater Management Plan.

Contour maps of groundwater elevations in Spring and Fall 2010 for the Purisima BC-unit are shown in Figure 4-2 and Figure 4-3. Figure 4-2 shows that the Spring 2010 pumping depression in the BC-unit was below sea level, with below sea level groundwater levels extending to the coast. Figure 4-3 shows the below sea level pumping depression deepened in the Fall at some locations, and extended to more of the coast than in the Spring. The pumping depression deepened less in the Fall 2010 than the previous year. This may be related to the T-Hopkins well being out of service for rehabilitation in Fall 2010, but also may be an artifact of the high dependence of static water levels in the area on pumping recovery times.

Table 4-2 (2010): Summary of Groundwater Level Trends in Central Purisima Area

Category	Well	Groundwater Level Trend Description	Notes
SqCWD Coastal Monitoring BC and DEF-unit Wells	SC-9B/C	Increasing WY 2008-2010	Reduced pumping at Estates WY 2009-2010
	SC-8D	Increasing WY 2008-2010	Declining pumping at Aptos Creek and T. Hopkins from WY 2007
	SC-8B	BC-unit higher WY 2010 and > 10 feet below SC-8D	Deeper drawdown from BC-unit pumping
SqCWD Shallow Monitoring Coastal Wells	SC-9E SC-8E	Relatively stable feet in overlying interval of DEF-unit since 1-2 foot drop WY 2007	Increasing precipitation since WY 2007
	SC-8F	Unreliable data	Well filled up to a depth of 106 feet from original 200 feet depth

4.3 WATER QUALITY CONDITIONS AND TRENDS

The most significant groundwater quality threat in the Soquel-Aptos basin is seawater intrusion. As discussed above, groundwater levels remain below protective elevations in the BC and DEF-units. As a result, there is ongoing risk of seawater intrusion into the productive units of the central Purisima area.

Observed Total Dissolved Solids (TDS) and chloride concentrations do not suggest any seawater intrusion impacting SqCWD's production wells in the Purisima BC and DEF-units. Observed TDS and chloride concentrations in SqCWD's monitoring wells in the BC and DEF-units also do not indicate incipient seawater intrusion. Recent chloride concentrations in both production and monitoring wells are at 100 mg/L or less, while the maximum contaminant limit (MCL) for chlorides is 250 mg/L. Chemographs for SqCWD wells in the area are included following this section.

Chloride concentrations in well SC-8F, completed in the shallow F-unit, were approximately 3,000 mg/L starting in Water Year 2007. Data from this well, however, are not reliable. The well is sanded up to 100 feet and the well is slated for replacement.

Water pumped from the Purisima formation continues to be treated for iron and manganese to meet drinking water standards. In Water Year 2010, color and turbidity were also reduced during treatment to meet drinking water standards.

In Water Years 2009 and 2010, the Aptos Creek and T. Hopkins wells had detections of arsenic that ranged from 1.9-4.7 ug/L, below the MCL of 10 ug/L for arsenic. Water from these wells is treated to reduce arsenic concentrations below 2 ug/L.

4.4 State of the Aquifer Summary

Seawater intrusion has not been detected in most of the Central Purisima area. However, the productive Purisima BC and DEF-units remain at risk for seawater intrusion as coastal groundwater levels remain well below protective elevations. Due to historically low production in Water Years 2009 and 2010, groundwater levels in the Purisima BC and DEF-units showed recovery over the last two years. A longer period of low production will be required to recover the basin to be protected against the risk for seawater intrusion.

SECTION 4 – WATER YEAR 2009 AQUIFER CONDITIONS FOR CENTRAL PURISIMA AREA (BC/DEF-UNITS)

This section presents groundwater level and water quality conditions for Water Year 2009 in the central portion of the Soquel-Aptos area where the primary production aquifers are the Purisima BC-unit and the Purisima DEF-unit.

4.1 SqCWD Service Area II Production

In the central portion of the Soquel-Aptos area, groundwater is produced for municipal purposes by SqCWD in Service Area II. Service Area II production was 827 acre-feet in Water Year 2009, the lowest annual amount since Water Year 1985. Production in Service Area II over the last 4 years has been below the historical average. Figure 4-1 shows the production in Service Area II by Water Year. Figure 4-1 also shows the production by well in Service Area II grouped by aquifer unit. Combined pumping at the wells grouped as BC-unit wells (Estates, Ledyard, and Madeline) was less than 500 acre-feet for the first time since Water Year 1986. Combined pumping at the wells grouped as DEF-unit wells (Aptos Creek and T. Hopkins) was 328 acre-feet, the second lowest amount since Water Year 1990. The recent evaluation of the sustainable yield (HydroMetrics LLC, 2009c) did not estimate annual sustainable yield specifically for Service Area II wells, but Water Year 2009 pumping in Service Area II was approximately 33% of the suggested estimate of SqCWD's share of the annual sustainable yield in the Purisima.

4.2 Groundwater Level Conditions and Trends

SqCWD has established protective groundwater elevations in coastal monitoring wells to protect the Purisima BC-unit and DEF-unit in the central portion of the Soquel-Aptos area from seawater intrusion over the long term. Cross-sectional models were used to estimate groundwater elevations that result in the freshwater-salt water interface in the productive aquifer unit being seaward of the coast over the long term (HydroMetrics LLC, 2009b).

Coastal groundwater levels in the SqCWD's BC-unit and DEF-unit monitoring wells remained below protective elevations in Water Year 2009, as shown in Table 4-1. Hydrographs for wells in the SC-9 and SC-8 clusters follow at the end of this section. The hydrographs show that groundwater levels at SC-9B and

SC-8D have been below protective elevations for most of the data record and remained below sea level for most of Water Year 2009.

Table 4-1 (2009): Comparison of Water Year 2009 Coastal Groundwater Levels with Protective Elevations

Well	Location	Unit	Minimum Groundwater Elevation (feet msl)	Maximum Groundwater Elevation (feet msl)	Protective Elevation (feet msl)
SC-9B	Seacliff	BC	-20.4	-9.4	11
SC-8D	Aptos Creek	DEF	-9.4	4.8	10

In general, the groundwater level trend at SqCWD's coastal monitoring wells completed in the BC and DEF-units in this area has been stable or increasing over the last 4-5 years. Four to five years ago, groundwater levels at SC-9B and SC-8D had declined to historic lows. The stable to increasing trend since that time has likely been due to reduced pumping at nearby SqCWD production wells.

Groundwater levels in the BC-unit are lower than levels in the DEF-units. This separation has occurred in the Aptos Creek area since Water Year 2004 even though the pumping at the Aptos Creek and T. Hopkins wells is mostly derived from the DEF-unit. This would suggest that drawdown caused by production wells in the BC-unit spreads farther laterally and deeper than drawdown in the DEF-unit.

Groundwater levels at more shallow coastal monitoring wells in this area have dropped slightly since Water Year 2006. This decline in the shallow interval of the DEF-unit may reflect a reduction in basin storage correlated with less precipitation.

Table 4-2 summarizes the important groundwater level trends by well. Hydrographs for these wells follow at the end of this section. Hydrographs for monitoring wells adjacent to production wells, and static groundwater levels in the production wells are also included following this section.

Contour maps of groundwater elevations in spring and fall 2009 for the Purisima BC-unit are shown in Figure 4-2 and Figure 4-3. Figure 4-2 shows that the spring 2009 pumping depression in the BC-unit was below sea level, with below sea level groundwater levels partially extending to the coast. Figure 4-3 shows the below sea level pumping depression deepened in the fall and extended closer to the coast.

Table 4-2 (2009): Summary of Groundwater Level Trends in Central Purisima Area

Category	Well	Groundwater Level Trend Description	Notes
SqCWD Coastal Monitoring BC and DEF-unit Wells	SC-9B	Stable WY 2006-2009 after sharp decline in WY 2005	Ledyard well returned to service in WY 2005 and steady pumping WY 2006-2009
	SC-8D	Increasing DEF-unit WY 2005-2009	Reduced pumping at Aptos Creek and T. Hopkins since WY 2004
	SC-8B	BC-unit stable WY 2005-2009 and > 10 feet below SC-8D	Deeper drawdown from BC-unit pumping
SqCWD Shallow Monitoring Coastal Wells	SC-9E SC-8E	Decline of 1-2 feet in overlying interval of DEF-unit since WY 2006	Reduced precipitation since WY 2006
	SC-8F	Unreliable data	Well filled up to a depth of 106 feet from original 200 feet depth

4.3 Water Quality Conditions and Trends

The most significant groundwater quality threat in the Soquel-Aptos basin is seawater intrusion. As discussed above, groundwater levels remain below protective elevations and sea level in the BC and DEF-units. As a result, there is ongoing risk of seawater intrusion into the productive units of the central Purisima area.

Observed Total Dissolved Solids (TDS) and chloride concentrations do not suggest any seawater intrusion impacting SqCWD's production wells in the Purisima BC and DEF-units and sub-Purisima Tu-unit. Observed TDS and chloride concentrations at SqCWD's monitoring wells in the BC and DEF-units also do not indicate incipient seawater intrusion. Recent chloride concentrations in both production and monitoring wells are at 60 mg/L or less, while the maximum contaminant limit (MCL) for chlorides is 250 mg/L. Chemographs for SqCWD wells in the area are included following this section.

Chloride concentrations in well SC-8F completed in the shallow F-unit were measured as approximately 3,000 mg/L starting in Water Year 2007, but these data from this well are not reliable. The well is sanded up to 100 feet and the well is slated for replacement.

Water pumped from the Purisima formation continues to be treated for iron and manganese to meet drinking water standards. In Water Year 2009, color and turbidity were also reduced during treatment to meet drinking water standards.

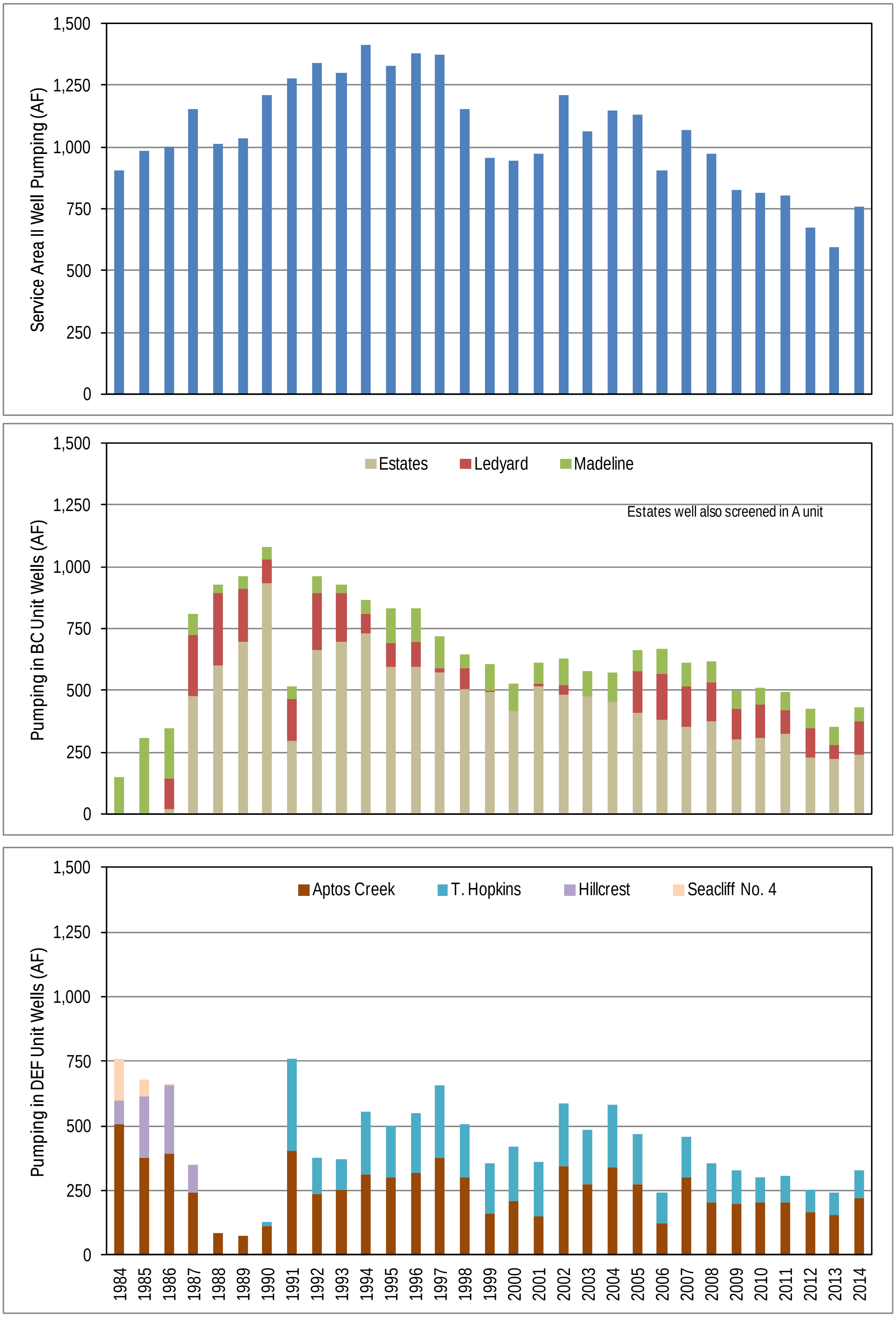
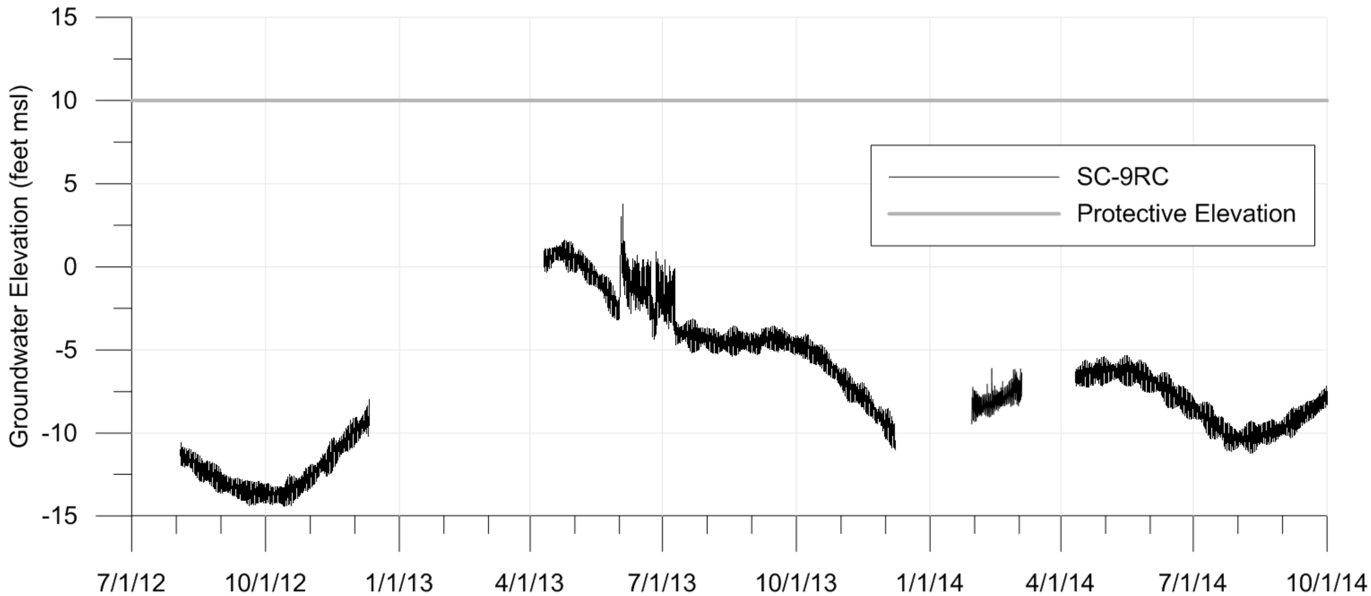


Figure 4-1: Pumping by Water Year in Central Purisima Area



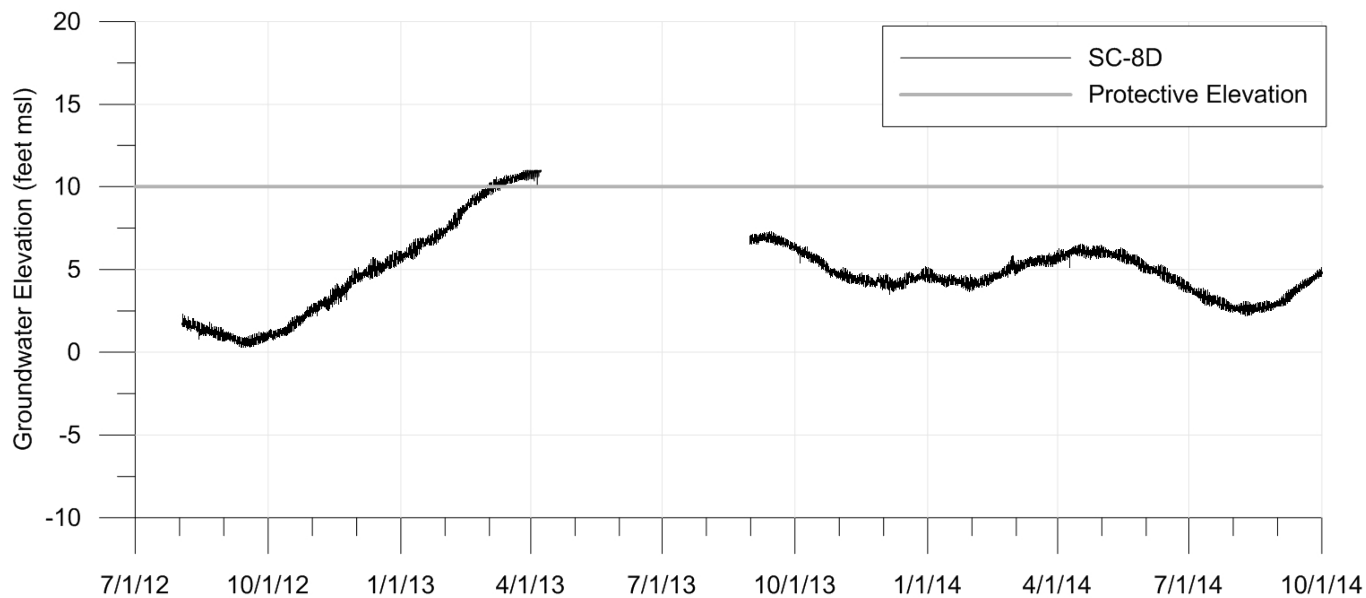


Figure 4-2: Groundwater Level Logger Hydrographs for SC-9C and SC-8D

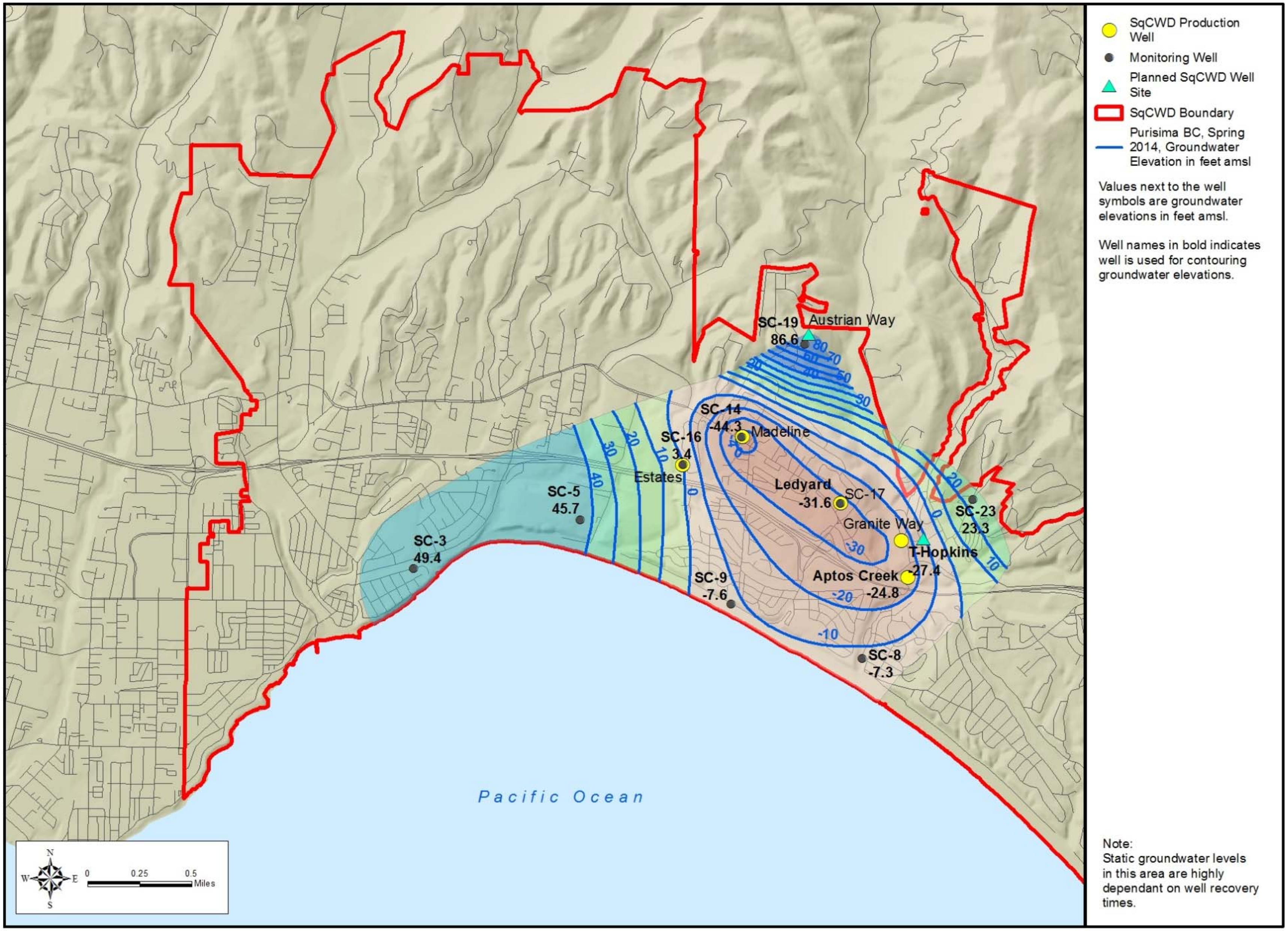


Figure 4-3 (2014): Groundwater Elevation Contours, Purisima BC-Unit, Spring 2014

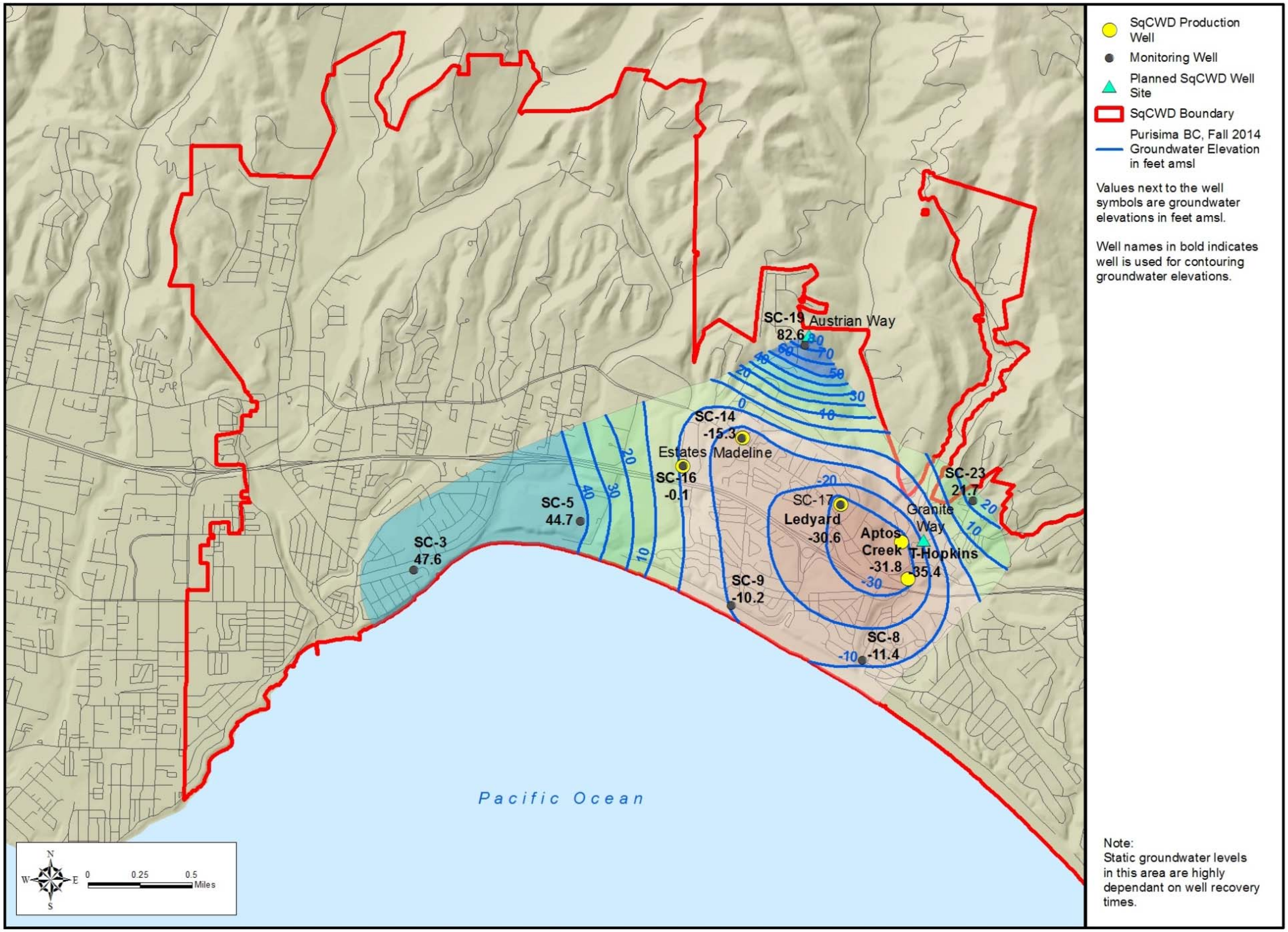


Figure 4-4 (2014): Groundwater Elevation Contours, Purisima BC-Unit, Fall 2014

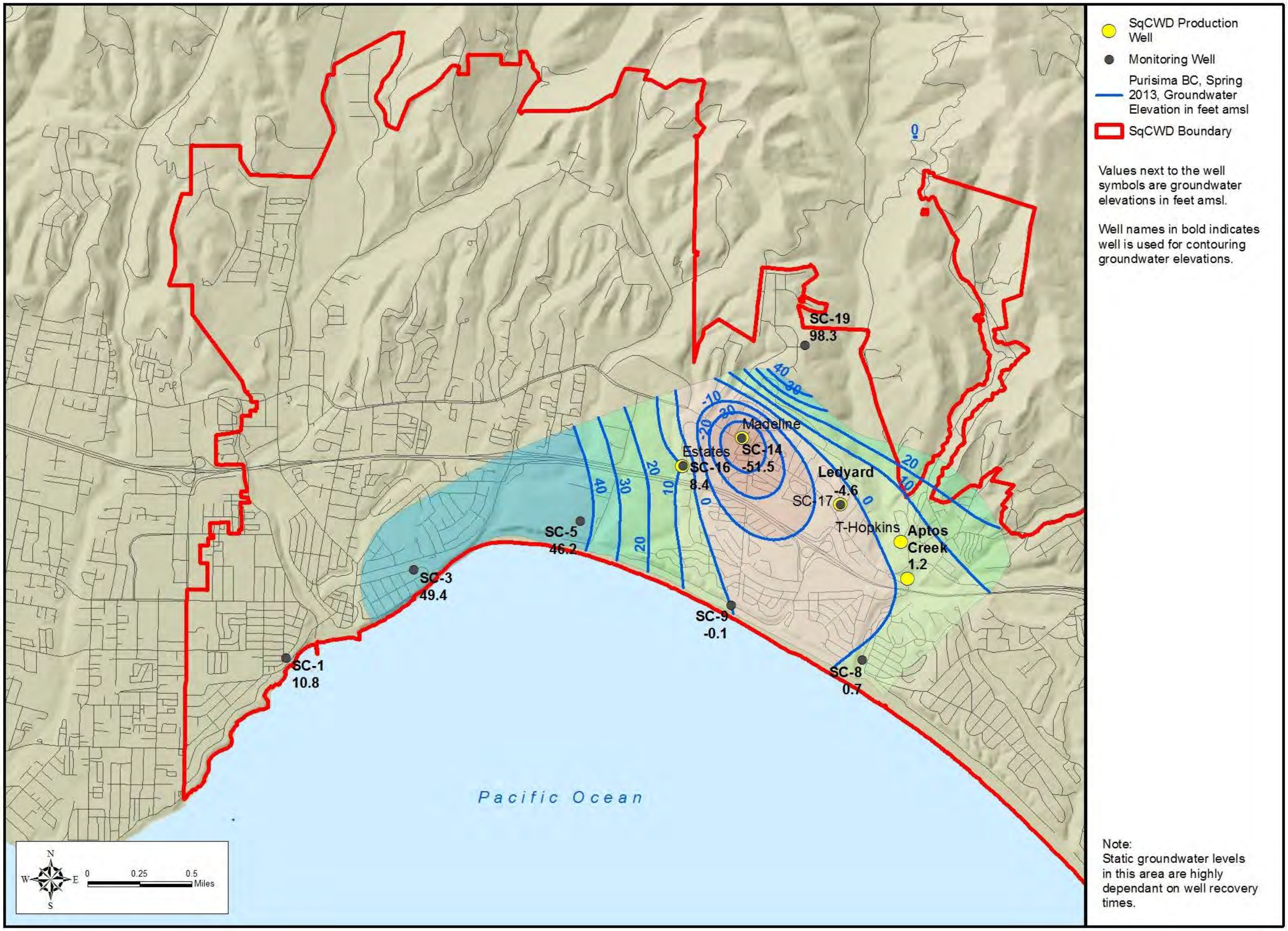


Figure 4-2 (2013): Groundwater Elevation Contours, Purisima BC-Unit, Spring 2013

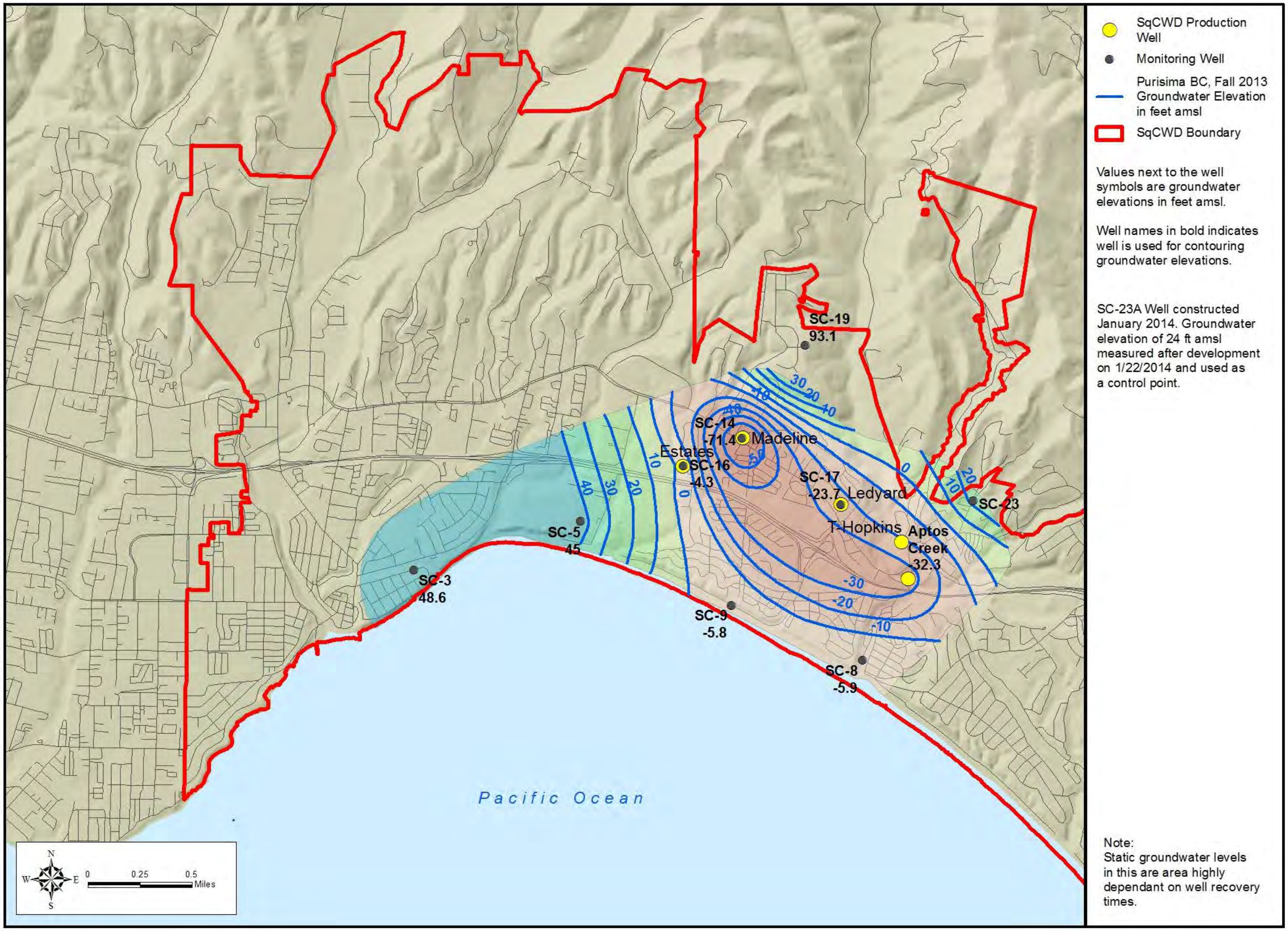


Figure 4-3 (2013): Groundwater Elevation Contours, Purisima BC-Unit, Fall 2013

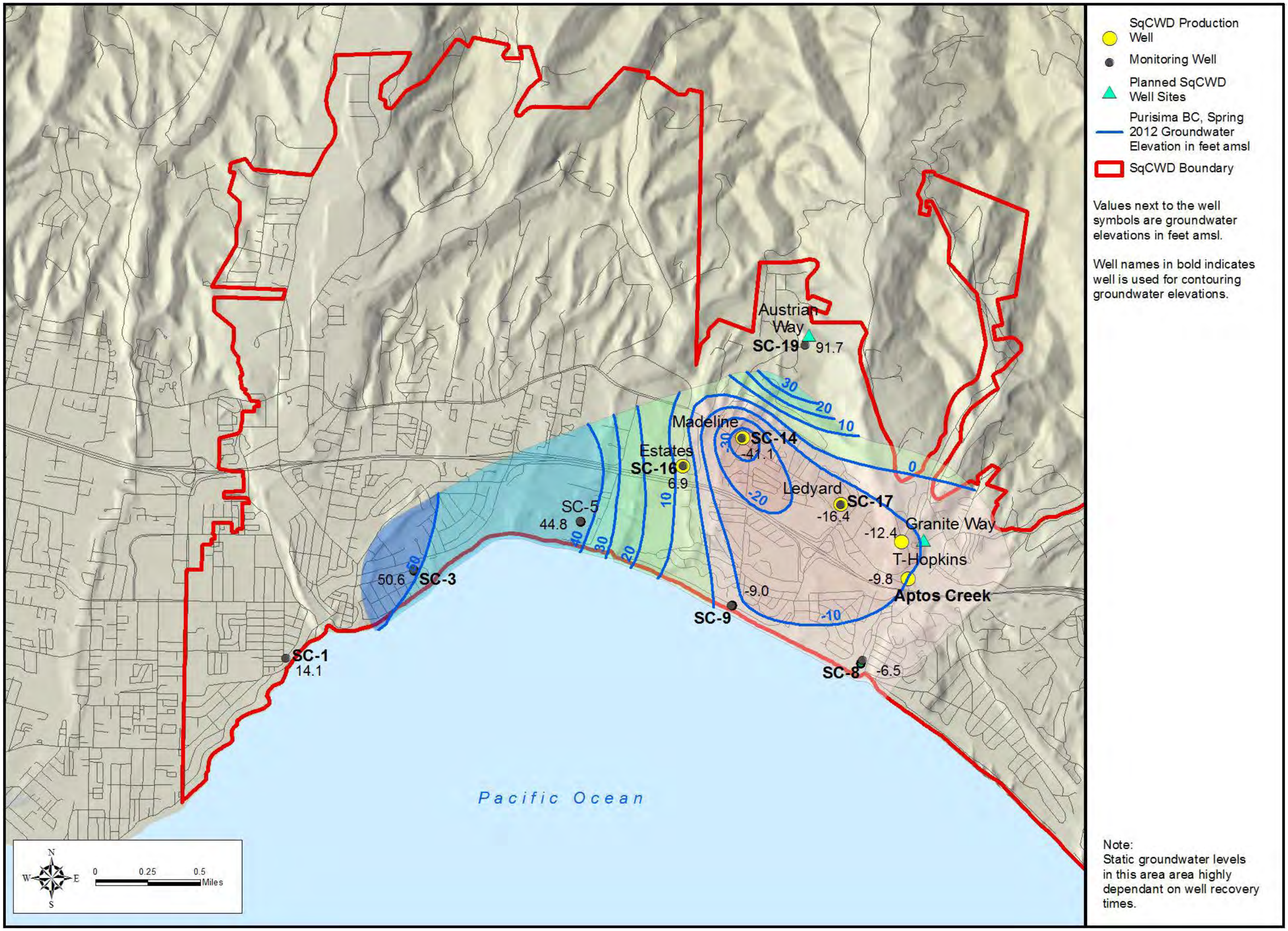


Figure 4-2 (2012): Groundwater Elevation Contours, Purisima BC-Unit, Spring 2012

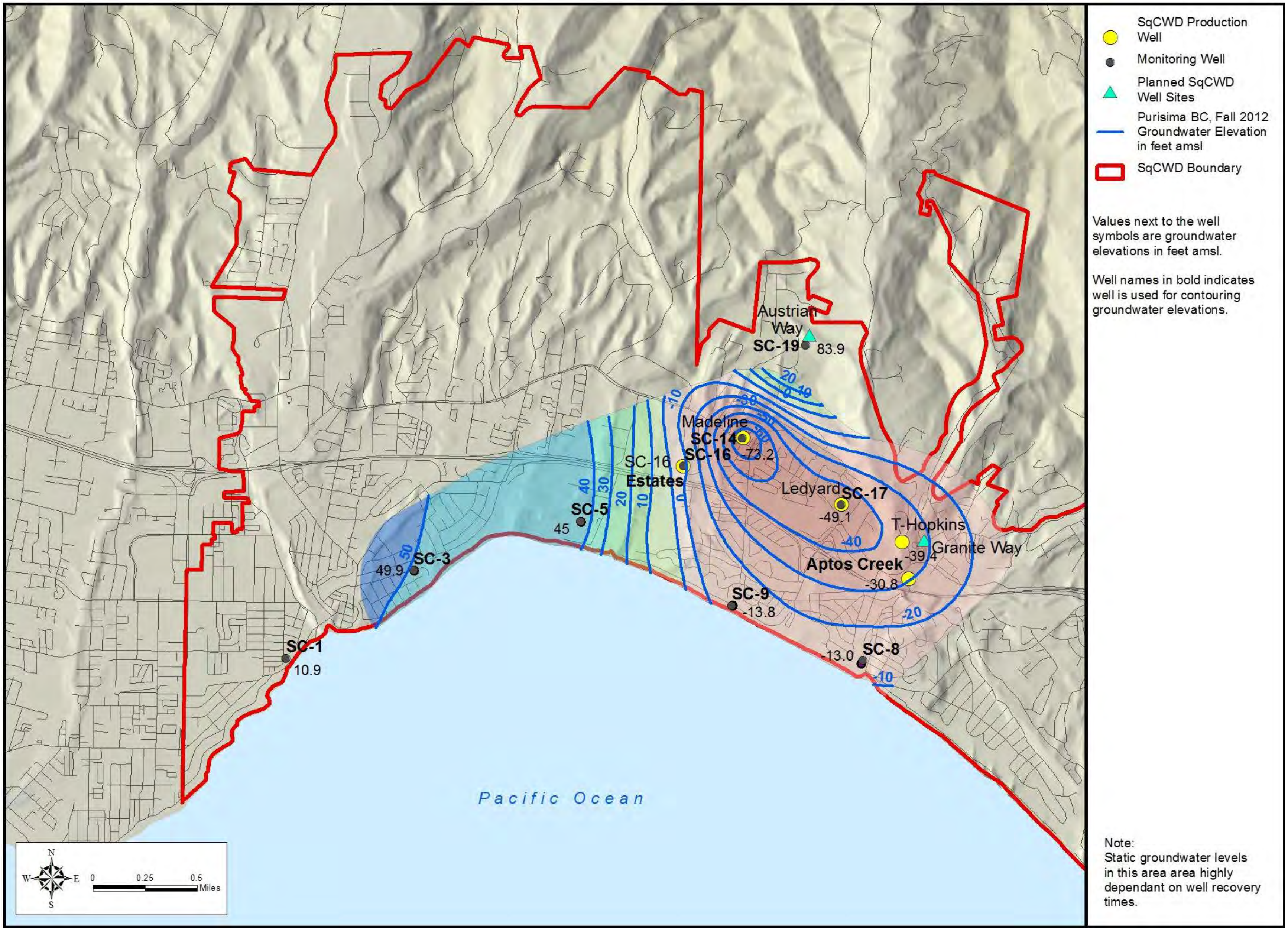


Figure 4-3 (2012): Groundwater Elevation Contours, Purisima BC-Unit, Fall 2012

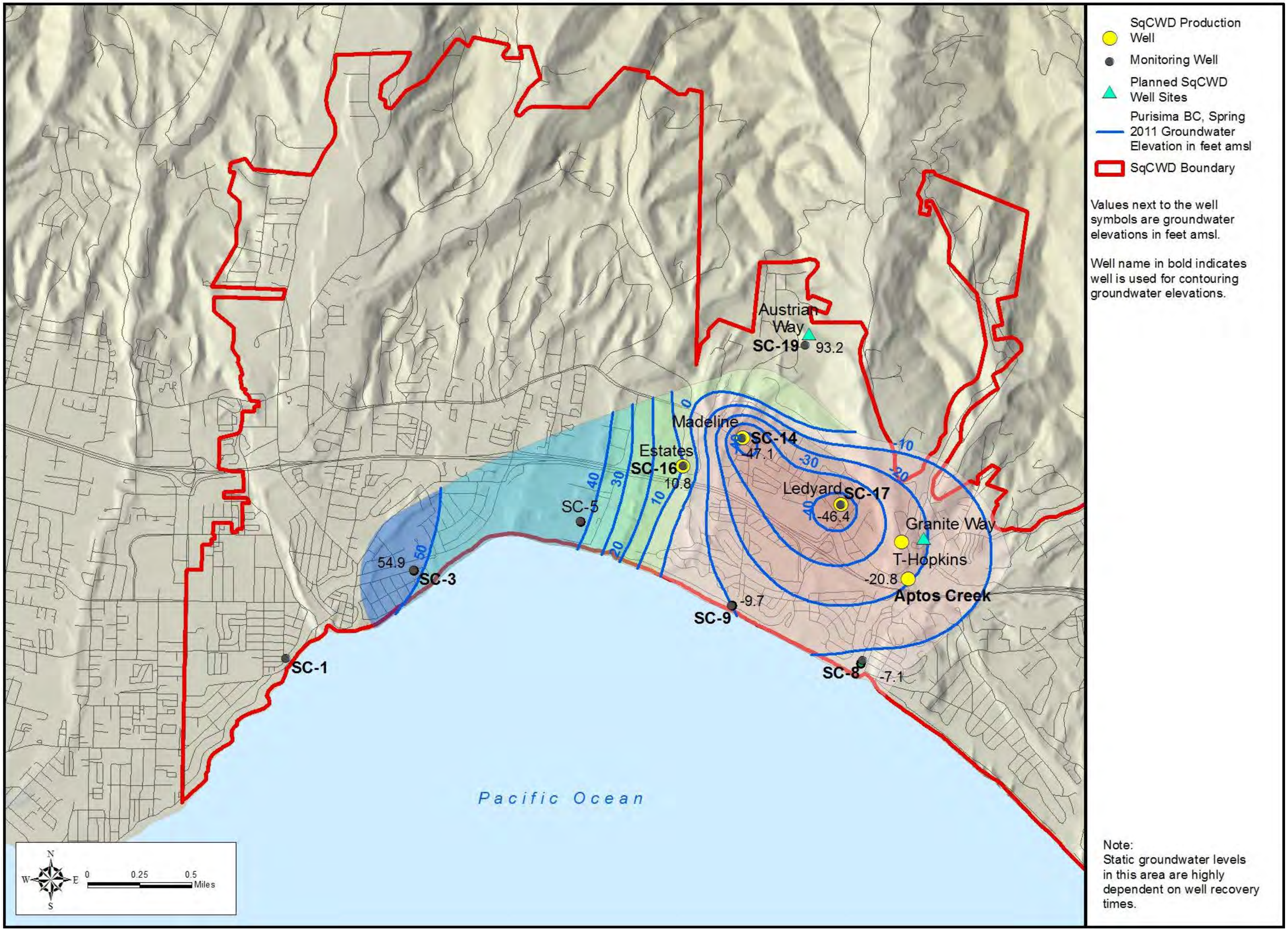


Figure 4-2 (2011): Groundwater Elevation Contours, Purisima BC-Unit, Spring 2011

HydroMetrics WRI

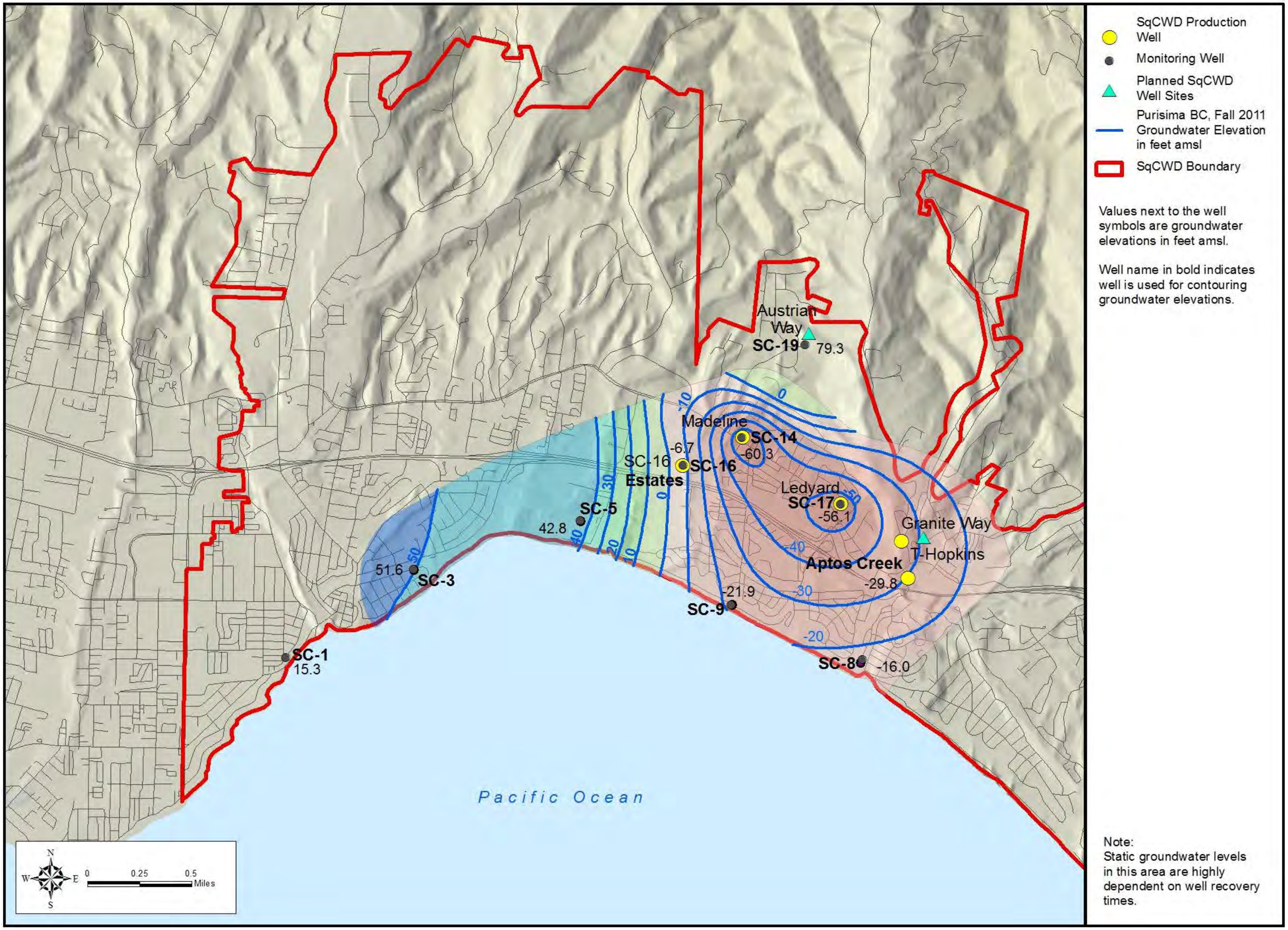


Figure 4-3 (2011): Groundwater Elevation Contours, Purisima BC-Unit, Fall 2011

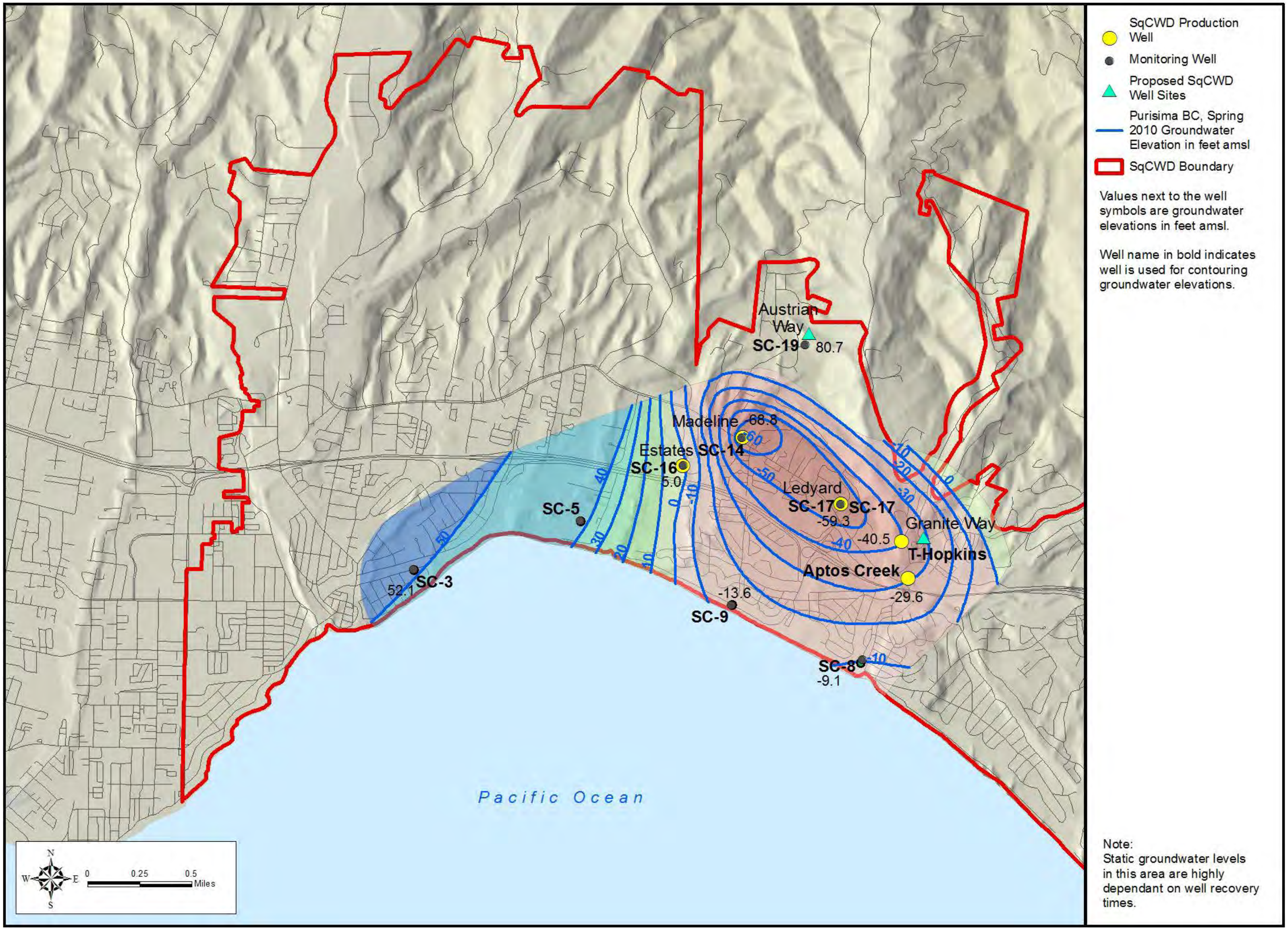


Figure 4-2 (2010): Groundwater Elevation Contours, Purisima BC-Unit, Spring 2010

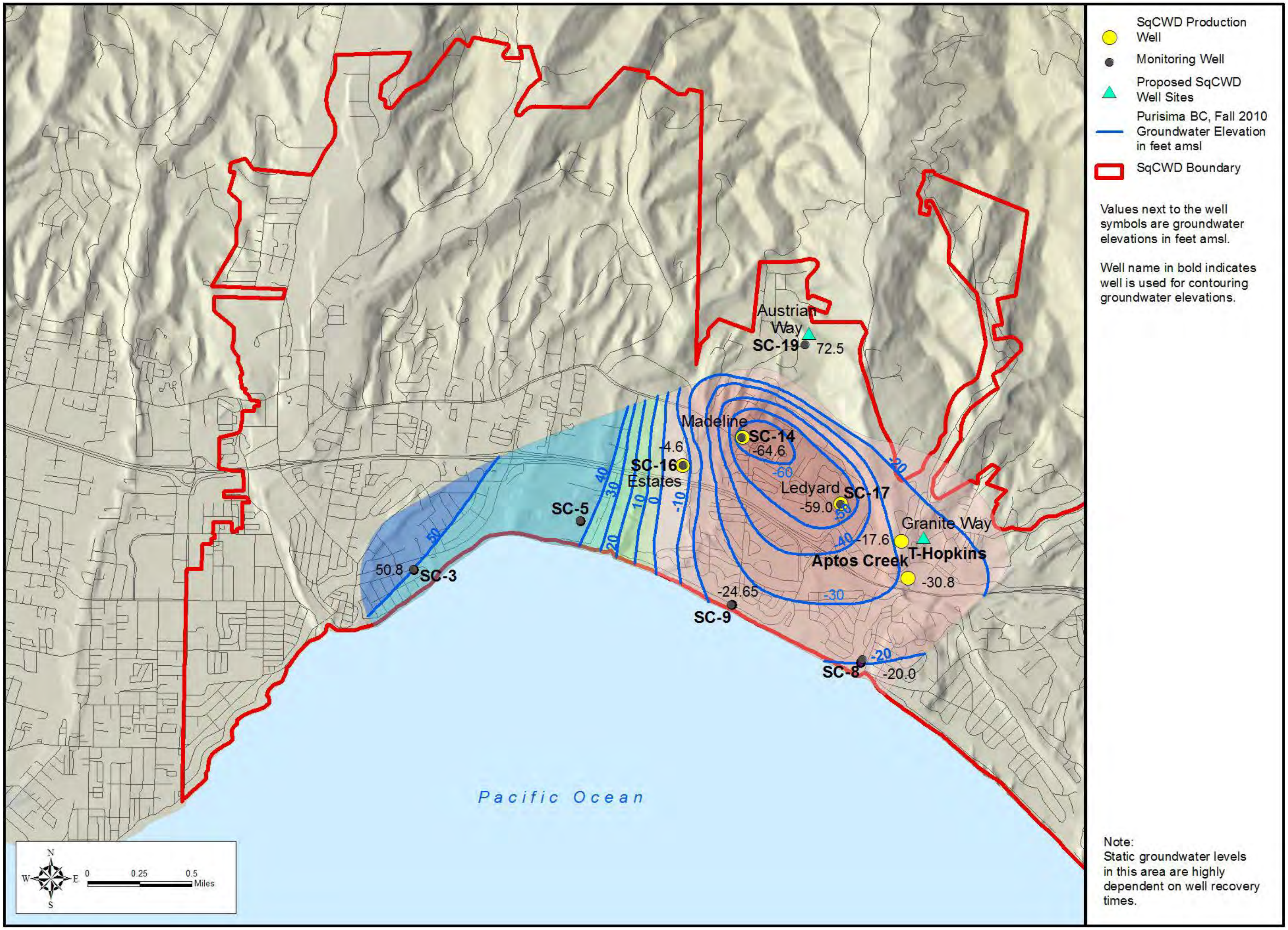


Figure 4-3 (2010): Groundwater Elevation Contours, Pursima BC-Unit, Fall 2010

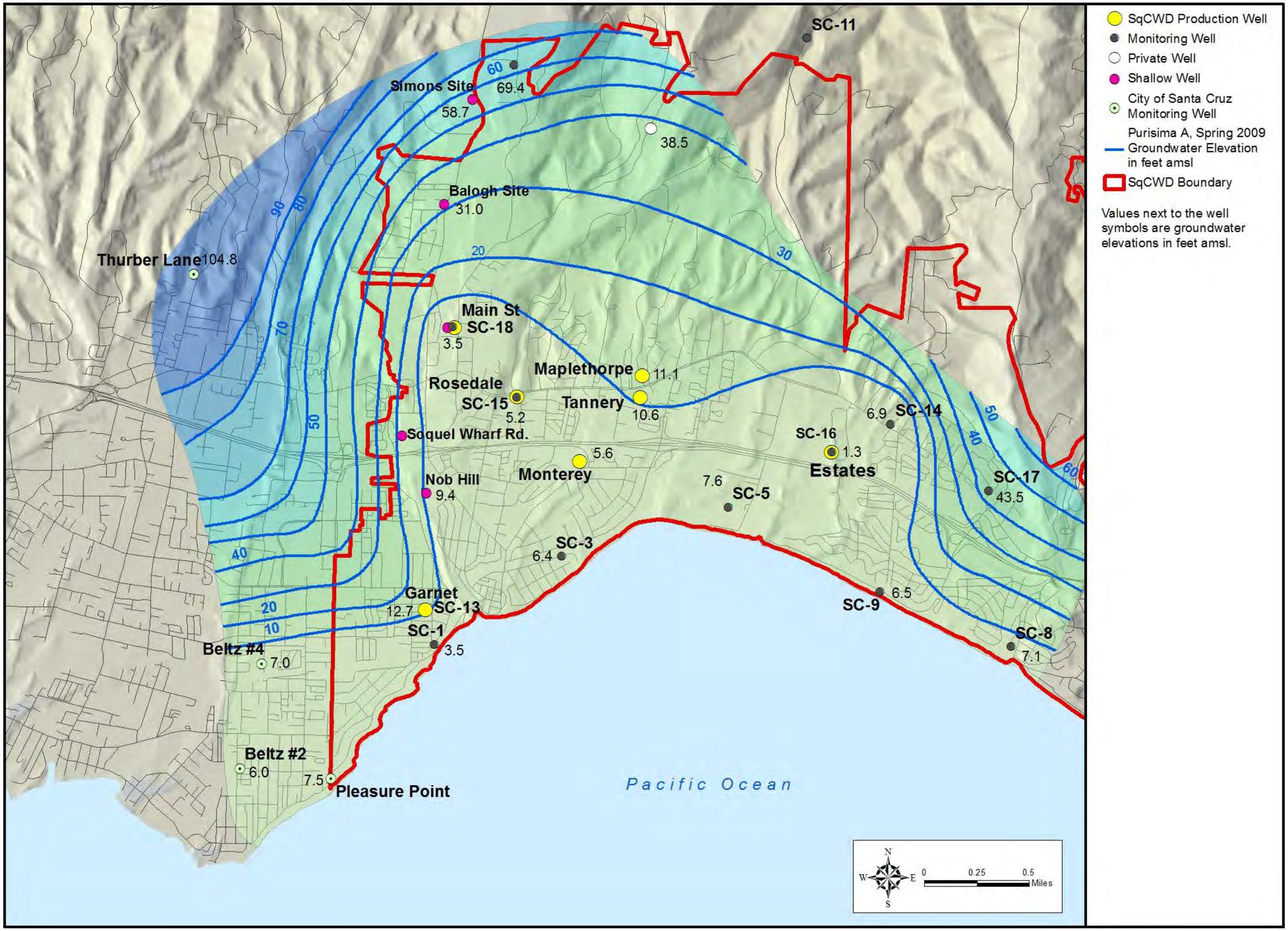


Figure 3-2 (2009): Groundwater Elevation Contours, Purisima A-Unit, Spring 2009

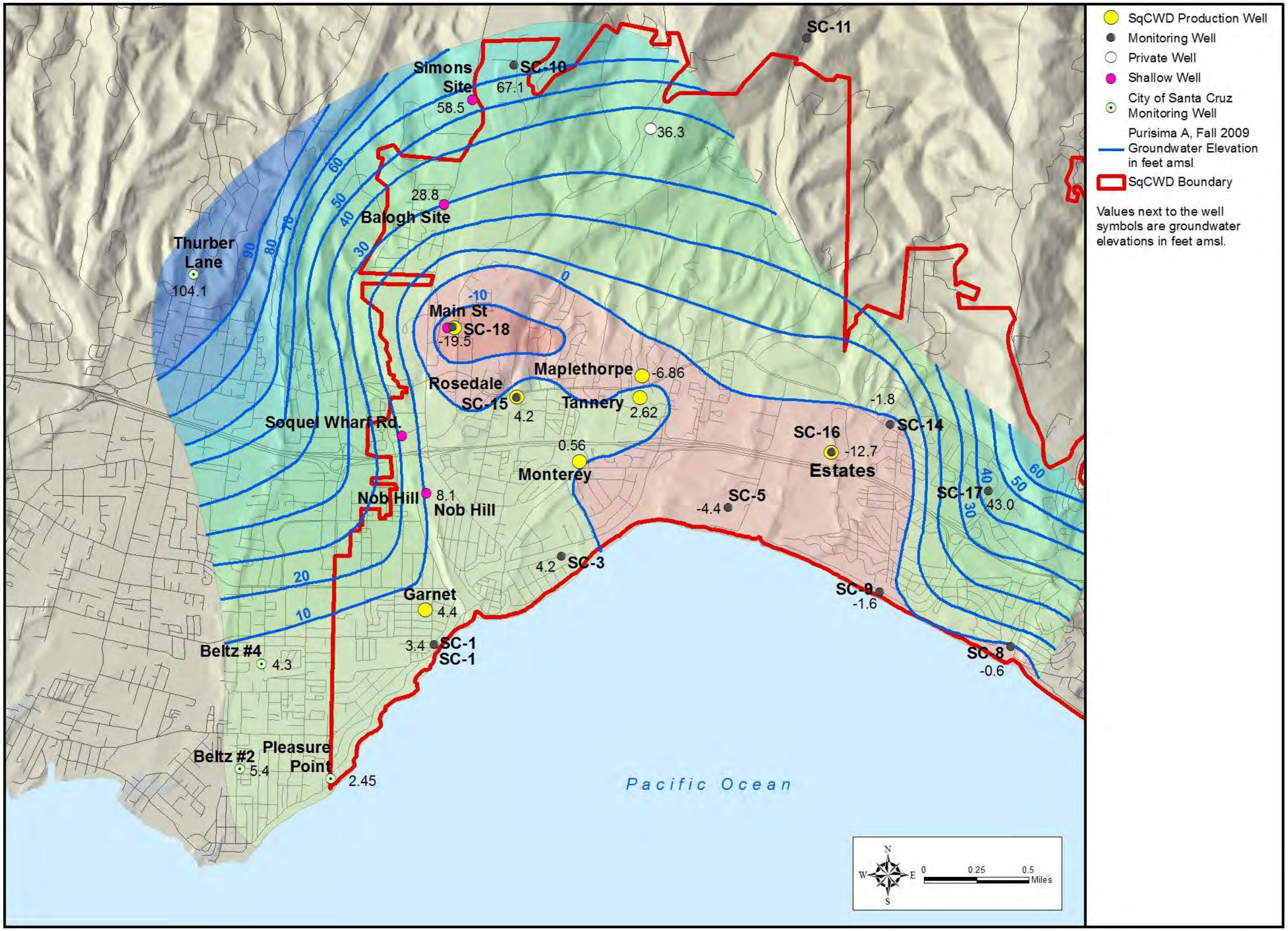


Figure 3-3 (2009): Groundwater Elevation Contours, Purisima A-Unit, Fall 2009

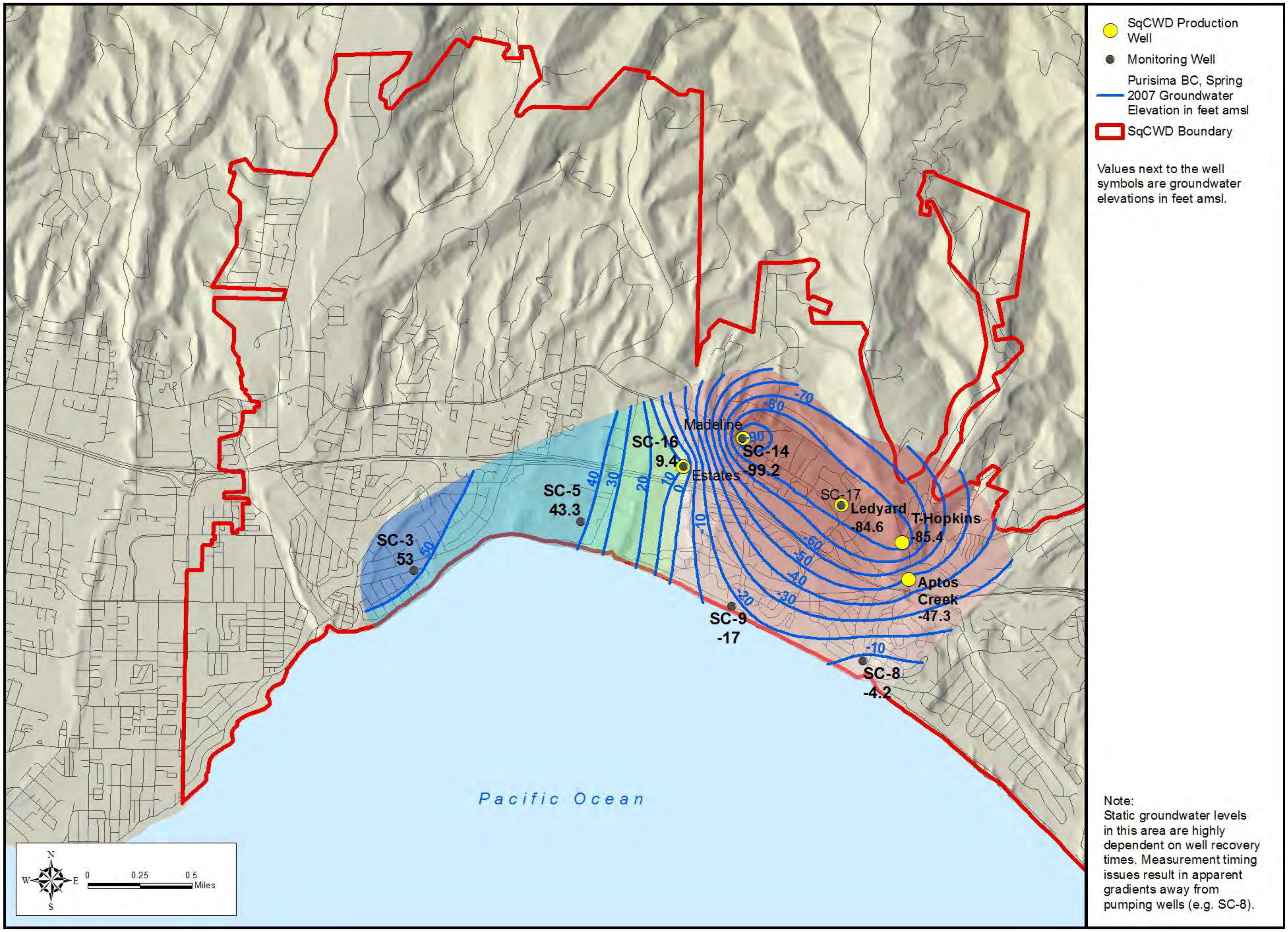


Figure 4-2 (2007): Groundwater Elevation Contours, Purisima BC-Unit, Spring 2007

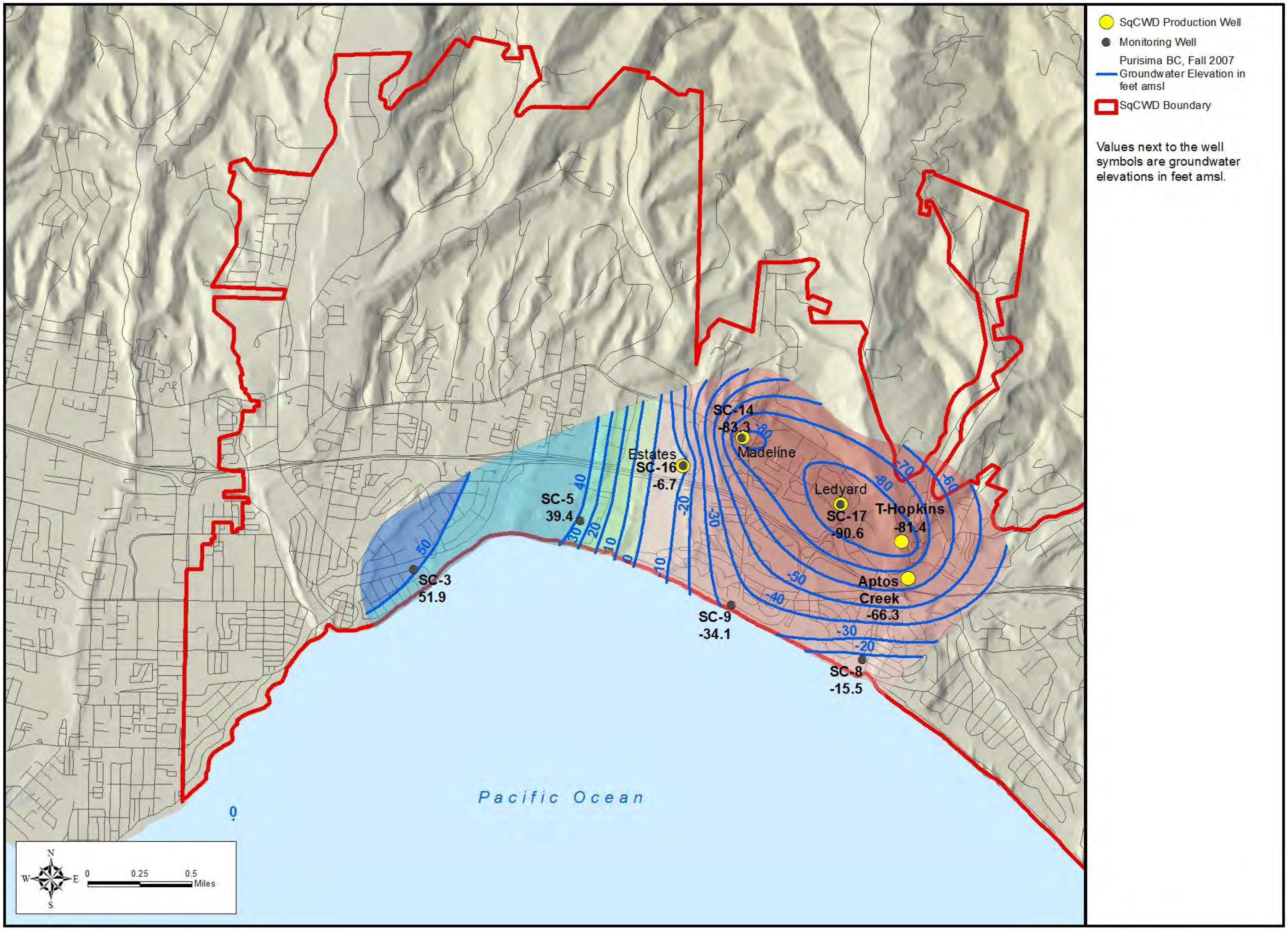


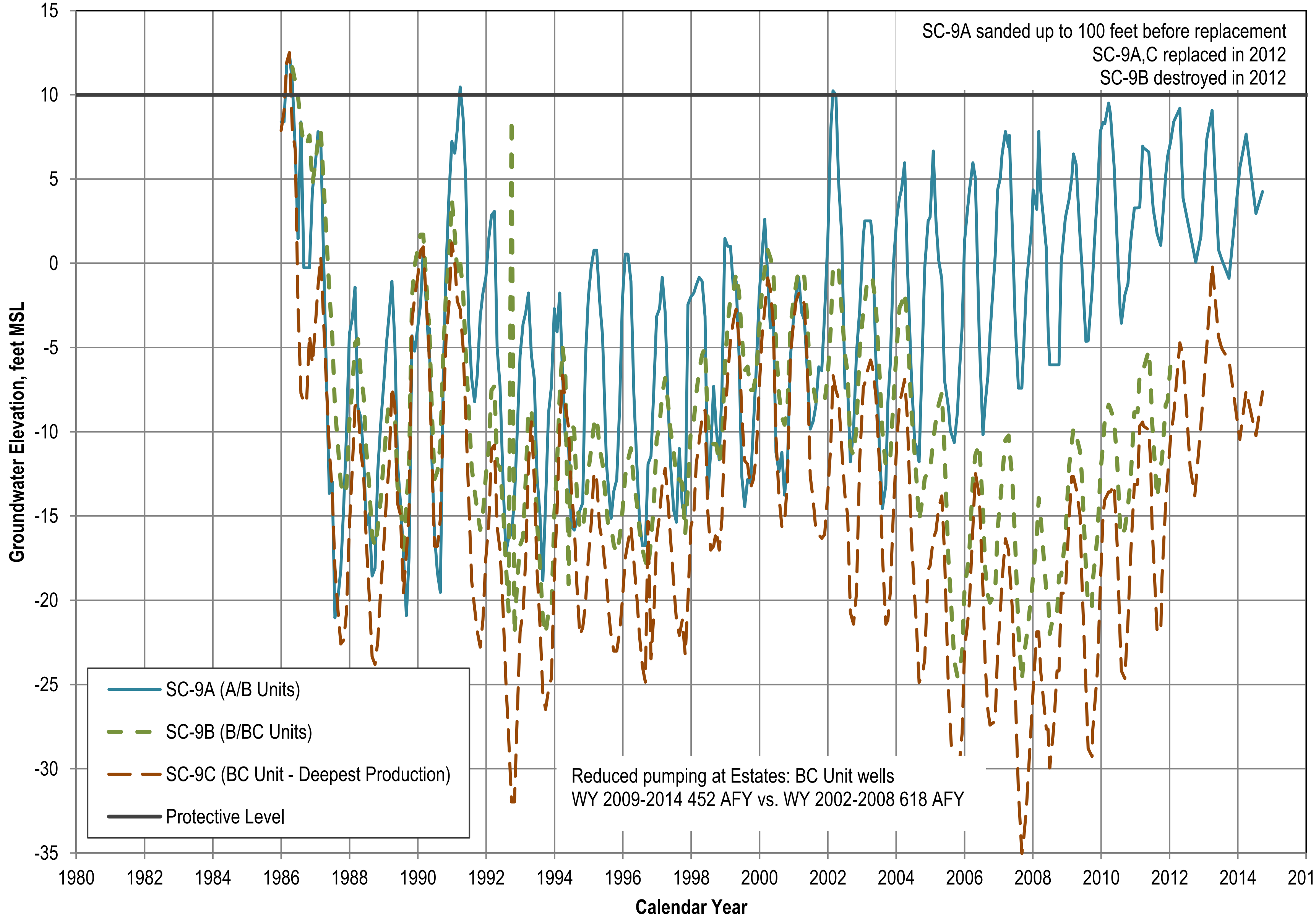
Figure 4-3 (2007): Groundwater Elevation Contours, Purisima BC-Unit, Fall 2007

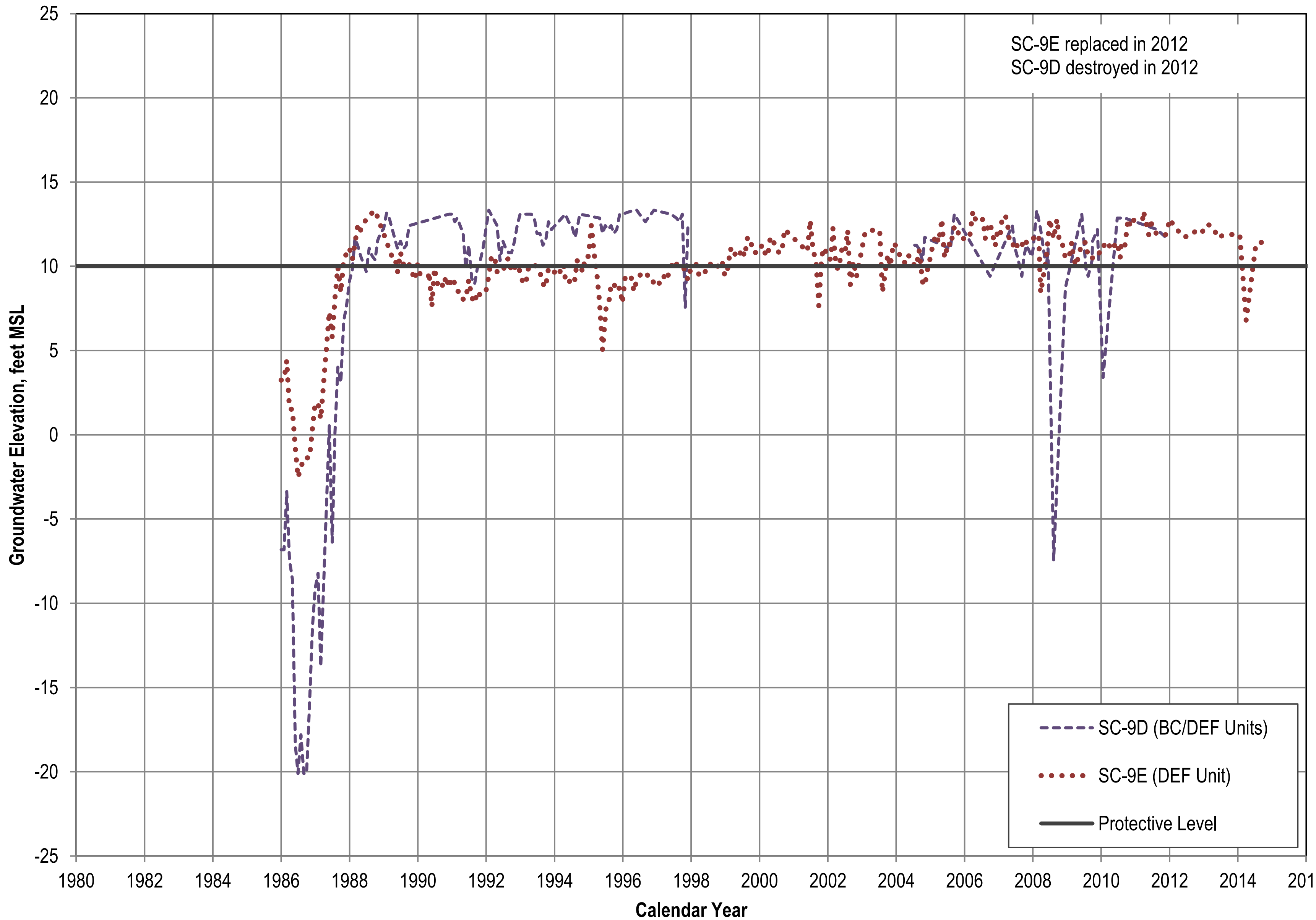
Monitoring Well Hydrographs for Central Purisima Area

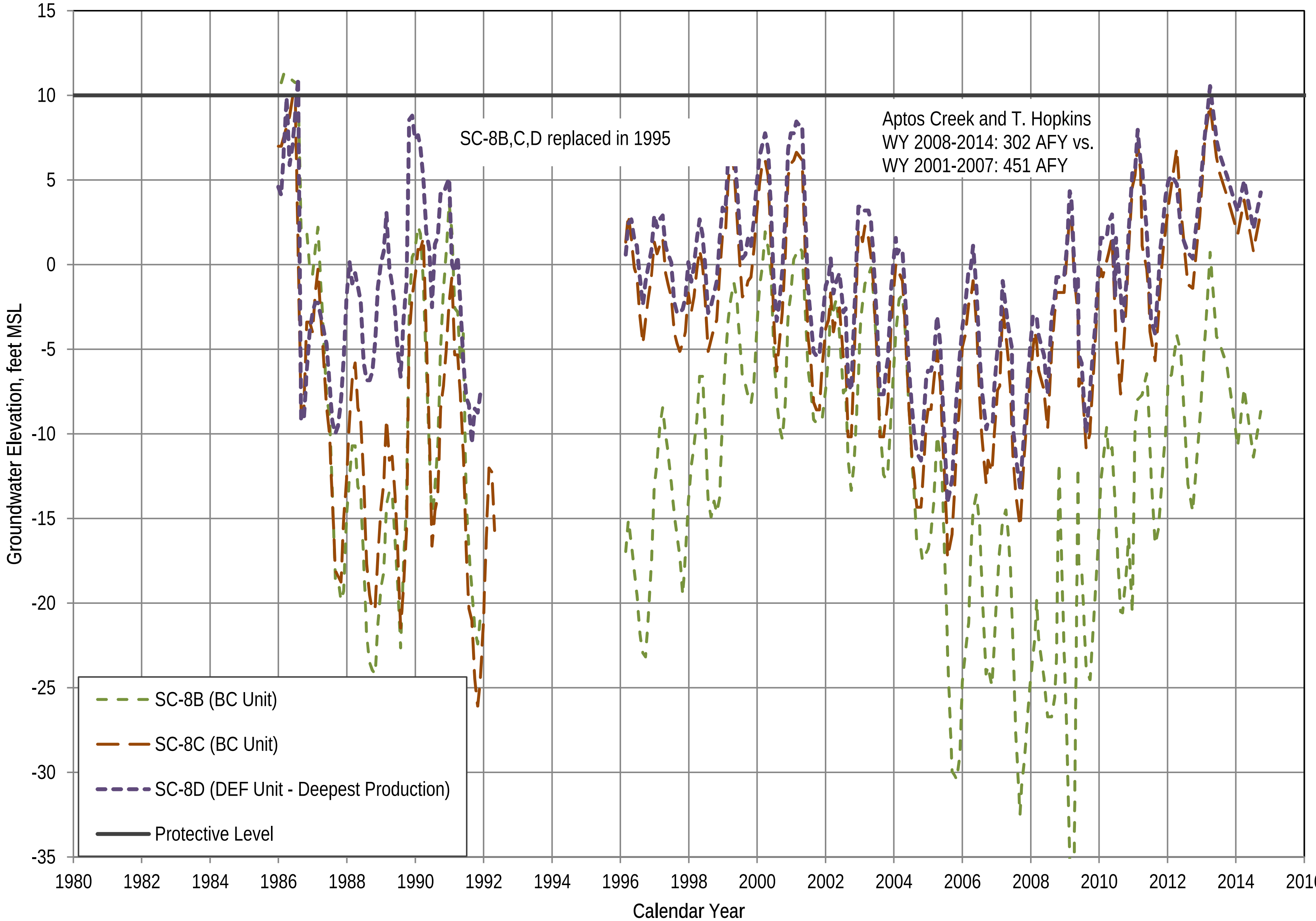
Hydrographs of SqCWD Coastal Monitoring Well Clusters

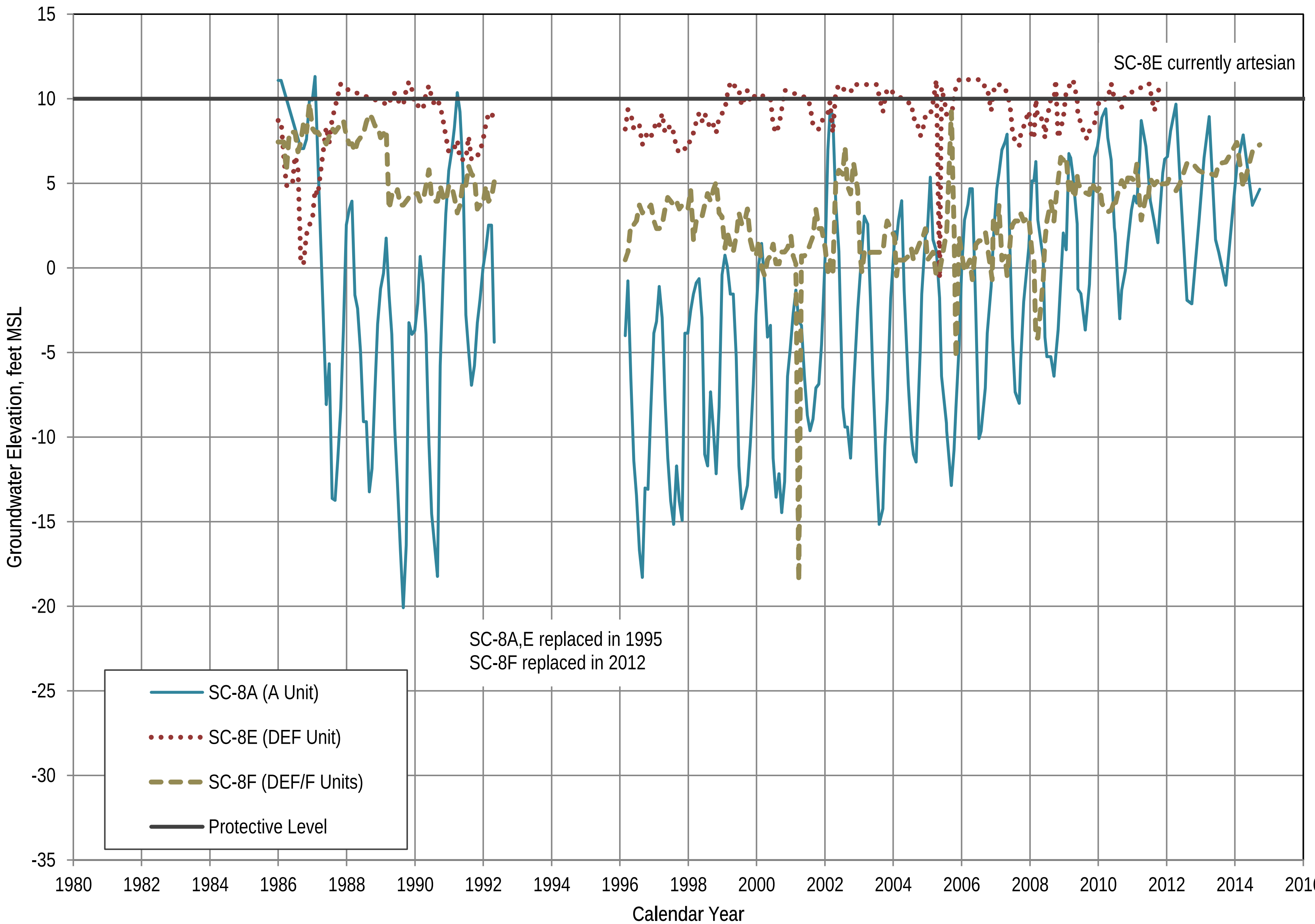
Hydrographs of SqCWD Inland Monitoring Well Clusters

Hydrographs of SqCWD Monitoring Wells Adjacent to Production Wells

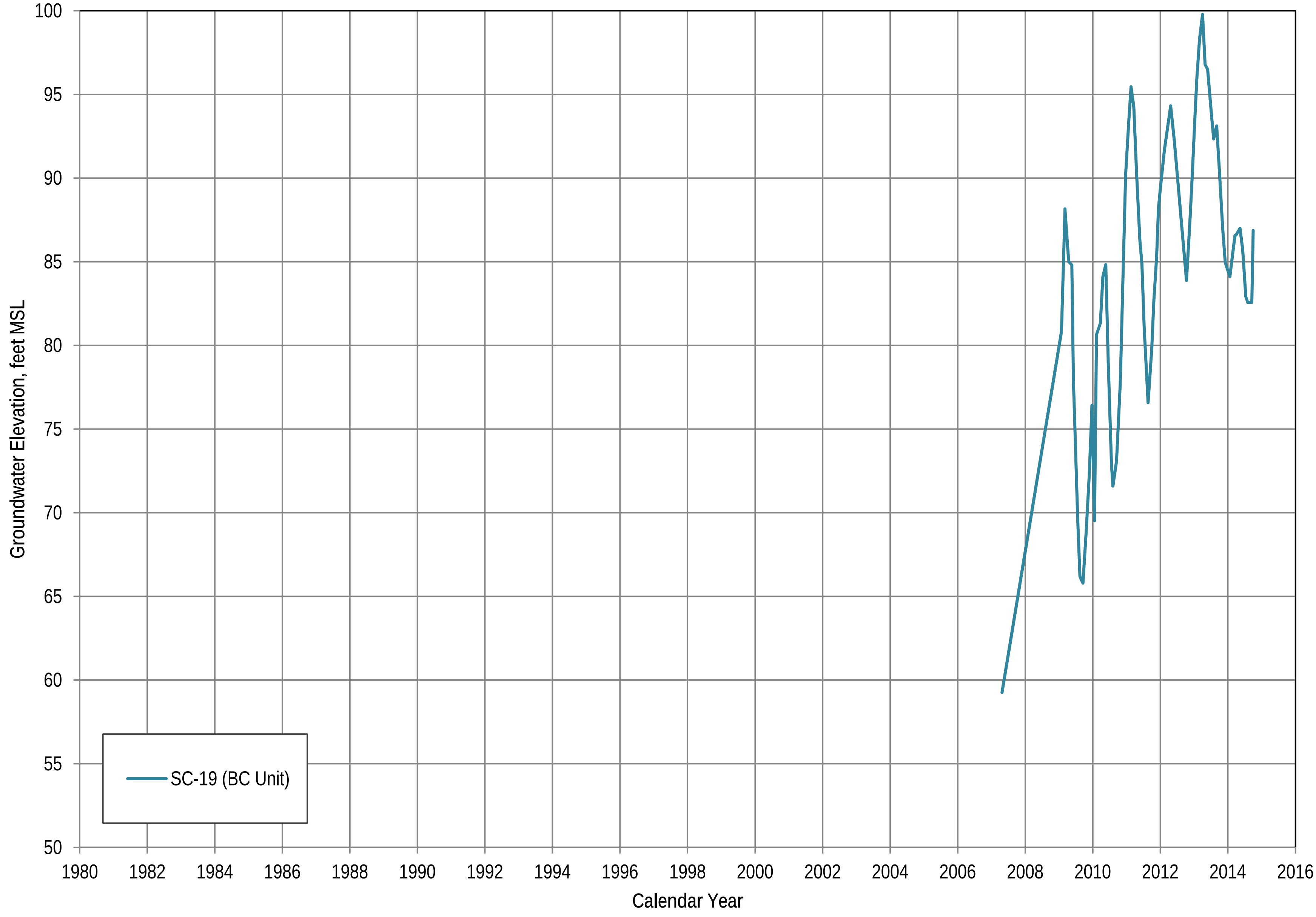

SC-9A sanded up to 100 feet before replacement
SC-9A,C replaced in 2012
SC-9B destroyed in 2012
Groundwater Elevation, feet MSL
Calendar Year
15
10
5
0
-5
-10
-15
-20
-25
-30
-35
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
SC-9A (A/B Units)
SC-9B (B/BC Units)
SC-9C (BC Unit - Deepest Production)
Protective Level
Reduced pumping at Estates: BC Unit wells
WY 2009-2014 452 AFY vs. WY 2002-2008 618 AFY


SC-9E replaced in 2012
SC-9D destroyed in 2012
Groundwater Elevation, feet MSL
25
20
15
10
5
0
-5
-10
-15
-20
-25
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
Calendar Year
SC-9D (BC/DEF Units)
SC-9E (DEF Unit)
Protective Level

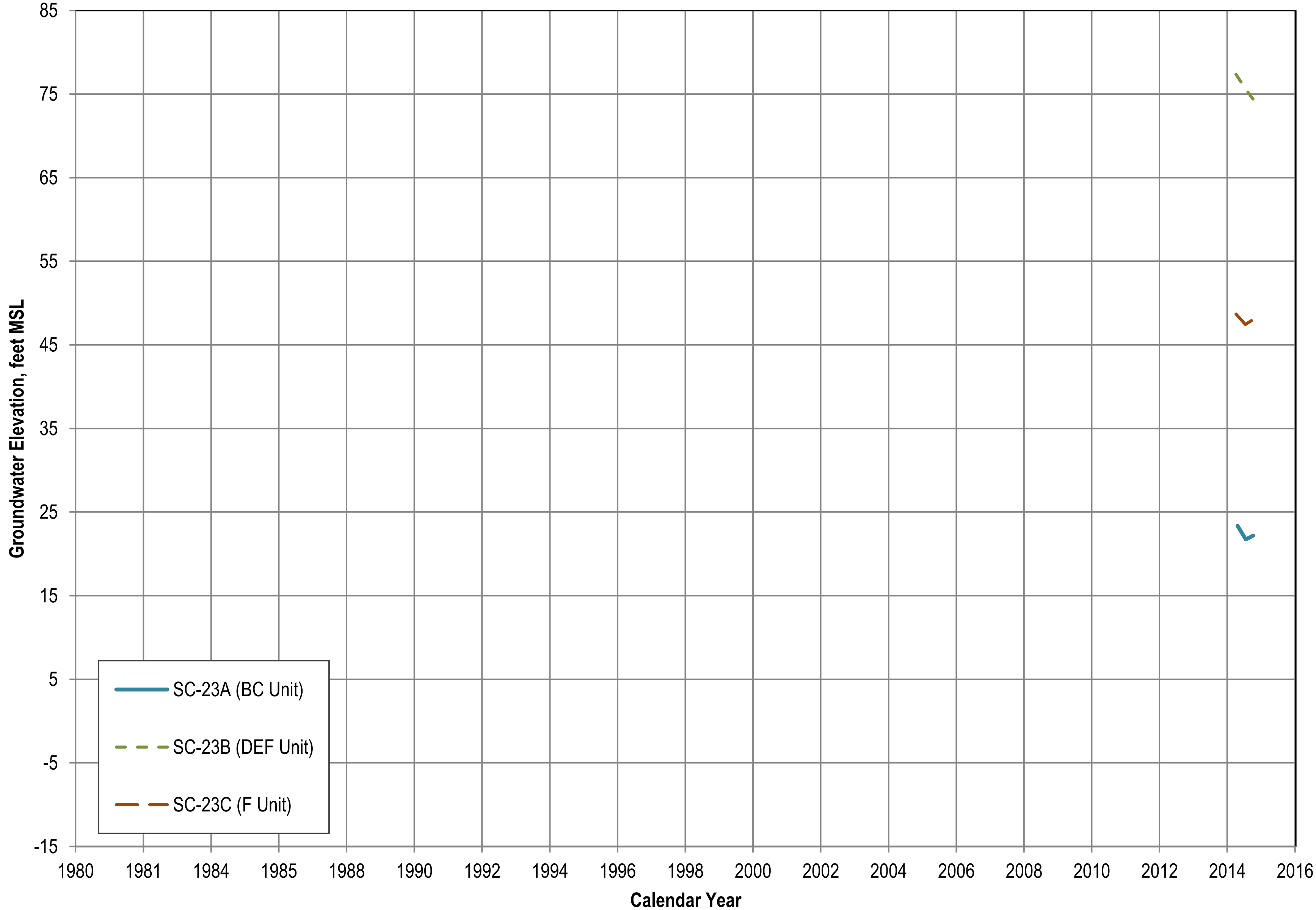

15
10
5
0
-5
-10
-15
-20
-25
-30
-35
Groundwater Elevation, feet MSL
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
Calendar Year
SC-8B,C,D replaced in 1995
Aptos Creek and T. Hopkins
WY 2008-2014: 302 AFY vs.
WY 2001-2007: 451 AFY
SC-8B (BC Unit)
SC-8C (BC Unit)
SC-8D (DEF Unit - Deepest Production)
Protective Level

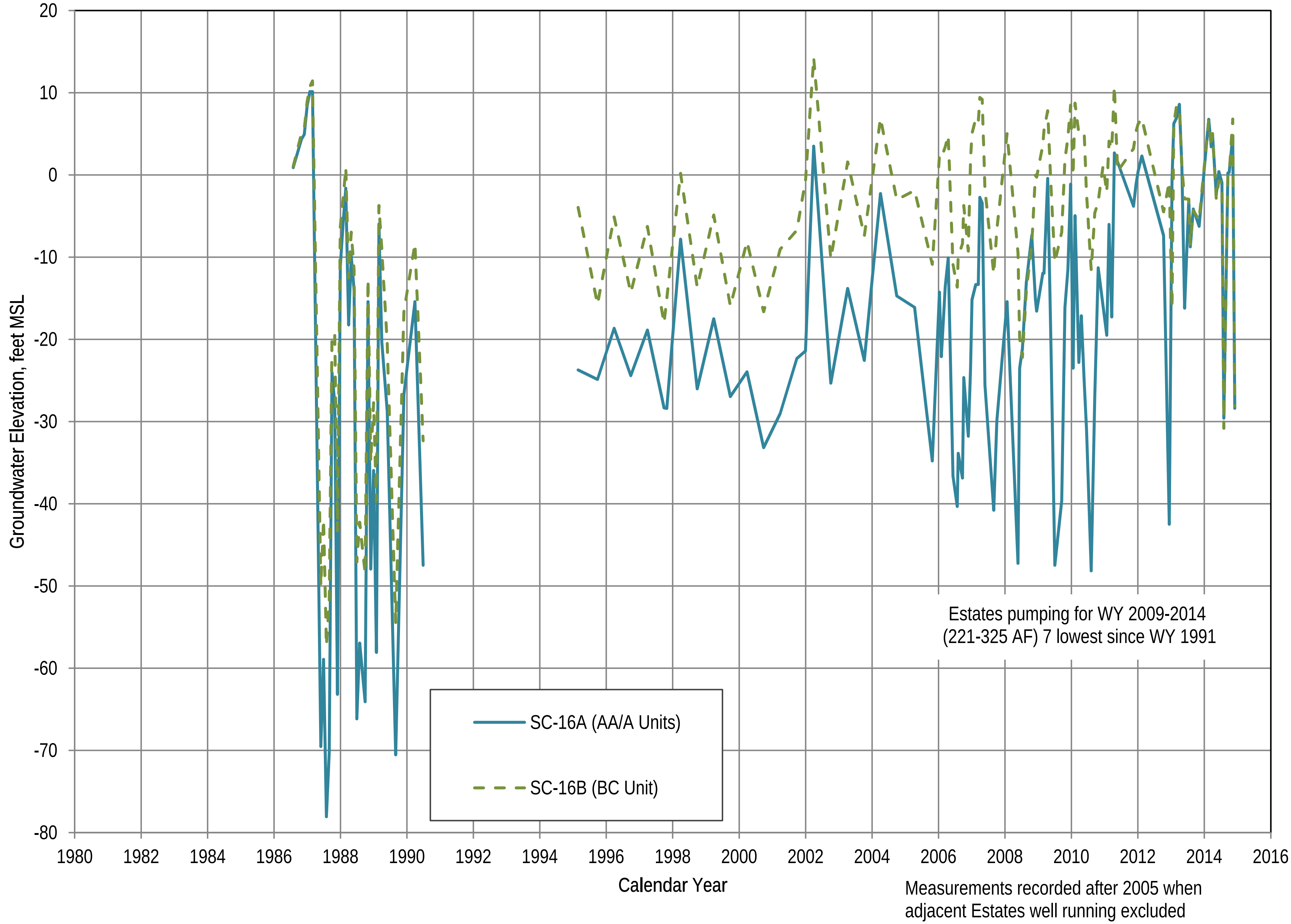


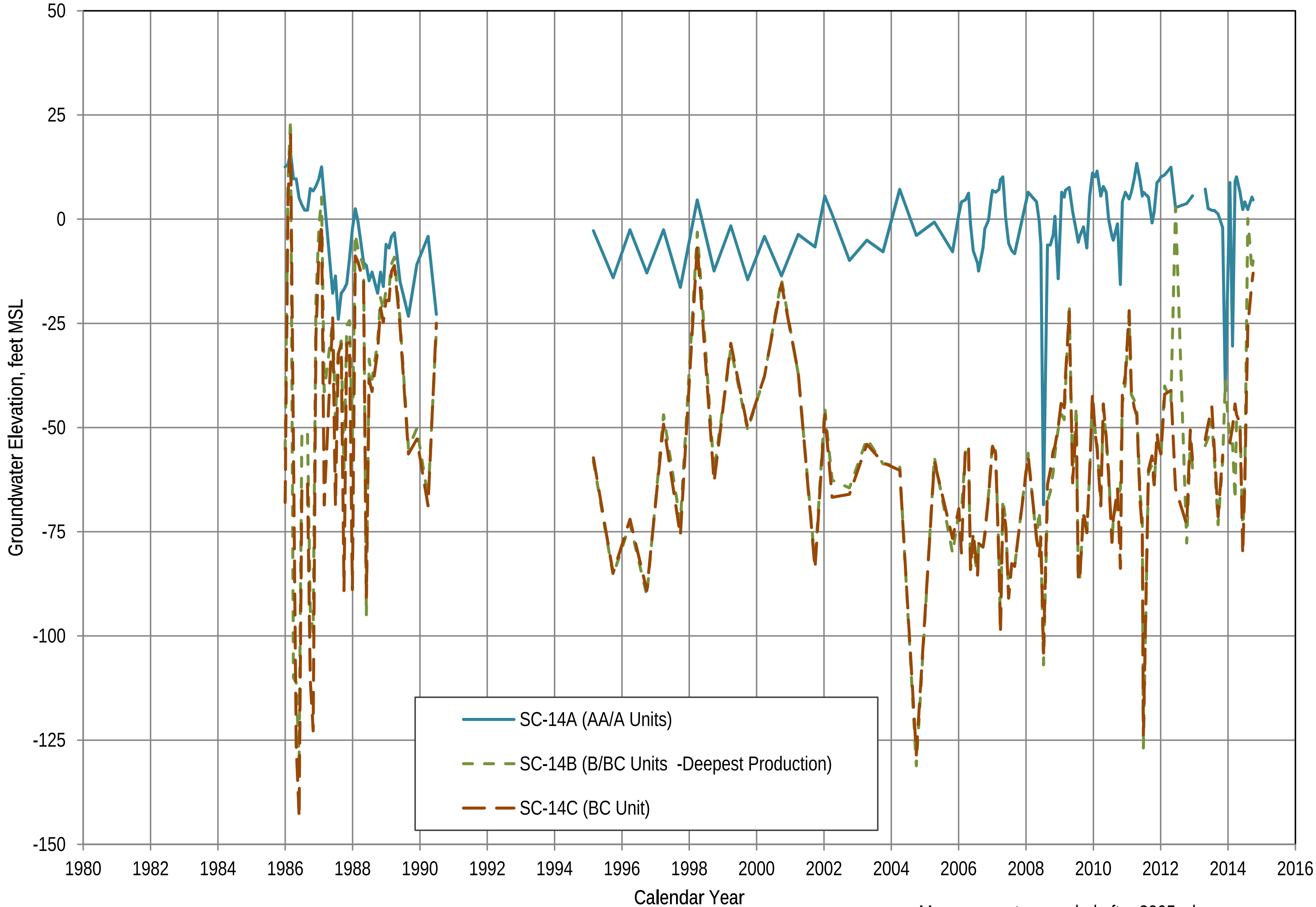
15
10
5
0
-5
-10
-15
-20
-25
-30
-35
Groundwater Elevation, feet MSL
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
Calendar Year
SC-8E currently artesian
SC-8A,E replaced in 1995
SC-8F replaced in 2012
SC-8A (A Unit)
SC-8E (DEF Unit)
SC-8F (DEF/F Units)
Protective Level



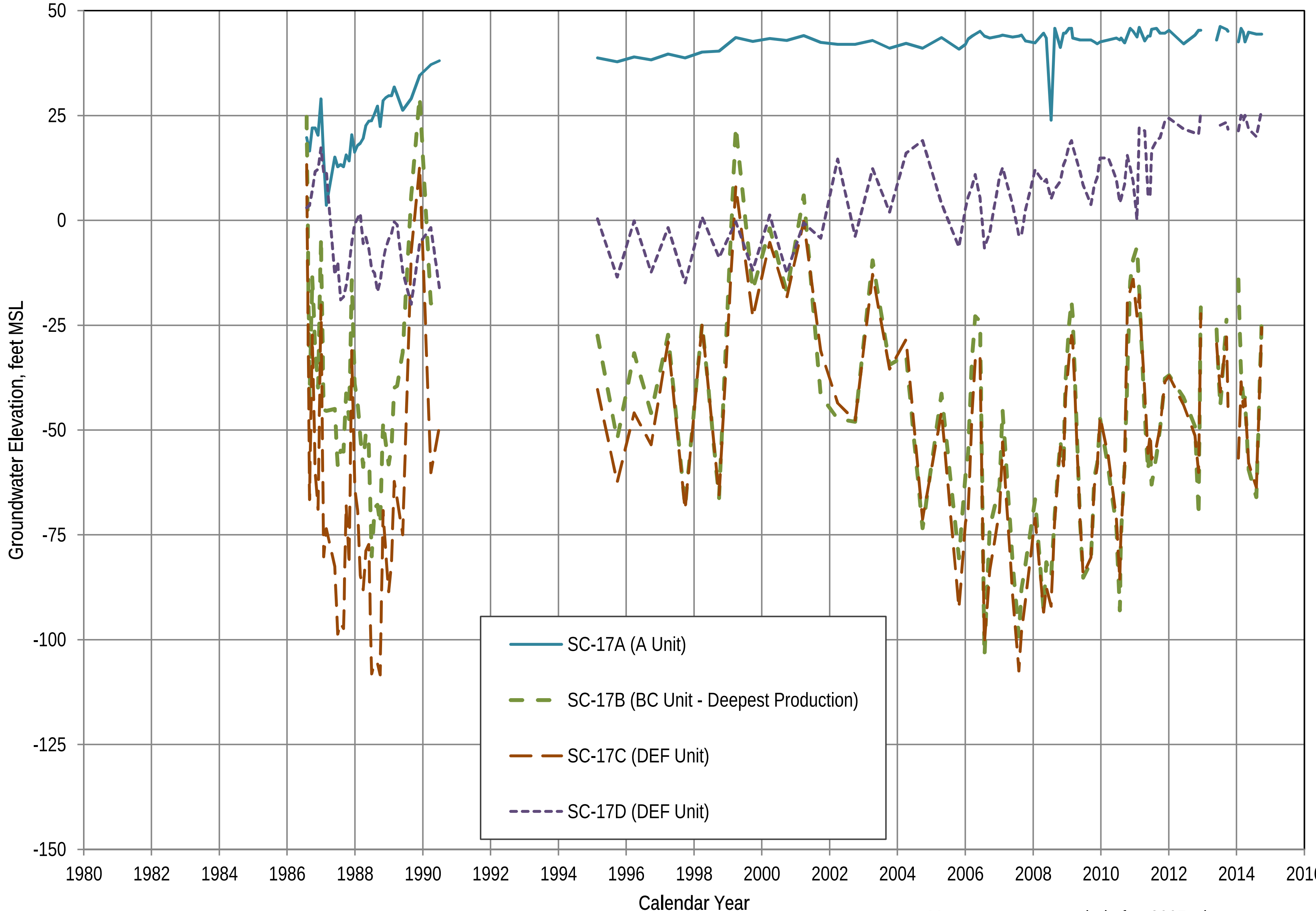
Groundwater Elevation, feet MSL
100
95
90
85
80
75
70
65
60
55
50
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
Calendar Year
SC-19 (BC Unit)


85
75
65
55
45
35
25
15
5
-5
-15
Groundwater Elevation, feet MSL
1980
1981
1984
1985
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
Calendar Year
SC-23A (BC Unit)
SC-23B (DEF Unit)
SC-23C (F Unit)


Groundwater Elevation, feet MSL
20
10
0
-10
-20
-30
-40
-50
-60
-70
-80
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
Calendar Year
Estates pumping for WY 2009-2014
(221-325 AF) 7 lowest since WY 1991
SC-16A (AA/A Units)
SC-16B (BC Unit)
Measurements recorded after 2005 when
adjacent Estates well running excluded



Measurements recorded after 2005 when adjacent Madeline well running excluded



Measurements recorded after 2005 when adjacent Ledyard well running excluded

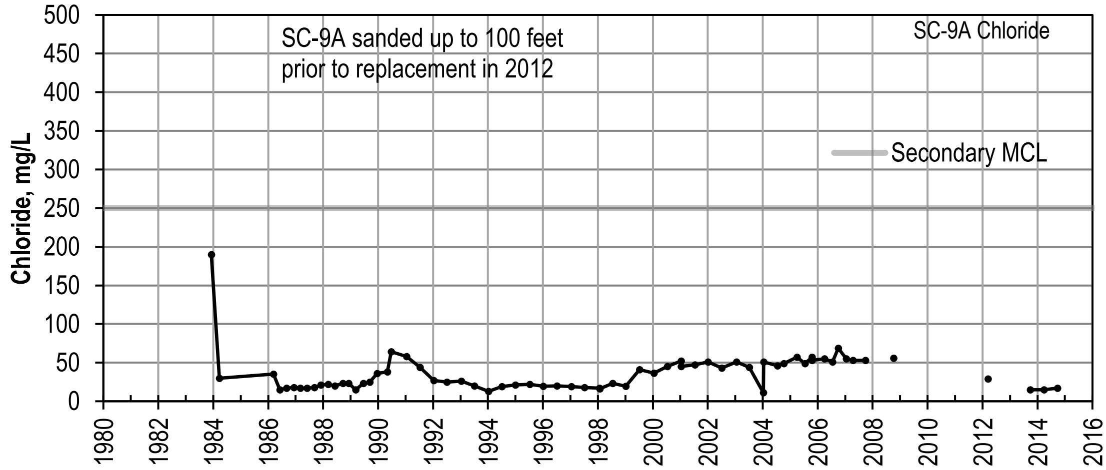
<u>**Chemographs and Single Well Hydrographs for Central Purisima Area**</u>

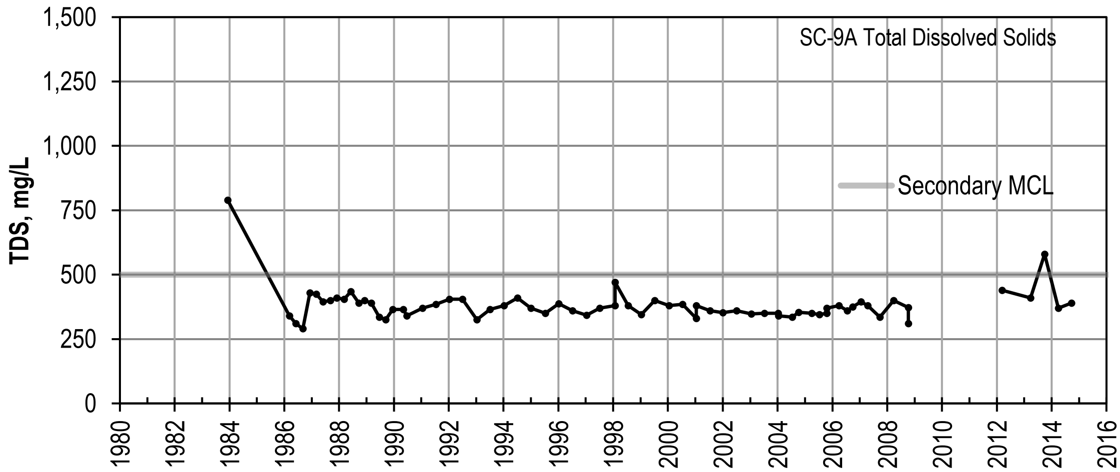
Graphs of SqCWD Coastal Monitoring Well Clusters

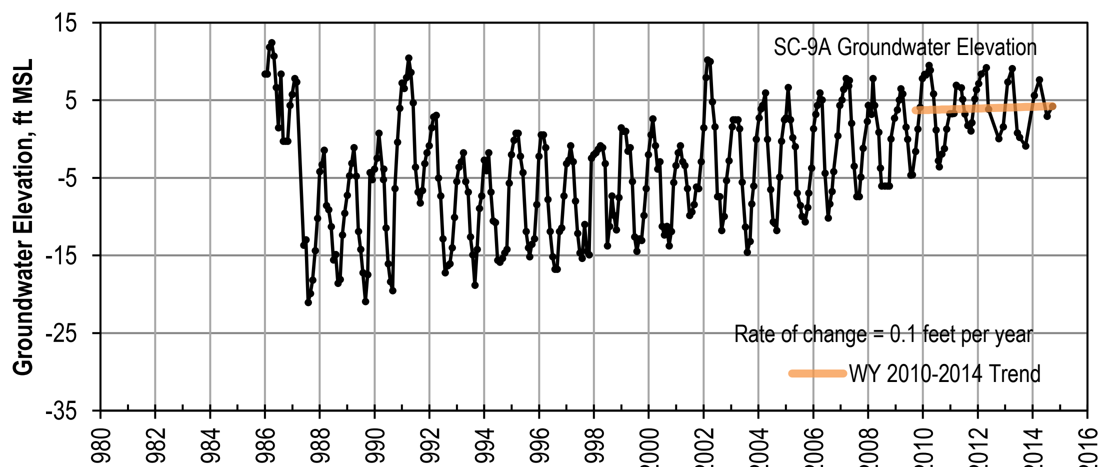
Graphs of SqCWD Inland Monitoring Well Clusters

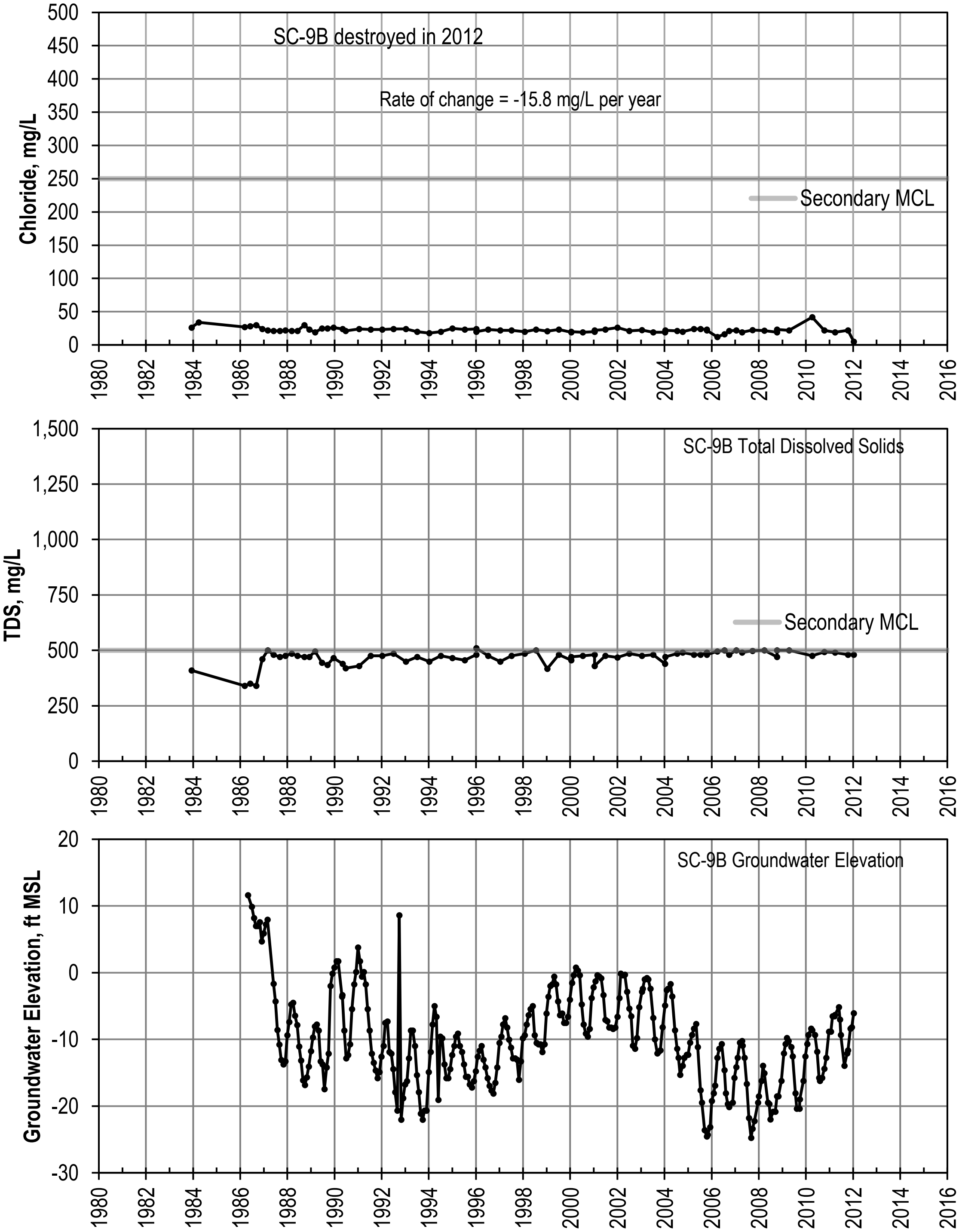
Graphs of SqCWD Production Wells and Monitoring Wells Adjacent to Production Wells

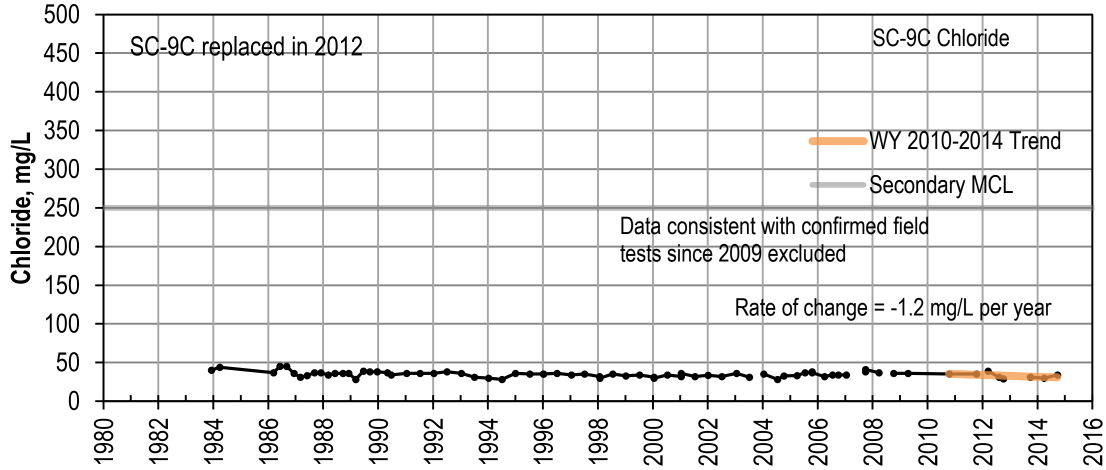
Trends shown on the hydrographs and chemographs are based on a linear fit to data in the specified time period.

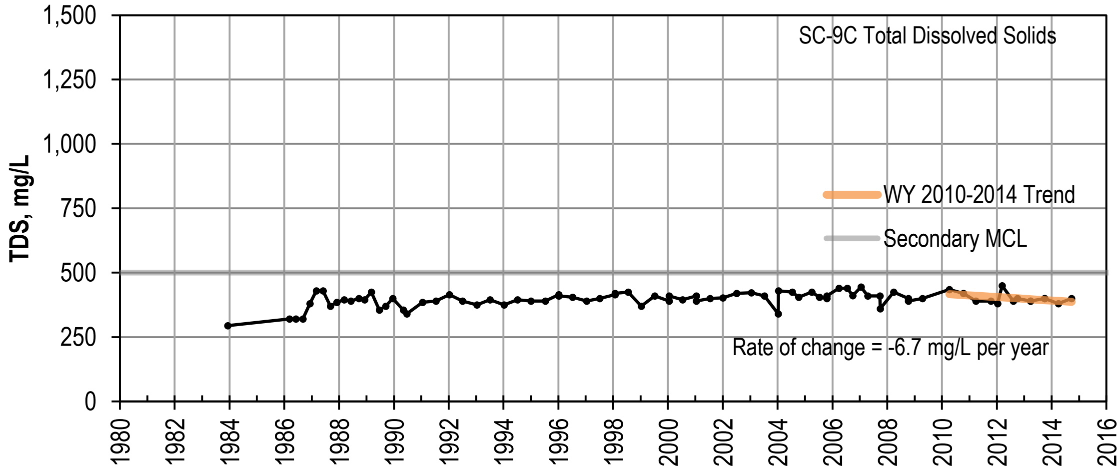

SC-9A Chloride
SC-9A sanded up to 100 feet
prior to replacement in 2012
Secondary MCL
Chloride, mg/L
500
450
400
350
300
250
200
150
100
50
0
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016

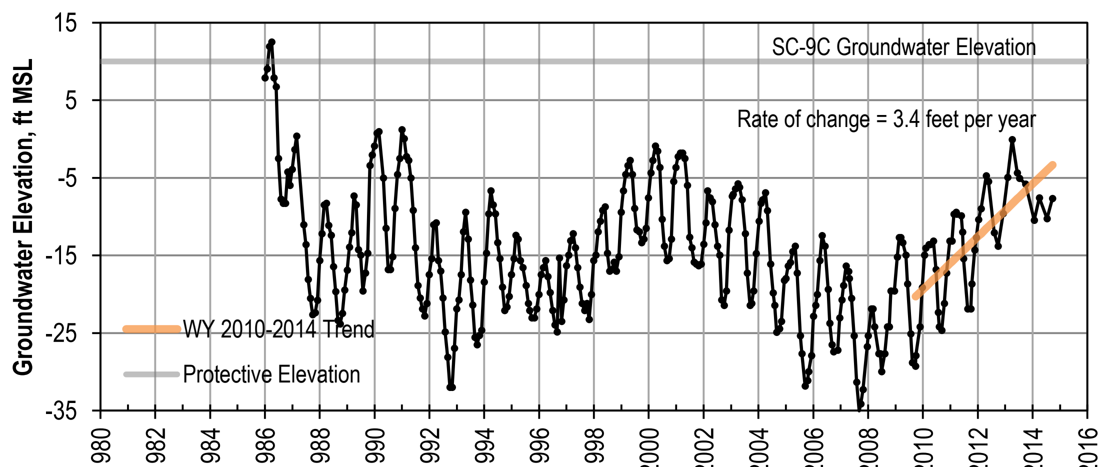

SC-9A Total Dissolved Solids
Secondary MCL
TDS, mg/L
1,500
1,250
1,000
750
500
250
0
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016

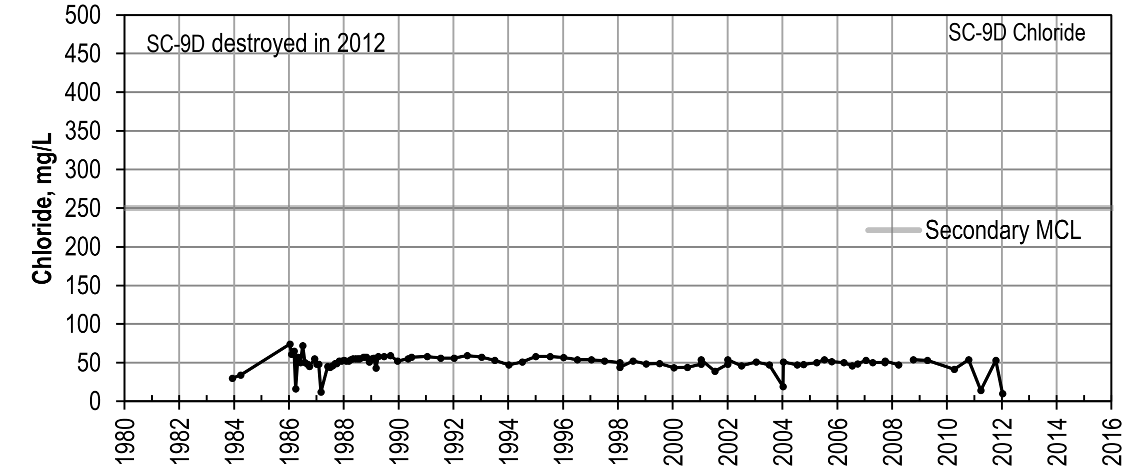

SC-9A Groundwater Elevation
Rate of change = 0.1 feet per year
WY 2010-2014 Trend
Groundwater Elevation, ft MSL
15
5
-5
-15
-25
-35
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016

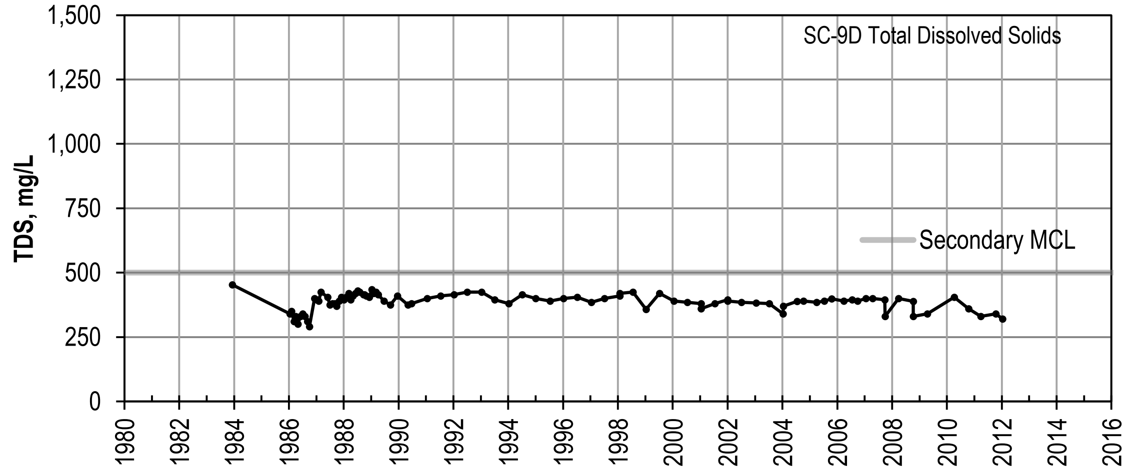

SC-9B destroyed in 2012
Rate of change = -15.8 mg/L per year
Secondary MCL
Chloride, mg/L
SC-9B Total Dissolved Solids
Secondary MCL
TDS, mg/L
SC-9B Groundwater Elevation
Groundwater Elevation, ft MSL

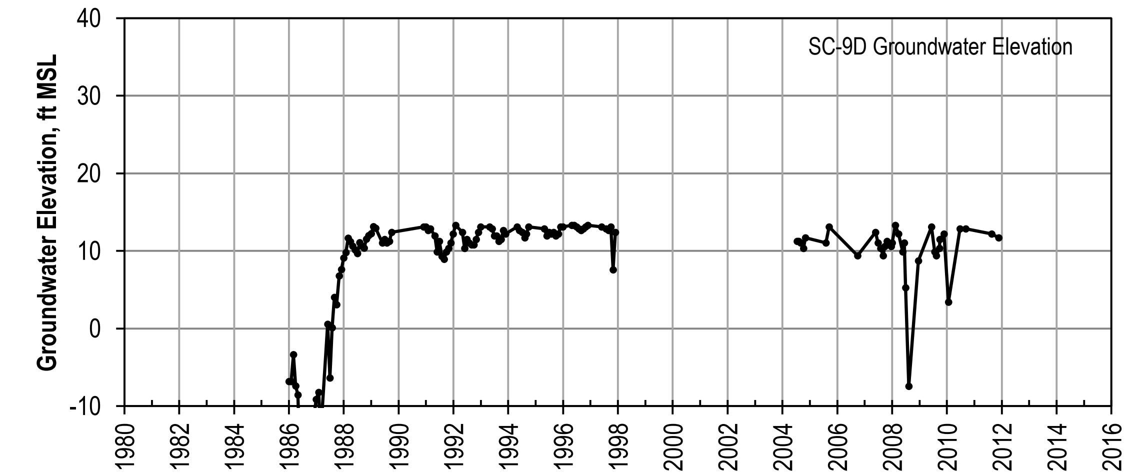

SC-9C replaced in 2012
SC-9C Chloride
WY 2010-2014 Trend
Secondary MCL
Data consistent with confirmed field tests since 2009 excluded
Rate of change = -1.2 mg/L per year
Chloride, mg/L

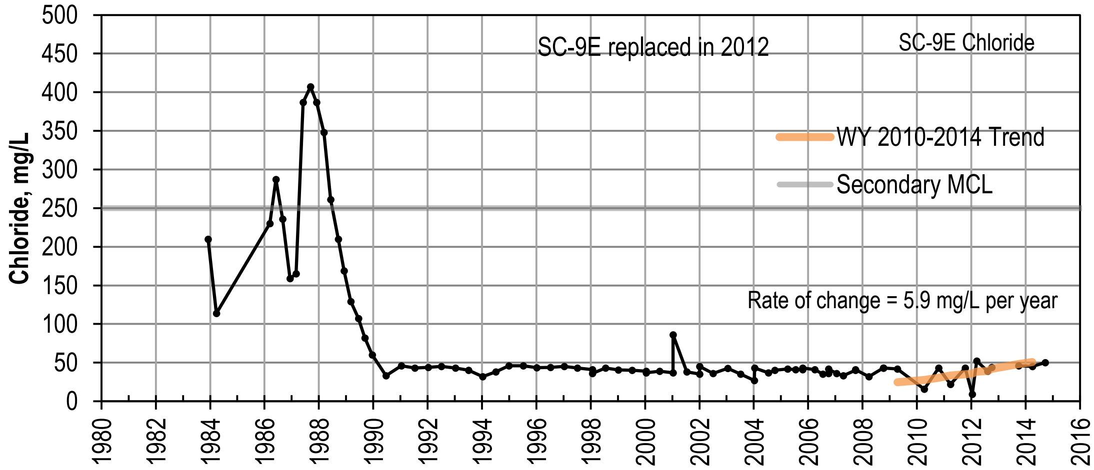

SC-9C Total Dissolved Solids
WY 2010-2014 Trend
Secondary MCL
Rate of change = -6.7 mg/L per year
TDS, mg/L

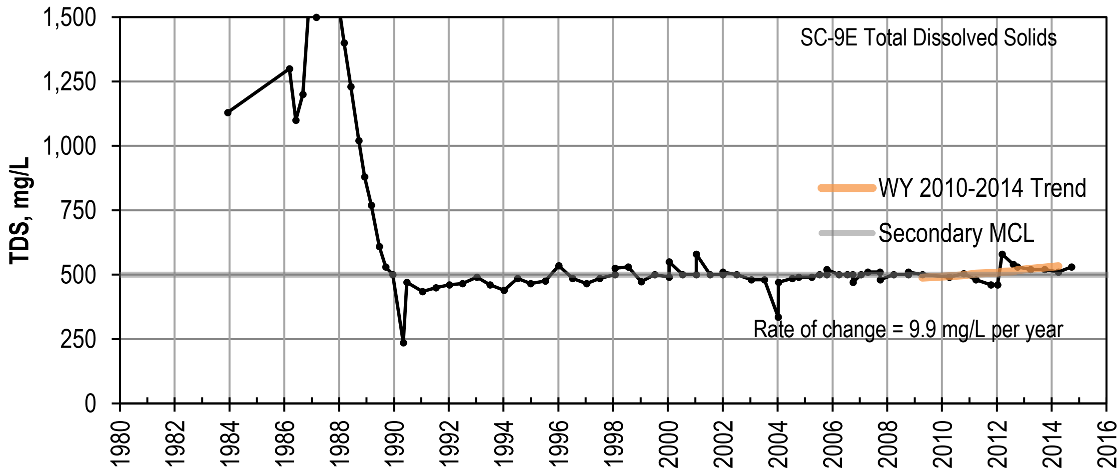

SC-9C Groundwater Elevation
Rate of change = 3.4 feet per year
WY 2010-2014 Trend
Protective Elevation
Groundwater Elevation, ft MSL

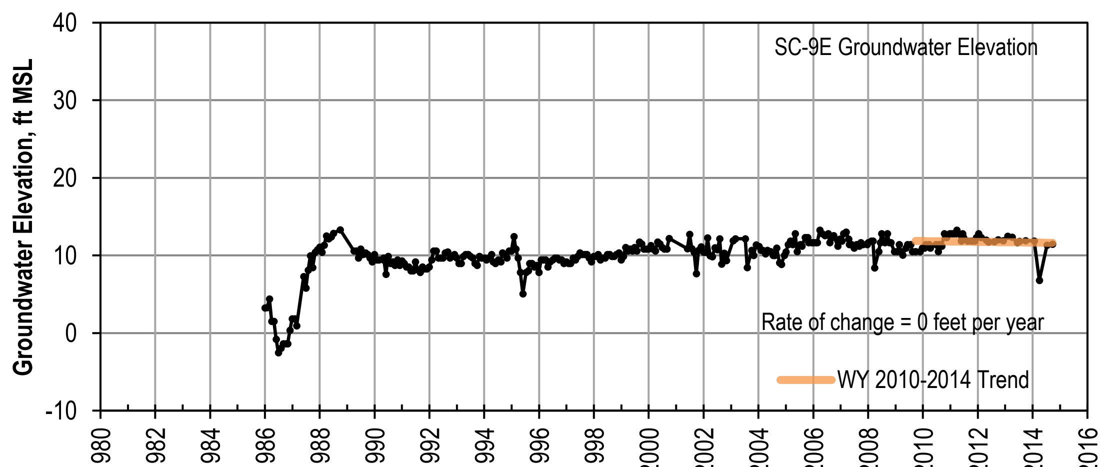

SC-9D destroyed in 2012
SC-9D Chloride
Secondary MCL
Chloride, mg/L

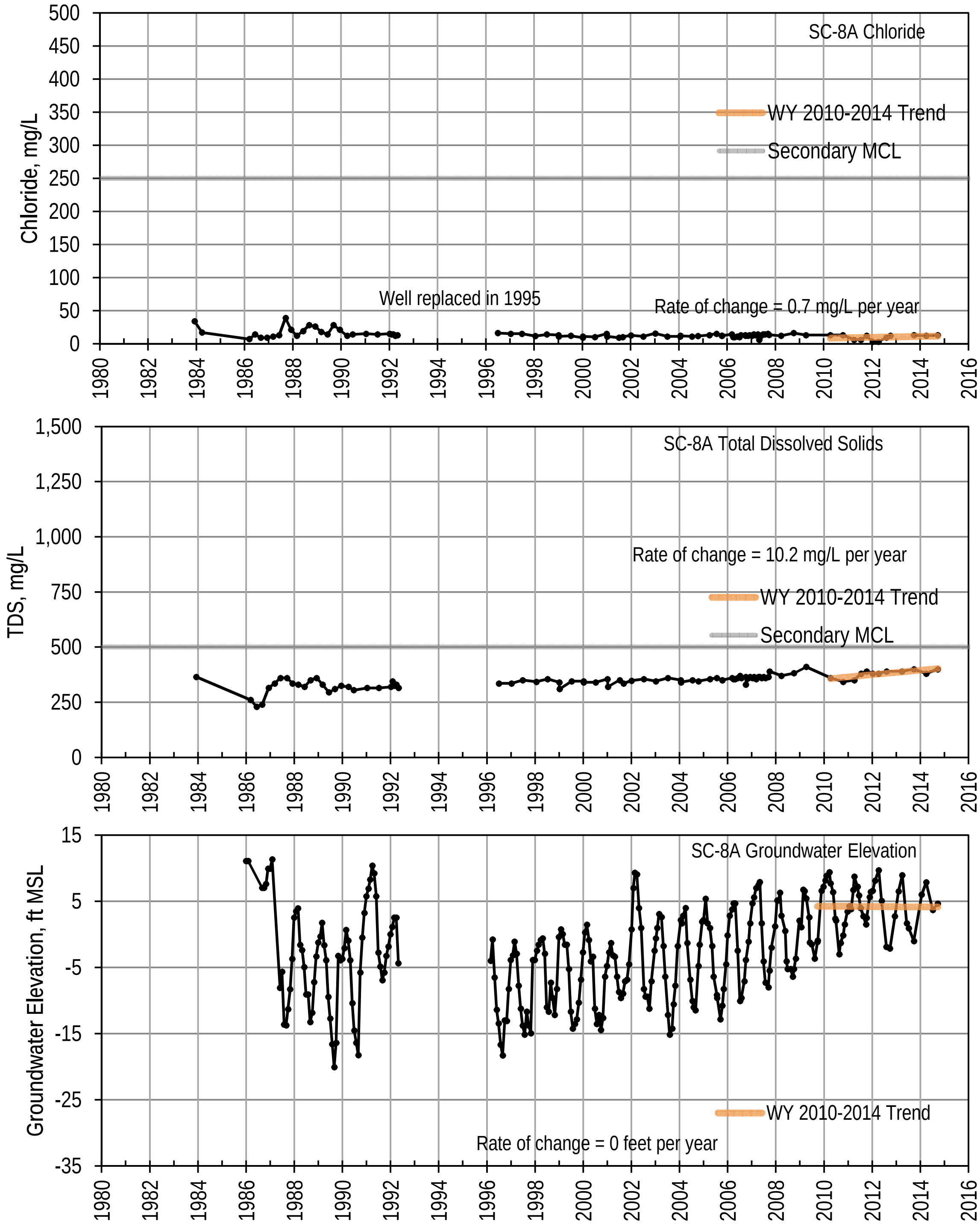

SC-9D Total Dissolved Solids
Secondary MCL
TDS, mg/L

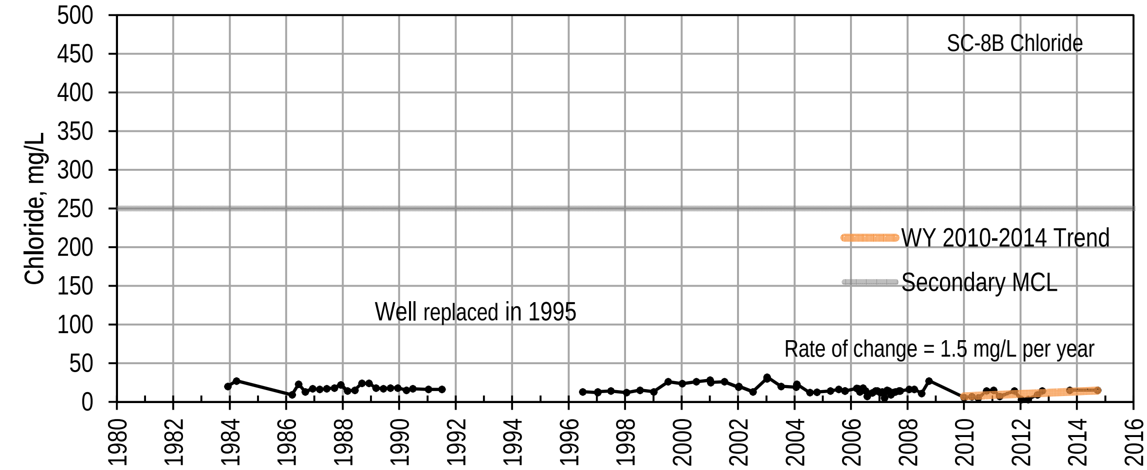

SC-9D Groundwater Elevation
Groundwater Elevation, ft MSL

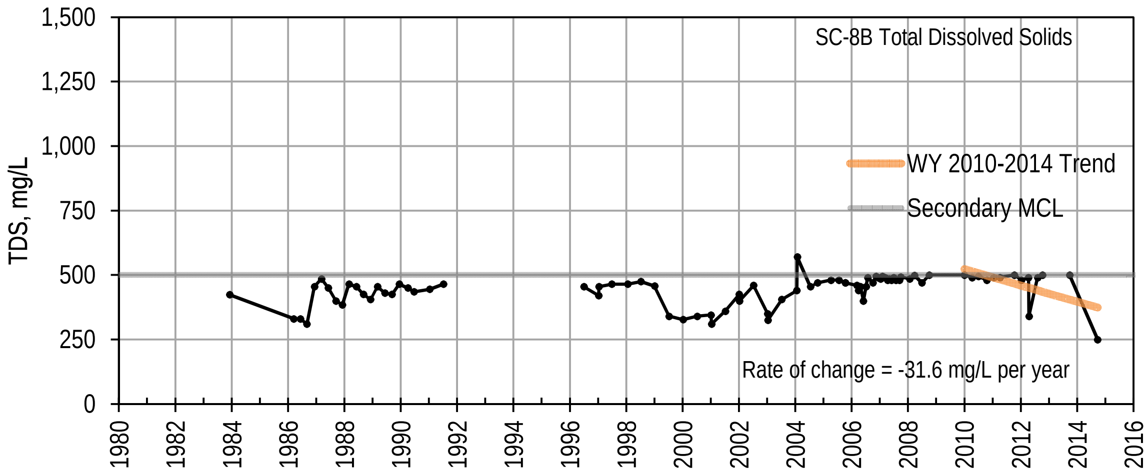

SC-9E replaced in 2012
SC-9E Chloride
WY 2010-2014 Trend
Secondary MCL
Rate of change = 5.9 mg/L per year
Chloride, mg/L

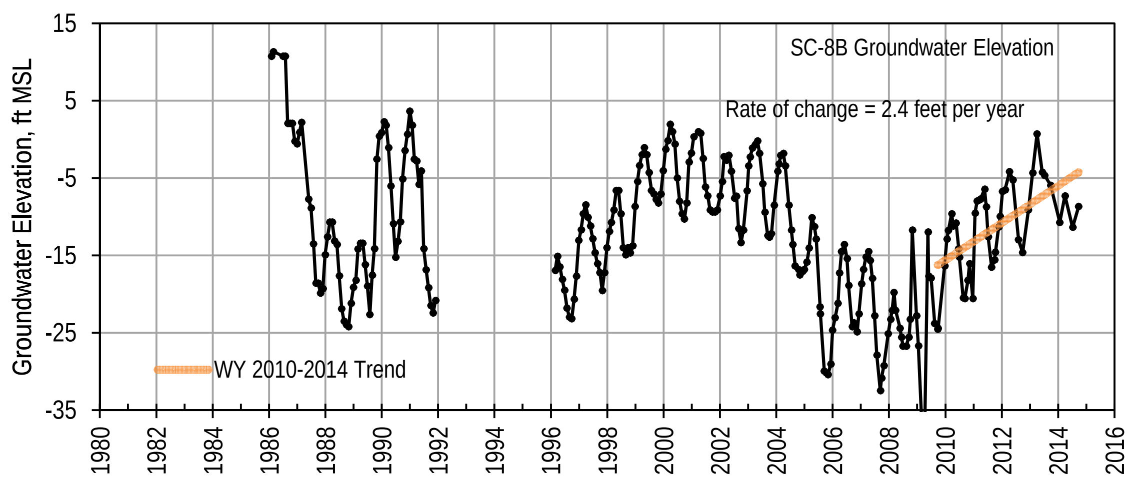

SC-9E Total Dissolved Solids
WY 2010-2014 Trend
Secondary MCL
Rate of change = 9.9 mg/L per year
TDS, mg/L

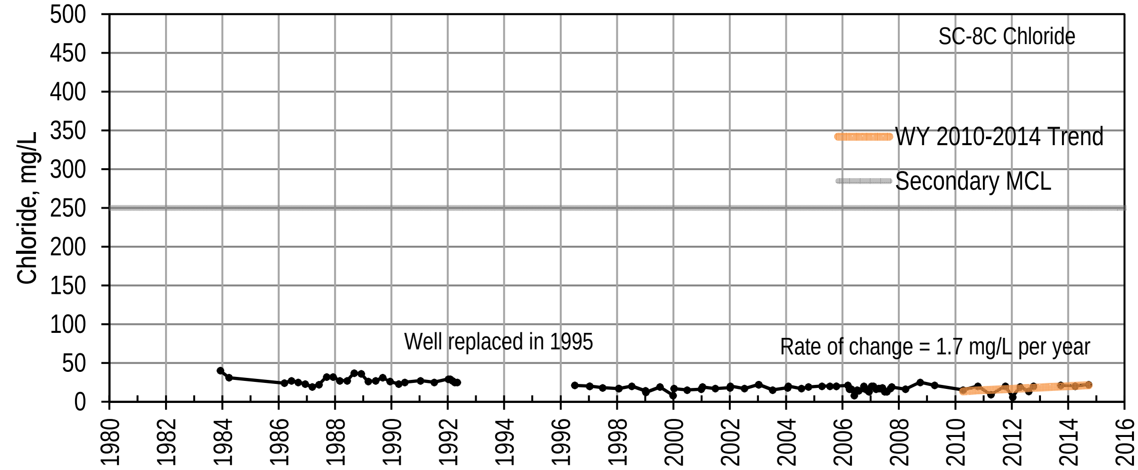

SC-9E Groundwater Elevation
Rate of change = 0 feet per year
WY 2010-2014 Trend
Groundwater Elevation, ft MSL

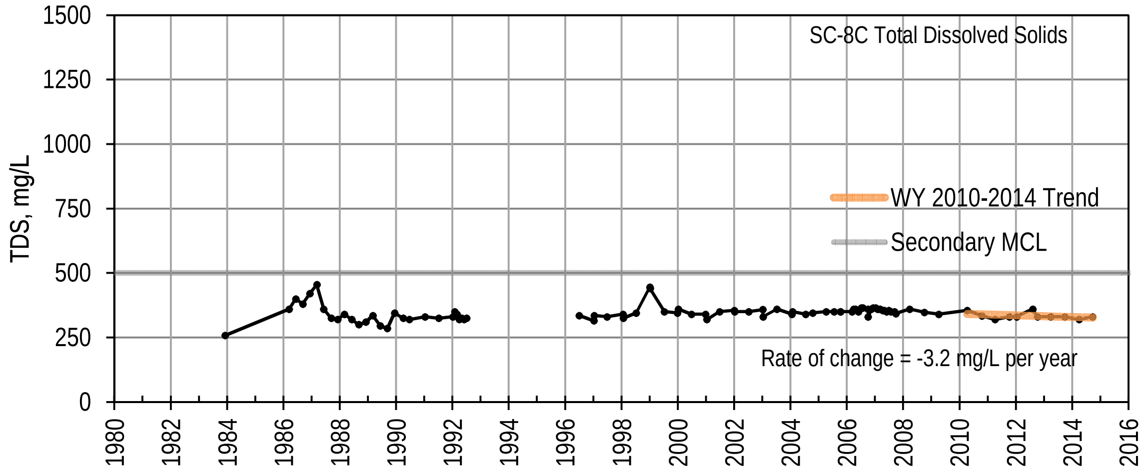

SC-8A Chloride
Chloride, mg/L
WY 2010-2014 Trend
Secondary MCL
Well replaced in 1995
Rate of change = 0.7 mg/L per year
SC-8A Total Dissolved Solids
TDS, mg/L
Rate of change = 10.2 mg/L per year
WY 2010-2014 Trend
Secondary MCL
SC-8A Groundwater Elevation
Groundwater Elevation, ft MSL
WY 2010-2014 Trend
Rate of change = 0 feet per year

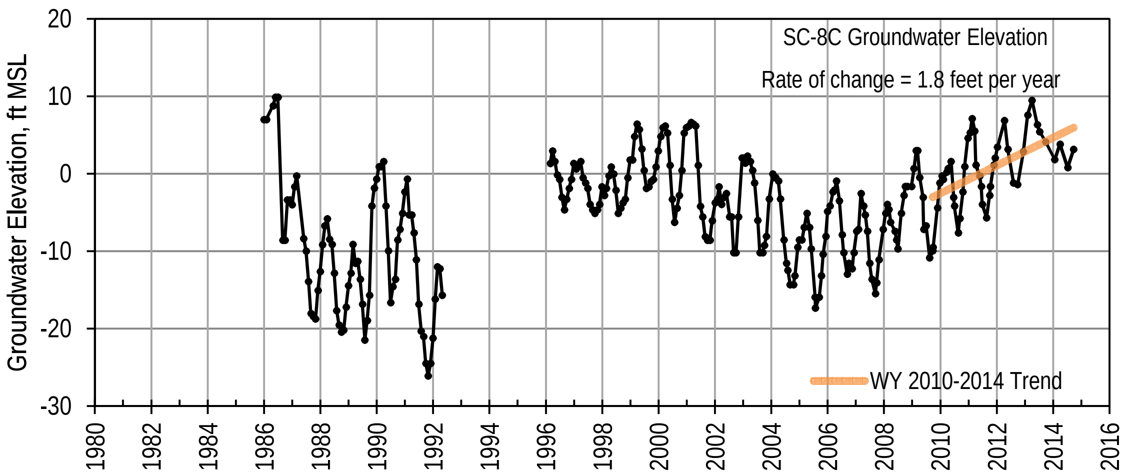

SC-8B Chloride
Chloride, mg/L
WY 2010-2014 Trend
Secondary MCL
Well replaced in 1995
Rate of change = 1.5 mg/L per year

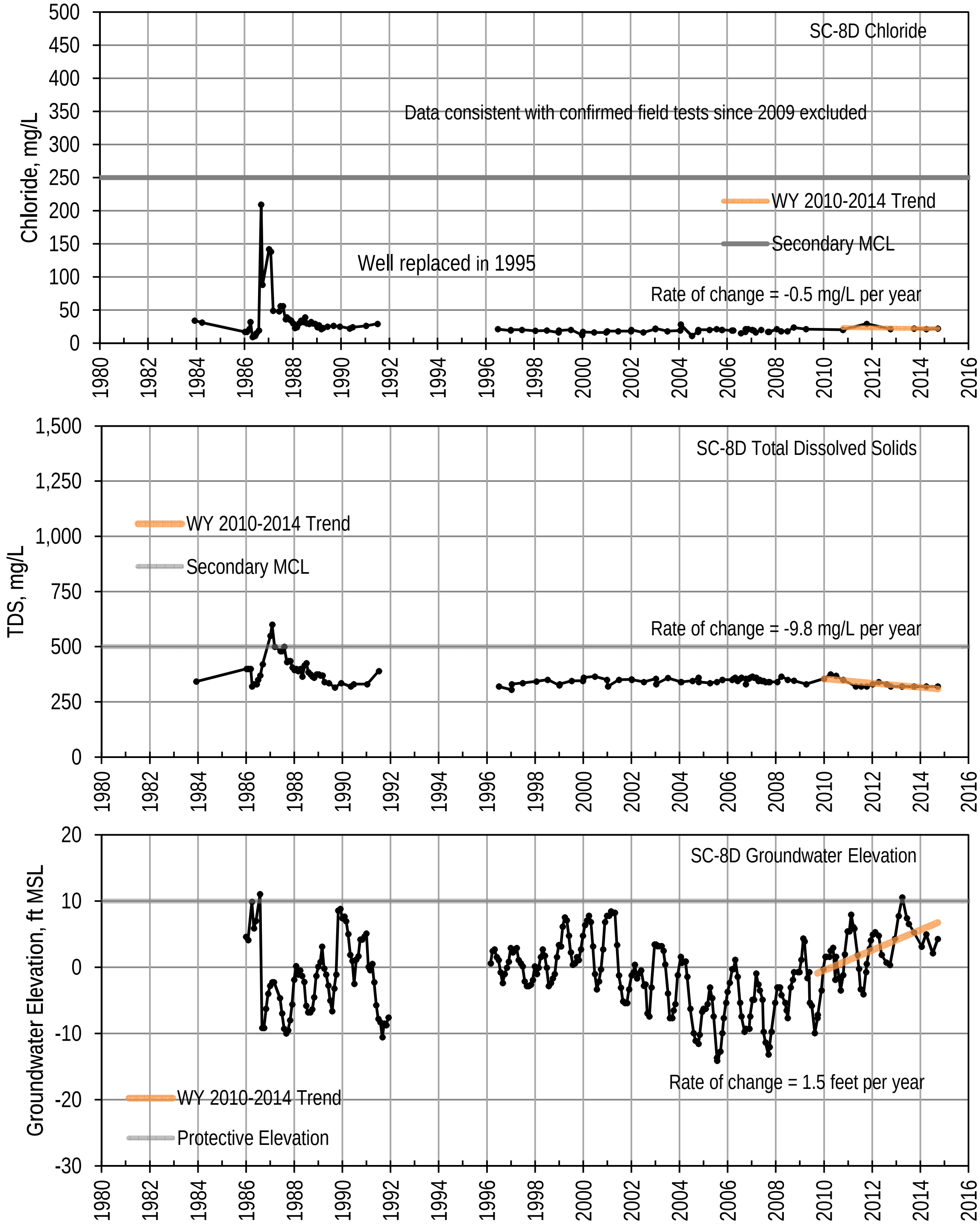

SC-8B Total Dissolved Solids
TDS, mg/L
WY 2010-2014 Trend
Secondary MCL
Rate of change = -31.6 mg/L per year

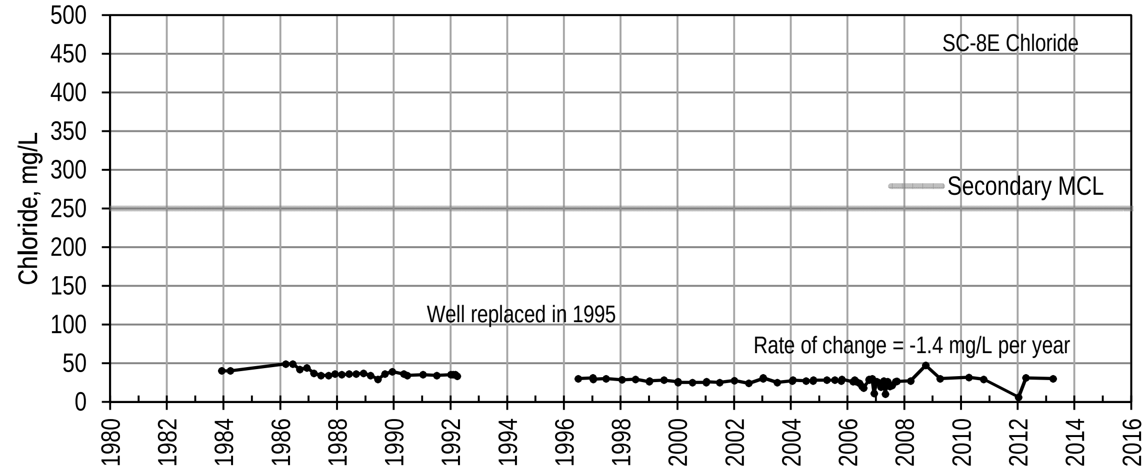

SC-8B Groundwater Elevation
Groundwater Elevation, ft MSL
Rate of change = 2.4 feet per year
WY 2010-2014 Trend

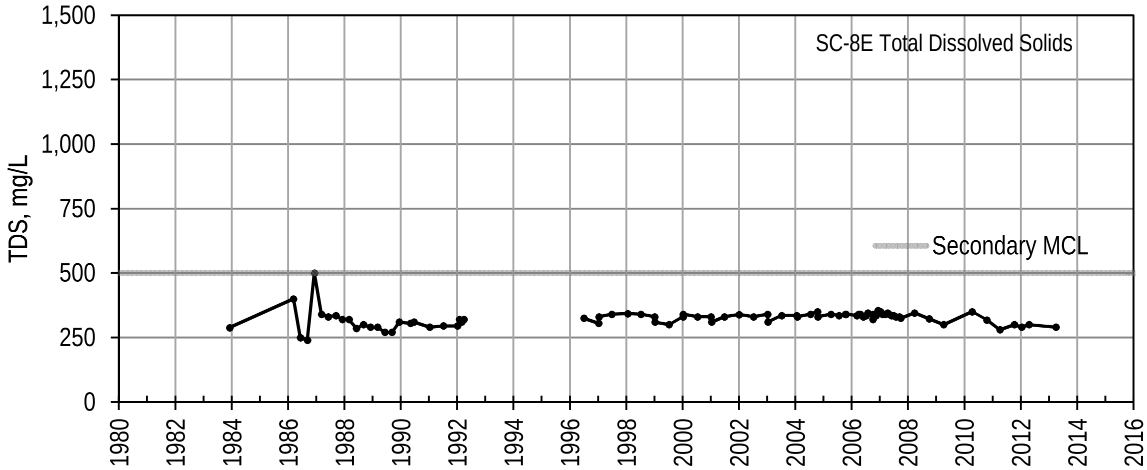

SC-8C Chloride
WY 2010-2014 Trend
Secondary MCL
Chloride, mg/L
Well replaced in 1995
Rate of change = 1.7 mg/L per year

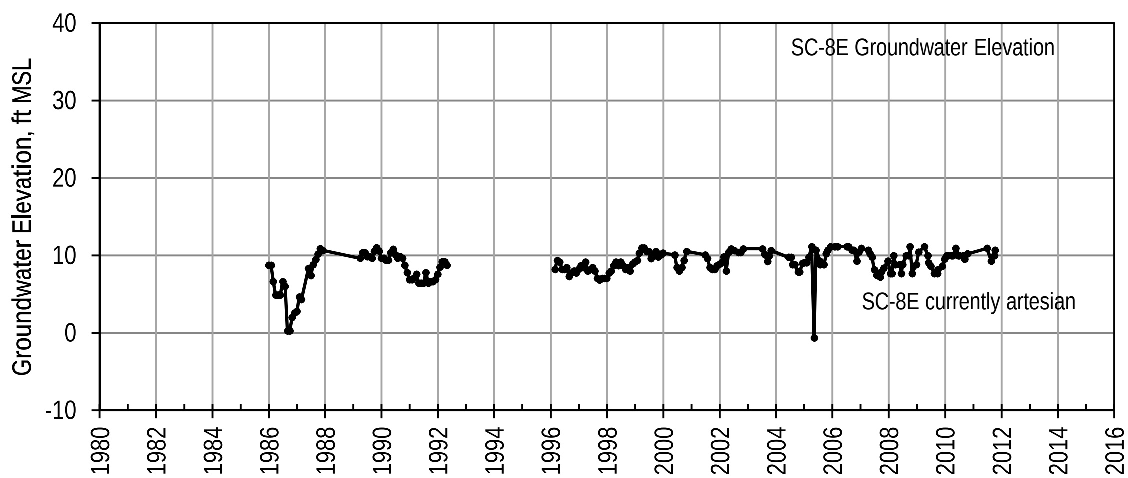

SC-8C Total Dissolved Solids
WY 2010-2014 Trend
Secondary MCL
TDS, mg/L
Rate of change = -3.2 mg/L per year

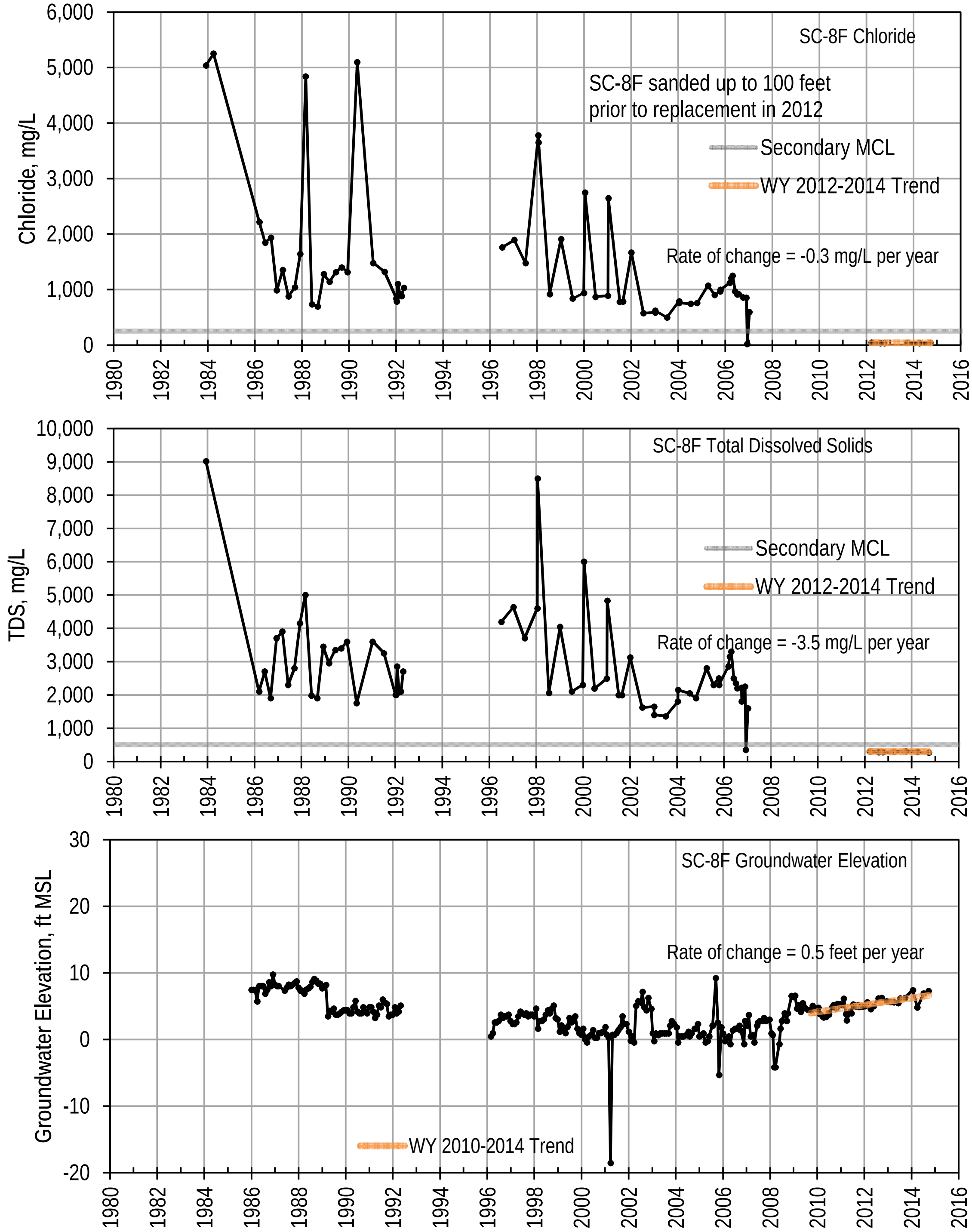

SC-8C Groundwater Elevation
Rate of change = 1.8 feet per year
Groundwater Elevation, ft MSL
WY 2010-2014 Trend

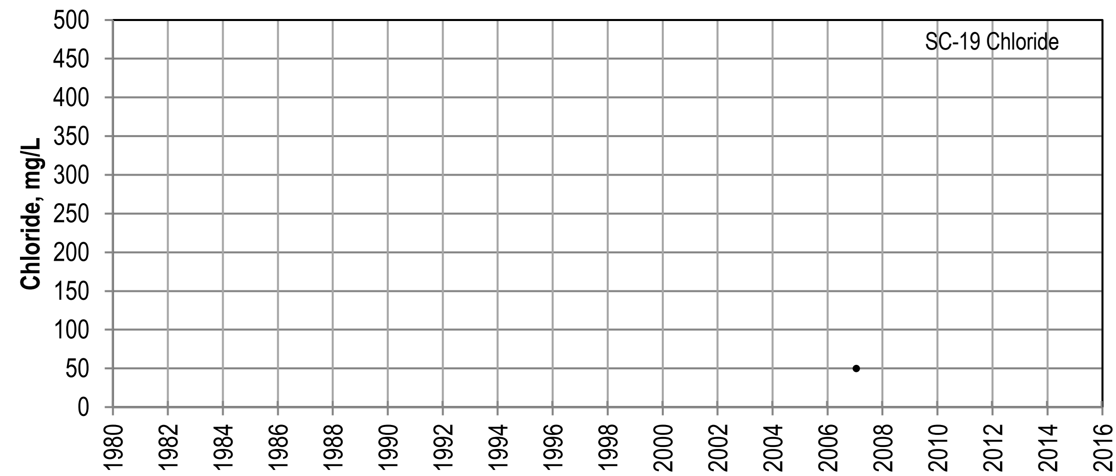

SC-8D Chloride
Data consistent with confirmed field tests since 2009 excluded
Well replaced in 1995
WY 2010-2014 Trend
Secondary MCL
Rate of change = -0.5 mg/L per year
Chloride, mg/L
SC-8D Total Dissolved Solids
WY 2010-2014 Trend
Secondary MCL
Rate of change = -9.8 mg/L per year
TDS, mg/L
SC-8D Groundwater Elevation
Rate of change = 1.5 feet per year
WY 2010-2014 Trend
Protective Elevation
Groundwater Elevation, ft MSL

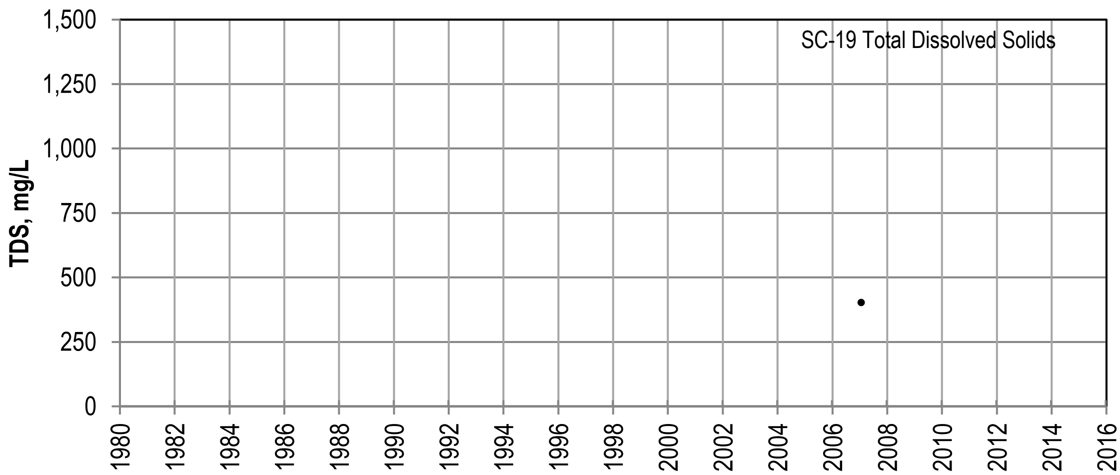

SC-8E Chloride
Chloride, mg/L
Secondary MCL
Well replaced in 1995
Rate of change = -1.4 mg/L per year

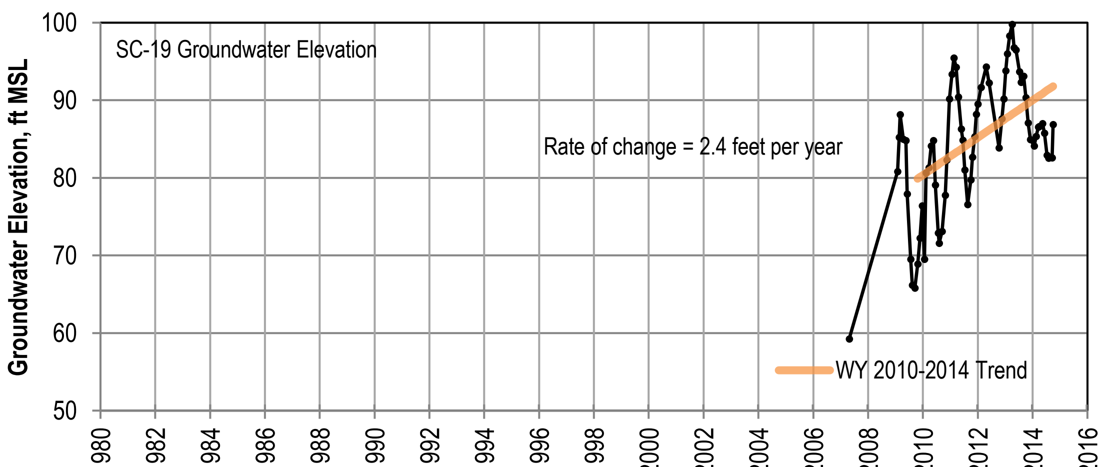

SC-8E Total Dissolved Solids
TDS, mg/L
Secondary MCL

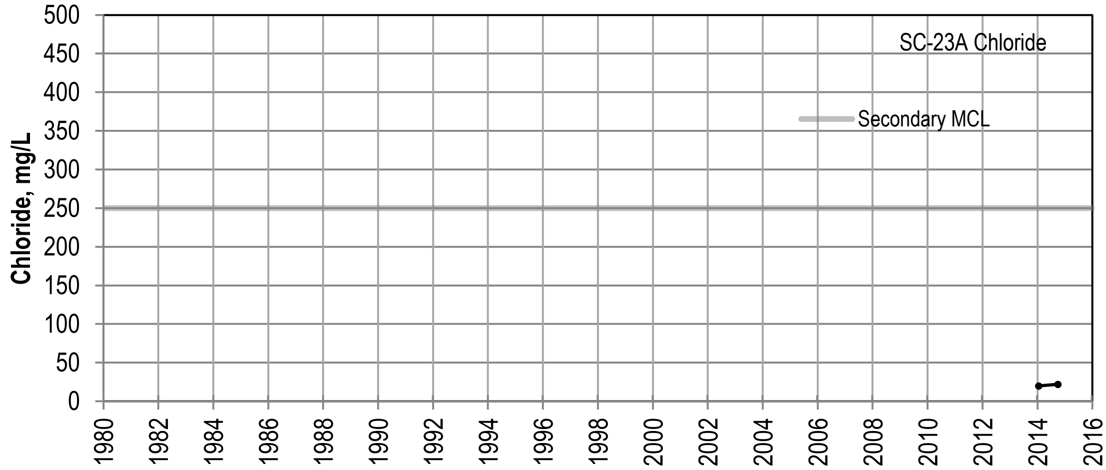

SC-8E Groundwater Elevation
Groundwater Elevation, ft MSL
SC-8E currently artesian

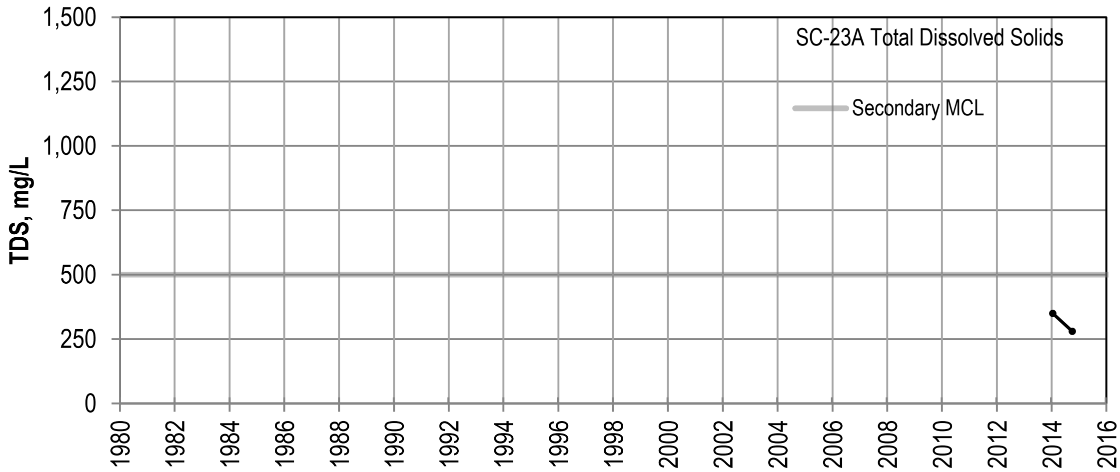

SC-8F Chloride
SC-8F sanded up to 100 feet prior to replacement in 2012
Secondary MCL
WY 2012-2014 Trend
Rate of change = -0.3 mg/L per year
Chloride, mg/L
SC-8F Total Dissolved Solids
Secondary MCL
WY 2012-2014 Trend
Rate of change = -3.5 mg/L per year
TDS, mg/L
SC-8F Groundwater Elevation
Rate of change = 0.5 feet per year
WY 2010-2014 Trend
Groundwater Elevation, ft MSL

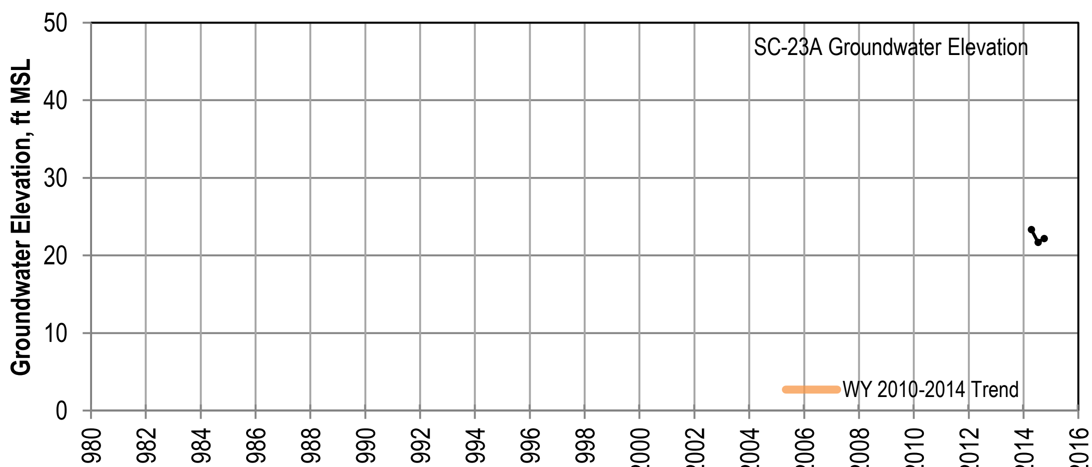

SC-19 Chloride
Chloride, mg/L
500
450
400
350
300
250
200
150
100
50
0
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016

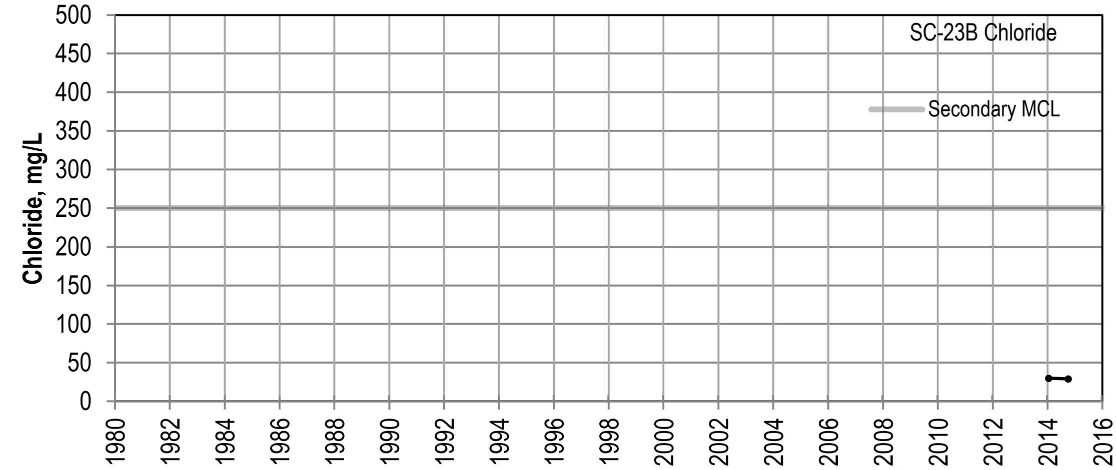

SC-19 Total Dissolved Solids
TDS, mg/L
1,500
1,250
1,000
750
500
250
0
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016


SC-19 Groundwater Elevation
Groundwater Elevation, ft MSL
Rate of change = 2.4 feet per year
WY 2010-2014 Trend
100
90
80
70
60
50
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016

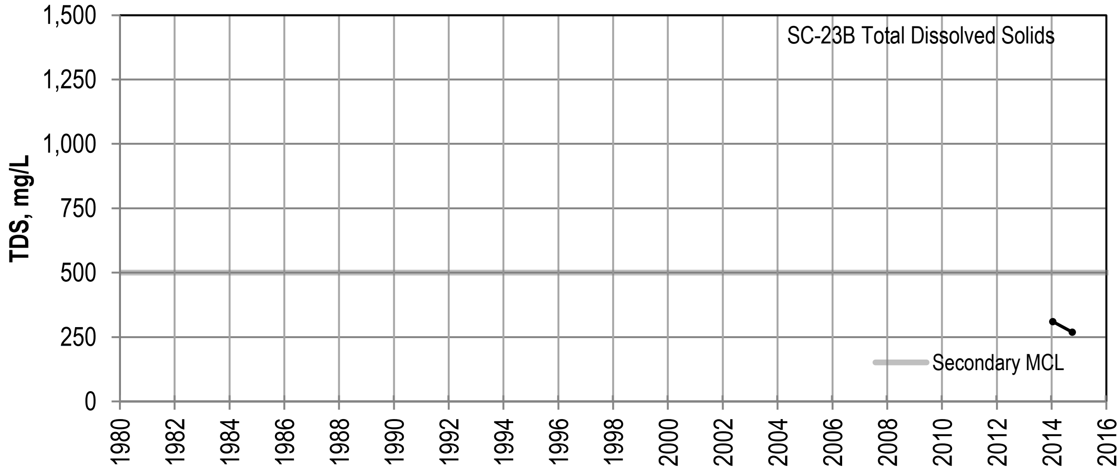

SC-23A Chloride
Secondary MCL
Chloride, mg/L
500
450
400
350
300
250
200
150
100
50
0
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016


SC-23A Total Dissolved Solids
Secondary MCL
TDS, mg/L
1,500
1,250
1,000
750
500
250
0
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016

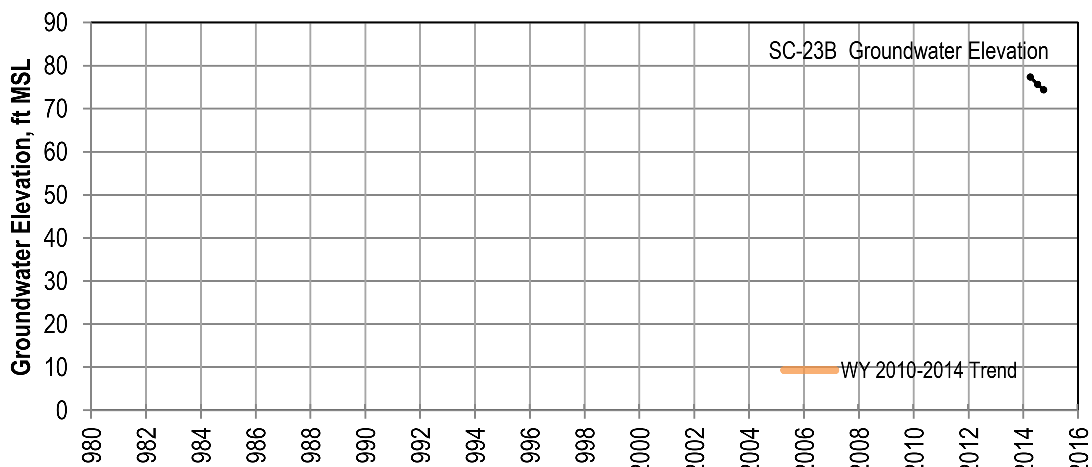

SC-23A Groundwater Elevation
WY 2010-2014 Trend
Groundwater Elevation, ft MSL
50
40
30
20
10
0
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016



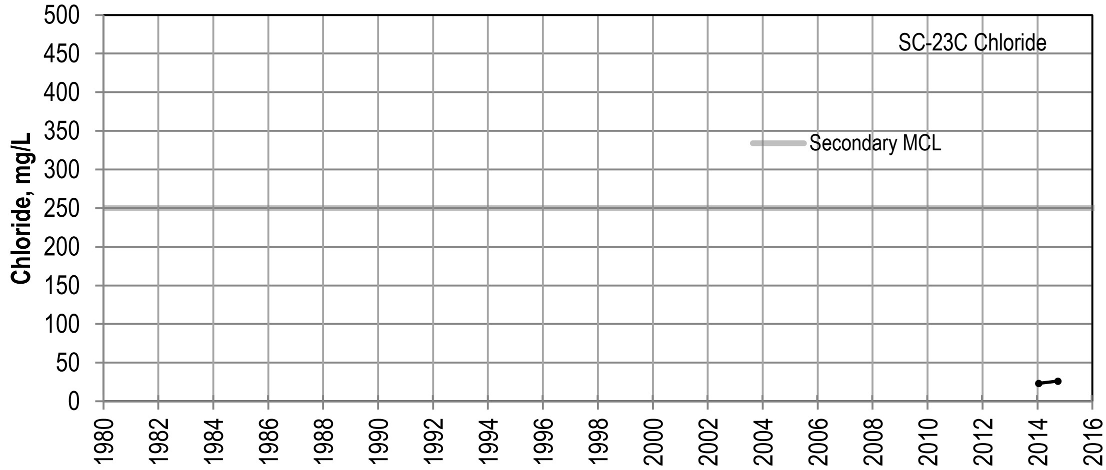
SC-23B Chloride
Secondary MCL
Chloride, mg/L
500
450
400
350
300
250
200
150
100
50
0
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016

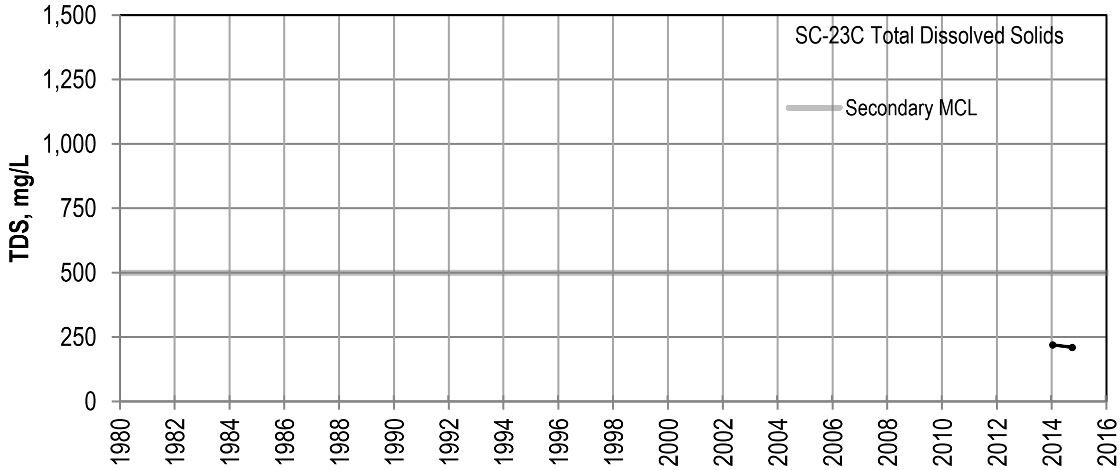


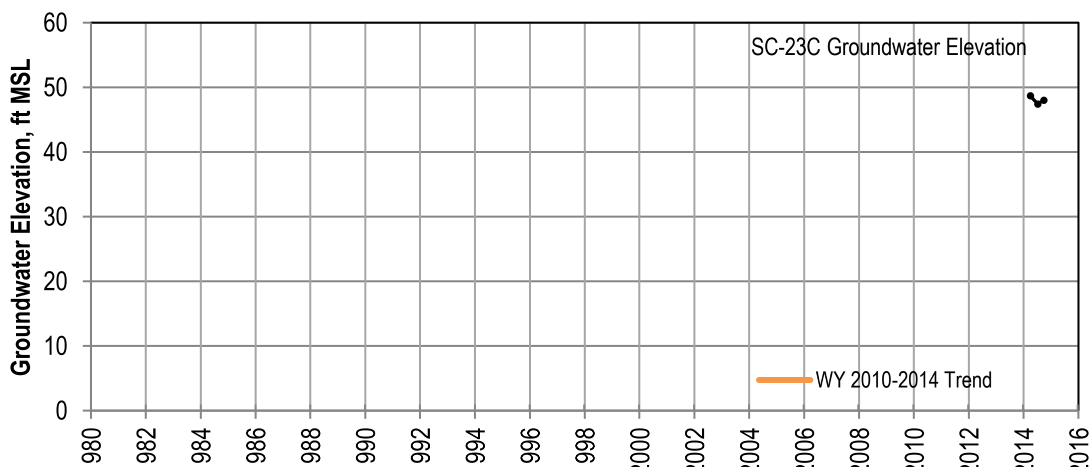
SC-23B Total Dissolved Solids
Secondary MCL
TDS, mg/L
1,500
1,250
1,000
750
500
250
0
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016

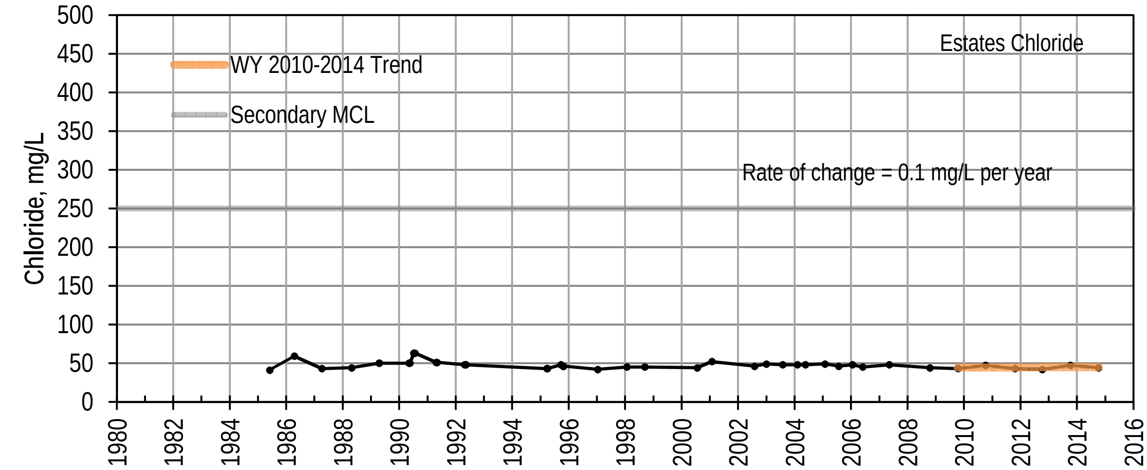


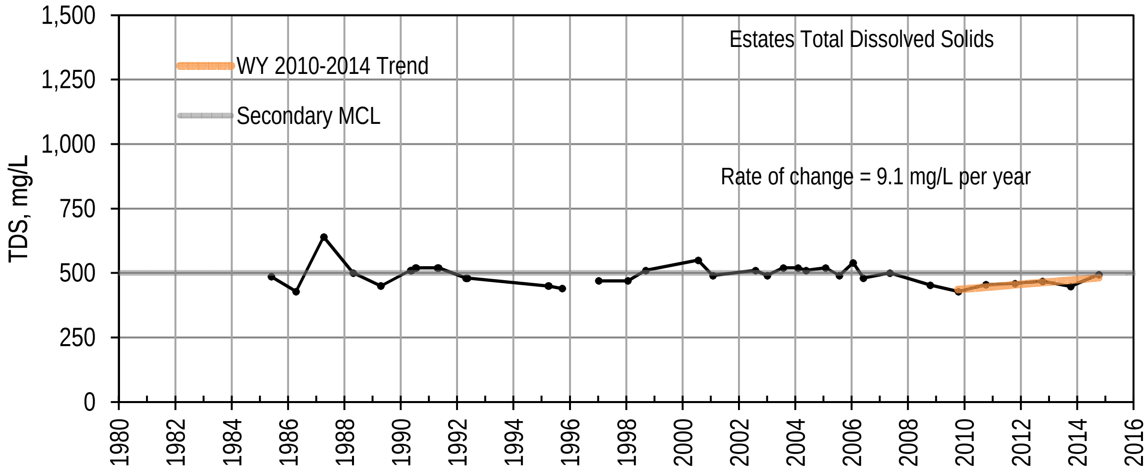
SC-23B Groundwater Elevation
WY 2010-2014 Trend
Groundwater Elevation, ft MSL
90
80
70
60
50
40
30
20
10
0
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016

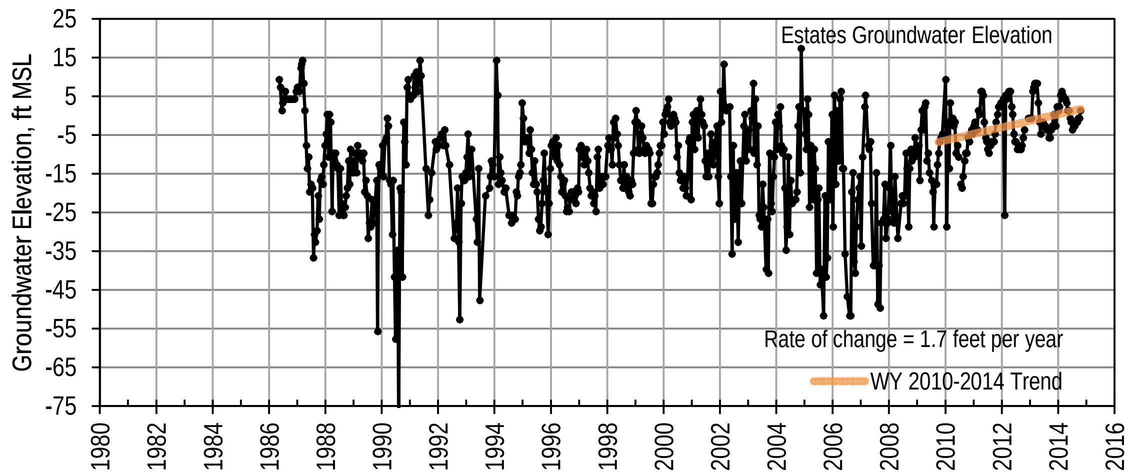

SC-23C Chloride
Secondary MCL
Chloride, mg/L
500
450
400
350
300
250
200
150
100
50
0
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016

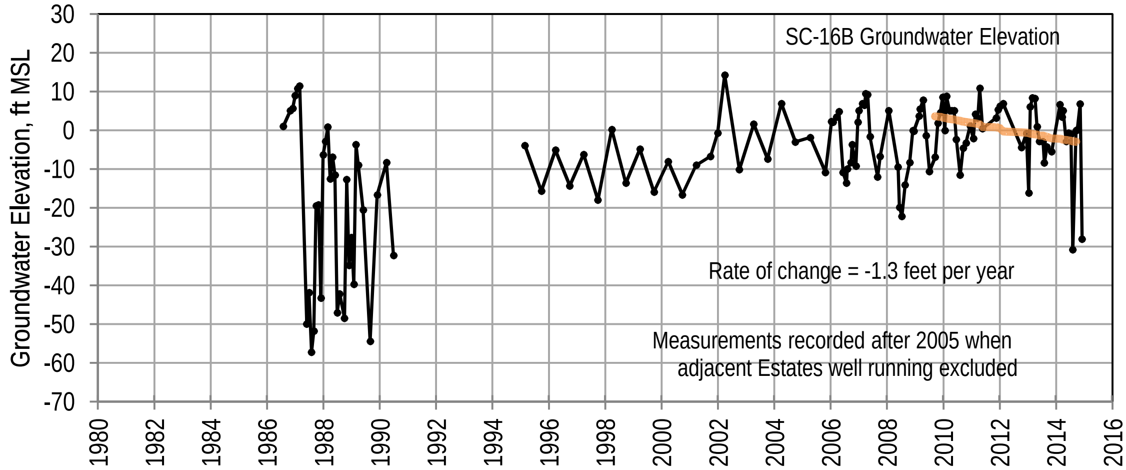

SC-23C Total Dissolved Solids
Secondary MCL
TDS, mg/L
1,500
1,250
1,000
750
500
250
0
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016

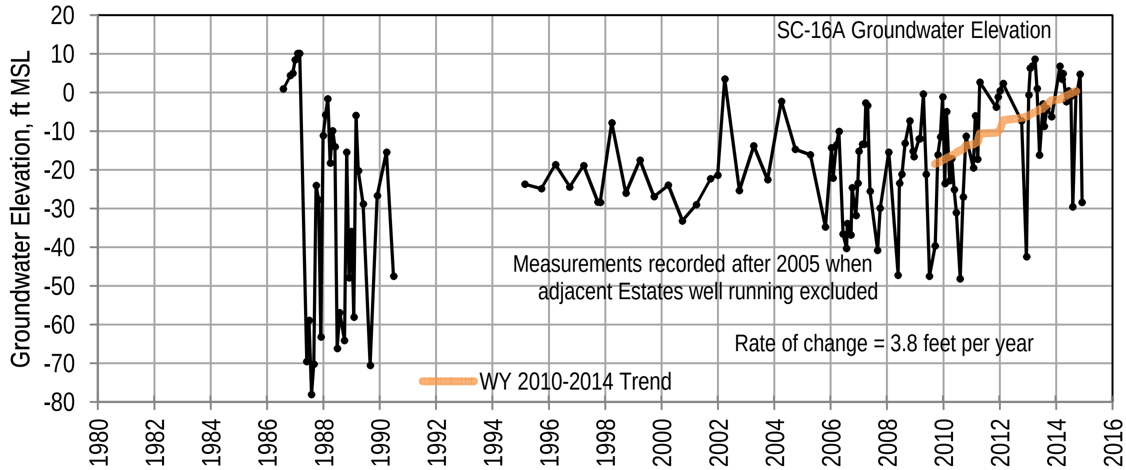

SC-23C Groundwater Elevation
WY 2010-2014 Trend
Groundwater Elevation, ft MSL
60
50
40
30
20
10
0
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016

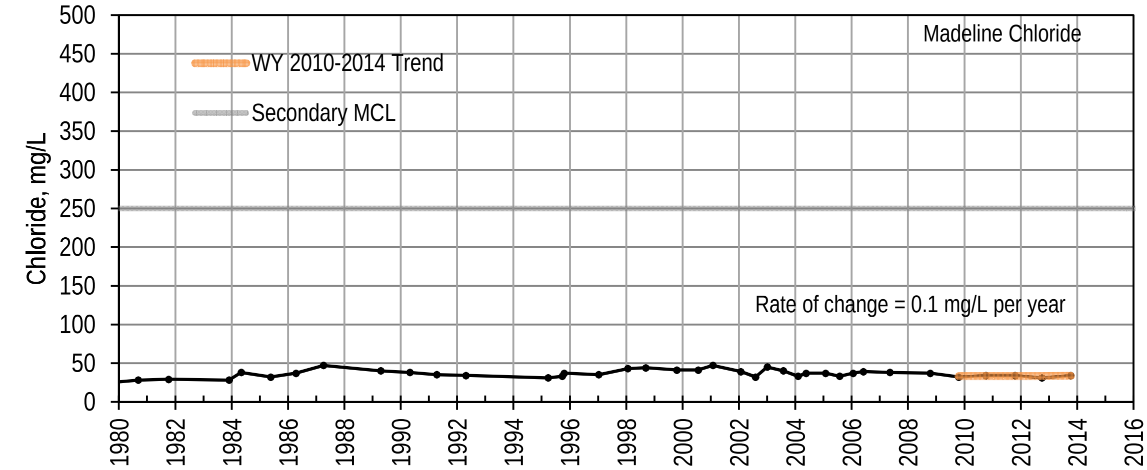

Estates Chloride
WY 2010-2014 Trend
Secondary MCL
Rate of change = 0.1 mg/L per year
Chloride, mg/L
500
450
400
350
300
250
200
150
100
50
0
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016

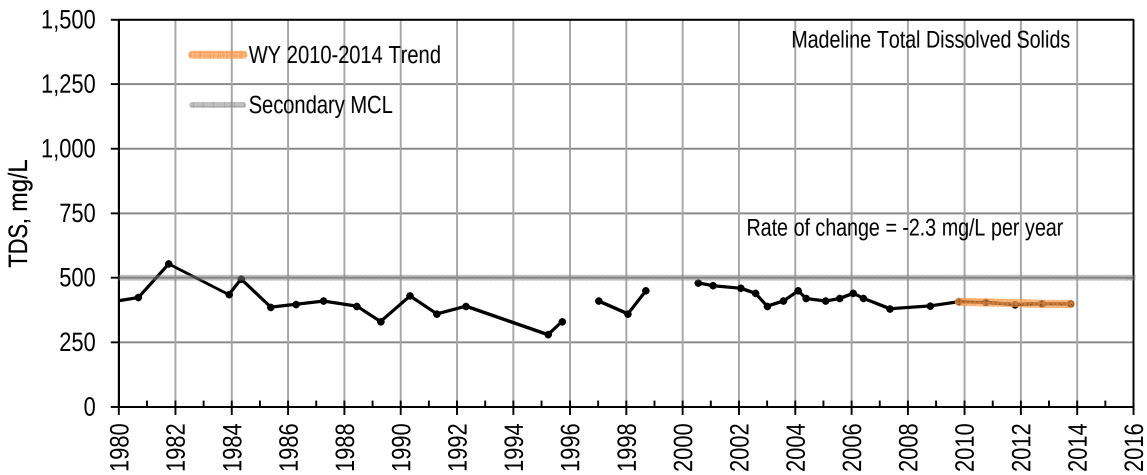

Estates Total Dissolved Solids
WY 2010-2014 Trend
Secondary MCL
Rate of change = 9.1 mg/L per year
TDS, mg/L
1,500
1,250
1,000
750
500
250
0
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016

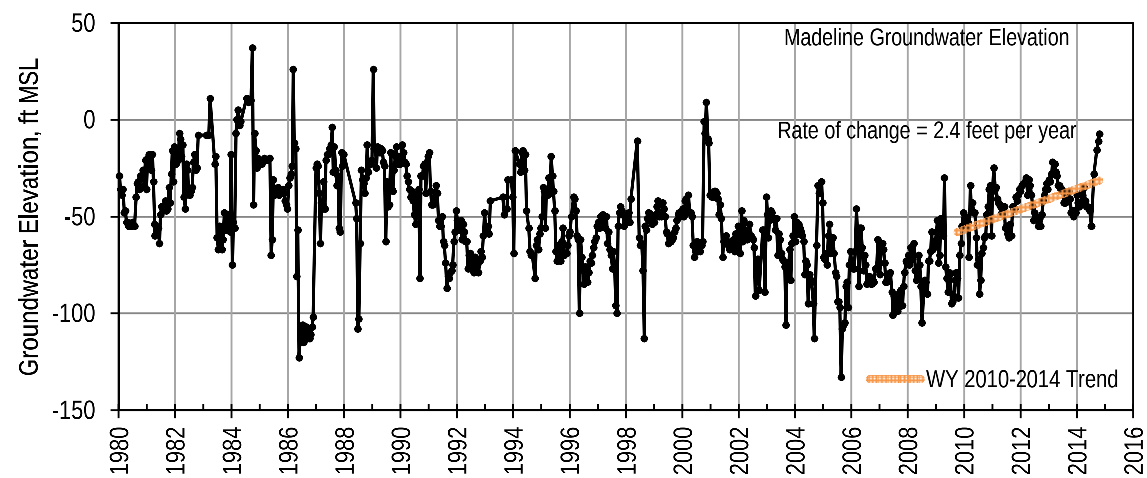

Estates Groundwater Elevation
Rate of change = 1.7 feet per year
WY 2010-2014 Trend
Groundwater Elevation, ft MSL
25
15
5
-5
-15
-25
-35
-45
-55
-65
-75
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016

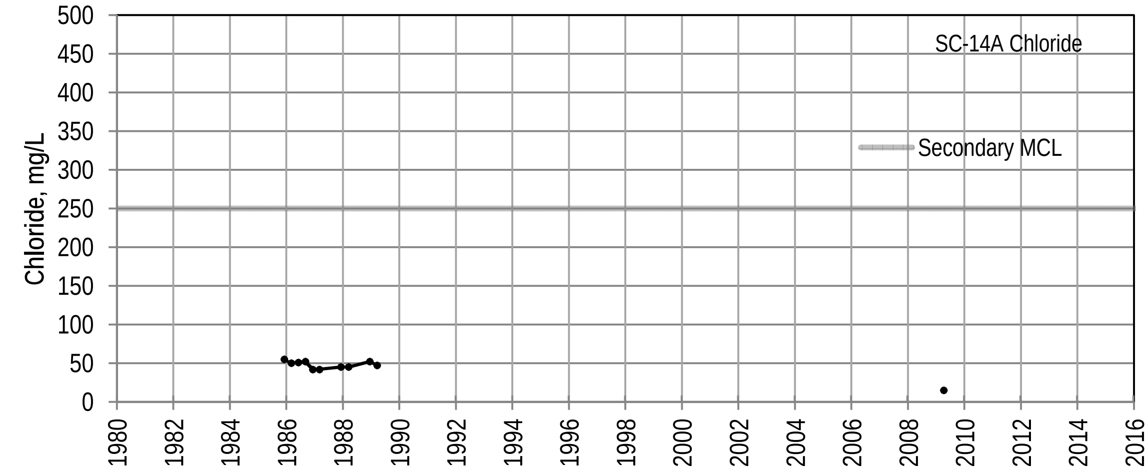

SC-16B Groundwater Elevation
Groundwater Elevation, ft MSL
Rate of change = -1.3 feet per year
Measurements recorded after 2005 when
adjacent Estates well running excluded
30
20
10
0
-10
-20
-30
-40
-50
-60
-70
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016


SC-16A Groundwater Elevation
Groundwater Elevation, ft MSL
Measurements recorded after 2005 when
adjacent Estates well running excluded
Rate of change = 3.8 feet per year
WY 2010-2014 Trend
20
10
0
-10
-20
-30
-40
-50
-60
-70
-80
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016

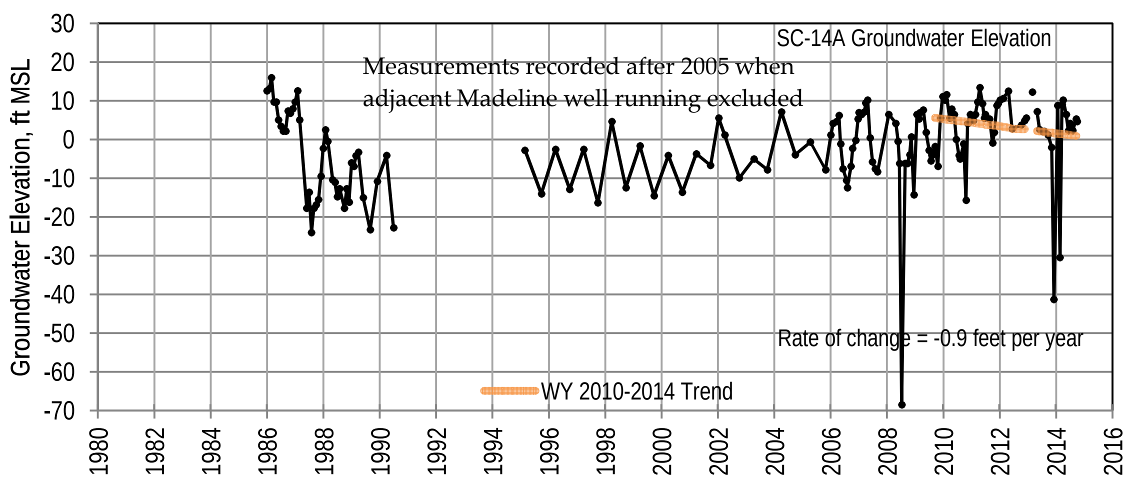

Madeline Chloride
WY 2010-2014 Trend
Secondary MCL
Rate of change = 0.1 mg/L per year
Chloride, mg/L

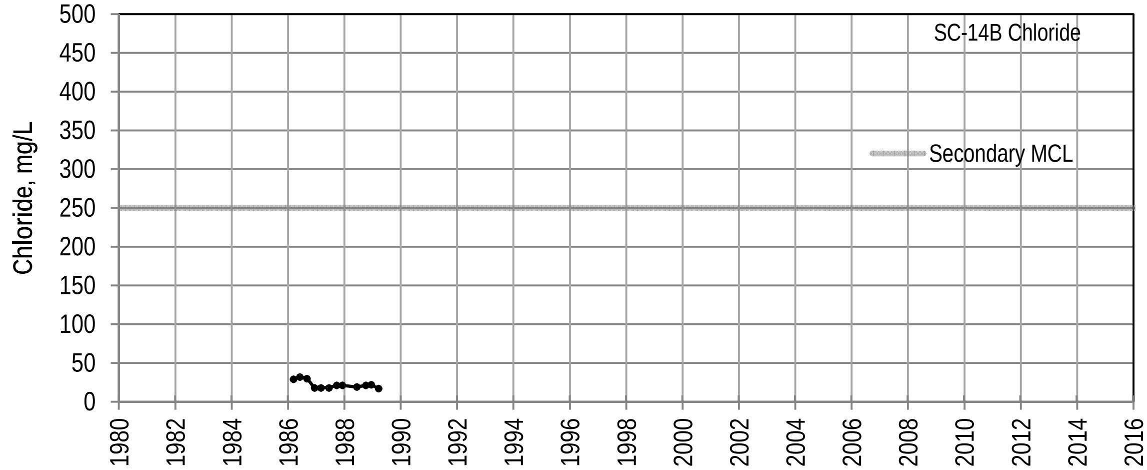

Madeline Total Dissolved Solids
WY 2010-2014 Trend
Secondary MCL
Rate of change = -2.3 mg/L per year
TDS, mg/L

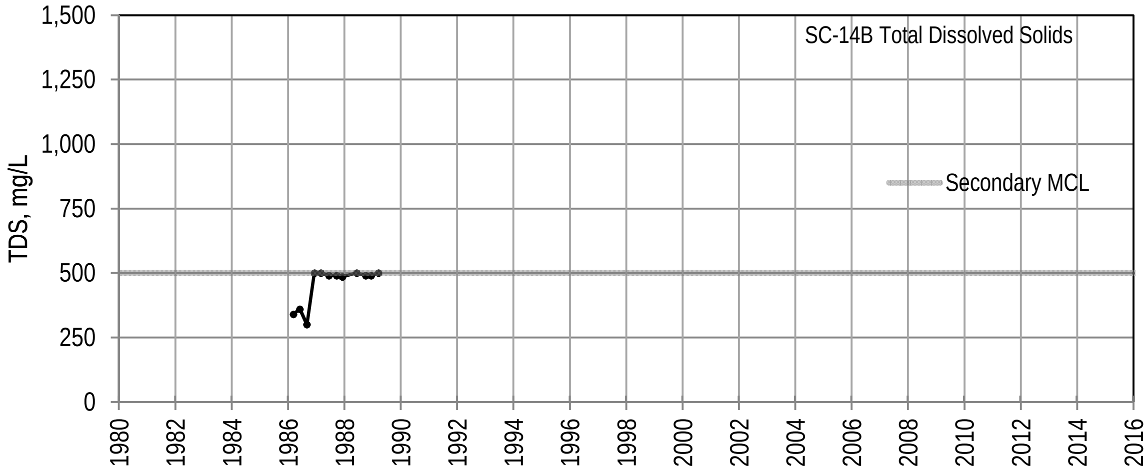

Madeline Groundwater Elevation
Rate of change = 2.4 feet per year
WY 2010-2014 Trend
Groundwater Elevation, ft MSL

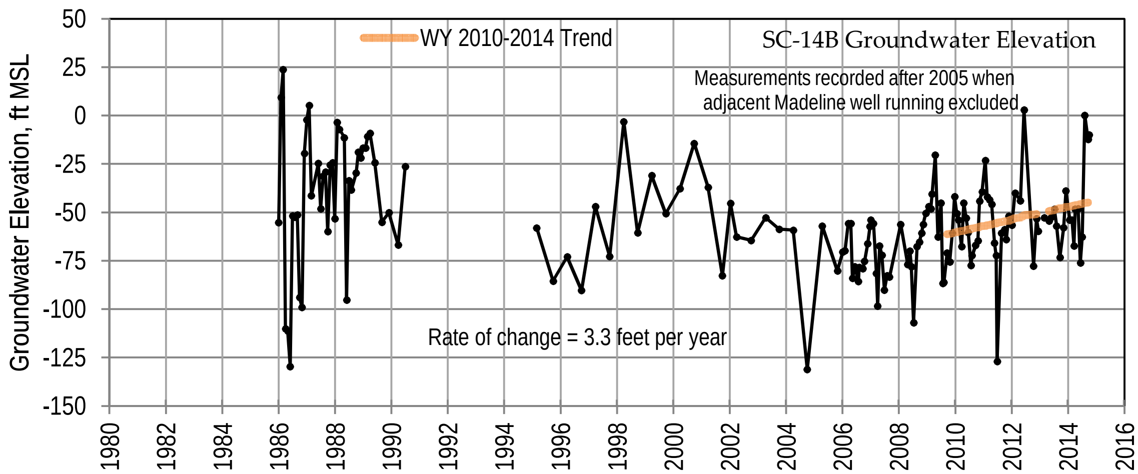

SC-14A Chloride
Secondary MCL
Chloride, mg/L

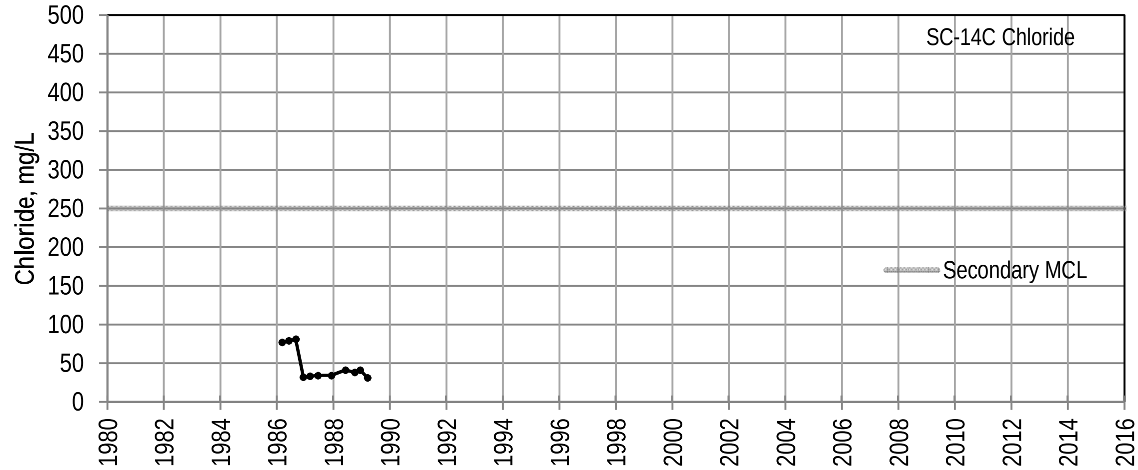

SC-14A Total Dissolved Solids
Secondary MCL
TDS, mg/L

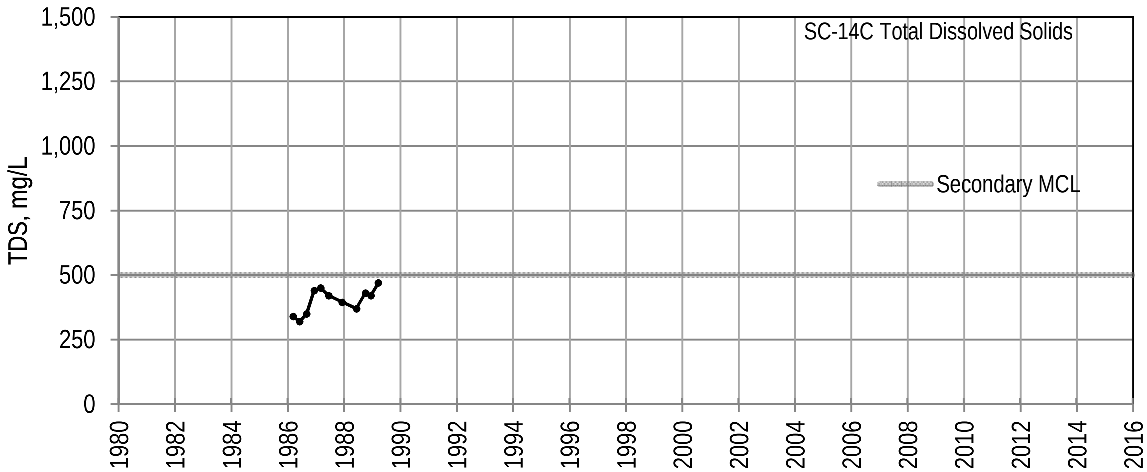

SC-14A Groundwater Elevation
Measurements recorded after 2005 when
adjacent Madeline well running excluded
Rate of change = -0.9 feet per year
WY 2010-2014 Trend
Groundwater Elevation, ft MSL

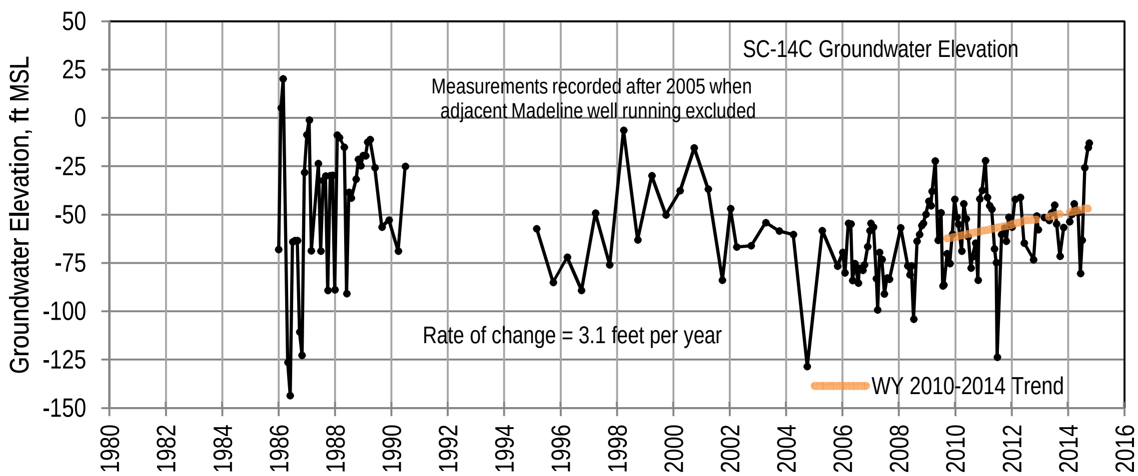

SC-14B Chloride
Secondary MCL
Chloride, mg/L
500
450
400
350
300
250
200
150
100
50
0
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016

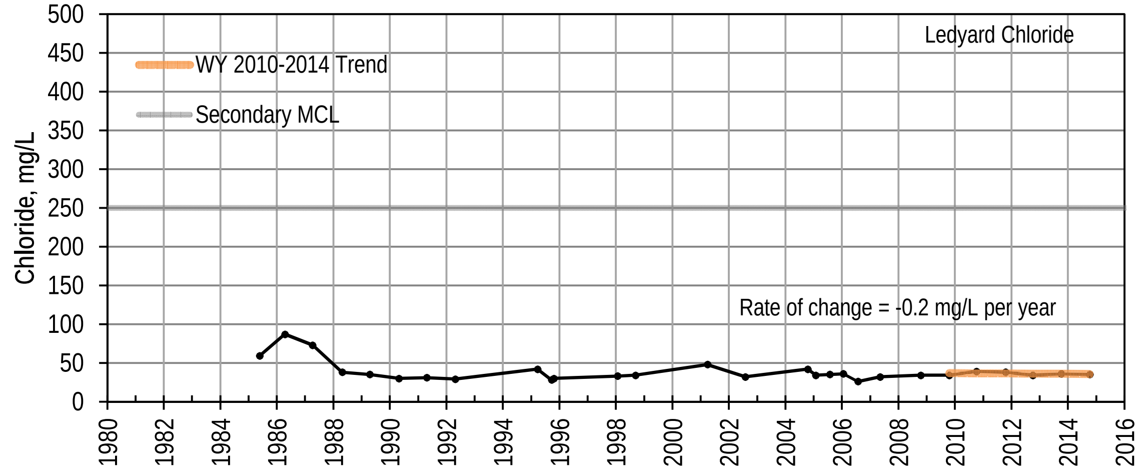

SC-14B Total Dissolved Solids
Secondary MCL
TDS, mg/L
1,500
1,250
1,000
750
500
250
0
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016

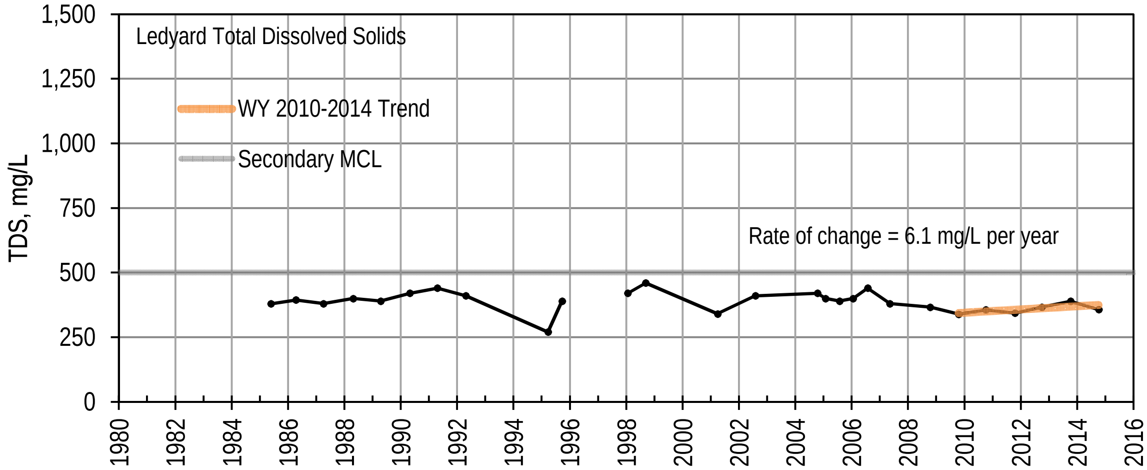

WY 2010-2014 Trend
SC-14B Groundwater Elevation
Measurements recorded after 2005 when adjacent Madeline well running excluded
Rate of change = 3.3 feet per year
Groundwater Elevation, ft MSL
50
25
0
-25
-50
-75
-100
-125
-150
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016

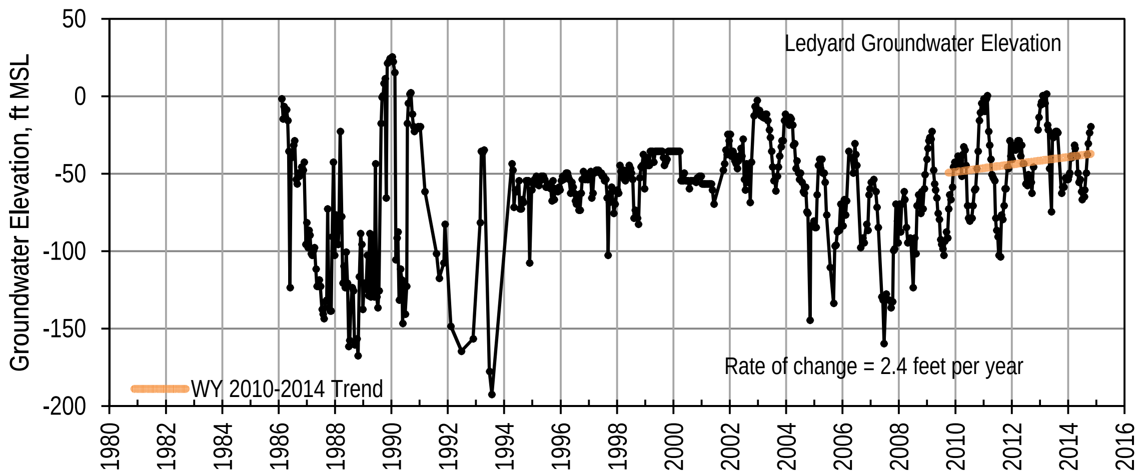

SC-14C Chloride
Secondary MCL
Chloride, mg/L
500
450
400
350
300
250
200
150
100
50
0
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016

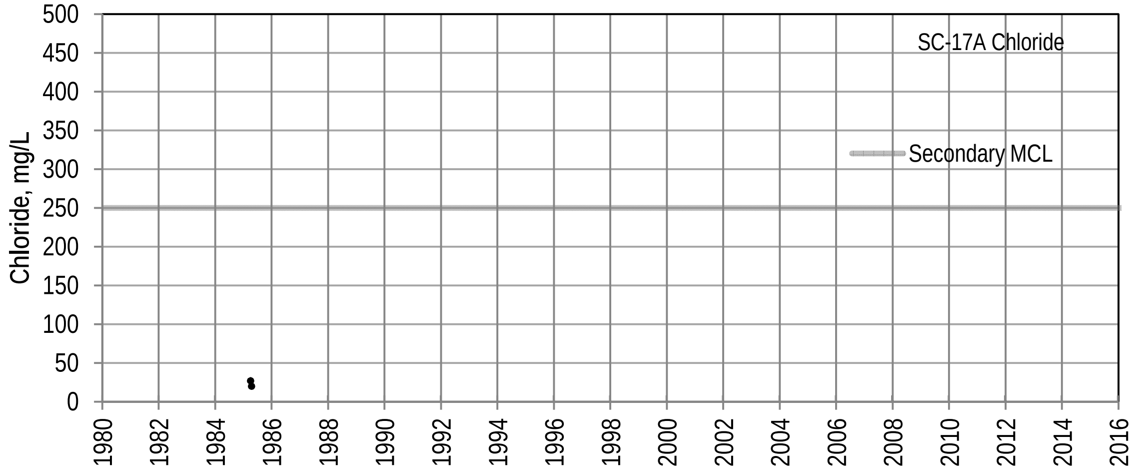

SC-14C Total Dissolved Solids
Secondary MCL
TDS, mg/L
1,500
1,250
1,000
750
500
250
0
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016

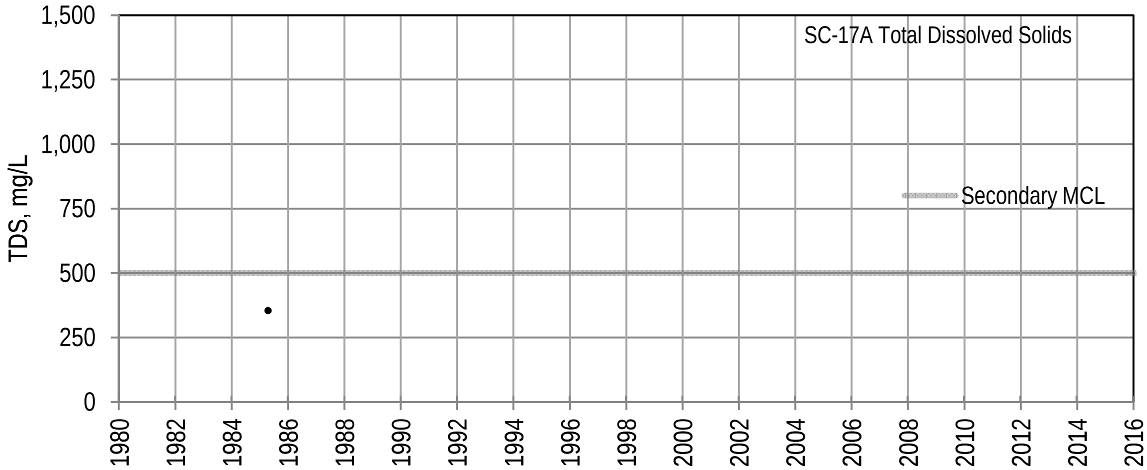

SC-14C Groundwater Elevation
Measurements recorded after 2005 when
adjacent Madeline well running excluded
Rate of change = 3.1 feet per year
WY 2010-2014 Trend
Groundwater Elevation, ft MSL
50
25
0
-25
-50
-75
-100
-125
-150
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016

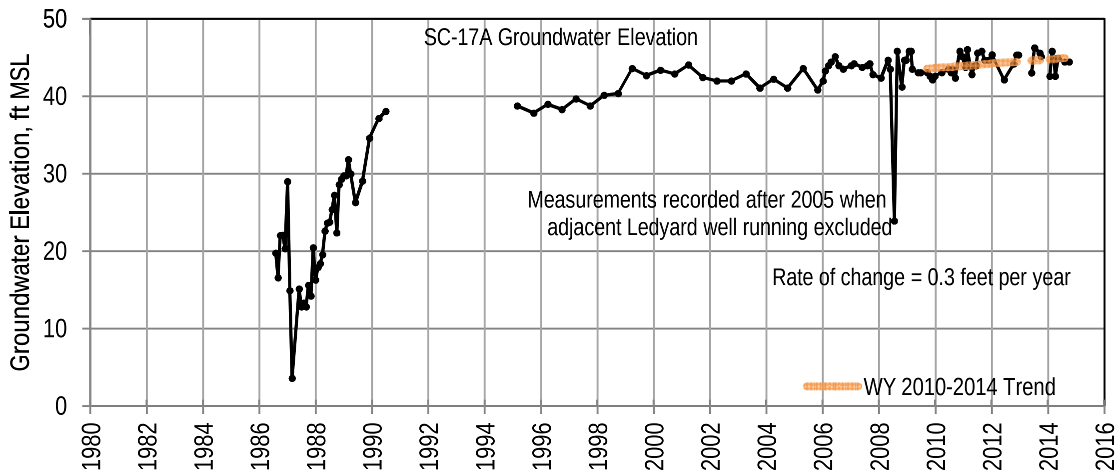

Ledyard Chloride
WY 2010-2014 Trend
Secondary MCL
Chloride, mg/L
Rate of change = -0.2 mg/L per year
500
450
400
350
300
250
200
150
100
50
0
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016

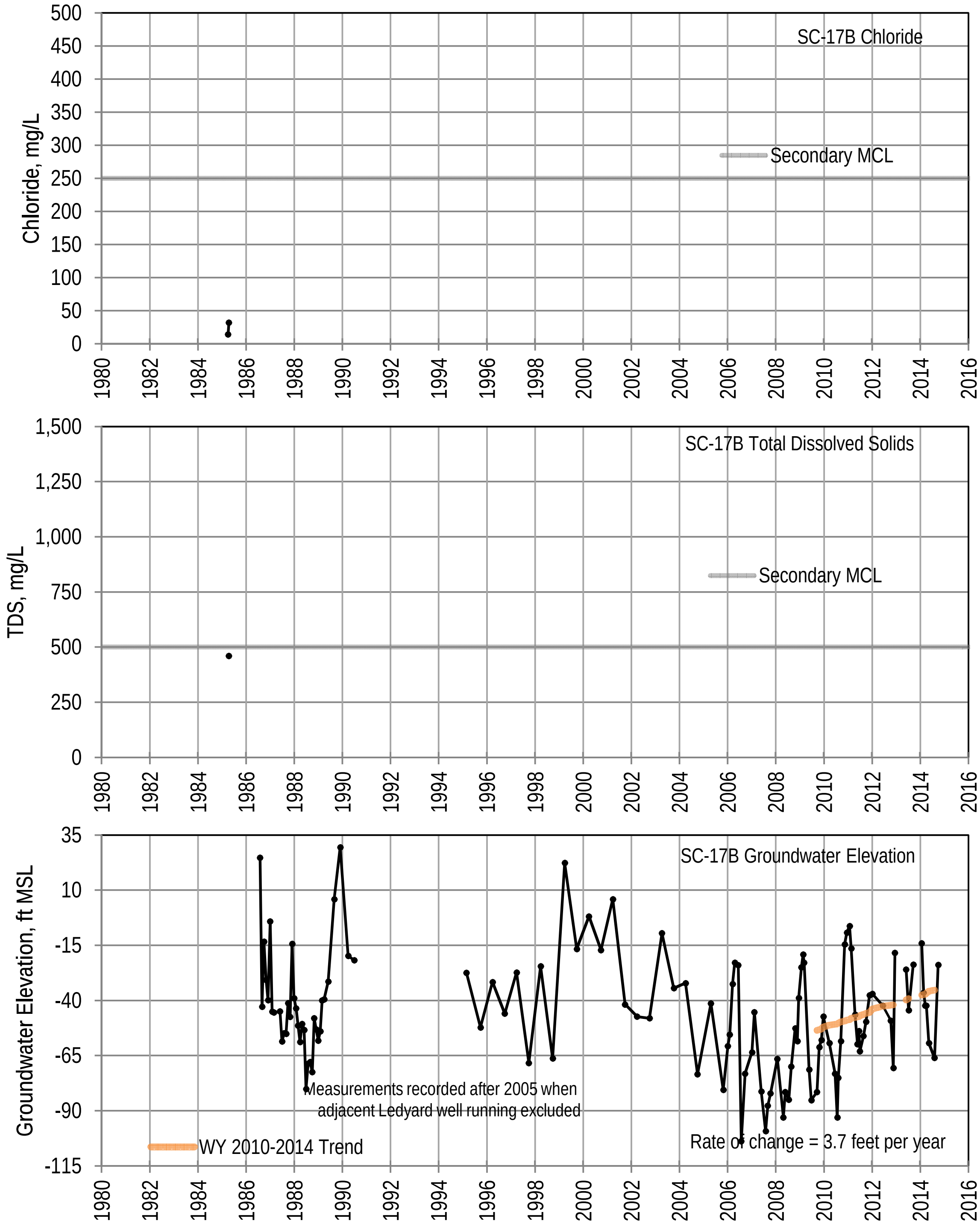

Ledyard Total Dissolved Solids
WY 2010-2014 Trend
Secondary MCL
TDS, mg/L
Rate of change = 6.1 mg/L per year
1,500
1,250
1,000
750
500
250
0
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016

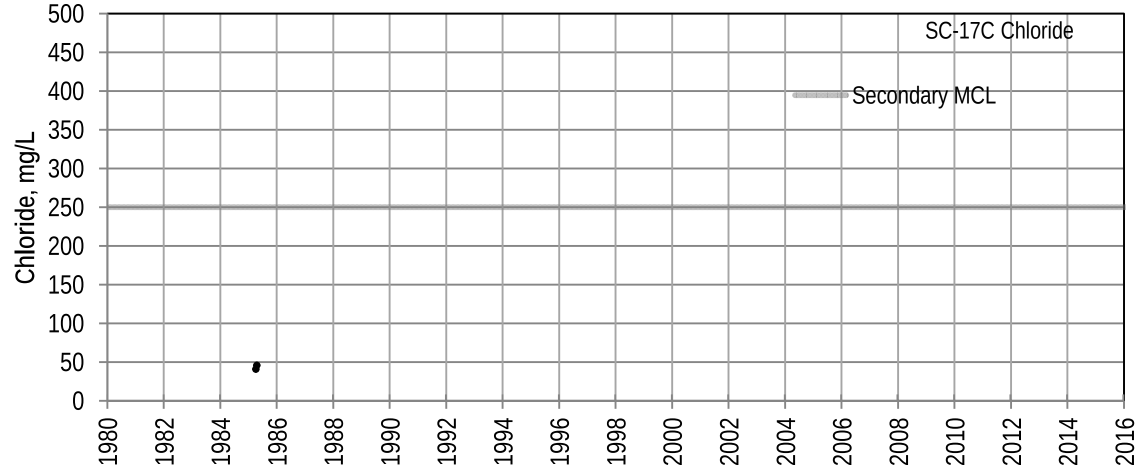

Ledyard Groundwater Elevation
Groundwater Elevation, ft MSL
Rate of change = 2.4 feet per year
WY 2010-2014 Trend
50
0
-50
-100
-150
-200
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016

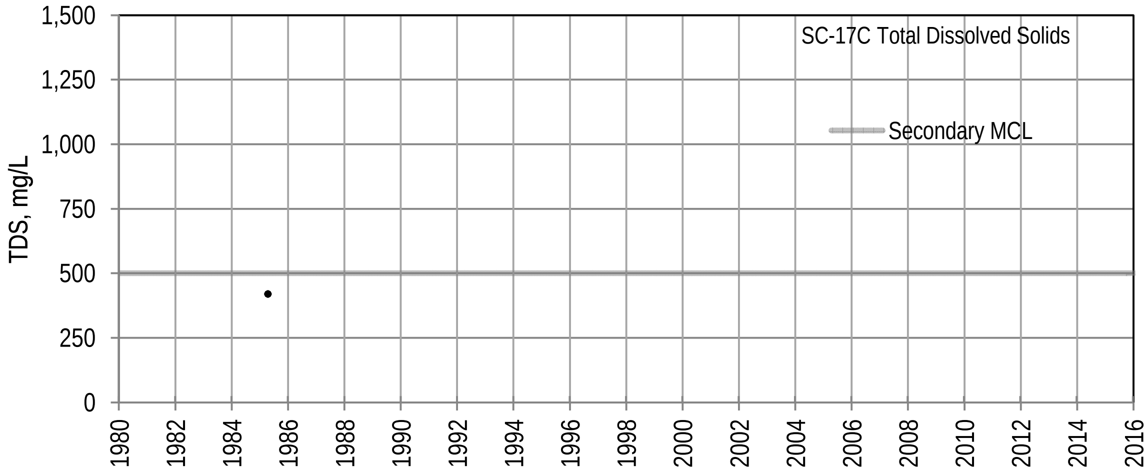

SC-17A Chloride
Secondary MCL
Chloride, mg/L
0
50
100
150
200
250
300
350
400
450
500
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016

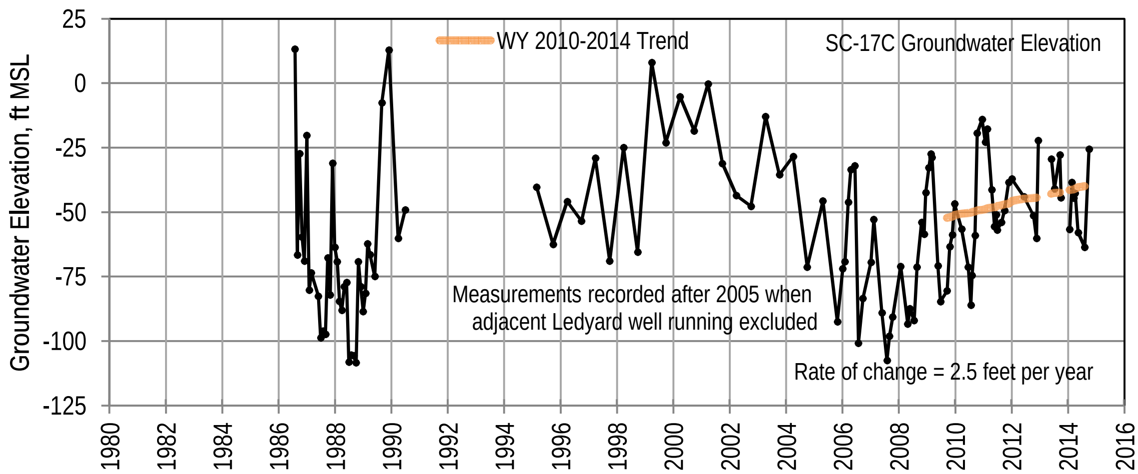

SC-17A Total Dissolved Solids
Secondary MCL
TDS, mg/L
0
250
500
750
1,000
1,250
1,500
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016

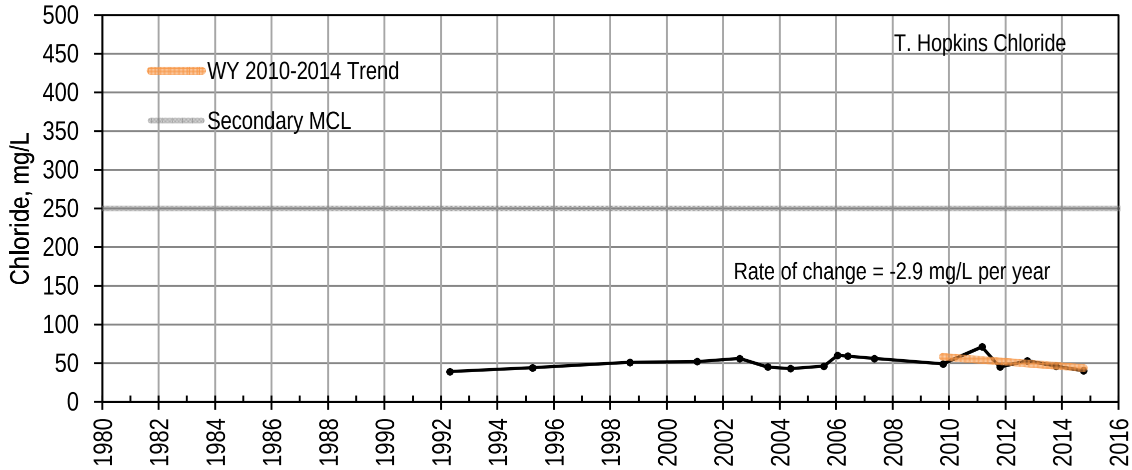

SC-17A Groundwater Elevation
Measurements recorded after 2005 when
adjacent Ledyard well running excluded
Rate of change = 0.3 feet per year
WY 2010-2014 Trend
Groundwater Elevation, ft MSL
0
10
20
30
40
50
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016

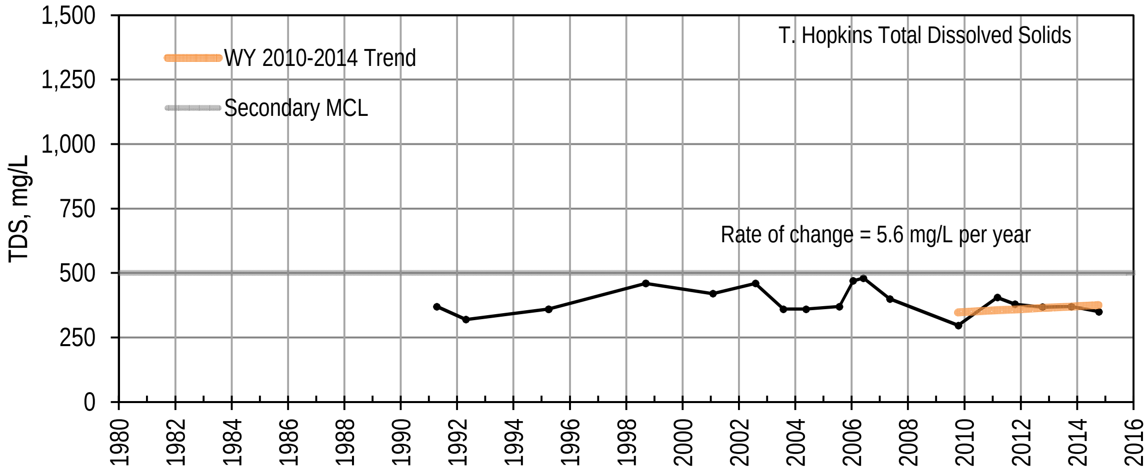

SC-17B Chloride
Secondary MCL
Chloride, mg/L
SC-17B Total Dissolved Solids
Secondary MCL
TDS, mg/L
SC-17B Groundwater Elevation
Groundwater Elevation, ft MSL
Measurements recorded after 2005 when adjacent Ledyard well running excluded
WY 2010-2014 Trend
Rate of change = 3.7 feet per year

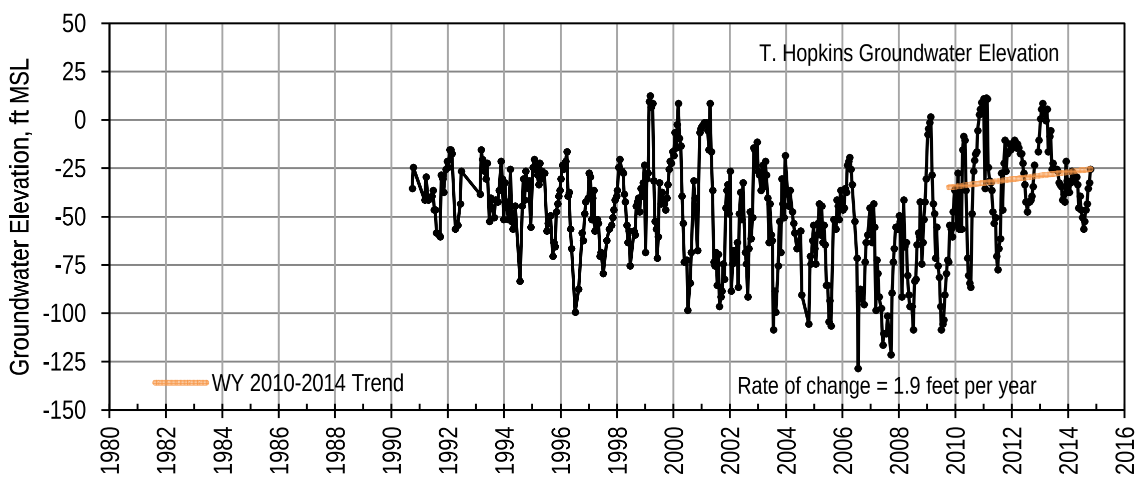

SC-17C Chloride
Secondary MCL
Chloride, mg/L

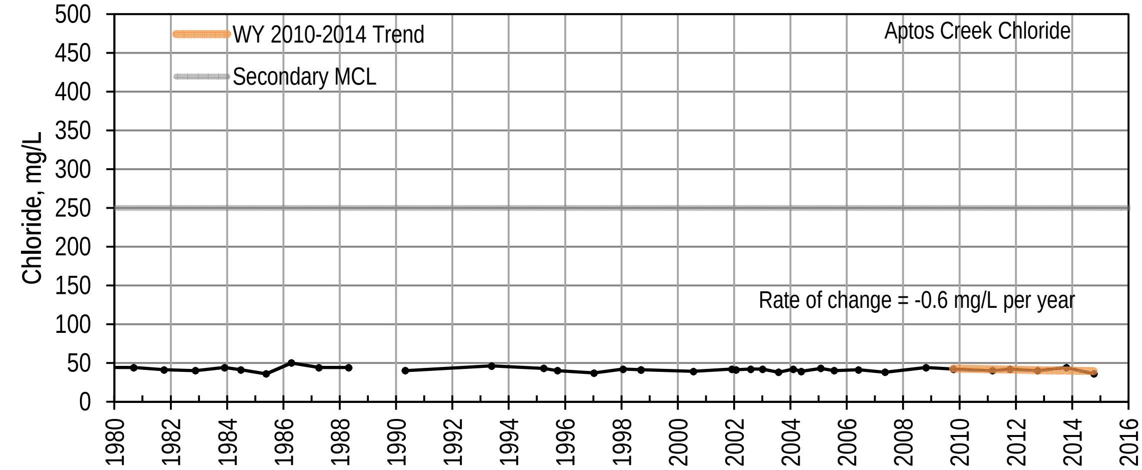

SC-17C Total Dissolved Solids
Secondary MCL
TDS, mg/L


WY 2010-2014 Trend
SC-17C Groundwater Elevation
Measurements recorded after 2005 when adjacent Ledyard well running excluded
Rate of change = 2.5 feet per year
Groundwater Elevation, ft MSL

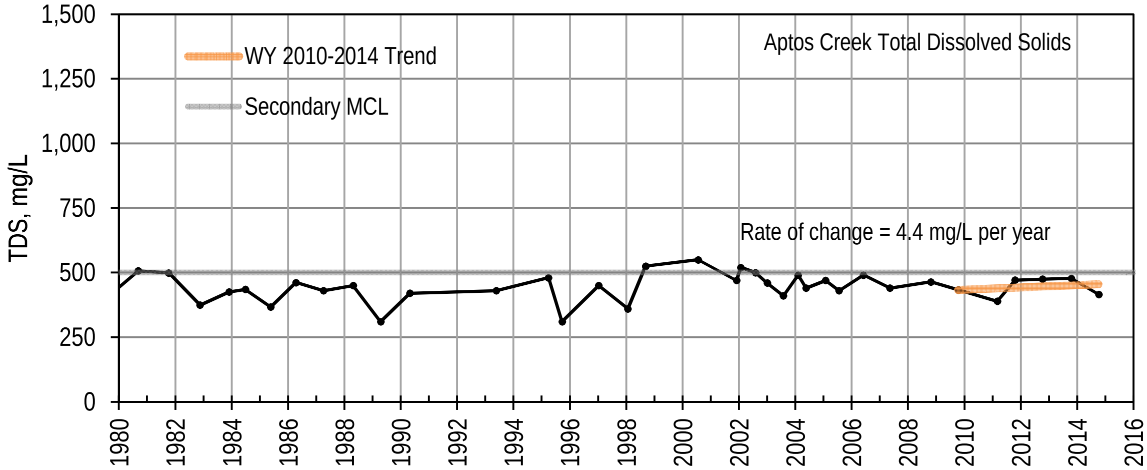

T. Hopkins Chloride
WY 2010-2014 Trend
Secondary MCL
Chloride, mg/L
Rate of change = -2.9 mg/L per year
500
450
400
350
300
250
200
150
100
50
0
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016


T. Hopkins Total Dissolved Solids
WY 2010-2014 Trend
Secondary MCL
TDS, mg/L
Rate of change = 5.6 mg/L per year
1,500
1,250
1,000
750
500
250
0
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016

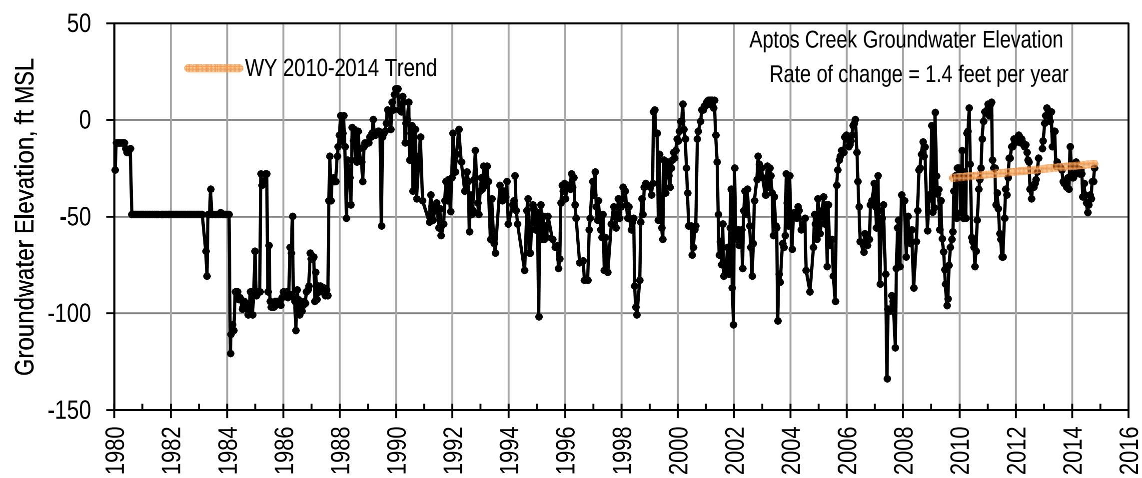

T. Hopkins Groundwater Elevation
Groundwater Elevation, ft MSL
WY 2010-2014 Trend
Rate of change = 1.9 feet per year
50
25
0
-25
-50
-75
-100
-125
-150
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016



Aptos Creek Chloride
WY 2010-2014 Trend
Secondary MCL
Rate of change = -0.6 mg/L per year
Chloride, mg/L
500
450
400
350
300
250
200
150
100
50
0
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016



Aptos Creek Total Dissolved Solids
WY 2010-2014 Trend
Secondary MCL
Rate of change = 4.4 mg/L per year
TDS, mg/L
1,500
1,250
1,000
750
500
250
0
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016



Aptos Creek Groundwater Elevation
Rate of change = 1.4 feet per year
WY 2010-2014 Trend
Groundwater Elevation, ft MSL
50
0
-50
-100
-150
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016

SECTION 5 – WATER YEAR 2014 AQUIFER CONDITIONS FOR AROMAS AREA (PURISIMA F-UNIT/AROMAS RED SANDS)

This section presents groundwater level and water quality conditions for Water Year 2014 in the eastern portion of the Soquel-Aptos area where the primary production aquifers are the Purisima F-unit and the Aromas Red Sands.

5.1 SQCWD SERVICE AREAS III AND IV AND CWD PRODUCTION

In the eastern portion of the Soquel-Aptos area, groundwater is produced for municipal purposes by SqCWD in Service Areas III and IV, and by CWD at its Cox and Rob Roy well fields. SqCWD's Service Area III production was 1,321 acre-feet in Water Year 2014, a decrease from the previous water year, and the lowest total production value in the historical record since Water Year 1984. Water Year 2013 was the first full water year with the Polo Grounds well as part of the Service Area III system as it was added in September 2012. Service Area IV production in the La Selva Beach area was 4.8 acre-feet in Water Year 2014, which is the lowest annual total since Water Year 1984. The Sells well was taken out of service in April 2009 due to high nitrate concentrations. There was no production from the CWD Cox well field due to the poor condition of those wells (HydroMetrics WRI and Kennedy/Jenks, 2013), completed in the Purisima F-unit, during Water Year 2014. Over the previous fifteen years, only a small proportion of CWD's pumping has been from the Cox well field. Production at its Rob Roy well field completed in the Aromas Red Sands was 500 acre-feet.

Figure 5-1 shows production in the Aromas area by water year, grouped into three geographical areas. The Valencia watershed area includes the SqCWD's Aptos Jr. High and Polo Grounds wells and CWD's Cox wells, which are screened in the Purisima F-unit. With pumping at the Aptos Jr. High and Polo Grounds wells totaling 391 acre-feet in Water Year 2014, annual municipal pumping in this area exceeded 300 acre-feet for the third straight year when 300 acre-feet had not been exceeded since Water Year 1986. The Aptos Jr. High well was out of service for Water Years 1987-2006. The Valencia watershed area south and east of Valencia Creek is now included in pumping totals for the Aromas area for comparisons to the post-recovery yield because geologic maps include this sub-area in the Aromas outcrop (HydroMetrics WRI, 2012). Water Year 2014 pumping at the Aptos Jr. High and Polo Grounds wells was approximately 27% of SqCWD's revised estimate of its post-recovery pumping yield in the Aromas area.

The wells in the other two areas are screened in both the Purisima F-unit and the Aromas Red Sands. The Seascape and Rob Roy area includes most of SqCWD's Service Area III wells and CWD's Rob Roy wells. This area has the largest portion of municipal production in the Aromas area. Overall, production has declined since Water Year 2004. Production from these wells was lower in Water Year 2014 following two years of increased production. SqCWD production in the Seascape area was 930 acre-feet in Water Year 2014, lowest total since Water Year 1984. SqCWD production of 930 acre-feet in Water Year 2014 is 65% of SqCWD's post-recovery yield for the Aromas yield (HydroMetrics WRI, 2012). Seascape area and Rob Roy combined total pumping in Water Year 2014 was 1,430 acre-feet, also the lowest total since Water Year 1984. CWD production at Rob Roy has been relatively steady over the last fifteen years and Well #12 has been used as the lead well starting in 2003.

The La Selva Beach area consists of SqCWD's Service Area IV wells, where pumping has declined since Water Year 2008 after the Sells well was taken out of service. In addition, SqCWD limits pumping at the Altivo well as it is the SqCWD production well with highest Chromium VI concentrations. Water Year 2014 pumping of under 5 acre-feet in Service Area IV was the lowest total going back to Water Year 1984 when records for service area totals begin.

SqCWD's post-recovery pumping yield for the Aromas area has been updated to 1,340 acre-feet per year assuming existing septic return flow will continue (HydroMetrics WRI, 2012). Therefore, SqCWD's pumping of 1,325 acre-feet in Water Year 2013 from SqCWD wells in the Aromas area was below the post-recovery pumping yield for the first time since 1982.

5.2 Groundwater Level Conditions and Trends

SqCWD has revised protective groundwater elevations in coastal monitoring wells to protect the Purisima F-unit and Aromas Red Sands in the eastern portion of the Soquel-Aptos area from seawater intrusion. Cross-sectional models were used to estimate groundwater elevations that result in the freshwater-salt water interface being maintained at the current location at the coastal monitoring wells in the long term (HydroMetrics WRI, 2012).

Coastal groundwater levels in SqCWD's F-unit and Aromas Red Sands monitoring wells compared to protective elevations are shown in Table 5-1. In the Aromas area, the revised protective elevations are selected to maintain the interface in both the A and B screens. Therefore, observed groundwater levels in both screens should be compared to protective elevations. Hydrographs for multiple completions of monitoring wells in the Aromas area follow at the end of this section Observed groundwater levels must also be adjusted to account for salinity before they are compared to protective elevations. The protective groundwater elevation estimated by SEAWAT-2000 is the equivalent freshwater head (Langevin and others, 2003). The equivalent freshwater head for groundwater with a substantial amount of salinity is higher than the observed groundwater levels due to the higher density of saline water. Equivalent freshwater heads are calculated where chloride concentrations in coastal monitoring wells are greater than 250 mg/L as described in Attachment A of *Revised Protective Groundwater Elevations and Outflows for Aromas Area and Updated Water Balance for Soquel-Aptos Groundwater Basin* (HydroMetrics WRI, 2012). The hydrographs for single monitoring wells grouped with chemographs for chlorides and total dissolved solids show the equivalent freshwater heads.

Average groundwater levels are above protective elevations in the northwest part of the Aromas area coastline at SC-A1, where the hydrographs show groundwater levels at these wells have been above protective elevations for most of the monitoring record. In the Seascape area, average equivalent freshwater heads remain below protective elevations at SC-A8A. Average equivalent freshwater heads at SC-A2 and SC-A3 were above protective elevations in Water Year 2014. Groundwater levels at SC-A3A rising above the protective elevation the last three years is associated with reduced Service Area IV pumping with the Sells well remaining offline. Maintaining groundwater levels above protective elevation at SC-A4 will likely depend on pumping by nearby small water systems and private pumping that are closer to SC-A4 than any municipal well.

Table 5-1 (2013): Comparison of Water Year 2013 Coastal Groundwater Levels with Protective Elevations

Well	Location	A Screen Unit/ B Screen Unit	Average Equivalent Freshwater Head A screen (feet msl)[1]	Average Equivalent Freshwater Head B screen (feet msl)[1]	Protective Elevation (feet msl)[1]
SC-A1[2]	Cliff	DEF/F	7.2	7.3	3
SC-A8[3]	Dolphin & Sumner	F/ Aromas	5.0	6.4	6
SC-A2[4]	Sumner	F/F	3.6	5.8	3
SC-A3[4]	Playa & Vista	Aromas/Aromas	3.8	4.6	3
SC-A4[4]	Canon del Sol	F/F	1.7	4.2	3

[1] msl = mean sea level

[2]Based on monthly data from June and September

[3]Based on monthly data from December, June, and September

[4]Based on monthly data from December, March, June, and September

In general, groundwater levels at SqCWD's coastal monitoring wells in the area have stabilized or show a slight increasing trend over the last four years, after showing a declining trend over previous years. The stabilized or rising groundwater levels correspond with historically low production by SqCWD in the area. However, the previous declines occurred despite reductions in pumping at some nearby municipal production wells. The lack of correlation between groundwater levels and local pumping may indicate that non-municipal pumping had a more immediate effect on groundwater levels in the Aromas area than the Purisima area. Johnson et al. (2004) had previously concluded that groundwater levels in the area did not reflect year to year changes in climatic conditions. Table 5-2 summarizes the important groundwater level trends by well.

Hydrographs for multiple completions of monitoring wells near the SqCWD and CWD production wells are included at the end of this section. Hydrographs for single wells including production wells are included with chemographs. These hydrographs show trend lines for Water Years 2010-2014 when there have been decreases of municipal production for the Aromas area.

Contour maps of groundwater elevations in Spring and Fall 2014 for the Purisima F-unit and Aromas Red Sands are shown in Figure 5-2 and Figure 5-3, respectively. Both Spring and Fall 2014 contour maps show that groundwater levels were above sea level, although coastal groundwater levels are below protective elevations along a good portion of the coast. There continues to be a pumping depression that developed at the Polo Grounds in Water Year 2013.

The contour maps show that groundwater generally flows from the hills to Monterey Bay with some of the flow pattern altered by pumping. There also appears to be a groundwater flow divide south and east of SqCWD and CWD. South and east of this divide, groundwater flows to Pajaro Valley. There is also a surface watershed divide in this area.

Table 5-2 (2014): Summary of Groundwater Level Trends in Aromas Area

Category	Well	Groundwater Level Trend Description	Notes
SqCWD Coastal Monitoring Wells	SC-A1A	Rise of ~2 feet in WY 2014	May indicate reversal of multi-year downward or steady trend due to reduced pumping
	SC-A1B	Rise of ~4 feet since WY 2010	
	SC-A8A	Steady since WY 2010	Reduced combined pumping at San Andreas and Seascape in WY 2014
	SC-A2A	Upward trend since WY 2009 following several years of decline; rise of >6 feet in WY 2014	Reduced combined pumping at San Andreas and Seascape in WY 2014
	SC-A3A	Stable through WY 2014 after abrupt rise in WY 2012	Historical low SA IV pumping in WY 2010-2014 after Sells went offline
	SC-A4A	Some decline since WY 2012 following prior upward trend	Nearest SqCWD wells are in SA IV
CWD Monitoring Wells in Rob Roy Field	CWD-A	Small downward trend since WY 2010	None
	CWD-B	Generally steady trend through the historical monitoring period	None
	CWD-C	Generally steady trend through the historical monitoring period	Higher percentage of CWD pumping at Rob Roy WY 2012-2014
Inland Wells	SC-20A	Decline of ~3 feet in WY 2014	WY 2013 first full year Polo Grounds online
	SC-20B	Decline of ~5 feet since WY 2010	
	Black Monitoring Well	~10 foot decline in WY 2012-2013. Very sparse groundwater elevation data through WY 2013 and WY 2014	Lower rainfall in WY 2012-2013. Also, Polo Grounds online and increased pumping at Rob Roy 12.

5.3 WATER QUALITY CONDITIONS AND TRENDS

Seawater intrusion has been consistently detected at deep monitoring wells along the coast of the Aromas area. At all coastal monitoring clusters in the Aromas area except SC-A1, the deepest completion was installed to be below the freshwater-saltwater interface. As discussed above, groundwater levels are below protective elevations in the part of the Aromas area nearest most of SqCWD's pumping in the Aromas area. This indicates, there is risk of seawater intrusion continuing to advance toward production wells in the Aromas area.

Observed Total Dissolved Solids (TDS) and chloride concentrations continue to be elevated at the deep coastal monitoring wells installed below the freshwater-saltwater interface. Chloride concentrations are above 6,000 mg/L in these wells.

In the northwest part of the Aromas area coast, the freshwater-salt water interface has not been observed at SC-A1 and salt concentrations at SC-A8A below the interface have remained relatively stable since well installation in 2007. The hydrographs show groundwater levels at these wells have been above protective elevations for most of the monitoring record at SC-A1 and just below protective elevations at SC-A8A.

At SC-A2 in the central part of the Aromas area coast, the freshwater-saltwater interface has continued to move shallower and landward over the long term although average equivalent freshwater head was above the protective elevation in Water Year 2014. There is a long-term increasing trend in TDS and chloride concentrations at both SC-A2A and SC-A2B; however, this trend appears to have stabilized somewhat at SC-A2B through WY 2014. The interface has moved up into the SC-A2B screen with TDS and chloride concentrations rising over the secondary MCLs over time. This apparent landward movement of seawater has put the nearby Seascape well at the highest risk to be impacted by seawater intrusion. If the interface continues to move shallower and landward while protective elevations are being met, the protective elevation should be re-evaluated.

The interface is most shallow at SC-A3 in the southeast part of the Aromas area coast near SqCWD's Service Area 4 production wells. Although TDS and chloride concentrations have been relatively stable in SC-3A, TDS and chloride concentrations in SC-A3B did rise over secondary MCLs in the past indicating the interface had moved up into the SC-A3B screen. Concentrations in SC-A3B did stabilize or decline after the Sells well was taken offline in 2009. The drop in concentrations observed at SC-A3B occurred after installation of new sampling equipment in March 2012 that appears to have sampled only the upper screen of SC-A3B and not the lower screen where the freshwater-salt water interface is more likely to occur will be tested. It is also notable that concentrations at SC-A3B have risen since equipment was installed in 2012. The rise in concentrations from the new equipment may indicate salt water has moved higher into the upper screen. Attempts at redeveloping the well did not fully remove the silt from the lower screen so the equipment has been lowered to the top of the bottom screens to better monitor the freshwater-salt water interface.

In the most southeast part of the Aromas area where the closest pumping is by small water systems and private pumping, TDS and chloride concentrations continue to rise in SC-A4A, where the protective elevation was not achieved in Water Year 2014. The freshwater-saltwater interface has not been observed to have risen up to SC-A4B.

In addition, concentrations at the SC-A5 wells screened below the Seascape well are rising and continue to indicate that seawater has advanced to below that production well. The rise should be monitored closely as a potential risk to the Seascape well.

Chemographs of TDS and chloride for SqCWD monitoring wells in the Aromas area are included at the end of this section. Table 5-3 summarizes the important water quality trends by well.

Observed Total Dissolved Solids (TDS) and chloride concentrations in SqCWD's production wells do not suggest any seawater intrusion impact on municipal production in the Purisima F-unit and Aromas Red Sands. Recent chloride concentrations in the production wells are at 60 mg/L or less, while the maximum contaminant level(MCL) for chlorides is 250 mg/L. Chemographs for SqCWD production wells in the area are included at the end of this section.

Nitrate at SqCWD's Sells well showed concentrations at or just under the maximum contaminant limit of 45 mg/L in 2009 and 2010. The well was removed from service in April 2009. The well was not sampled for nitrate from 2011.

The California Department of Public Health implemented a new drinking water standard (MCL) for Chromium VI of 10 µg/L beginning July 1, 2014. Chromium VI concentrations in SqCWD production wells Bonita, San Andreas, and Seascape screened in the Aromas Red Sands ranged from 13 to 18 µg/L in late 2014. Chromium VI concentrations in CWD production wells Rob Roy 4, 10, and 12 screened in the Aromas Red Sands were below 10 µg/L in 2014. . . A report on depth discrete testing of flows and Chromium VI concentrations at the Bonita, San Andreas, and Altivo wells was issued in 2009 (HydroMetrics LLC, 2009d). Similar tests were conducted at the Rob Roy 12 well in 2012 (HydroMetrics WRI, 2014a).

OEHHA established a PHG for 1,2,3-trichloropropane of 0.0007 µg/L in August 2009, but an enforceable drinking water standard has not yet been set by the California Department of Public Health. The compound 1,2,3-trichloropropane ranged from <0.005 µg/L to 0.015 µg/L in the Country Club well in 2011. The well was not sampled for TCP in 2012-2014. This constituent has not been detected at other wells.

At the end of Water Year 2014 in September 2014, arsenic was measured at 1.3 µg/L in groundwater from the Aptos Jr. High well, which is below the MCL of 10 µg/L for arsenic.

5.4 State of the Aquifer Summary

Seawater intrusion has been detected along the coast of the Aromas area. Coastal groundwater levels have been below protective elevations in the southeast part of the Aromas area indicating risk for continued seawater intrusion into the productive Purisima F unit and the Aromas aquifer. The long-term water quality trend indicates that seawater intrusion has advanced over the last 25 years. Overall, historically low municipal production in the Aromas area has resulted in some recovery of groundwater levels, but not enough to protect the production aquifers over the entire Aromas area. Reducing the risk of seawater intrusion by raising groundwater levels may not be achieved by maintaining recent low municipal production in the Aromas area.

Table 5-3 (2013): Summary of TDS and Chloride Concentration Trends in Aromas Area

Category	Well	Concentration Trend Description	Notes
SqCWD Coastal Monitoring Wells	SC-A1	Chloride consistently <40 mg/L	No completions (deepest to -455 ft msl[1]) installed below freshwater/seawater interface
	SC-A8A	Relatively stable since 2007 installation; chloride=7,000 mg/L	Installed (-391 to -411 ft msl[1]) below interface
	SC-A2A	Long-term increasing trend; chloride = 14,500 mg/L in WY 2013	Installed below interface; near Seascape
	SC-A2B	Long-term increasing trend, chloride ~ 400 mg/L in WY 2013	Installed (-293 to -313 ft msl[1]) above interface when chloride ~ 30 mg/L in WY 1987
	SC-A3A	Stable long-term trend, although slight decline in WY 2012; chloride > 17,000 mg/L (near full strength seawater)	Installed below interface; near Sells and Bonita, rise in groundwater levels WY 2012
	SC-A3B	Long-term increasing trend, but sudden drop in WY 2012 and stable since	Installed (-127 to -167 ft msl[1]) above interface when chloride < 10 mg/L in WY 1987. Concentrations drop after bladder pumps installed.
	SC-A4A	Increasing trend; chloride > 10,000 mg/L in WY 2013	Installed (-334 to -354 ft msl[1]) below interface
	SC-A4B	Increasing trend; chloride 20-70 mg/L in WY 2012	Installed above interface
SqCWD Monitoring Wells near Production Wells	SC-A5A	Increasing trend; chloride > 8,000 mg/L in WY 2012	Installed (-475 to -495 ft msl[1]) below interface; screened 100 feet below Seascape well
	SC-A5B	Increasing trend; Chloride 50-100 mg/L in WY 2012.	Installed above interface; screened 30 feet below Seascape well

[1] msl = mean sea level

Screen elevations listed for most shallow well in the cluster with current chloride concentrations above 250 mg/L.

SECTION 5 – WATER YEAR 2013
AQUIFER CONDITIONS FOR AROMAS AREA
(PURISIMA F-UNIT/AROMAS RED SANDS)

This section presents groundwater level and water quality conditions for Water Year 2013 in the eastern portion of the Soquel-Aptos area where the primary production aquifers are the Purisima F-unit and the Aromas Red Sands.

5.1 SQCWD SERVICE AREAS III AND IV AND CWD PRODUCTION

In the eastern portion of the Soquel-Aptos area, groundwater is produced for municipal purposes by SqCWD in Service Areas III and IV, and by CWD at its Cox and Rob Roy well fields. SqCWD's Service Area III production was 1,545 acre-feet in Water Year 2013, an increase from the three previous years which had the three lowest annual total since Water Year 1995. Water Year 2013 was the first full water year with the Polo Grounds well as part of the Service Area III system as it was added in September 2012. Service Area IV production in the La Selva Beach area was 65 acre-feet in Water Year 2013, the fourth lowest annual total going back to Water Year 1984 but the highest of the last four years. The Sells well was taken out of service in April 2009 due to high nitrate concentrations. CWD production at its Cox well field, completed in the Purisima F-unit, was 2 acre-feet in Water Year 2013. Over the previous fifteen years, only a small proportion of CWD's pumping has been from the Cox well field, but the well field was virtually shut down in Water Year 2013. Production at its Rob Roy well field completed in the Aromas Red Sands was 556 acre-feet. Rob Roy production was the fifth highest annual total on record.

Figure 5-1 shows production in the Aromas area by water year, grouped into three geographical areas. The Valencia watershed area includes the SqCWD's Aptos Jr. High and Polo Grounds wells and CWD's Cox wells, which are screened in the Purisima F-unit. With pumping at the Aptos Jr. High and Polo Grounds wells totaling 349 acre-feet in Water Year 2013, annual municipal pumping in this area exceeded 300 acre-feet for the third straight year when 300 acre-feet had not been exceeded since Water Year 1986. The Aptos Jr. High well was out of service for Water Years 1987-2006. The Valencia watershed area south and east of Valencia Creek is now included in pumping totals for the Aromas area for comparisons to the post-recovery yield because geologic maps include this sub-area in the Aromas outcrop (HydroMetrics WRI, 2012). Water Year 2013 pumping at the Aptos Jr. High and Polo Grounds wells was approximately 29% of SqCWD's revised estimate of its post-recovery pumping yield in the Aromas area.

The wells in the other two areas are screened in both the Purisima F-unit and the Aromas Red Sands. The Seascape and Rob Roy area includes most of SqCWD's Service Area III wells and CWD's Rob Roy wells. This area has the largest portion of municipal production in the Aromas area. Production has declined since Water Year 2004, but production has increased in each of the last two water years. SqCWD production in the Seascape area was 1,183 acre-feet in Water Year 2013, the second lowest total since Water Year 1984. SqCWD production of 1,195 acre-feet in Water Year 2013 is over 99% of SqCWD's post-recovery yield for the Aromas yield (HydroMetrics WRI, 2012). Seascape and Rob Roy combined total pumping in Water Year 2013 was 1,751 acre-feet, an increase over the previous year. CWD production at Rob Roy has been relatively steady over the last fifteen years and Well #12 has been used as the lead well starting in 2003.

The La Selva Beach area consists of SqCWD's Service Area IV wells, where pumping has declined since Water Year 2008 after the Sells well was taken out of service. Water Year 2012 pumping of 65 acre-feet in Service Area IV was the fourth lowest total going back to Water Year 1984 when records for service area totals begin but the highest of the last four years.

SqCWD's post-recovery pumping yield for the Aromas area has been updated to 1,200 acre-feet per year, including pumping from the Aptos Jr. High well and the Polo Grounds well (HydroMetrics WRI, 2012). Therefore, SqCWD's pumping of 1,609 acre-feet in Water Year 2013 from SqCWD wells in the Aromas area still exceeds the post-recovery pumping yield. In addition, pumping will have to be reduced below the pumping yield to recover the basin to protective levels.

5.2 Groundwater Level Conditions and Trends

SqCWD has revised protective groundwater elevations in coastal monitoring wells to protect the Purisima F-unit and Aromas Red Sands in the eastern portion of the Soquel-Aptos area from seawater intrusion. Cross-sectional models were used to estimate groundwater elevations that result in the freshwater-salt water interface being maintained at the current location at the coastal monitoring wells in the long term (HydroMetrics WRI, 2012).

Coastal groundwater levels in SqCWD's F-unit and Aromas Red Sands monitoring wells compared to protective elevations are shown in Table 5-1. In the Aromas area, the revised protective elevations are selected to maintain the interface in both the A and B screens. Therefore, observed groundwater levels in both screens should be compared to protective elevations. Hydrographs for multiple completions of monitoring wells in the Aromas area follow at the end of this section Observed groundwater levels must also be adjusted to account for salinity before they are compared to protective elevations. The protective groundwater elevation estimated by SEAWAT-2000 is the equivalent freshwater head (Langevin and others, 2003). The equivalent freshwater head for groundwater with a substantial amount of salinity is higher than the observed groundwater levels due to the higher density of saline water. Equivalent freshwater heads are calculated where chloride concentrations in coastal monitoring wells are greater than 250 mg/L as described in Attachment A of HydroMetrics WRI (2012). The hydrographs for single monitoring wells grouped with chemographs for chlorides and total dissolved solids show the equivalent freshwater heads.

Average groundwater levels are above protective elevations in the northwest part of the Aromas area coastline at SC-A1, where the hydrographs show groundwater levels at these wells have been above protective elevations for most of the monitoring record. In the Seascape area, average equivalent freshwater heads remain below protective elevations at SC-A8A and SC-A2A. . In Service Area IV to the southeast, average equivalent freshwater heads at SC-A3 and SC-A4 were above protective elevations in Water Year 2013. Groundwater levels at SC-A3A rising above the protective elevation the last two years have occurred during a four year period with reduced Service Area IV pumping with the Sells well offline. Maintaining groundwater levels above protective elevation at SC-A4 will likely depend on pumping by nearby small water systems and private pumping that are closer to SC-A4 than any municipal well.

Table 5-1 (2013): Comparison of Water Year 2013 Coastal Groundwater Levels with Protective Elevations

Well	Location	A Screen Unit/ B Screen Unit	Average Equivalent Freshwater Head A screen[1] (feet msl)[2]	Average Equivalent Freshwater Head B screen (feet msl)[1]	Protective Elevation (feet msl)[1]
SC-A1	Cliff	DEF/F	7.7	7.6	3
SC-A8	Dolphin & Sumner	F/ Aromas	5.6	7.0	6
SC-A2	Sumner	F/F	1.5	5.2	3
SC-A3	Playa & Vista	Aromas/Aromas	3.9	4.6	3
SC-A4	Canon del Sol	F/F	3.2	5.2	3

[1] Bi-monthly data from October, December, February, April, June, and September.

[2] msl = mean sea level

In general, groundwater levels at SqCWD's coastal monitoring wells in the area have stabilized or show a slight increasing trend over the last four years, after showing a declining trend over previous years. The stabilized or rising groundwater levels correspond with historically low production by SqCWD in the area. However, the previous declines occurred despite reductions in pumping at some nearby municipal production wells. The lack of correlation between groundwater levels and local pumping may indicate that non-municipal pumping had a more immediate effect on groundwater levels in the Aromas area than the Purisima area. Johnson et al. (2004) had previously concluded that groundwater levels in the area did not reflect year to year changes in climatic conditions.

Table 5-2 summarizes the important groundwater level trends by well. Changes to trends in WY 2013 include:

- Decline of 2 feet in SC-A2A over Water Years 2012-2013. Combined pumping at Seascape and San Andreas varied from low pumping in WY 2011 to high pumping in Water Year 2012 to average pumping in Water Year 2013.
- Decline of 2 feet in CWD-C in Water Year 2013. CWD's Rob Roy 12 well had its highest annual production since coming online in 1999.
- Decline of 20 feet in SC-20A over Water Years 2012-2013. The Polo Grounds well came online in August 2012.

- Decline of 10 feet in Black monitoring well over Water Years 2012-2013. This decline may be related to lower rainfall over the two years and/or increased pumping at CWD's Rob Roy 12 well and SqCWD's Polo Grounds well.

Hydrographs for multiple completions of monitoring wells near the SqCWD and CWD production wells are included at the end of this section. Hydrographs for single wells including production wells are included with chemographs. These hydrographs show trend lines for Water Years 2008-2012 when there have been decreases of municipal production for the Aromas area.

Contour maps of groundwater elevations in Spring and Fall 2013 for the Purisima F-unit and Aromas Red Sands are shown in Figure 5-2 and Figure 5-3, respectively. Both Spring and Fall 2013 contour maps show that groundwater levels were above sea level, although coastal groundwater levels are below protective elevations along a good portion of the coast. Slightly higher coastal groundwater levels in the spring than the fall are evidenced by the location of the 5 foot contour. The main difference from the previous year is the greater pumping depression that has developed at the Polo Grounds and Rob Roy #12 wells.

The contour maps show that groundwater generally flows from the hills to Monterey Bay with some of the flow pattern altered by pumping. There also appears to be a groundwater flow divide south and east of SqCWD and CWD. South and east of this divide, groundwater flows to Pajaro Valley. There is also a surface watershed divide in this area.

Table 5-2 (2013): Summary of Groundwater Level Trends in Aromas Area

Category	Well	Groundwater Level Trend Description	Notes
SqCWD Coastal Monitoring Wells	SC-A1	Rise of ~2 feet WY 2010-2013. Rise of ~4 feet in B screen since WY 2009.	Lower pumping at Country Club WY 2010-2013 vs. previous years; Seascape Golf Course also pumping nearby
	SC-A8	Slight rise since installation in WY 2007	Lower combined pumping at Seascape and San Andreas WY 2009-2013 vs. previous nine years
	SC-A2	Rise of 1.5-2 feet WY 2009-2012. Decline of 2 feet WY 2012-2013	Combined pumping at San Andreas and Seascape WY 2013 similar to long-term average after high pumping in WY 2012
	SC-A3	. Stable WY 2013 after rise in WY 2012	Historical low SA IV pumping in WY 2010-2013 after Sells went offline
	SC-A4	Rise of 2+ feet WY 2009-2013	Nearest SqCWD wells are in SA IV
CWD Monitoring Wells in Rob Roy Field	CWD-A	Stable trend wince WY 2006	None
	CWD-B	Stable trend since WY 2006	None
	CWD-C	Decline of 2+ feet in WY 2013	Rob Roy 12 WY 2013 highest annual pumping since well came online in WY 1999
Inland Wells	SC-20	Decline of ~20 feet WY 2012-2013	WY 2013 first full year Polo Grounds online
	Black Monitoring Well	~10 foot decline in WY 2012-2013	Lower rainfall in WY 2012-2013. Also, Polo Grounds online and increased pumping at Rob Roy 12.

5.3 WATER QUALITY CONDITIONS AND TRENDS

Seawater intrusion has been consistently detected at deep monitoring wells along the coast of the Aromas area. At all coastal monitoring clusters in the Aromas area except SC-A1, the deepest completion was installed to be below the freshwater-saltwater interface. As discussed above, groundwater levels are below protective elevations in the part of the Aromas area nearest most of SqCWD's pumping in the Aromas area As a result, there is risk of seawater intrusion continuing to advance toward production wells in the Aromas area.

Observed Total Dissolved Solids (TDS) and chloride concentrations continue to be elevated at the deep coastal monitoring wells installed below the freshwater-saltwater interface. Chloride concentrations are above 6,000 mg/L in these wells.

In the northwest part of the Aromas area coast, the freshwater-salt water interface has not been observed at SC-A1 and salt concentrations at SC-A8A below the interface have remained relatively stable since well installation in 2007. The hydrographs show groundwater levels at these wells have been above protective elevations for most of the monitoring record at SC-A1 and just below protective elevations at SC-A8A.

At SC-A2 in the central part of the Aromas area coast, the freshwater-saltwater interface has continued to move shallower and landward over the long term as the SC-A2A hydrograph continues to show equivalent freshwater heads below protective elevation in Water Year 2013. There is a long-term increasing trend in TDS and chloride concentrations at both SC-A2A and SC-A2B. The interface has moved up into the SC-A2B screen with TDS and chloride concentrations rising over the secondary MCLs over time. This apparent landward movement of seawater has put the nearby Seascape well at the highest risk to be impacted by seawater intrusion

The interface is most shallow at SC-A3 in the southeast part of the Aromas area coast near SqCWD's Service Area 4 production wells. Although TDS and chloride concentrations have been relatively stable in SC-3A, TDS and chloride concentrations in SC-A3B did rise over secondary MCLs in the past indicating the interface had moved up into the SC-A3B screen. Concentrations in SC-A3B did stabilize or decline after the Sells well was taken offline in 2009. The drop in concentrations observed at SC-A3B occurred after installation of new sampling equipment in March 2012 and the hypothesis that the new equipment only represents the upper screen of SC-A3B and not the lower screen where the freshwater-salt water interface is more likely to occur will be tested.

In the most southeast part of the Aromas area where the closest pumping is by small water systems and private pumping, TDS and chloride concentrations continue to rise in SC-A4A as the protective elevation was only achieved in the last year. The freshwater-saltwater interface has not been observed to have risen up to SC-A4B.

In addition, concentrations at the SC-A5 wells screened below the Seascape well are rising and continue to indicate that seawater has advanced to below that production well. The rise should be monitored closely as a potential risk to the Seascape well.

Chemographs of TDS and chloride for SqCWD monitoring wells in the Aromas area are included at the end of this section. Table 5-3 summarizes the important water quality trends by well.

Observed Total Dissolved Solids (TDS) and chloride concentrations in SqCWD's production wells do not suggest any seawater intrusion impact on municipal production in the Purisima F-unit and Aromas Red Sands. Recent chloride concentrations in the production wells are at 60 mg/L or less, while the maximum contaminant level(MCL) for chlorides is 250 mg/L. Chemographs for SqCWD production wells in the area are included at the end of this section.

Nitrate at SqCWD's Sells well showed concentrations at or just under the maximum contaminant limit of 45 mg/L in 2009 and 2010. The well was removed from service in April 2009. The well was not sampled for nitrate in 2011 and 2012.

The California Department of Public Health is scheduled to implement a new drinking water standard (MCL) for Chromium VI of 10 μg/L beginning July 1, 2014. Chromium VI concentrations in SqCWD production wells screened in the Aromas Red Sands ranged from 6,3 to 22 μg/L in 2013. Chromium VI concentrations in CWD production wells screened in the Aromas Red Sands ranged from 4 to 11 μg/L in 2009 and 2013. Concentrations for total chromium met current drinking water standards for all wells. A report on depth discrete testing of flows and Chromium VI concentrations at the Bonita, San Andreas, and Altivo wells was issued in 2009 (HydroMetrics LLC, 2009d). Similar tests were conducted at the Rob Roy 12 well in 2012 (HydroMetrics WRI, 2014a).

OEHHA established a PHG for 1,2,3-trichloropropane of 0.0007 μg/L in August 2009, but an enforceable drinking water standard has not yet been set by the California Department of Public Health. The compound 1,2,3-trichloropropane ranged from <0.005 μg/L to 0.015 μg/L in the Country Club well in 2011. The well was not sampled for TCP in 2012 or 2013. This constituent has not been detected at other wells.

Screen elevations listed for most shallow well in the cluster with current chloride concentrations above 250 mg/L.

In 2013, arsenic was measured at 0.6 μg/L in groundwater from the Aptos Jr. High well but treatment plant effluent samples at other times were measured up to 1.4 ug/L, which is below the MCL of 10 μg/L for arsenic.

5.4 State of the Aquifer Summary

Seawater intrusion has been detected along the coast of the Aromas area. Coastal groundwater levels have been below protective elevations in the southeast part of the Aromas area indicating risk for continued seawater intrusion into the productive Purisima F unit and the Aromas aquifer. The long-term water quality trend indicates that seawater intrusion has advanced over the last 25 years. Overall, historically low municipal production in the Aromas area has resulted in some recovery of groundwater levels, but not enough to protect the production aquifers over the entire Aromas area. Reducing the risk of seawater intrusion by raising groundwater levels may not be achieved by maintaining recent low municipal production in the Aromas area.

Table 5-3 (2013): Summary of TDS and Chloride Concentration Trends in Aromas Area

Category	Well	Concentration Trend Description	Notes
SqCWD Coastal Monitoring Wells	SC-A1	Chloride consistently <40 mg/L	No completions (deepest to -455 ft msl[1]) installed below freshwater/seawater interface
	SC-A8A	Relatively stable since 2007 installation; chloride=7,000 mg/L	Installed (-391 to -411 ft msl[1]) below interface
	SC-A2A	Long-term increasing trend; chloride = 14,500 mg/L in WY 2013	Installed below interface; near Seascape
	SC-A2B	Long-term increasing trend, chloride ~ 400 mg/L in WY 2013	Installed (-293 to -313 ft msl[1]) above interface when chloride ~ 30 mg/L in WY 1987
	SC-A3A	Stable long-term trend, although slight decline in WY 2012; chloride > 17,000 mg/L (near full strength seawater)	Installed below interface; near Sells and Bonita, rise in groundwater levels WY 2012
	SC-A3B	Long-term increasing trend, but sudden drop in WY 2012 and stable since	Installed (-127 to -167 ft msl[1]) above interface when chloride < 10 mg/L in WY 1987. Concentrations drop after bladder pumps installed.
	SC-A4A	Increasing trend; chloride > 10,000 mg/L in WY 2013	Installed (-334 to -354 ft msl[1]) below interface
	SC-A4B	Increasing trend; chloride 20-70 mg/L in WY 2012	Installed above interface
SqCWD Monitoring Wells near Production Wells	SC-A5A	Increasing trend; chloride > 8,000 mg/L in WY 2012	Installed (-475 to -495 ft msl[1]) below interface; screened 100 feet below Seascape well
	SC-A5B	Increasing trend; Chloride 50-100 mg/L in WY 2012.	Installed above interface; screened 30 feet below Seascape well

[1] msl = mean sea level

SECTION 5 – WATER YEAR 2012 AQUIFER CONDITIONS FOR AROMAS AREA (PURISIMA F-UNIT/AROMAS RED SANDS)

This section presents groundwater level and water quality conditions for Water Year 2012 in the eastern portion of the Soquel-Aptos area where the primary production aquifers are the Purisima F-unit and the Aromas Red Sands.

5.1 SQCWD SERVICE AREAS III AND IV AND CWD PRODUCTION

In the eastern portion of the Soquel-Aptos area, groundwater is produced for municipal purposes by SqCWD in Service Areas III and IV, and by CWD at its Cox and Rob Roy well fields. SqCWD's Service Area III production was 1,475 acre-feet in Water Year 2012, an increase from the previous year but the second lowest annual total since Water Year 1995. The Polo Grounds well was added to the Service Area III system in September 2012. Service Area IV production in the La Selva Beach area was 39 acre-feet in Water Year 2012, the second lowest annual total going back to Water Year 1984. The Sells well was taken out of service in April 2009 due to high nitrate concentrations. CWD production at its Cox well field, completed in the Purisima F-unit, was 17 acre-feet in Water Year 2012, but the Cox pumping meters may not have been accurate. Production at its Rob Roy well field completed in the Aromas Red Sands was 572 acre-feet. Rob Roy production was the fourth highest annual total on record. Also, the distribution of CWD production between the two well fields is consistent with the previous fourteen years.

Figure 5-1 shows production in the Aromas area by water year, grouped into three geographical areas. The Valencia watershed area includes the SqCWD's Aptos Jr. High and Polo Grounds wells and CWD's Cox wells, which are screened in the Purisima F-unit. With the increase in pumping at the Aptos Jr. High well, annual municipal pumping in this area exceeded 300 acre-feet for the second straight year when 300 acre-feet had not been exceeded since Water Year 1986. Pumping increased in Water Year 2007 when the Aptos Jr. High well was put back into service. The Valencia watershed area south and east of Valencia Creek is now included in pumping totals for the Aromas area for comparisons to the post-recovery yield because geologic maps include this sub-area in the

Aromas outcrop (HydroMetrics WRI, 2012). Water Year 2012 pumping at the Aptos Jr. High and Polo Grounds wells was approximately 24% of SqCWD's revised estimate of its post-recovery pumping yield in the Aromas area.

The wells in the other two areas are screened in both the Purisima F-unit and the Aromas Red Sands. The Seascape and Rob Roy area includes most of SqCWD's Service Area III wells and CWD's Rob Roy wells. This area has the largest portion of municipal production in the Aromas area, although production has declined since Water Year 2005. SqCWD production in the Seascape area was 1,183 acre-feet in Water Year 2012, the second lowest total since Water Year 1984. SqCWD production of 1,183 acre-feet is approximately 99% of SqCWD’s post-recovery yield for the Aromas yield (HydroMetrics WRI, 2012). Seascape and Rob Roy combined total pumping in Water Year 2012 was 1,755 acre-feet, an increase over the previous year. CWD production at Rob Roy has been relatively steady over the last fifteen years and Well #12 has been used as the lead well starting in 2003.

The La Selva Beach area consists of SqCWD's Service Area IV wells, where pumping has declined since Water Year 2008 after the Sells well was taken out of service. Water Year 2012 pumping of 39 acre-feet in Service Area IV was the second lowest total going back to Water Year 1984, when records for service area totals begin and higher only than Water Year 2012.

SqCWD’s post-recovery pumping yield for the Aromas area has been updated to 1,200 acre-feet per year, including pumping from the Aptos Jr. High well and the planned Polo Grounds well (HydroMetrics WRI, 2012). Therefore, SqCWD's pumping of 1,516 acre-feet in Water Year 2012 from SqCWD wells in the Aromas area still exceeds the post-recovery pumping yield. In addition, pumping will have to be reduced below the pumping yield to recover the basin to protective levels.

5.2 GROUNDWATER LEVEL CONDITIONS AND TRENDS

SqCWD has revised protective groundwater elevations in coastal monitoring wells to protect the Purisima F-unit and Aromas Red Sands in the eastern portion of the Soquel-Aptos area from seawater intrusion. Cross-sectional models were used to estimate groundwater elevations that result in the freshwater-salt water interface being maintained at the current location at the coastal monitoring wells in the long term (HydroMetrics WRI, 2012).

Coastal groundwater levels in the SqCWD's F-unit and Aromas Red Sands monitoring wells compared to protective elevations are shown in Table 5-1. In the Aromas area, the revised protective elevations are selected to maintain the interface in both the A and B screens. Therefore, observed groundwater levels in both screens should be compared to protective elevations. Hydrographs for multiple completions of monitoring wells in the Aromas area follow at the end of this section Observed groundwater levels must also be adjusted to account for salinity before they are compared to protective elevations. The protective groundwater elevation estimated by SEAWAT-2000 is the equivalent freshwater head (Langevin and others, 2003). The equivalent freshwater head for groundwater with a substantial amount of salinity is higher than the observed groundwater levels due to the higher density of saline water. Equivalent freshwater heads are calculated where chloride concentrations in coastal monitoring wells are greater than 250 mg/L as described in Attachment A of HydroMetrics WRI (2012). The hydrographs for single monitoring wells grouped with chemographs for chlorides and total dissolved solids show the equivalent freshwater heads.

Average groundwater levels are above protective elevations in the northwest part of the Aromas area coastline at SC-A1, where the hydrographs show groundwater levels at these wells have been above protective elevations for most of the monitoring record. Due to a revision in survey elevations, average equivalent freshwater heads at SC-A8A have not been above protective elevations as previously thought. Further southeast, average equivalent freshwater heads remain below protective elevations at SC-A2. The hydrographs show equivalent freshwater heads in the A screens in SC-A2 and SC-A3 have been below protective elevations for much of the monitoring record. In the most southeast part of the Aromas area average equivalent freshwater heads at SC-A4A have been closer to protective elevations than previously thought due to a revision in survey elevations. In Water Year 2012, average equivalent freshwater heads at SC-A4A were at protective elevations as they were for Water Years 2005-2008.

Table 5-1 (2012): Comparison of Water Year 2012 Coastal Groundwater Levels with Protective Elevations

Well	Location	A Screen Unit/ B Screen Unit	Average Equivalent Freshwater Head A screen (feet msl) [1]	Average Equivalent Freshwater Head B screen (feet msl) [1]	Protective Elevation (feet msl) [1]
SC-A1	Cliff	DEF/F	7.3	8.6	3
SC-A8	Dolphin & Sumner	F/ Aromas	5.9	7.5	6
SC-A2	Sumner	F/F	2.2	5.6	3
SC-A3	Playa & Vista	Aromas/Aromas	3.2	4.7	3
SC-A4	Canon del Sol	F/F	3.0	4.1	3

[1] msl = mean sea level

In general, groundwater levels at SqCWD's coastal monitoring wells in the area have stabilized or show a slight increasing trend over the last four years, after showing a declining trend over previous years. The stabilized or rising groundwater levels correspond with historically low production by SqCWD in the area. However, the previous declines occurred despite reductions in pumping at some nearby municipal production wells. The lack of correlation between groundwater levels and local pumping may indicate that non-municipal pumping had a more immediate effect on groundwater levels in the Aromas area than the Purisima area. Johnson et al. (2004) had previously concluded that groundwater levels in the area did not reflect year to year changes in climatic conditions.

Hydrographs for multiple completions of monitoring wells near the SqCWD and CWD production wells are included at the end of this section. Some inland, upgradient wells, including the Black monitoring well, have a stable groundwater level trend. Table 5-2 summarizes the important groundwater level trends by well.

Hydrographs for single wells including production wells are included with chemographs. These hydrographs show trend lines for Water Years 2008-2012 when there have been decreases of municipal production for the Aromas area.

Table 5-2 (2011): Summary of Groundwater Level Trends in Aromas Area

Category	**Well**	**Groundwater Level Trend Description**	**Notes**
SqCWD Coastal Monitoring Wells	SC-A1	Long-term decline in A screen, but slight rise WY 2010-2012. Rise of ~4 feet in B screen since WY 2009.	Lower pumping at Country Club WY 2010-2012 vs. previous four years;, Seascape Golf Course also pumping nearby
	SC-A8	Slight rise since installation in WY 2007	Lower combined pumping at Bonita and San Andreas vs. previous nine years; Bonita shut down Feb-July 2012
	SC-A2	Decline of 1.5-3+ feet WY 2006-2009; Rise of 1.5-2 feet WY 2009-2012	Combined pumping at San Andreas and Seascape WY 2012 highest since WY 2004
	SC-A3	Relatively stable WY 2009-2011 then rise in WY 2012	Historical low SA IV pumping in WY 2010-2012 after Sells went offline
	SC-A4	Rise of 2+ feet WY 2009-2012	Nearest SqCWD wells are in SA IV
SqCWD Monitoring Wells near Production Wells	SC-A6A	Recovery in WY 2010-2011 from WY 2009 decline then slight decline WY 2012	Historical low Bonita pumping WY 2009-2012
	SC-A5	Relatively stable WY 2009-2012; rise in SC-A5B WY 2012	Seascape pumping higher WY 2009-2012 than WY 2004-2008
	SC-A7A	Decline since WY 2009, but high levels may be anomalous	Historical low SA IV pumping in WY 2010-2012
	SC-A7B,C	Increase of 4-7 feet in WY 2010 then stable	
CWD Monitoring Wells in Rob	CWD-A	Increase in WY 2010-2011, but decrease in WY 2012	Increased precipitation WY 2010-2011

Category	Well	Groundwater Level Trend Description	Notes
Roy Field	CWD-B	Stable trend since WY 2006, but decrease in WY 2011	None
	CWD-C	Stable trend since WY 2006	Pumping at Rob Roy WY 2012 similar to WY 2006-2009 after reduction WY 2010-2011
Inland Wells	Aptos Jr. High well	Decline of at least 10 feet since WY 2007; Decline in WY 2011-2012 after rise in WY 2010	Well returned to service in WY 2007; historical high pumping in WY 2011-2012
	Black Monitoring Well	Stable WY 2007-2012; higher than prior	None

Contour maps of groundwater elevations in Spring and Fall 2012 for the Purisima F-unit and Aromas Red Sands are shown in Figure 5-2 and Figure 5-3, respectively. Both Spring and Fall 2012 contour maps show that groundwater levels were above sea level, although coastal groundwater levels are below protective elevations along much of the coast. Higher coastal groundwater levels in the spring than the fall are evidenced by the location of the 5 foot contour.

Contour maps for years prior to 2012 have inaccuracies related to survey elevations at SC-A4 and SC-A8 used to calculate groundwater levels that have since been revised. These contour maps will be revised and replaced with the Water Year 2013 Annual Report and Review.

5.3 Water Quality Conditions and Trends

Seawater intrusion has been consistently detected at deep monitoring wells along the coast of the Aromas area. At all coastal monitoring clusters in the Aromas area except SC-A1, the deepest completion was installed to be below the freshwater-saltwater interface. As discussed above, groundwater levels continue to be below protective elevations in the southeast part of the Aromas area. As a result, there is risk of seawater intrusion advancing toward production wells in the Aromas area.

Observed Total Dissolved Solids (TDS) and chloride concentrations continue to be elevated at the deep coastal monitoring wells installed below the freshwater-saltwater interface. Chloride concentrations are above 6,000 mg/L in these wells.

In the northwest part of the Aromas area coast, the freshwater-salt water interface has not been observed at SC-A1 and salt concentrations at SC-A8A below the interface have remained relatively stable since well installation in 2007. The hydrographs show groundwater levels at these wells have been above protective elevations for most of the monitoring record at SC-A1 and just below protective elevations at SC-A8A.

In the southeast part of the Aromas area coast, the freshwater-saltwater interface has apparently moved shallower and landward over the long term. The hydrographs show equivalent freshwater heads in the SC-A2A, SC-A3A, and SC-A4A have been below protective elevations for much of the monitoring record There is a long-term increasing trend in TDS and chloride concentrations at wells SC-A2B and SC-A3B, where the interface is most shallow. This apparent landward movement of seawater has put the nearby Seascape, Altivo, and Sells wells at the highest risk to be impacted by seawater intrusion. The drop in concentrations observed at SC-A3B occurred after installation of new sampling equipment in March 2012 and further evaluation of what the data represent is necessary.

In addition, concentrations at the SC-A5 wells screened below the Seascape well are rising and continue to indicate that seawater has advanced to below that production well. The additional rise observed in 2012 should be monitored closely as a potential risk to the Seascape well.

Chemographs of TDS and chloride for SqCWD monitoring wells in the Aromas area are included at the end of this section. Table 5-3 summarizes the important water quality trends by well.

Observed Total Dissolved Solids (TDS) and chloride concentrations in SqCWD's production wells do not suggest any seawater intrusion impact on municipal production in the Purisima F-unit and Aromas Red Sands. Recent chloride concentrations in the production wells are at 60 mg/L or less, while the maximum contaminant level(MCL) for chlorides is 250 mg/L. Chemographs for SqCWD production wells in the area are included at the end of this section.

Nitrate at SqCWD's Sells well showed concentrations at or just under the maximum contaminant limit of 45 mg/L in 2009 and 2010. The well was removed from service in April 2009. The well was not sampled for nitrate in 2011 and 2012.

California Office of Environmental Health Hazard Assessment (OEHHA) released a revised draft public health goal (PHG) for Chromium VI in December 2010, however, the PHG has not been finalized and is only one step in developing an enforceable drinking water standard set by the California Department of Public Health. Chromium VI concentrations in SqCWD production wells screened in the Aromas Red Sands ranged from 9.7 to 38 μg/L in 2012. Chromium VI concentrations in CWD production wells screened in the Aromas Red Sands ranged from 4 to 11 μg/L in 2009. Concentrations for total chromium met current drinking water standards for all wells. A report on depth discrete testing of flows and Chromium VI concentrations at the Bonita, San Andreas, and Altivo wells was issued in 2009 (HydroMetrics LLC, 2009d). Similar tests were conducted at the Rob Roy 12 well in 2012 and the well head concentration for Chromium VI was 3.7 μg/L.

OEHHA established a PHG for 1,2,3-trichloropropane of 0.0007 μg/L in August 2009, but an enforceable drinking water standard has not yet been set by the California Department of Public Health. The compound 1,2,3-trichloropropane ranged from <0.005 μg/L to 0.015 μg/L in the Country Club well in 2011. The well was not sampled for TCP in 2012. This constituent has not been detected at other wells.

Table 5-3 (2012): Summary of TDS and Chloride Concentration Trends in Aromas Area

Category	Well	Concentration Trend Description	Notes
SqCWD Coastal Monitoring Wells	SC-A1	Chloride consistently <40 mg/L	No completions (deepest to -455 ft msl[1]) installed below freshwater/seawater interface
	SC-A8A	Relatively stable since 2007 installation; chloride=7,000 mg/L	Installed (-391 to -411 ft msl[1]) below interface
	SC-A2A	Long-term increasing trend; chloride = 14,000 mg/L in WY 2012	Installed below interface; near Seascape
	SC-A2B	Long-term increasing trend, chloride ~ 400 mg/L in WY 2011	Installed (-293 to -313 ft msl[1]) above interface when chloride ~ 30 mg/L in WY 1987
	SC-A3A	Stable long-term trend, although slight decline in WY 2012; chloride > 17,000 mg/L (near full strength seawater)	Installed below interface; near Sells and Bonita, rise in groundwater levels WY 2012
	SC-A3B	Long-term increasing trend, but sudden drop in WY 2012	Installed (-127 to -167 ft msl[1]) above interface when chloride < 10 mg/L in WY 1987. Concentrations drop after bladder pumps installed.
	SC-A4A	Increasing trend; chloride > 10,000 mg/L in WY 2012	Installed (-334 to -354 ft msl[1]) below interface
	SC-A4B	Increasing trend; chloride 20-70 mg/L in WY 2012	Installed above interface
SqCWD Monitoring Wells near Production Wells	SC-A5A	Increasing trend; chloride > 8,000 mg/L in WY 2012	Installed (-475 to -495 ft msl[1]) below interface; screened 100 feet below Seascape well
	SC-A5B	Increasing trend; Chloride 50-100 mg/L in WY 2012	Installed above interface; screened 30 feet below Seascape well

[1] msl = mean sea level

Screen elevations listed for most shallow well in the cluster with current chloride concentrations above 250 mg/L.

In 2012, arsenic averaged 1.3 μg/L at the Aptos Jr. High well and was detected at Country Club well (0.71 μg/L) and San Andreas Well, (0.56 μg/L), but at levels below the MCL of 10 μg/L for arsenic. Water from the Aptos Jr. High well is treated to reduce arsenic concentrations.

5.4 STATE OF THE AQUIFER SUMMARY

Seawater intrusion has been detected along the coast of the Aromas area. Coastal groundwater levels have been below protective elevations in the southeast part of the Aromas area indicating risk for continued seawater intrusion into the productive Purisima F unit and the Aromas aquifer. The long-term water quality trend indicates that seawater intrusion has advanced over the last 25 years. Overall, historically low municipal production in the Aromas area has resulted in some recovery of groundwater levels, but not enough to protect the basin. Reducing the risk of seawater intrusion by raising groundwater levels may not be achieved by maintaining recent low municipal production in the Aromas area.

SECTION 5 – WATER YEAR 2011
AQUIFER CONDITIONS FOR AROMAS AREA
(PURISIMA F-UNIT/AROMAS RED SANDS)

This section presents groundwater level and water quality conditions for Water Year 2011 in the eastern portion of the Soquel-Aptos area where the primary production aquifers are the Purisima F-unit and the Aromas Red Sands.

5.1 SqCWD SERVICE AREAS III AND IV AND CWD PRODUCTION

In the eastern portion of the Soquel-Aptos area, groundwater is produced for municipal purposes by SqCWD in Service Areas III and IV, and by CWD at its Cox and Rob Roy well fields. SqCWD's Service Area III production was 1,360 acre-feet in Water Year 2011, the lowest annual total since Water Year 1991. Service Area IV production in the La Selva Beach area was 36 acre-feet in Water Year 2011, the lowest annual total going back to Water Year 1984. The Sells well was taken out of service in April 2009 due to high nitrate concentrations. CWD production at its Cox well field, completed in the Purisima F-unit, was 19 acre-feet in Water Year 2011, while production at its Rob Roy well field completed in the Aromas Red Sands was 464 acre-feet. Rob Roy production was the lowest annual total since Water Year 1998. Also, the distribution of CWD production between the two well fields is consistent with the previous thirteen years.

Figure 5-1 shows production in the Aromas area by water year, grouped into three geographical areas. The Valencia watershed area includes the SqCWD's Aptos Jr. High well and CWD's Cox wells, which are screened in the Purisima F-unit. With the increase in pumping at the Aptos Jr. High well, annual municipal pumping in this area exceeded 300 acre-feet for the first time since Water Year 1986. Pumping increased in Water Year 2007 when the Aptos Jr. High well was put back into service. The Valencia watershed area south and east of Valencia Creek is now included in pumping totals for the Aromas area for comparisons to the post-recovery yield because geologic maps include this sub-area in the Aromas outcrop (HydroMetrics WRI, 2012). Water Year 2011 pumping at the Aptos Jr. High well was approximately 24% of SqCWD's revised estimate of its post-recovery pumping yield in the Aromas area.

The wells in the other two areas are screened in both the Purisima F-unit and the Aromas Red Sands. The Seascape and Rob Roy area includes most of SqCWD's Service Area III wells and CWD's Rob Roy wells. This area has the largest portion of municipal production in the Aromas area, although production has declined since Water Year 2005. SqCWD production in the Seascape area was 1,070 acre-feet in Water Year 2011, the lowest total going back to Water Year 1984, when records for service area totals begin. SqCWD production of 1,070 acre-feet is approximately 89% of SqCWD's post-recovery yield for the Aromas yield (HydroMetrics WRI, 2012). Seascape and Rob Roy combined total pumping in Water Year 2011 was 1,534 acre-feet, the lowest total since Water Year 1986. CWD production at Rob Roy has been relatively steady over the last fifteen years and Well #12 has been used as the lead well starting in 2003.

The La Selva Beach area consists of SqCWD's Service Area IV wells, where pumping has declined since Water Year 2008 after the Sells well was taken out of service. Water Year 2011 pumping of 36 acre-feet in Service Area IV was the lowest total going back to Water Year 1984, when records for service area totals begin.

SqCWD's post-recovery pumping yield for the Aromas area has been updated to 1,200 acre-feet per year, including pumping from the Aptos Jr. High well and the planned Polo Grounds well (HydroMetrics WRI, 2012). Therefore, SqCWD's pumping of 1,396 acre-feet in Water Year 2011 from SqCWD wells in the Aromas area still exceeds the post-recovery pumping yield. In addition, pumping will have to be reduced below the pumping yield to recover the basin to protective levels.

5.2 Groundwater Level Conditions and Trends

SqCWD has revised protective groundwater elevations in coastal monitoring wells to protect the Purisima F-unit and Aromas Red Sands in the eastern portion of the Soquel-Aptos area from seawater intrusion. Cross-sectional models were used to estimate groundwater elevations that result in the freshwater-salt water interface being maintained at the current location at the coastal monitoring wells in the long term (HydroMetrics WRI, 2012).

Coastal groundwater levels in the SqCWD's F-unit and Aromas Red Sands monitoring wells compared to protective elevations are shown in Table 5-1. In the Aromas area, the revised protective elevations are selected to maintain the interface in both the A and B screens. Therefore, observed groundwater levels in both screens should be compared to protective elevations. Hydrographs for multiple completions of monitoring wells in the Aromas area follow at the end of this section Observed groundwater levels must also be adjusted to account for salinity before they are compared to protective elevations. The protective groundwater elevation estimated by SEAWAT-2000 is the equivalent freshwater head (Langevin and others, 2003). The equivalent freshwater head for groundwater with a substantial amount of salinity is higher than the observed groundwater levels due to the higher density of saline water. Equivalent freshwater heads are calculated where chloride concentrations in coastal monitoring wells are greater than 250 mg/L as described in Attachment A of HydroMetrics WRI (2012). The hydrographs for single monitoring wells grouped with chemographs for chlorides and total dissolved solids show the equivalent freshwater heads.

Average equivalent freshwater heads are above protective elevations in the northwest part of the Aromas area coastline at SC-A1 and SC-A8. The hydrographs show groundwater levels at these wells have been above protective elevations for most of the monitoring record. In the southeast part of the Aromas area coastline, average equivalent freshwater heads are below protective elevations at SC-A2, SC-A3, and SC-A4. The hydrographs show equivalent freshwater heads in the A screens have been below protective elevations for much of the monitoring record.

Table 5-1 (2011): Comparison of Water Year 2011 Coastal Groundwater Levels with Protective Elevations

Well	Location	A Screen Unit/ B Screen Unit	Average Equivalent Freshwater Head A screen (feet msl)[1]	Average Equivalent Freshwater Head B screen (feet msl)[1]	Protective Elevation (feet msl)[1]
SC-A1B	Cliff	DEF/F	5.9	7.9	3
SC-A8B	Dolphin & Sumner	F/ Aromas	5.5	6.7	6
SC-A2B	Sumner	F/F	2.2	5.3	3
SC-A3B	Playa & Vista	Aromas/Aromas	0.8	2.7	3
SC-A4B	Canon del Sol	F/F	1.7	4.4	3

[1] msl = mean sea level

In general, groundwater levels at SqCWD's coastal monitoring wells in the area have stabilized or show a slight increasing trend over the last three years, after showing a declining trend over previous years. The stabilized or rising groundwater levels correspond with historically low production by SqCWD in the area. However, the previous declines occurred despite reductions in pumping at some nearby municipal production wells. The lack of correlation between groundwater levels and local pumping may indicate that non-municipal pumping and/or lower precipitation had a more immediate effect on groundwater levels in the Aromas area than the Purisima area.

Hydrographs for multiple completions of monitoring wells near the SqCWD and CWD production wells are included at the end of this section. Some inland, upgradient wells, including the Black monitoring well, have a stable groundwater level trend. Table 5-2 summarizes the important groundwater level trends by well.

Hydrographs for single wells including production wells are included with chemographs. These hydrographs show trend lines for Water Years 2007-2011 when there have been decreases of municipal production for the Aromas area.

Table 5-2 (2011): Summary of Groundwater Level Trends in Aromas Area

Category	Well	Groundwater Level Trend Description	Notes
SqCWD Coastal Monitoring Wells	SC-A1	Long-term decline in A screen, but relatively stable WY 2009-2011. Rise of 3+ feet in B screen since WY 2009.	Lower pumping at Country Club WY 2008-2011 vs. previous four years; Bonita pumping in WY 2011 lowest on record, Seascape Golf Course also pumping nearby
	SC-A2	Decline of 1.5-3+ feet WY 2006-2009; Rise of 1.5-2 feet WY 2009-2011	Combined pumping at San Andreas and Seascape WY 2011 lowest since WY 1991
	SC-A3	Decline of 1.5-2 feet since WY 2006-2009; relatively stable WY 2009-2011	Historical low SA IV pumping in WY 2010-2011 after Sells went offline

Category	Well	Groundwater Level Trend Description	Notes
	SC-A4	Slight rise WY 2009-2011	Nearest SqCWD wells are in SA IV
SqCWD Monitoring Wells near Production Wells	SC-A6A	Recovery in WY 2010-2011 from WY 2009 decline	Historical low Bonita pumping WY 2009-2011
	SC-A5	Relatively stable WY 2009-2011	Seascape pumping decreased from WY 2009 to WY 2011 but not to WY 2004-2008 totals
	SC-A7A	Decline since WY 2009	Historical low SA IV pumping in WY 2010-2011
	SC-A7B,C	Increase of 4-7 feet in WY 2010 then stable	
CWD Monitoring Wells in Rob Roy Field	CWD-A	Stable trend since WY 2006, but increase in WY 2010-2011	Increased precipitation WY 2010-2011
	CWD-B	Stable trend since WY 2011, but decrease in WY 2011	None
	CWD-C	Rise in WY 2010-2011	Reduced pumping at Rob Roy WY 2010-2011
Inland Wells	Aptos Jr. High well	Decline of at least 10 feet since WY 2007; Decline in WY 2011 after rise in WY 2010	Well returned to service in WY 2007; historical high pumping in WY 2011
	Black Monitoring Well	Stable WY 2007-2011; higher than prior	None

Contour maps of groundwater elevations in spring and fall 2011 for the Purisima F-unit and Aromas Red Sands are shown in Figure 5-2 and Figure 5-3, respectively. Both spring and fall 2011 contour maps show that groundwater levels were above sea level, although coastal groundwater levels are below protective elevations in the southeast part of the coast.

5.3 WATER QUALITY CONDITIONS AND TRENDS

Seawater intrusion has been consistently detected at deep monitoring wells along the coast of the Aromas area. At all coastal monitoring clusters in the Aromas area except SC-A1, the deepest completion was installed to be below the freshwater-saltwater interface. As discussed above, groundwater levels continue to be below protective elevations in the southeast part of the Aromas area. As a result, there is risk of seawater intrusion advancing toward production wells in the Aromas area.

Observed Total Dissolved Solids (TDS) and chloride concentrations continue to be elevated at the deep coastal monitoring wells installed below the freshwater-saltwater interface. Chloride concentrations are above 6,000 mg/L in these wells.

In the northwest part of the Aromas area coast, the freshwater-salt water interface has not been observed at SC-A1 and salt concentrations at SC-A8A below the interface have remained stable since well installation in 2007. The hydrographs show groundwater levels at these wells have been above protective elevations for most of the monitoring record.

In the southeast part of the Aromas area coast, the freshwater-saltwater interface has apparently moved shallower and landward over the long term. The hydrographs show equivalent freshwater heads in the SC-A2A, SC-A3A, and SC-A4A have been below protective elevations for much of the monitoring record There is a long-term increasing trend in TDS and chloride concentrations at wells SC-A2B and SC-A3B, where the interface is most shallow. This apparent landward movement of seawater has put the nearby Seascape, Altivo, and Sells wells at the highest risk to be impacted by seawater intrusion. In addition, concentrations at the SC-A5 wells near the Seascape well continue to indicate that seawater has advanced to just below that production well.

Chemographs of TDS and chloride for SqCWD monitoring wells in the Aromas area are included at the end of this section. Table 5-3 summarizes the important water quality trends by well.

Table 5-3 (2011): Summary of TDS and Chloride Concentration Trends in Aromas Area

Category	Well	Concentration Trend Description	Notes
SqCWD Coastal Monitoring Wells	SC-A1	Chloride consistently <40 mg/L	No completions (deepest to -455 ft msl[1]) installed below interface
	SC-A2A	Long-term increasing trend; chloride = 13,000 mg/L in WY 2011	Installed below fresh water/seawater interface; near Seascape
	SC-A2B	Long-term increasing trend, chloride ~ 500 mg/L in WY 2011	Installed (-293 to -313 ft msl[1]) above interface when chloride ~ 30 mg/L in WY 1987
	SC-A3A	Stable trend; chloride > 17,000 mg/L (near full strength seawater)	Installed below fresh water/seawater interface; near Sells and Bonita
	SC-A3B	Long-term increasing trend, but relatively stable WY 2008-2011; chloride ~2,700 mg/L in WY 2011	Installed (-127 to -167 ft msl[1]) above fresh water/seawater interface when chloride < 10 mg/L in WY 1987
	SC-A4A	Increasing trend; chloride > 8,000 mg/L in WY 2010	Installed (-334 to -354 ft msl[1]) below fresh water/seawater interface
	SC-A4B	Increasing trend; chloride 20-38 mg/L in WY 2011	Installed above fresh water/seawater interface
SqCWD Monitoring Wells near Production Wells	SC-A5A	Increasing trend; chloride > 6,000 mg/L in WY 2010	Installed (-475 to -495 ft msl[1]) below fresh water/seawater interface; screened 100 feet below Seascape well
	SC-A5B	Increasing trend; Chloride ~ 50 mg/L in WY 2010	Installed above fresh water/seawater interface; screened 30 feet below Seascape well

[1] msl = mean sea level

Screen elevations listed for most shallow well in the cluster with current chloride concentrations above 250 mg/L.

SC-A8A has approximately 7,000 mg/L chloride and is installed at -388 to -408 ft msl.

Observed Total Dissolved Solids (TDS) and chloride concentrations in SqCWD's production wells do not suggest any seawater intrusion impact on municipal production in the Purisima F-unit and Aromas Red Sands. Recent chloride concentrations in the production wells are at 60 mg/L or less, while the maximum contaminant level(MCL) for chlorides is 250 mg/L. Chemographs for SqCWD production wells in the area are included at the end of this section.

Nitrate at SqCWD's Sells well showed concentrations at or just under the maximum contaminant limit of 45 mg/L. The well was removed from service in April 2009. Concentrations from the offline well continued to be above the maximum contaminant limit in 2011.

California Office of Environmental Health Hazard Assessment (OEHHA) released a revised draft public health goal (PHG) for Chromium VI in December 2010, however, the PHG has not been finalized and is only one step in developing an enforceable drinking water standard set by the California Department of Public Health. Chromium VI concentrations in SqCWD production wells screened in the Aromas Red Sands ranged from 0.42 to 40 µg/L in 2011. Chromium VI concentrations in CWD production wells screened in the Aromas Red Sands ranged from 4 to 11 µg/L in 2009. Concentrations for total chromium met current drinking water standards for all wells. A report on depth discrete testing of flows and Chromium VI concentrations at the Bonita, San Andreas, and Altivo wells was issued in 2009 (HydroMetrics LLC, 2009d).

OEHHA established a PHG for 1,2,3-trichloropropane of 0.0007 µg/L in August 2009, but an enforceable drinking water standard has not yet been set by the California Department of Public Health. The compound 1,2,3-trichloropropane ranged from <0.005 µg/L to 0.015 µg/L in the Country Club well in 2011. However, this constituent has not been detected at other wells.

In 2011, arsenic averaged 1.3 µg/L at the Aptos Jr. High well and was detected at Country Club well (0.71 µg/L) and San Andreas Well, (0.59 µg/L), but at levels below the MCL of 10 µg/L for arsenic. Water from the Aptos Jr. High well is treated to reduce arsenic concentrations.

5.4 STATE OF THE AQUIFER SUMMARY

Seawater intrusion has been detected along the coast of the Aromas area. Coastal groundwater levels have been below protective elevations in the southeast part of the Aromas area indicating risk for continued seawater intrusion into the productive Purisima F unit and the Aromas aquifer. The long-term water quality trend indicates that seawater intrusion has advanced over the last 25 years. Historically low municipal production in the Aromas area has resulted in some recovery of groundwater levels, but not enough to protect the basin. Reducing the risk of seawater intrusion by raising groundwater levels may not be achieved by maintaining recent low municipal production in the Aromas area.

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SECTION 5 – WATER YEAR 2010 AQUIFER CONDITIONS FOR AROMAS AREA (PURISIMA F-UNIT/AROMAS RED SANDS)

This section presents groundwater level and water quality conditions for Water Year 2010 in the eastern portion of the Soquel-Aptos area where the primary production aquifers are the Purisima F-unit and the Aromas Red Sands.

5.1 SqCWD Service Areas III and IV and CWD Production

In the eastern portion of the Soquel-Aptos area, groundwater is produced for municipal purposes by SqCWD in Service Area III and IV, and by CWD at its Cox and Rob Roy well fields. SqCWD's Service Area III production was 1,478 acre-feet in Water Year 2010, the lowest annual total since Water Year 1995. Service Area IV production in the La Selva Beach area was 40 acre-feet in Water Year 2010, the lowest annual total going back to Water Year 1984. The Sells well was taken out of service in April 2009 due to high nitrate concentrations. CWD production at its Cox well field completed in the Purisima F-unit was 20 acre-feet in Water Year 2010, while production at its Rob Roy well field completed in the Aromas Red Sands was 488 acre-feet. This distribution of CWD production between the two well fields is consistent with the previous twelve years. The Rob Roy production was similar to minimum annual totals over that time period.

Figure 5-1 shows production in the Aromas area by water year, grouped into three geographical areas. The Valencia watershed area includes the SqCWD's Aptos Jr. High well and CWD's Cox wells, which are screened in the Purisima F-unit. Annual municipal pumping in this area has been less than 300 acre-feet starting in Water Year 1986. Pumping increased in Water Year 2007 when the Aptos Jr. High well was put back into service. Water Year 2009 pumping at the Aptos Jr. High well was approximately 9% of SqCWD's revised estimate of its share of the annual sustainable yield in the Purisima area.

The wells in the other two areas are screened in both the Purisima F-unit and the Aromas Red Sands. The Seascape and Rob Roy area includes most of SqCWD's Service Area III wells and CWD's Rob Roy wells. This area has the largest portion of municipal production in the Aromas area, although production has declined since Water Year 2005. SqCWD production in the Seascape area was

1,255 acre-feet in Water Year 2010, the lowest total since Water Year 1986. This production decline is partly because the Bonita and Country Club wells were out of service 2-3 months. Seascape and Rob Roy total pumping in Water Year 2010 was 1,815 acre-feet, the lowest total since Water Year 1995; CWD production at Rob Roy has been relatively steady over the last fifteen years.

The La Selva Beach area consists of SqCWD's Service Area IV wells, where pumping has declined since Water Year 2008 after the Sells well was taken out of service. Water Year 2010 pumping of 40 acre-feet in Service Area IV was the lowest total going back to Water Year 1984.

The recent evaluation of sustainable yield concluded that the GMP goal of 1,800 acre-feet per year for SqCWD pumping in the Aromas was at least hundreds of acre-feet too high (HydroMetrics LLC, 2009c). Therefore, SqCWD's pumping of 1,295 acre-feet in Water Year 2010 from wells screened in the Aromas Red Sands may not be within a reasonable estimate of SqCWD's share of sustainable yield.

5.2 GROUNDWATER LEVEL CONDITIONS AND TRENDS

SqCWD has established protective groundwater elevations in coastal monitoring wells to protect the Purisima F-unit and Aromas Red Sands in the eastern portion of the Soquel-Aptos area from seawater intrusion. Cross-sectional models were used to estimate groundwater elevations that result in the freshwater-salt water interface at the historical depth being seaward of the coast over the long term (HydroMetrics LLC, 2009b).

Coastal groundwater levels in the SqCWD's F-unit and Aromas Red Sands monitoring wells remained below protective elevations in Water Year 2010, as shown in Table 5-1. In the Aromas area, protective elevations are established for the B completion of each well cluster because its screen was above the freshwater-salt water interface when installed. Hydrographs for multiple completions of monitoring wells in the Aromas area follow at the end of this section The hydrographs show coastal groundwater levels have been below protective elevations since the early 1990s or longer.

Table 5-1 (2010):
Comparison of Water Year 2010 Coastal Groundwater Levels with Protective Elevations

Well	Location	A Screen Unit/ B Screen Unit	Average Equivalent Freshwater Head A screen (feet msl) [1]	Average Equivalent Freshwater Head B screen (feet msl) [1]	Protective Elevation (feet msl) [1]
SC-A1B	Cliff	DEF/F	6.3	5.2	3
SC-A8B	Dolphin & Sumner	F/ Aromas	5.3	6.6	6
SC-A2B	Sumner	F/F	1.9	4.2	3
SC-A3B	Playa & Vista	Aromas/Aromas	-0.4	1.6	3
SC-A4B	Canon del Sol	F/F	1.0	5.0	3

[1] msl = mean sea level

In general, groundwater levels at SqCWD's coastal monitoring wells in the area have stabilized over the last two years after showing a declining trend over previous years. The recent stable water levels correspond with historically low production by SqCWD in the area. However, the previous declines occurred despite reductions in pumping at some nearby municipal production wells. The lack of correlation between groundwater levels and local pumping may indicate that non-municipal pumping and/or lower precipitation had a more immediate effect on groundwater levels in the Aromas area than the Purisima area. The Pajaro Valley Hydrologic Model covers part of the Aromas area and may provide more information on this subject. The model report is due to be released in 2011.

Hydrographs for multiple completions of monitoring wells near the SqCWD and CWD production wells are included at the end of this section. Some inland, upgradient wells, including the Black monitoring well, have a stable groundwater level trend. Table 5-2 summarizes the important groundwater level trends by well.

Hydrographs for single wells including production wells are included with chemographs. These hydrographs show trendlines for Water Years 2005-2010 when municipal production for the basin has been at or below pumping goals in the Groundwater Management Plan.

Table 5-2 (2010): Summary of Groundwater Level Trends in Aromas Area

Category	Well	Groundwater Level Trend Description	Notes
SqCWD Coastal Monitoring Wells	SC-A1	Increasing up to 3 feet WY 2009-2010; Relatively stable since decline in WY 2002	Reduced pumping at Country Club in WY 2010; Bonita and Seascape Golf Course also pumping nearby
	SC-A2	Decline of up to 6 feet since WY 2006; relatively stable WY 2009-2010	Combined pumping at San Andreas and Seascape WY 2005-2010 lowest since WY 1996 Increased pumping at Seascape in WY 2009-2010
	SC-A3	Decline of 1-2 feet since WY 2006; relatively stable WY 2009-2010	Historical low SA IV pumping in WY 2010
	SC-A4	Relatively stable WY 2009-2010	Nearest SqCWD wells are in SA IV
SqCWD Monitoring Wells near Production Wells	SC-A6A	Recovery in WY 2010 from WY 2009decline	Bonita pumping decreased in WY 2009
	SC-A5	Relatively stable WY 2009-2010	Seascape pumping decreased in WY 2010 but not to WY 2004-2008 totals
	SC-A7A	Decline of 5 feet in WY 2010	Historical low SA IV pumping in WY 2010
	SC-A7B,C	Increase of 4-7 feet in WY 2010	
CWD Monitoring Wells in Rob Roy Field	CWD-A,B	Stable trend since WY 2006, but increase in WY 2010	Steady pumping at Rob Roy since WY 2006
	CWD-C	Decline of 1 foot since WY 2006 but stable trend WY 2008-2010	Reduced precipitation since WY 2006
Inland Wells	Aptos Jr. High well	Decline of at least 10 feet since WY 2007, stable trend WY 2009-2010, increases August	Well returned to service in WY 2007; well out of service late Aug-Sep 2010
	Black Monitoring Well	Stable WY 2007-2009; higher than prior	None

Contour maps of groundwater elevations in spring and fall 2010 for the Purisima F-unit and Aromas Red Sands are shown in Figure 5-2 and Figure 5-3. Both spring and fall 2010 contours (Figure 5-2) show that groundwater levels were above sea level, although coastal groundwater levels are below protective elevations.

5.3 WATER QUALITY CONDITIONS AND TRENDS

Seawater intrusion has been consistently detected at deep monitoring wells along the coast of the Aromas area. At all coastal monitoring clusters in the Aromas area except SC-A1, the deepest completion was installed to be below the freshwater-saltwater interface. As discussed above, groundwater levels continue to be below protective elevations in the Aromas area. As a result, there is risk of seawater intrusion advancing toward production wells in the Aromas area.

Observed Total Dissolved Solids (TDS) and chloride concentrations continue to be elevated at the deep coastal monitoring wells installed below the freshwater-saltwater interface. Chloride concentrations are above 6,000 mg/L in these wells. Concentrations are generally increasing in these wells.

The freshwater-saltwater interface has apparently moved shallower and landward over the long term at the coastal monitoring clusters near SqCWD's southernmost production wells. There is a long-term increasing trend in TDS and chloride concentrations at wells SC-A2B and SC-A3B, where the interface is most shallow. This apparent landward movement of seawater has put the nearby Seascape, Altivo, and Sells wells at the highest risk to be impacted by seawater intrusion. The recent trend at these wells show concentrations stabilizing. However, concentrations at the SC-A5 wells near the Seascape well continue to indicate that seawater has advanced to just below that production well.

Chemographs of TDS and chloride for SqCWD monitoring wells in the Aromas area are included at the end of this section. Table 5-3 summarizes the important water quality trends by well.

Table 5-3 (2010): Summary of TDS and Chloride Concentration Trends in Aromas Area

Category	Well	Concentration Trend Description	Notes
SqCWD Coastal Monitoring Wells	SC-A1	Chloride consistently <40 mg/L	No completions (deepest to -455 ft msl[1]) installed below interface
	SC-A2A	Long-term increasing trend, but stable WY 2009-2010; chloride = 13,000 mg/L in WY 2010	Installed below fresh water/seawater interface; near Seascape
	SC-A2B	Long-term increasing trend, but stable WY 2009-2010; chloride ~ 400 mg/L in WY 2010	Installed (-293 to -313 ft msl[1]) above interface when chloride ~ 30 mg/L in WY 1987
	SC-A3A	Stable trend; chloride > 17,000 mg/L (near full strength seawater)	Installed below fresh water/seawater interface; near Sells and Bonita
	SC-A3B	Long-term increasing trend, but relatively stable WY 2005-2010; chloride 2,660-4,220 mg/L in WY 2010	Installed (-127 to -167 ft msl[1]) above fresh water/seawater interface when chloride < 10 mg/L in WY 1987
	SC-A4A	Increasing trend; chloride > 8,000 mg/L in WY 2010	Installed (-334 to -354 ft msl[1]) below fresh water/seawater interface
	SC-A4B	Increasing trend; chloride 29-53mg/L in WY 2010	Installed above fresh water/seawater interface
SqCWD Monitoring Wells near Production Wells	SC-A5A	Increasing trend; chloride > 6,000 mg/L in WY 2010	Installed (-475 to -495 ft msl[1]) below fresh water/seawater interface; screened 100 feet below Seascape well
	SC-A5B	Increasing trend; Chloride ~ 50 mg/L in WY 2010	Installed above fresh water/seawater interface; screened 30 feet below Seascape well

[1] mean sea level. Screen elevations shown for shallowest well in cluster with current chloride concentrations above 250 mg/L. SC-A8A has approximately 7,000 mg/L chloride and is installed at -388 to -408 ft msl.

Observed Total Dissolved Solids (TDS) and chloride concentrations in SqCWD's production wells do not suggest any seawater intrusion impact on municipal production in the Purisima F-unit and Aromas Red Sands. Recent chloride concentrations in the production wells are at 60 mg/L or less, while the maximum contaminant level(MCL) for chlorides is 250 mg/L. Chemographs for SqCWD production wells in the area are included at the end of this section.

Nitrate at SqCWD's Sells well showed concentrations at or just under the maximum contaminant limit of 45 mg/L. The well was removed from service in April 2009. Concentrations from the offline well continued to be above the maximum contaminant limit in 2010.

California Office of Environmental Health Hazard Assessment (OEHHA) released a revised draft public health goal (PHG) for Chromium VI in December 2010, however, the PHG has not been finalized and is only one step in developing an enforceable drinking water standard set by the California Department of Public Health. Chromium VI concentrations in SqCWD production wells screened in the Aromas Red Sands ranged from 7 to 39 ug/L in 2010. Chromium VI concentrations in CWD production wells screened in the Aromas Red Sands ranged from 4 to 11 ug/L in 2009. Concentrations for total chromium met current drinking water standards for all wells. A report on depth discrete testing of flows and Chromium VI concentrations at the Bonita, San Andreas, and Altivo wells was issued in 2009 (HydroMetrics LLC, 2009d).

OEHHA established a PHG for 1,2,3-trichloropropane of 0.0007 ug/L in August 2009, but an enforceable drinking water standard has not yet been set by the California Department of Public Health. 1,2,3-trichloropropane has been detected at 0.013 ug/L in the Country Club well in 2009 and 2010. However, this constituent has not been detected at other wells or in the drinking water distribution system.

In 2009 and 2010, arsenic was detected at the Aptos Jr. High (1.2-1.3 ug/L) and Country Club (0.7-0.8 ug/L) well, but at levels below the MCL of 10 ug/L for arsenic. Water from the Aptos Jr. High well is treated to reduce arsenic concentrations.

5.4 STATE OF THE AQUIFER SUMMARY

Seawater intrusion has been detected along the coast of the Aromas area. Groundwater levels have been below protective elevations indicating risk for continued seawater intrusion into the productive Purisima F unit and the Aromas aquifer. The long-term water quality trend indicates that seawater intrusion has advanced over the last 25 years, though the recent trend shows a possible slowing in the advancement. Despite historically low municipal production in the Aromas area, groundwater levels have not shown recovery. Reducing the risk of seawater intrusion by raising groundwater levels may not be achieved by continued low municipal production in the Aromas area.

SECTION 5 – WATER YEAR 2009
AQUIFER CONDITIONS FOR AROMAS AREA
(PURISIMA F-UNIT/AROMAS RED SANDS)

This section presents groundwater level and water quality conditions for Water Year 2009 in the eastern portion of the Soquel-Aptos area where the primary production aquifers are the Purisima F-unit and the Aromas Red Sands.

5.1 SQCWD SERVICE AREAS III AND IV AND CWD PRODUCTION

In the eastern portion of the Soquel-Aptos area, groundwater is produced for municipal purposes by SqCWD in Service Area III and IV, and by CWD at its Cox and Rob Roy well fields. Service Area III production was 1,612 acre-feet in Water Year 2009, an increase in pumping from the previous four years as production was shifted from Service Area IV. Service Area IV production in the La Selva Beach area was 124 acre-feet in Water Year 2009, a decrease in pumping from the previous five years as the Sells well was taken out of service in April 2009 due to high nitrate concentrations. CWD production at its Cox well field completed in the Purisima F-unit was 45 acre-feet in Water Year 2009, while production at its Rob Roy well field completed in the Aromas Red Sands was 556 acre-feet. This pattern of CWD production is consistent with the previous 10 years.

Figure 5-1 shows production in the Aromas area by water year grouped by three geographical areas. The Valencia watershed area includes the SqCWD's Aptos Jr. High well and CWD's Cox wells, which are screened in the Purisima F-unit. Annual municipal pumping in this area has been less than 300 acre-feet starting in Water Year 1986, but pumping has increased starting in Water Year 2007 when the Aptos Jr. High well was put back into service. The recent evaluation of the sustainable yield (HydroMetrics LLC, 2009c) did not estimate annual sustainable yield specifically for SqCWD's pumping in the Valencia watershed, but Water Year 2009 pumping at the Aptos Jr. High well was approximately 11% of the suggested estimate of SqCWD's share of the annual sustainable yield in the Purisima.

The wells in the other two areas are screened in both the Purisima F-unit and the Aromas Red Sands. The Seascape and Rob Roy area includes most of SqCWD's

Service Area III and CWD's Rob Roy wells. This area has the largest portion of municipal pumping in the Aromas area, although production has declined since Water Year 2005. The La Selva Beach area consists of SqCWD's Service Area IV where pumping increased from Water Year 2002-2008, but declined in Water Year 2009 as the Sells well was taken out of service. The recent evaluation of sustainable yield concluded that the GMP goal of 1,800 acre-feet per year for SqCWD pumping in the Aromas was at least hundreds of acre-feet too high. Therefore, SqCWD's pumping of 1,468 acre-feet in Water Year 2009 from wells screened in the Aromas Red Sands may not be within a reasonable estimate of SqCWD's share of sustainable yield.

Also, SqCWD and CWD formed an agreement that allowed CWD to sell SqCWD water as an emergency supply during SqCWD's Precautionary Drought Curtailment through October 2009. In Water Year 2009, a total of 16 acre-feet were transferred from CWD to SqCWD through the Huntington Drive intertie from August to September.

5.2 Groundwater Level Conditions and Trends

SqCWD has established protective groundwater elevations in coastal monitoring wells to protect the Purisima F-unit and Aromas Red Sands in the eastern portion of the Soquel-Aptos area from seawater intrusion over the long term. Cross-sectional models were used to estimate groundwater elevations that result in the freshwater-salt water interface at the historical depth being seaward of the coast over the long term (HydroMetrics LLC, 2009b).

Coastal groundwater levels in the SqCWD's F-unit and Aromas Red Sands monitoring wells remained below protective elevations in Water Year 2009, as shown in Table 5-1. In the Aromas area, protective elevations are established for the B completion because its screen was above the freshwater-salt water interface when installed. Hydrographs for wells in the Aromas area monitoring well clusters follow at the end of this section The hydrographs show coastal groundwater levels have been below protective elevations since the early 1990s or longer.

Table 5-1 (2009): Comparison of Water Year 2009 Coastal Groundwater Levels with Protective Elevations

Well	Location	A Screen Unit/ B Screen Unit	Average Equivalent Freshwater Head A screen (feet msl) [1]	Average Equivalent Freshwater Head B screen (feet msl) [1]	Protective Elevation (feet msl) [1]
SC-A1B	Cliff	DEF/F	5.4	4.4	3
SC-A8B	Dolphin & Sumner	F/ Aromas	5.0	6.6	6
SC-A2B	Sumner	F/F	1.0	3.9	3
SC-A3B	Playa & Vista	Aromas/Aromas	-0.8	1.7	3
SC-A4B	Canon del Sol	F/F	2.1	4.6	3

In general, the groundwater level trend at SqCWD's coastal monitoring wells in the area is declining. These declines have occurred despite reductions in pumping at some nearby municipal production wells. The lack of correlation between groundwater levels and local pumping may indicate that non-municipal pumping has increased in the area and/or lower precipitation has a more immediate effect on groundwater levels in the Aromas area than the Purisima area.

Hydrographs for monitoring wells near the SqCWD and CWD production wells and all SqCWD and CWD production wells are included at the end of this section. Many of these wells show declines in groundwater levels. Some inland, upgradient wells, including the Black monitoring well, have a stable groundwater level trend. Table 5-2 summarizes the important groundwater level trends by well.

Contour maps of groundwater elevations in spring and fall 2009 for the Purisima F-unit and Aromas Red Sands are shown in Figure 5-2 and Figure 5-3. Spring 2009 contours (Figure 5-2) show that, except in the area of the Seascape well, groundwater levels were above sea level. Groundwater level contours for fall 2009 (Figure 5-3) are very similar to those in spring with the exception of an increase in levels at the Seascape well to above sea level.

Table 5-2 (2009): Summary of Groundwater Level Trends in Aromas Area

Category	Well	Groundwater Level Trend Description	Notes
SqCWD Coastal Monitoring Wells	SC-A1	Decline of up to 4 feet since WY 2007	Reduced pumping at Country Club and Bonita Seascape Golf Course also pumping nearby
	SC-A2	Decline of up to 6 feet since WY 2006	Combined pumping at San Andreas and Seascape WY 2005-2009 lowest since WY 1996 Increased pumping at Seascape in WY 2009
	SC-A3	Decline of 1-2 feet since WY 2006	Sells well removed from service in WY 2009
	SC-A4	Decline of up to 4 feet in WY 2009	Nearest SqCWD wells are Sells and Altivo where pumping declined
SqCWD Monitoring Wells near Production Wells	SC-A6A	Decline of 5 feet in WY 2009	Bonita pumping declined in WY 2009
	SC-A5	Decline of 3-4 feet in WY 2009	Seascape pumping increased in WY 2009
	SC-A7	Decline of 6-8 feet in WY 2009	Sells well removed from service in WY 2009
CWD Monitoring Wells in Rob Roy Field	CWD-A,B	Stable trend since WY 2006	Steady pumping at Rob Roy since WY 2006
	CWD-C	Decline of 1 foot since WY 2006	Reduced precipitation since WY 2006
Inland Wells	Aptos Jr. High well	Decline of at least 10 feet since WY 2007	Well returned to service in WY 2007
	Black Monitoring Well	Stable WY 2007-2009; higher than prior	None

5.3 WATER QUALITY CONDITIONS AND TRENDS

Seawater intrusion has been consistently detected at deep monitoring wells along the coast of the Aromas area. At all coastal monitoring clusters in the Aromas area except SC-A1, the deepest completion was installed to be below the freshwater-saltwater interface. As discussed above, groundwater levels continue to be below protective elevations in the Aromas area. As a result, there is risk of seawater intrusion advancing toward production wells in the Aromas area.

Observed Total Dissolved Solids (TDS) and chloride concentrations continue to be elevated at the deep coastal monitoring wells installed below the freshwater-saltwater interface. Chloride concentrations are above 6,000 mg/L in these wells. Concentrations are generally increasing in these wells.

The freshwater-saltwater interface appears to be moving shallower and landward at the coastal monitoring clusters near SqCWD's southernmost production wells. There is a long-term increasing trend in TDS and chloride concentrations at wells SC-A2B and SC-A3B. This apparent landward movement of seawater puts the nearby Seascape, Altivo, and Sells wells at the highest risk to be impacted by seawater intrusion. Concentrations at the SC-A5 wells near the Seascape well also continue to indicate that seawater has advanced to just below that production well.

Chemographs of TDS and chloride for SqCWD monitoring wells in the Aromas area are included at the end of this section. Table 5-3 summarizes the important water quality trends by well.

Table 5-3 (2009): Summary of TDS and Chloride Concentration Trends in Aromas Area

Category	Well	Concentration Trend Description	Notes
SqCWD Coastal Monitoring Wells	SC-A1	Stable trend; chloride < 40 mg/L	No completions installed below interface
	SC-A2A	Increasing trend; chloride = 13,000 mg/L in WY 2009	Installed below fresh water/seawater interface; near Seascape
	SC-A2B	Increasing trend; chloride ~ 400 mg/L in WY 2009	Installed above interface when chloride ~ 30 mg/L in WY 1987
	SC-A3A	Stable trend; chloride > 17,000 mg/L (near full strength seawater)	Installed below fresh water/seawater interface; near Sells and Bonita
	SC-A3B	Increasing trend; chloride > 4,000 mg/L in WY 2009	Installed above fresh water/seawater interface when chloride < 10 mg/L in WY 1987
	SC-A4A	Increasing trend; chloride > 8,000 mg/L in WY 2009	Installed below fresh water/seawater interface
	SC-A4B	Increasing trend; chloride ~ 30 mg/L in WY 2009	Installed above fresh water/seawater interface
SqCWD Monitoring Wells near Production Wells	SC-A5A	Increasing trend; chloride > 6,000 mg/L in WY 2009	Installed below fresh water/seawater interface; screened 100 feet below Seascape well
	SC-A5B	Increasing trend; Chloride ~ 50 mg/L in WY 2009	Installed above fresh water/seawater interface; screened 30 feet below Seascape well

Observed Total Dissolved Solids (TDS) and chloride concentrations in SqCWD's production wells do not suggest any seawater intrusion impact on municipal production in the Purisima F-unit and Aromas Red Sands. Recent chloride concentrations in the production wells are at 60 mg/L or less, while the maximum contaminant limit (MCL) for chlorides is 250 mg/L. Chemographs for SqCWD production wells in the area are included at the end of this section.

Nitrate at SqCWD's Sells well has a concentration at or just under the maximum contaminant limit of 45 mg/L. The well was removed from service in April 2009.

California Office of Environmental Health Hazard Assessment released a draft public health goal (PHG) for Chromium VI in August 2009, however, the PHG has not been finalized and is only one step in developing an enforceable drinking water standard set by the California Department of Public Health. Chromium VI concentrations in SqCWD and CWD production wells screened in the Aromas Red Sands ranged from 4 to 39 ug/L. Concentrations for total chromium met current drinking water standards for all wells. A report on depth discrete testing of flows and Chromium VI concentrations at the Bonita, San Andreas, and Altivo wells was issued in 2009 (HydroMetrics LLC, 2009d).

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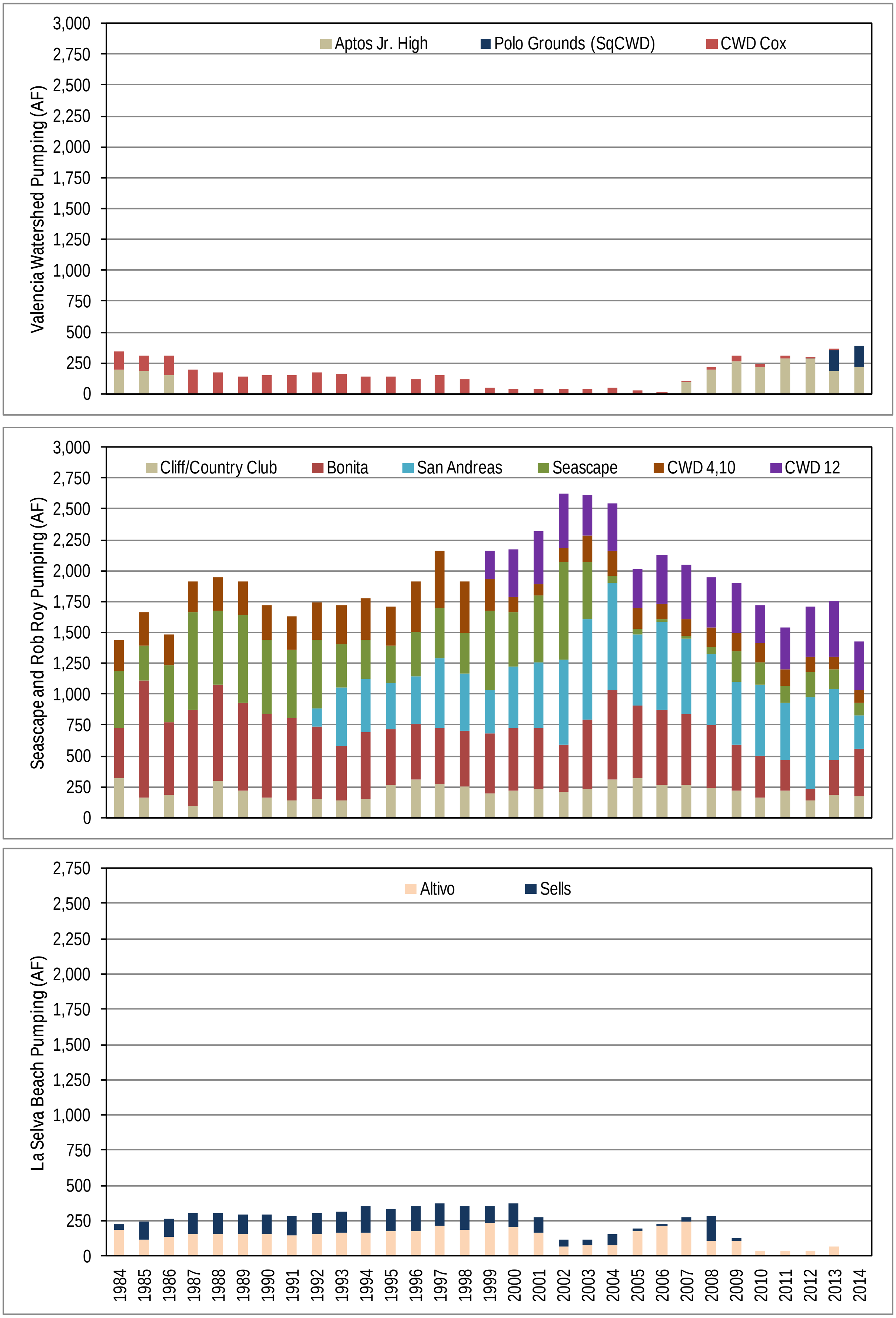

Figure 5-1: Pumping By Water Year in the Aromas Area

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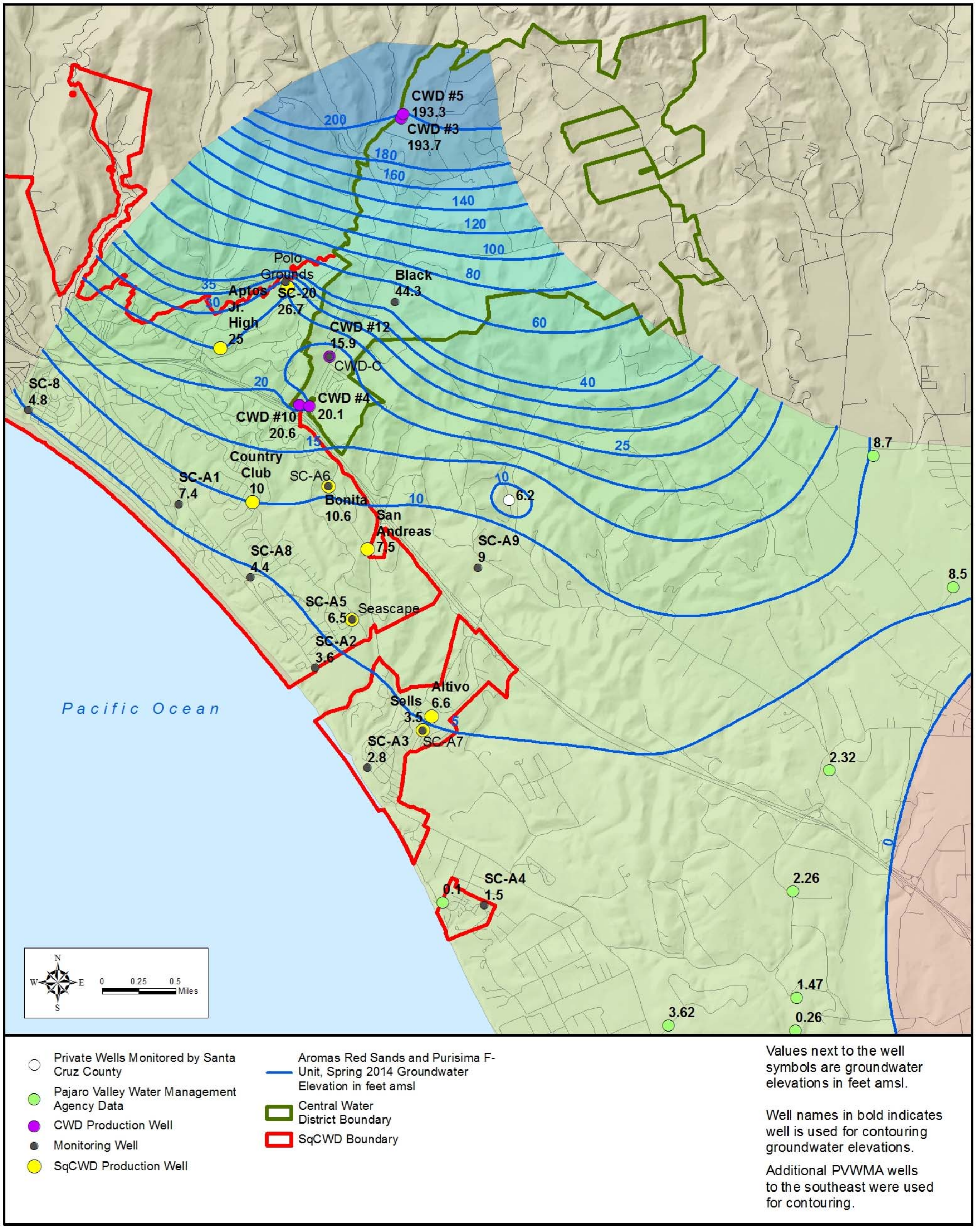


Figure 5-2 (2014): Groundwater Elevation Contours, Aromas Area, Spring 2014

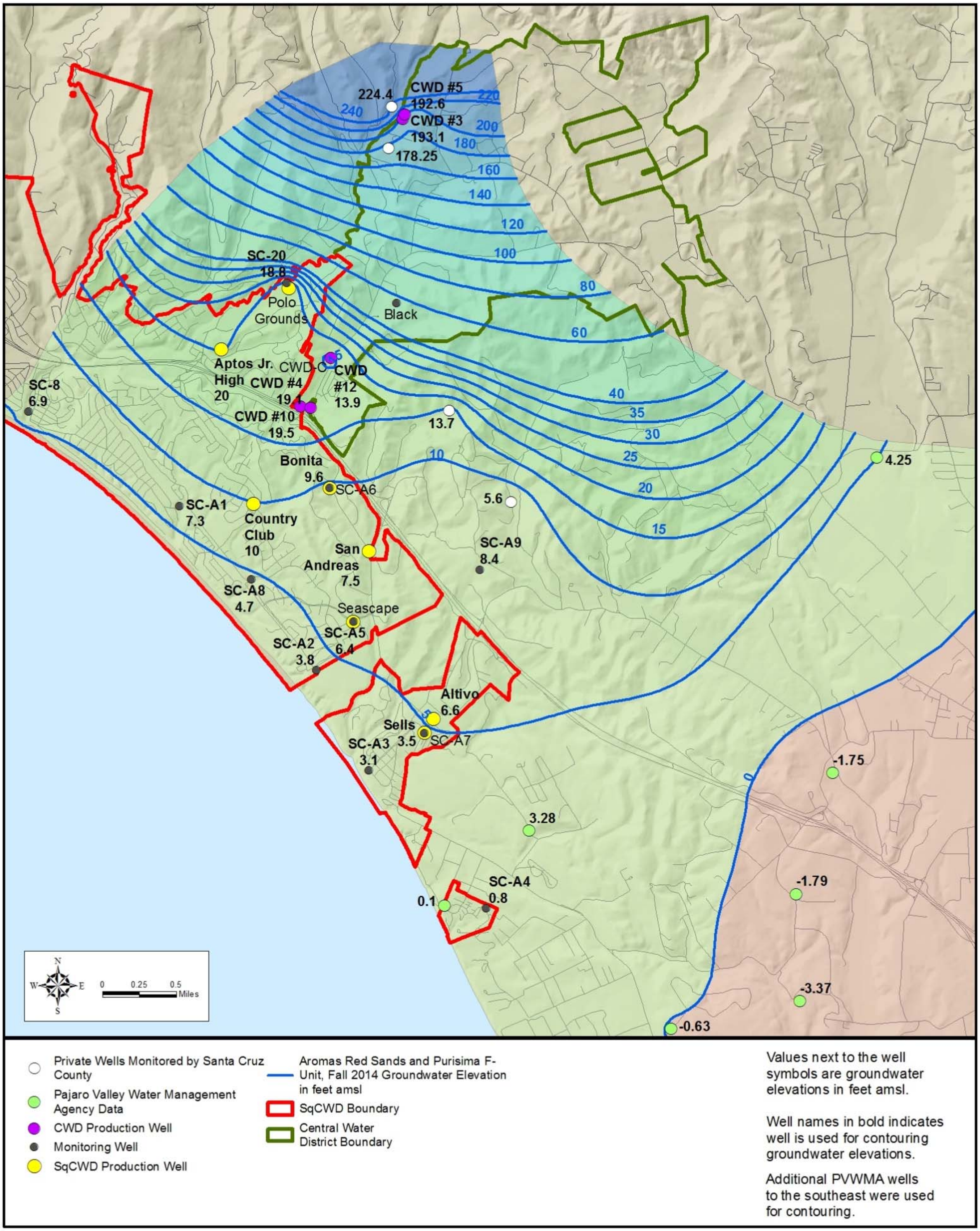


Figure 5-3 (2014): Groundwater Elevation Contours, Aromas Area, Fall 2014

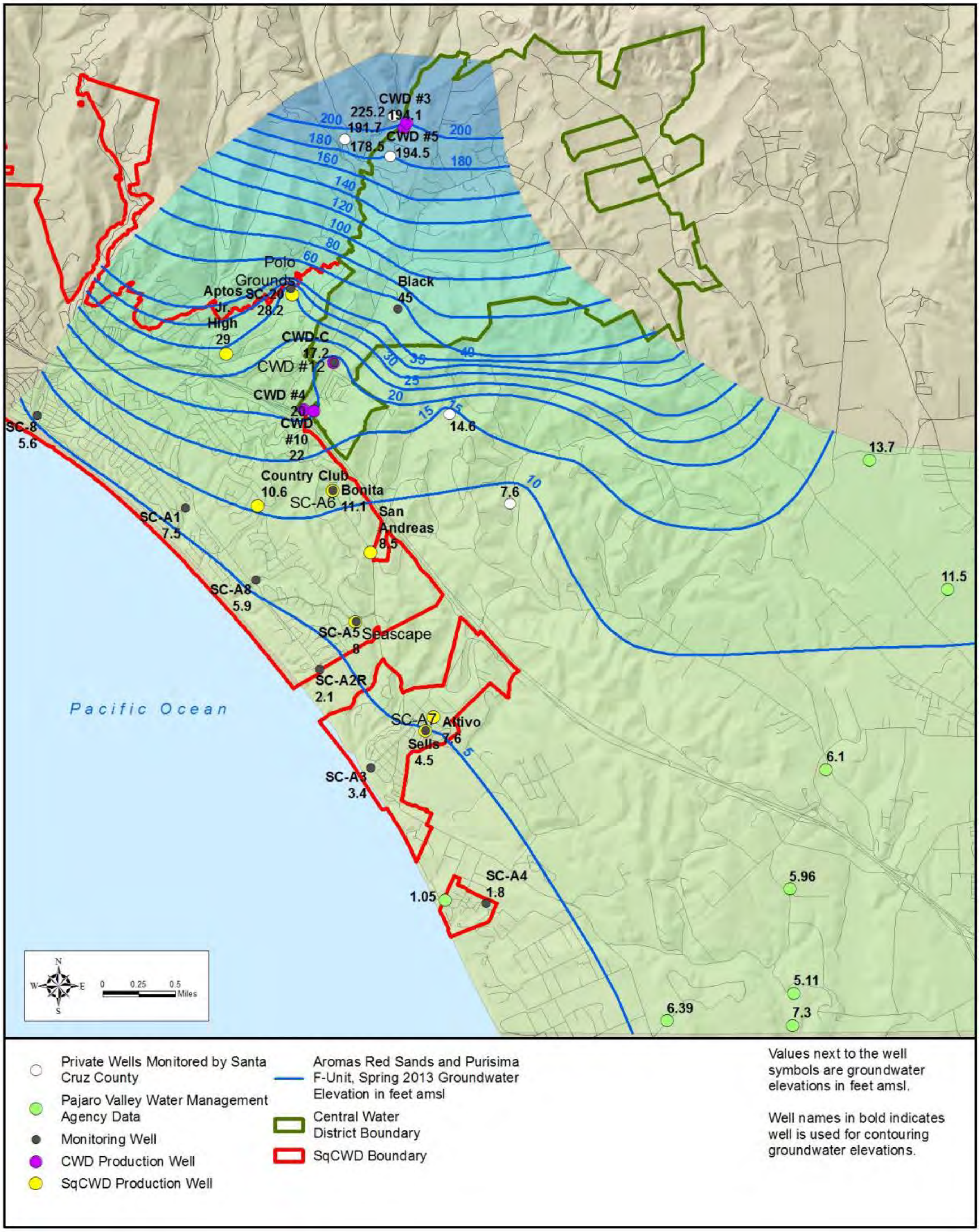


Figure 5-2 (2013): Groundwater Elevation Contours, Aromas Area, Spring 2013

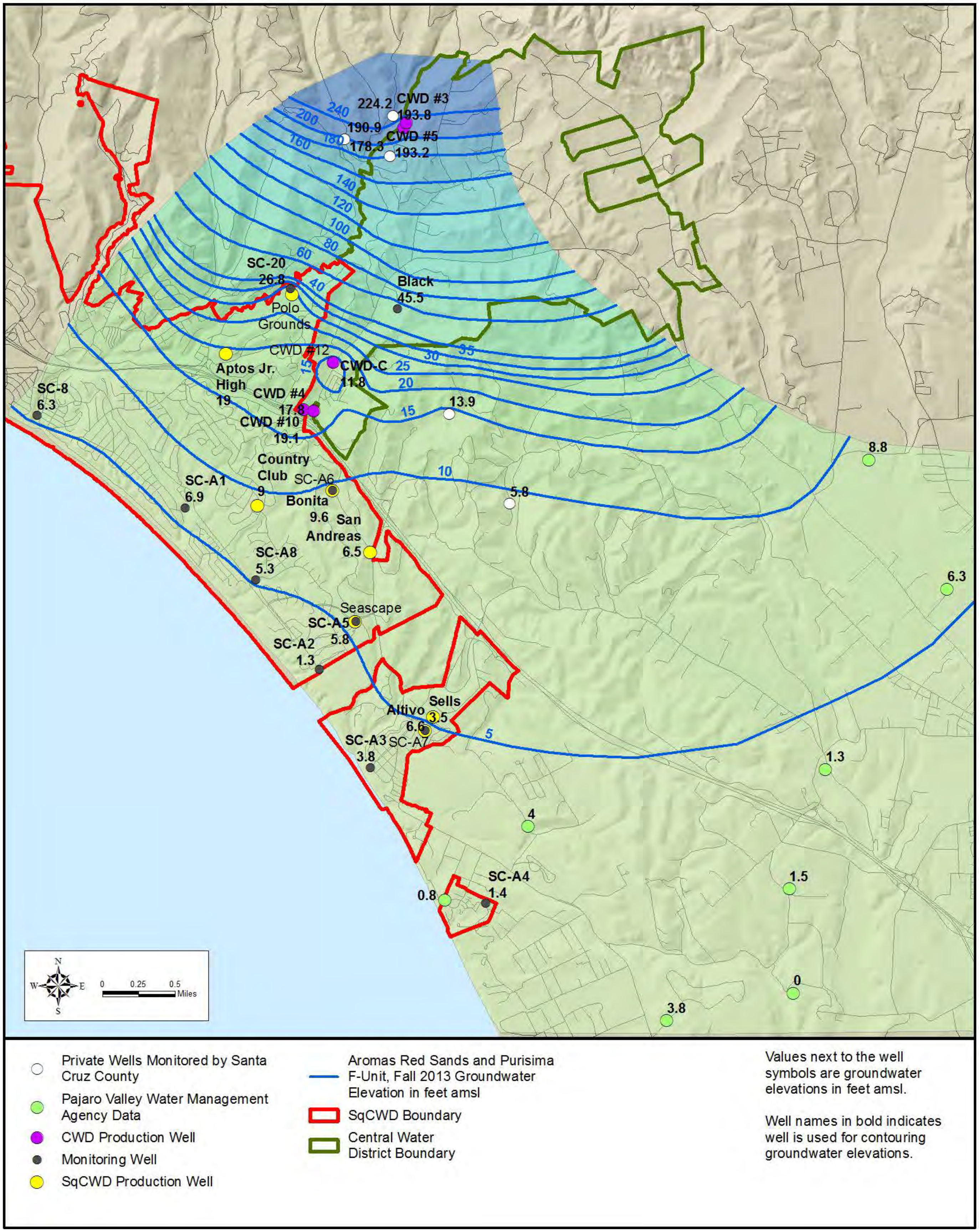


Figure 5-3 (2013): Groundwater Elevation Contours, Aromas Area, Fall 2013

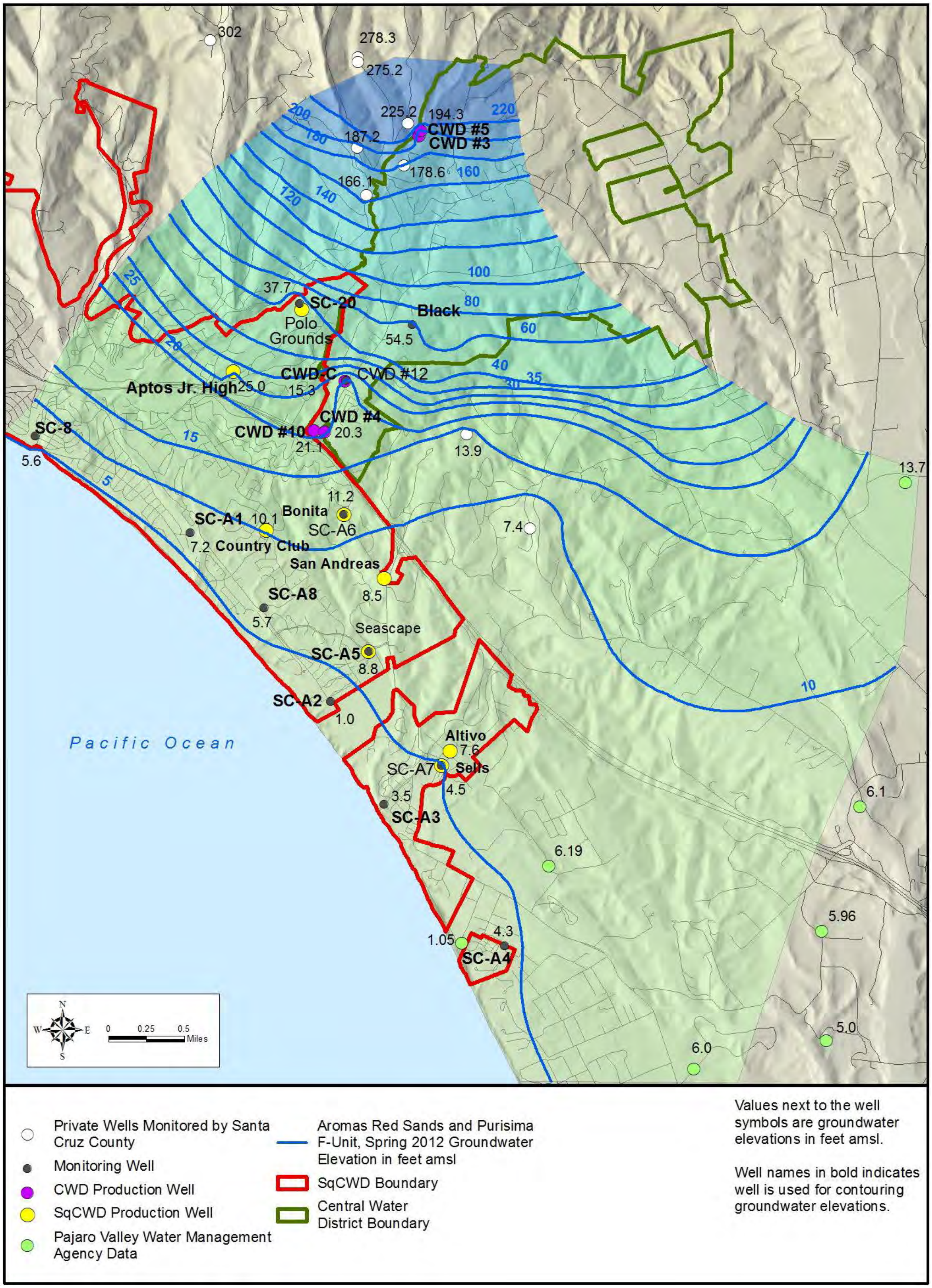


Figure 5-2 (2012): Groundwater Elevation Contours, Aromas Area, Spring 2012

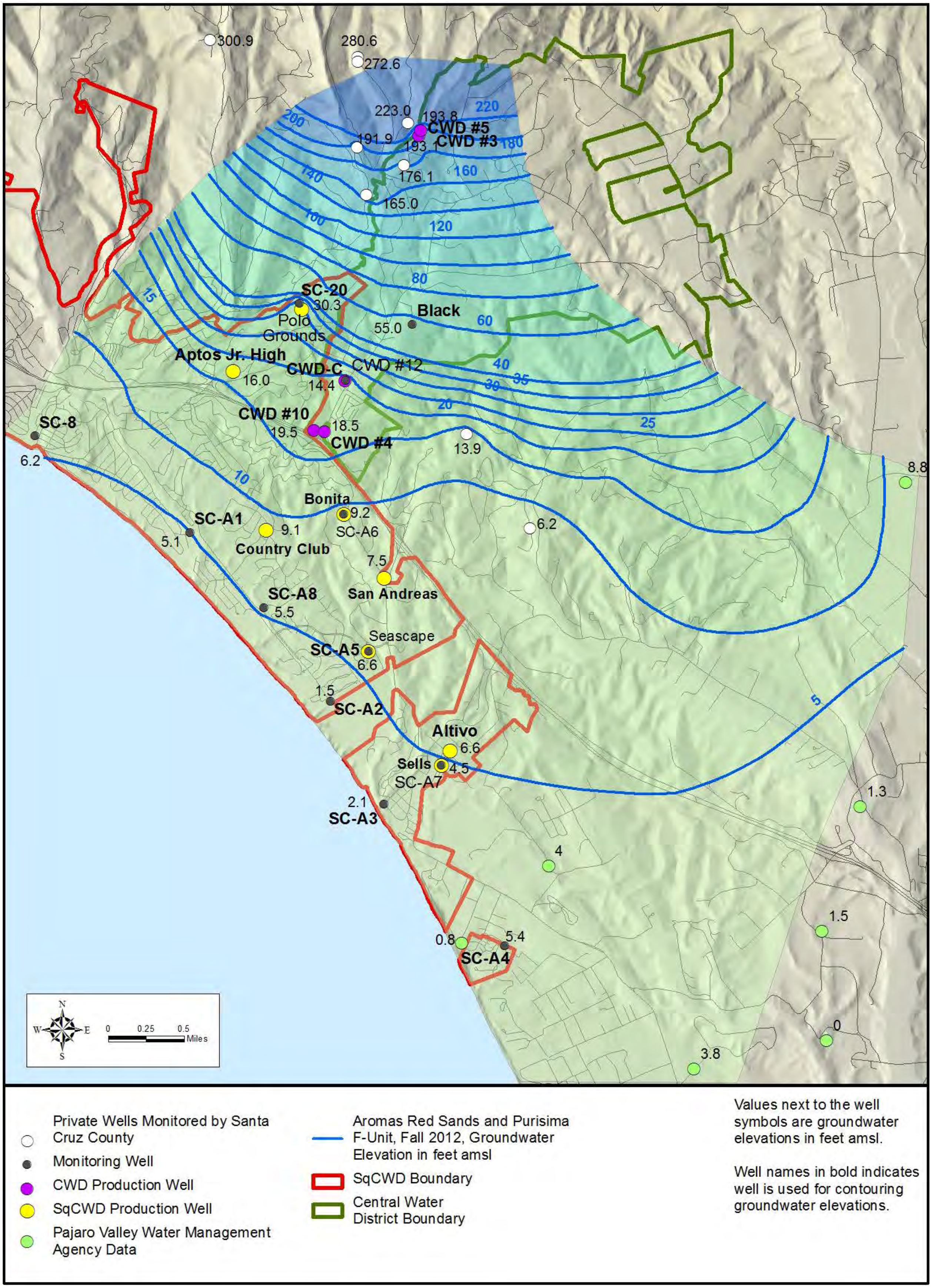


Figure 5-3 (2012): Groundwater Elevation Contours, Aromas Area, Fall 2012

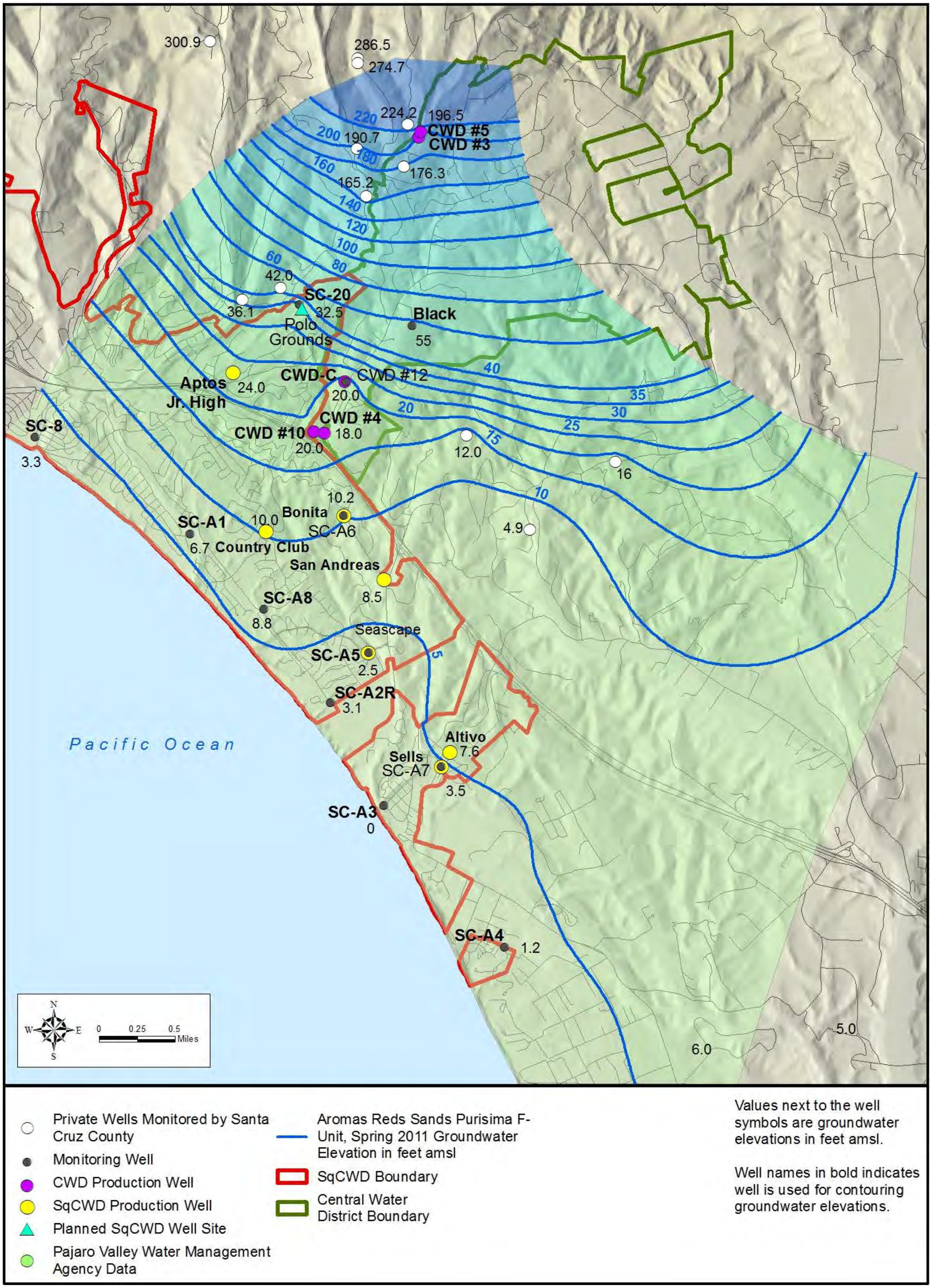


Figure 5-2 (2011): Groundwater Elevation Contours, Aromas Area, Spring 2011

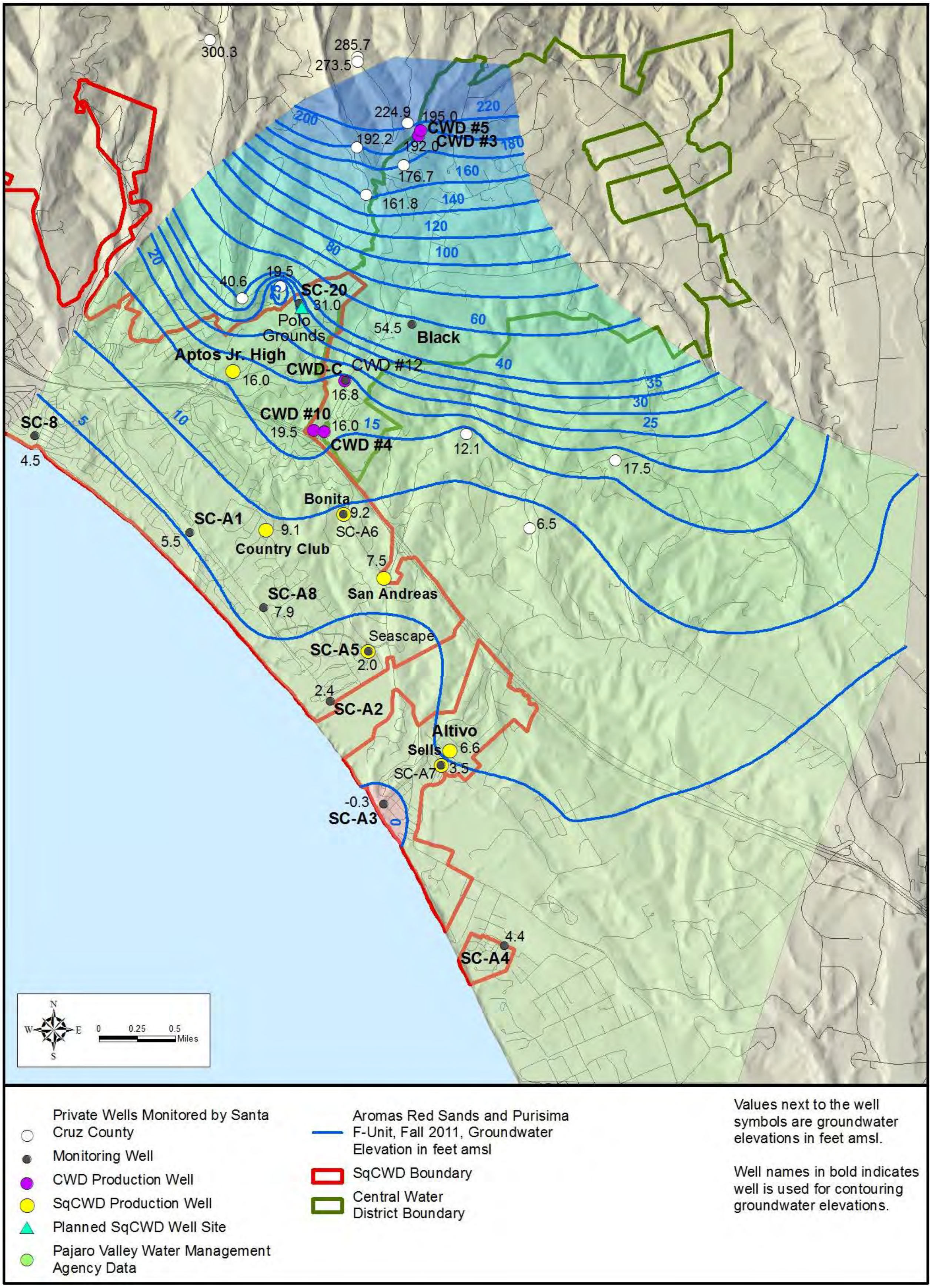


Figure 5-3 (2011): Groundwater Elevation Contours, Aromas Area, Fall 2011

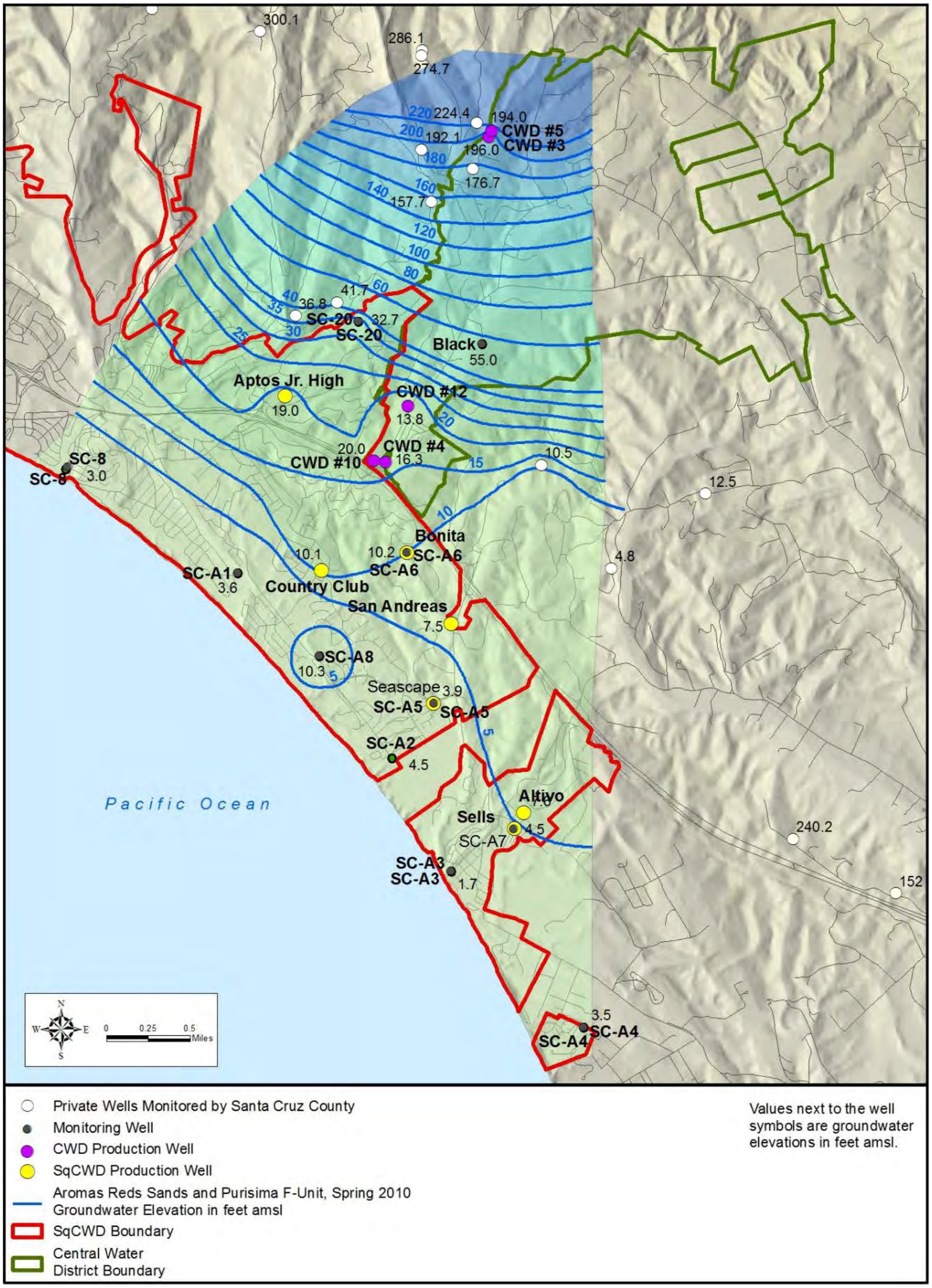


Figure 5-2 (2010): Groundwater Elevation Contours, Aromas Area, Spring 2010

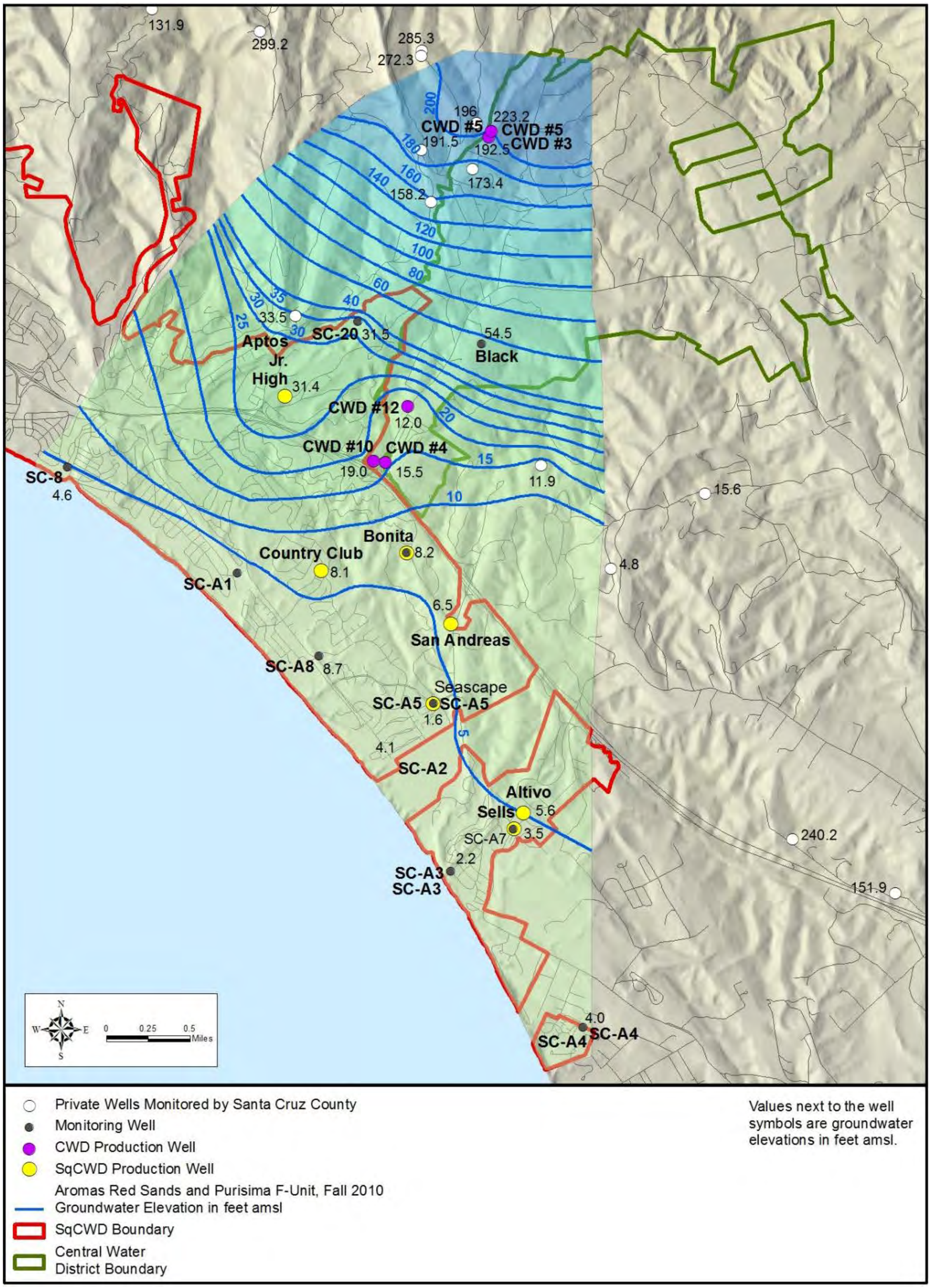


Figure 5-3 (2010): Groundwater Elevation Contours, Aromas Area, Fall 2010

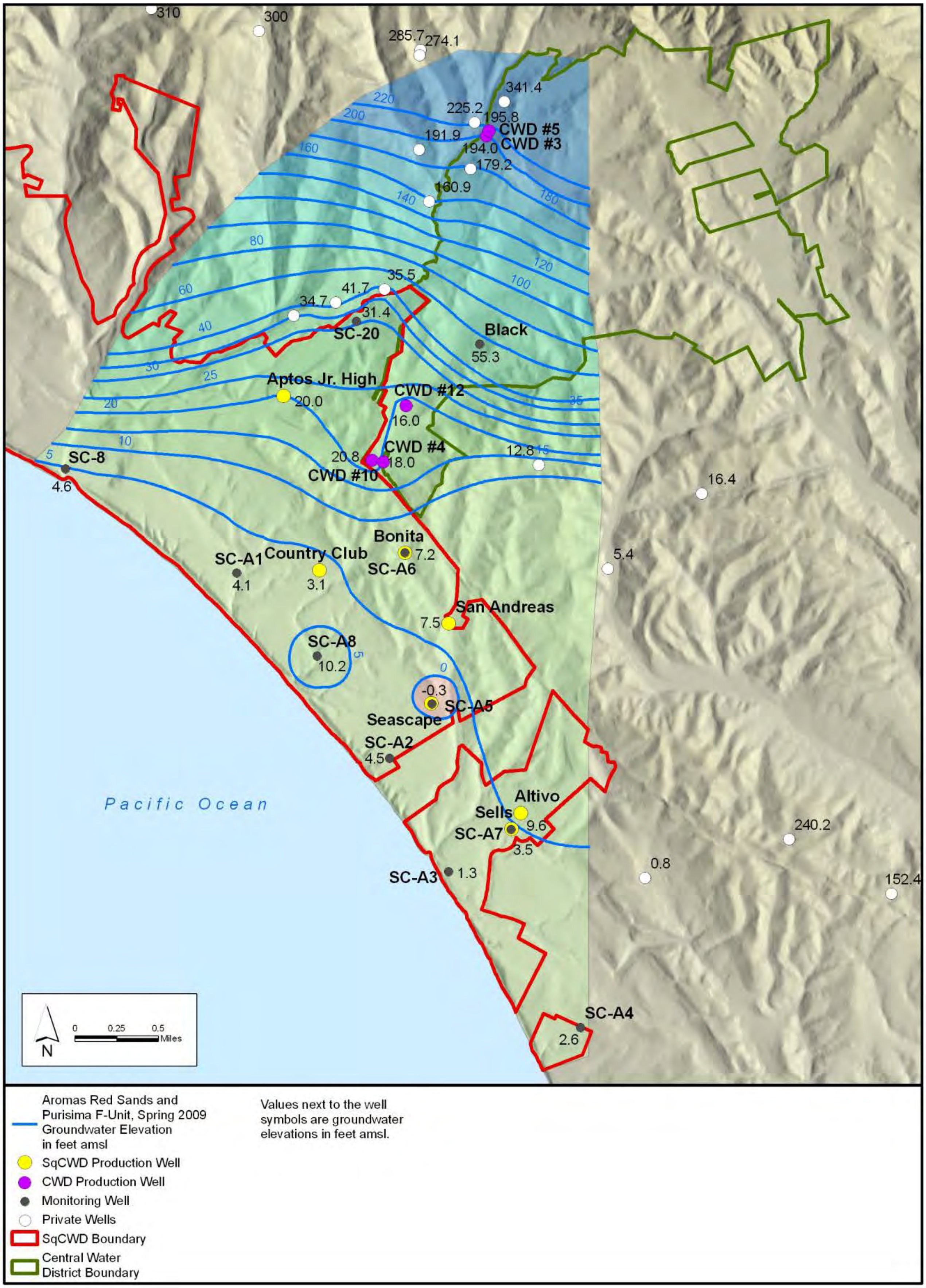


Figure 5-2 (2009): Groundwater Elevation Contours, Aromas Area, Spring 2009

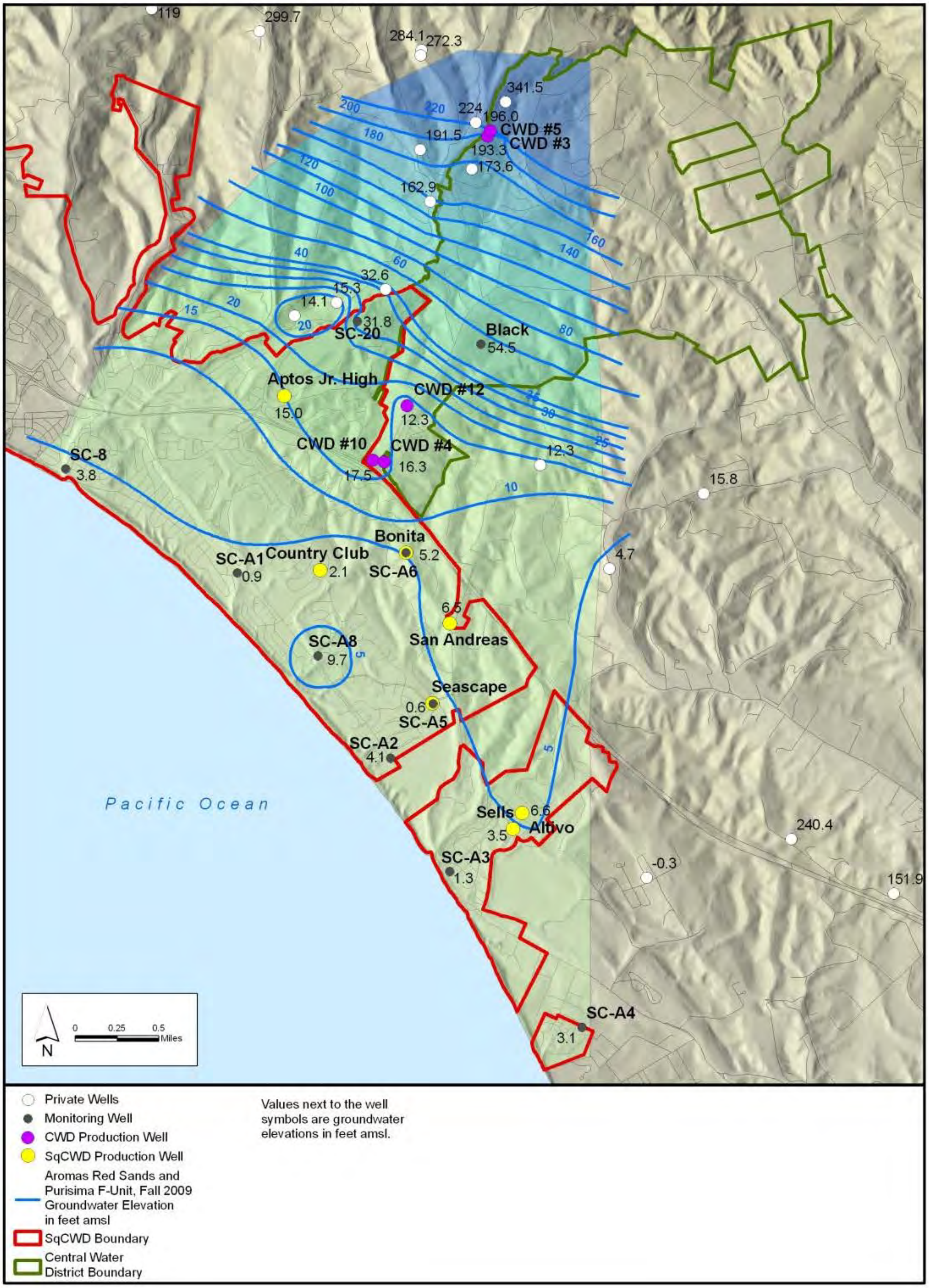


Figure 5-3 (2009): Groundwater Elevation Contours, Aromas Area, Fall 2009

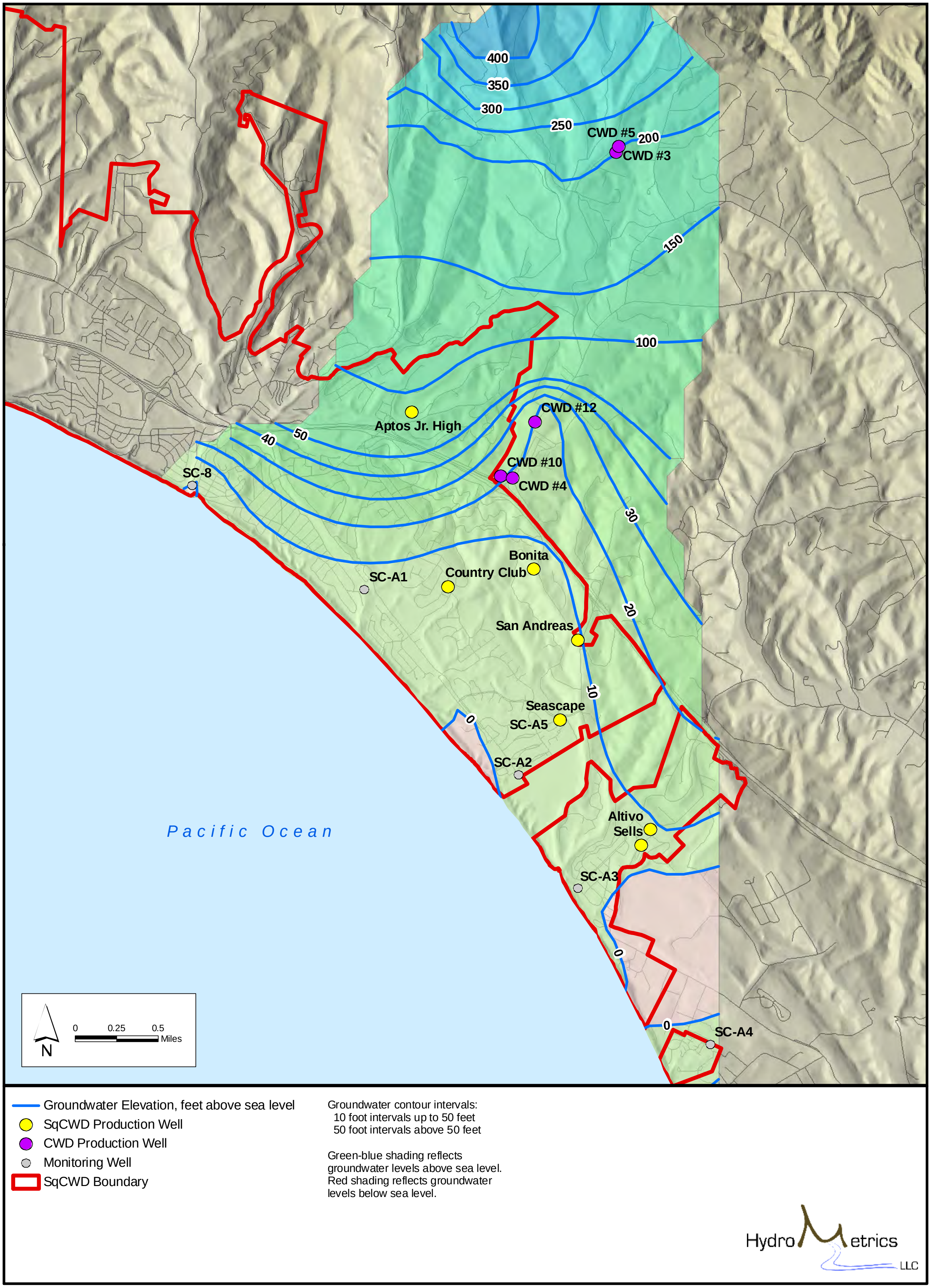


Figure 5-2 (2007): Groundwater Elevation Contours, Aromas Area, Spring 2007

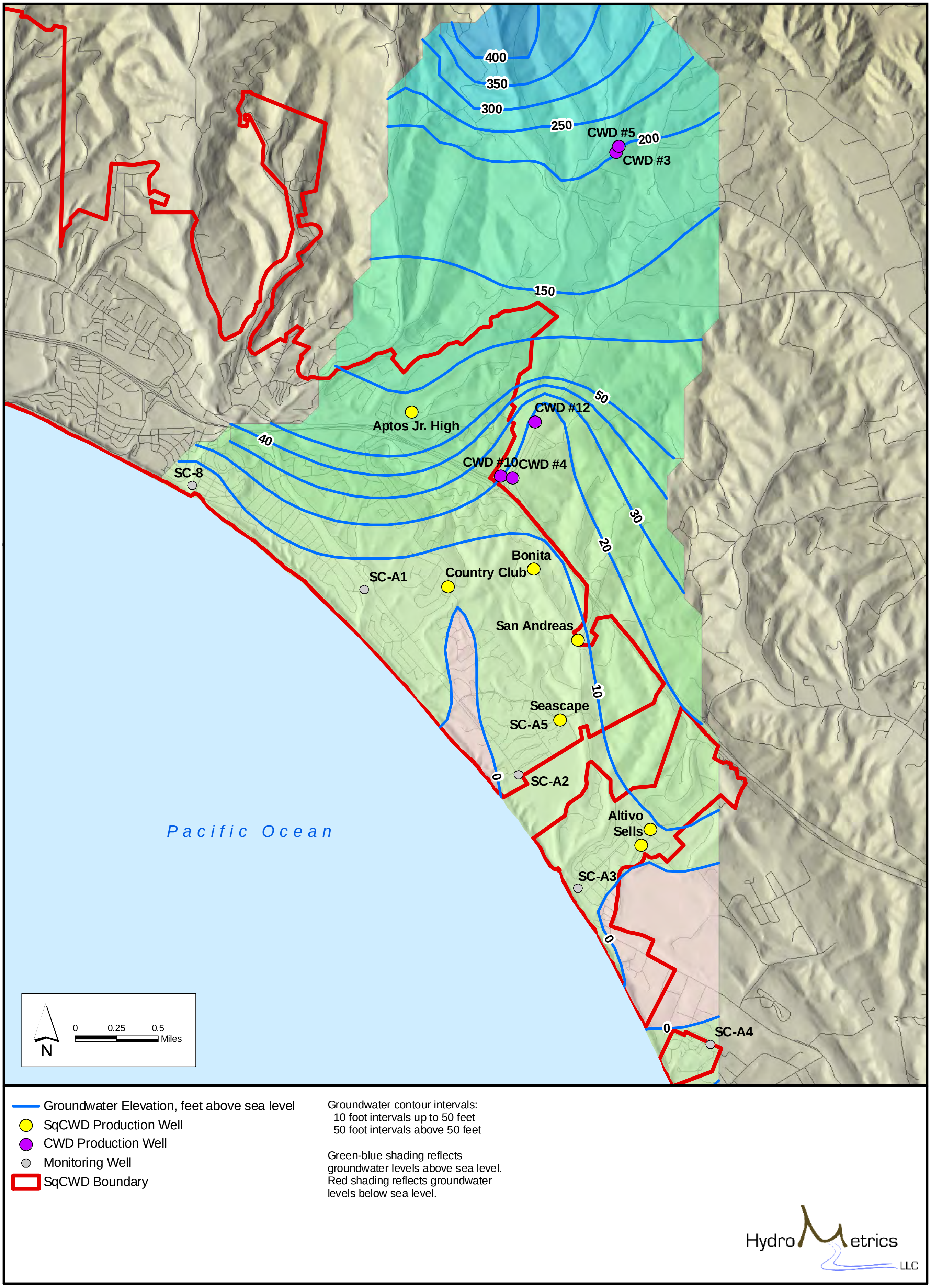


Figure 5-3 (2007): Groundwater Elevation Contours, Aromas Area, Fall 2007

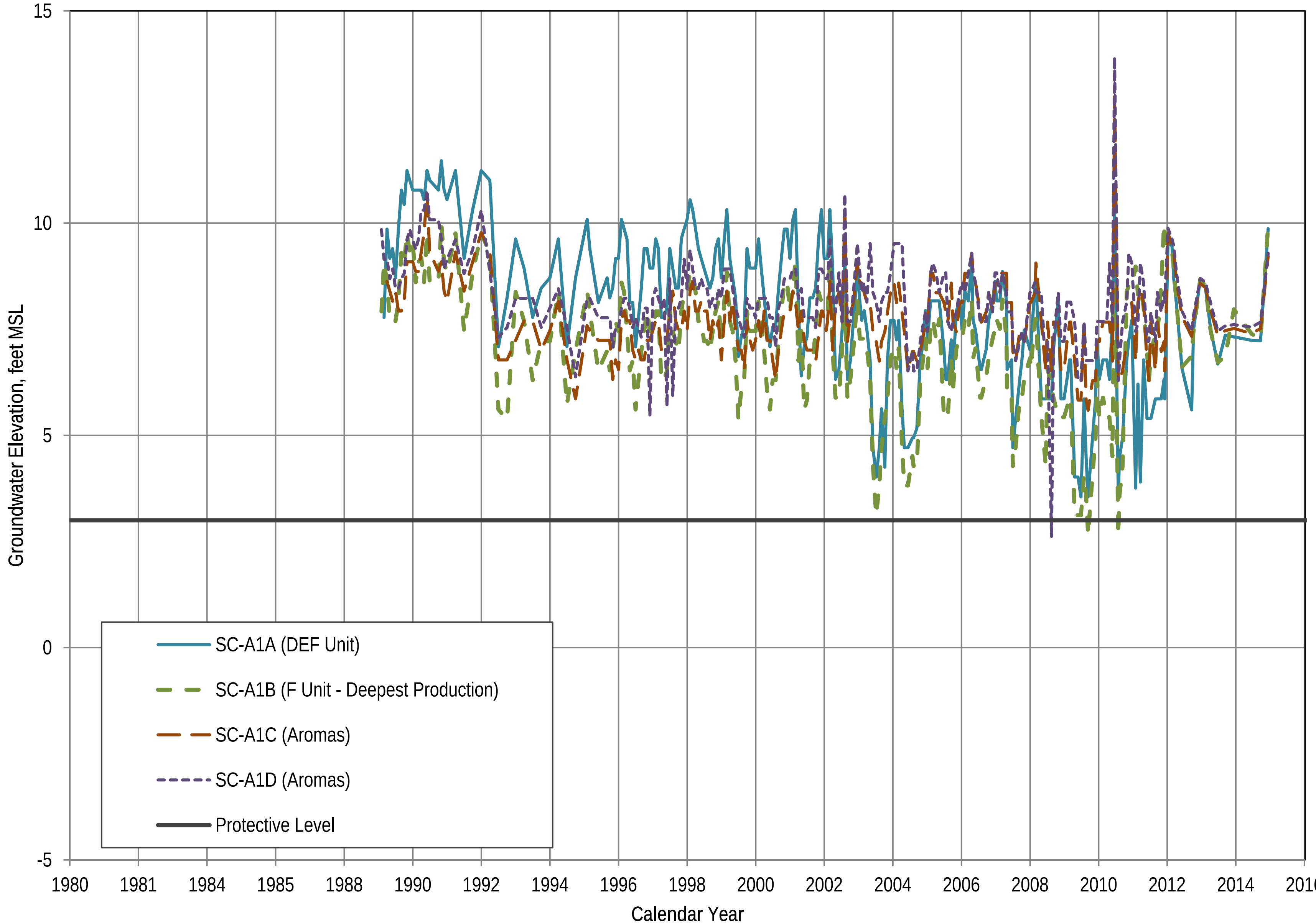
Hydrographs for Aromas Area

Hydrographs of SqCWD Coastal Monitoring Well Clusters

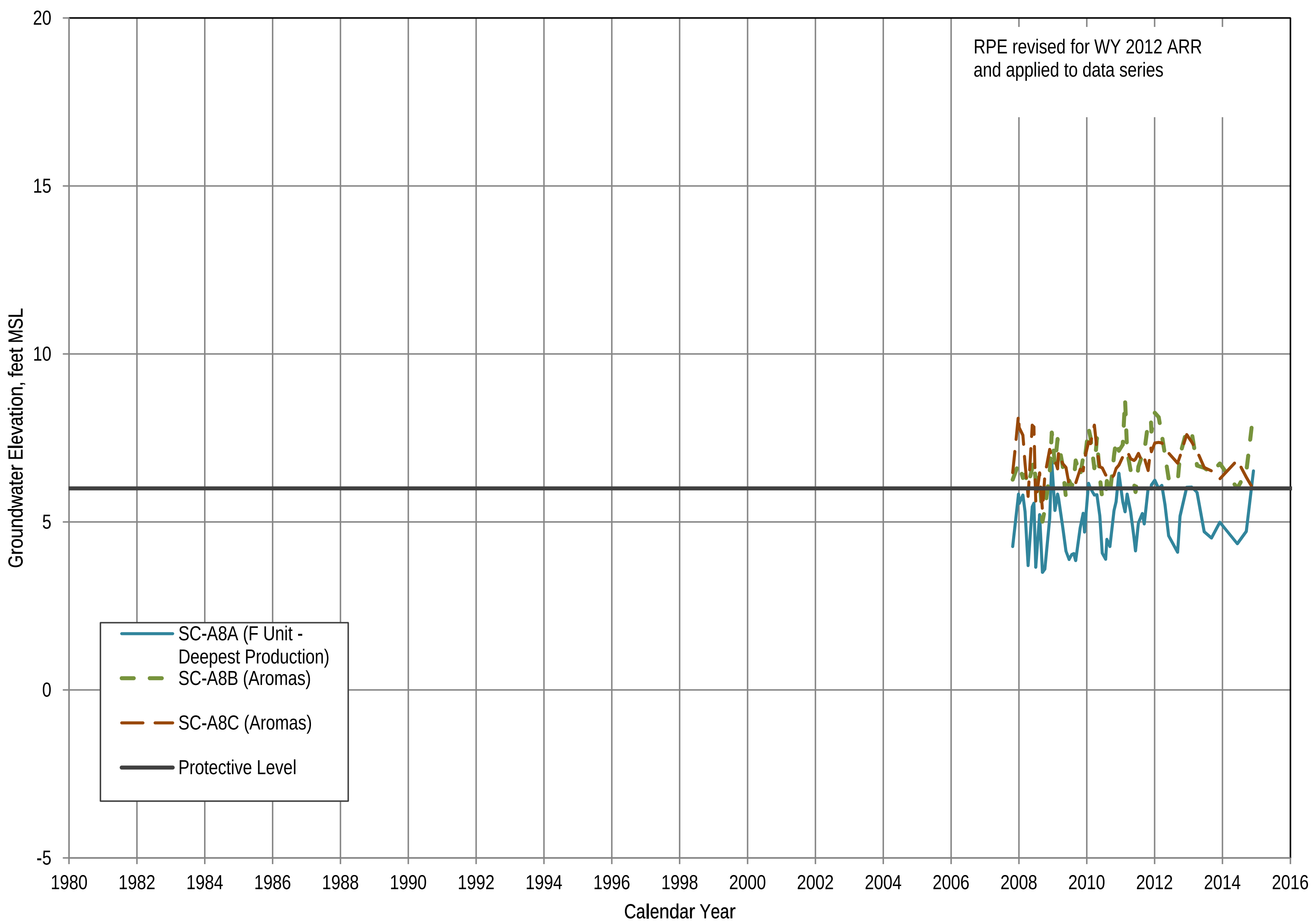
Hydrographs of SqCWD Monitoring Wells Adjacent to Production Wells

Hydrographs of CWD Monitoring Wells Adjacent to Production Wells

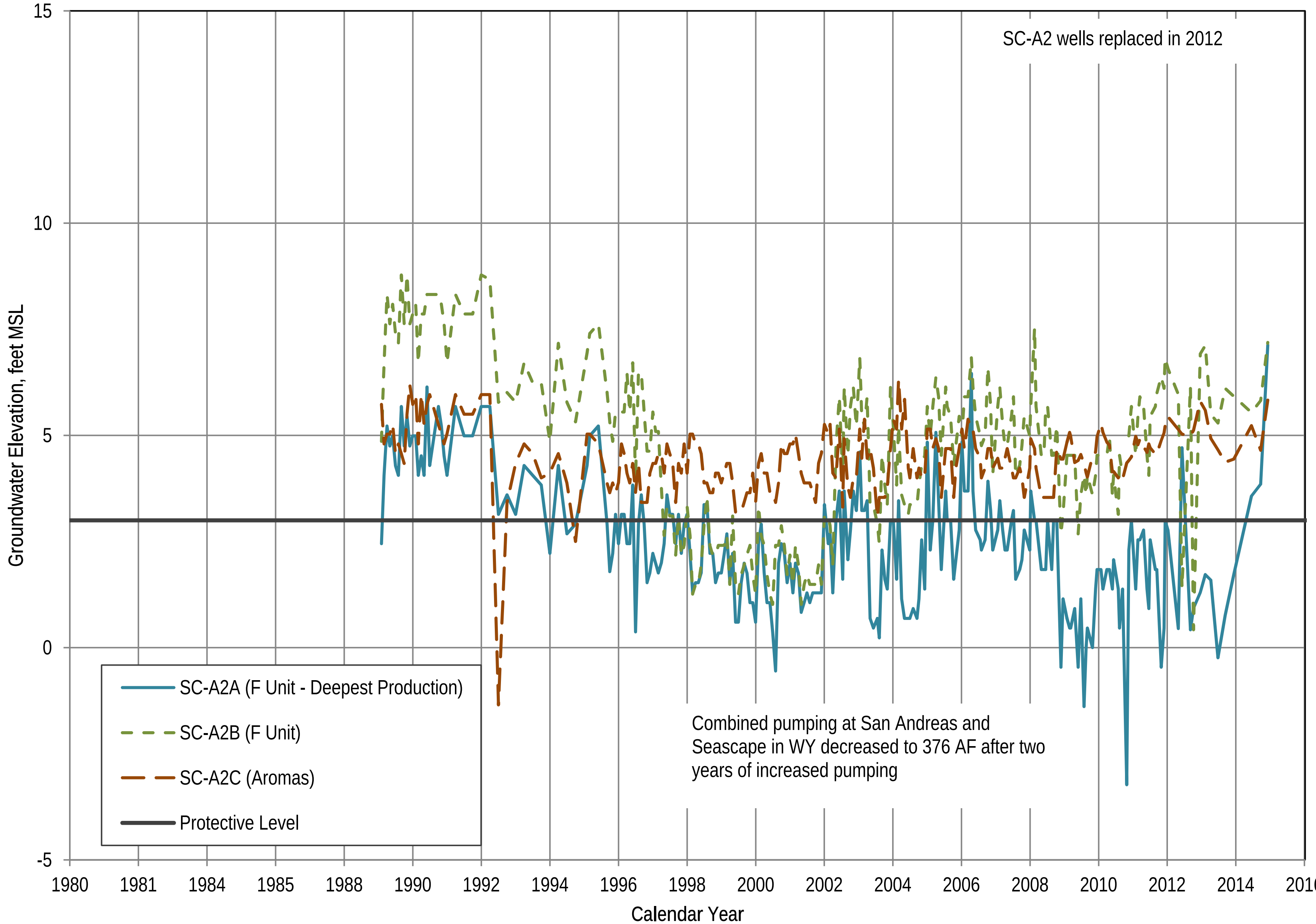
Hydrograph of Inland Monitoring Wells



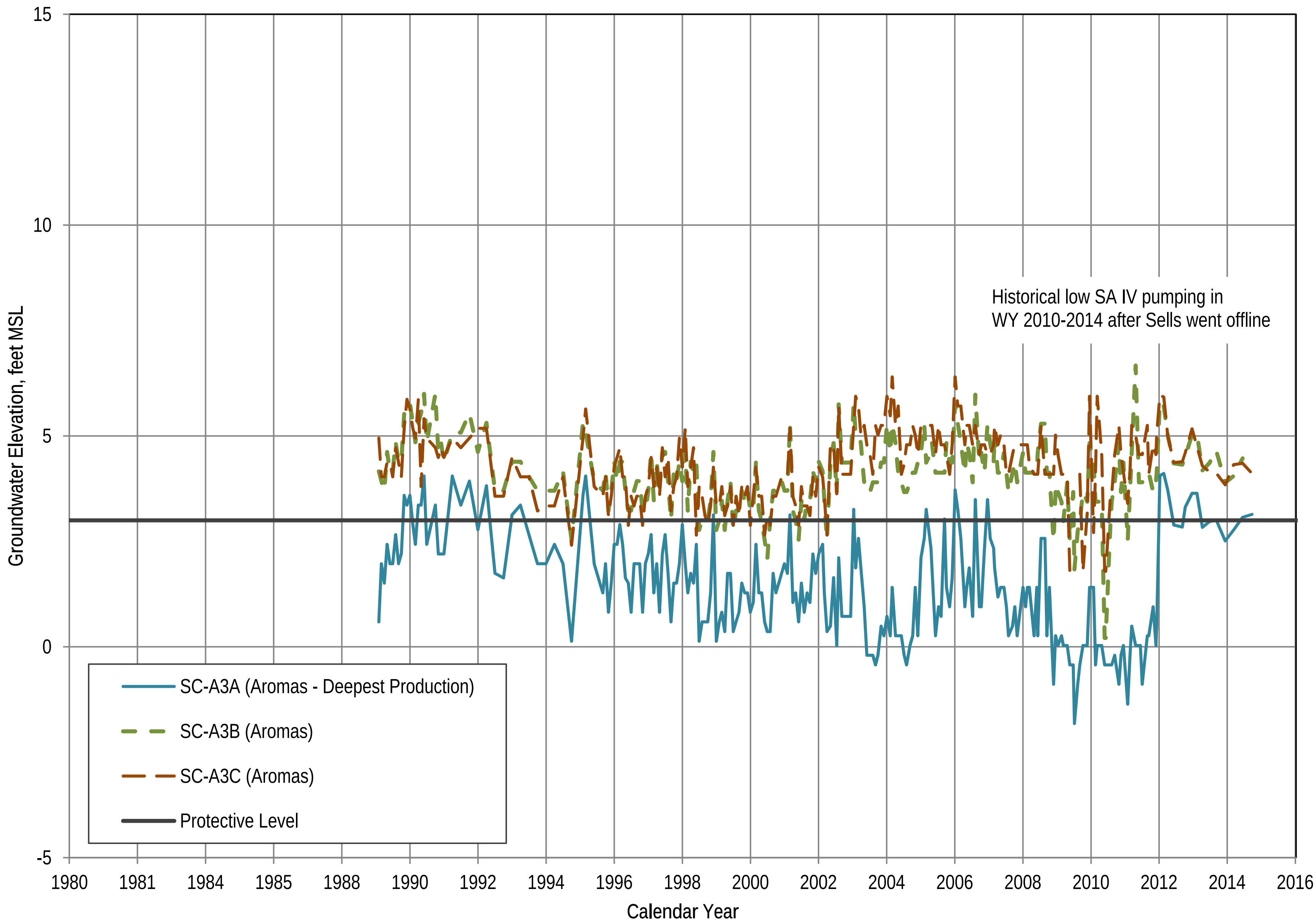
15
10
5
0
-5
Groundwater Elevation, feet MSL
1980
1981
1984
1985
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
Calendar Year
SC-A1A (DEF Unit)
SC-A1B (F Unit - Deepest Production)
SC-A1C (Aromas)
SC-A1D (Aromas)
Protective Level



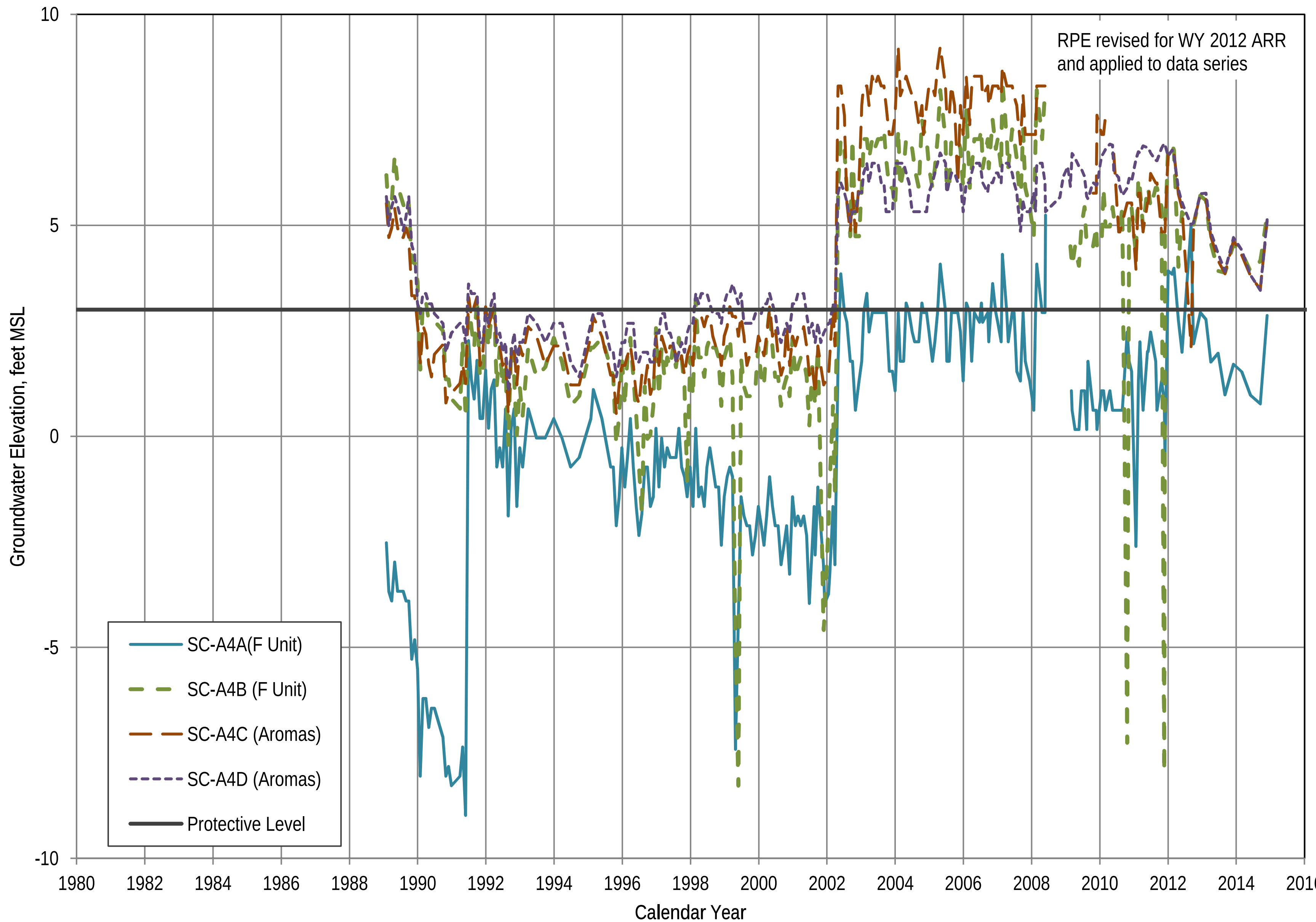
RPE revised for WY 2012 ARR
and applied to data series
Groundwater Elevation, feet MSL
Calendar Year
20
15
10
5
0
-5
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
SC-A8A (F Unit - Deepest Production)
SC-A8B (Aromas)
SC-A8C (Aromas)
Protective Level



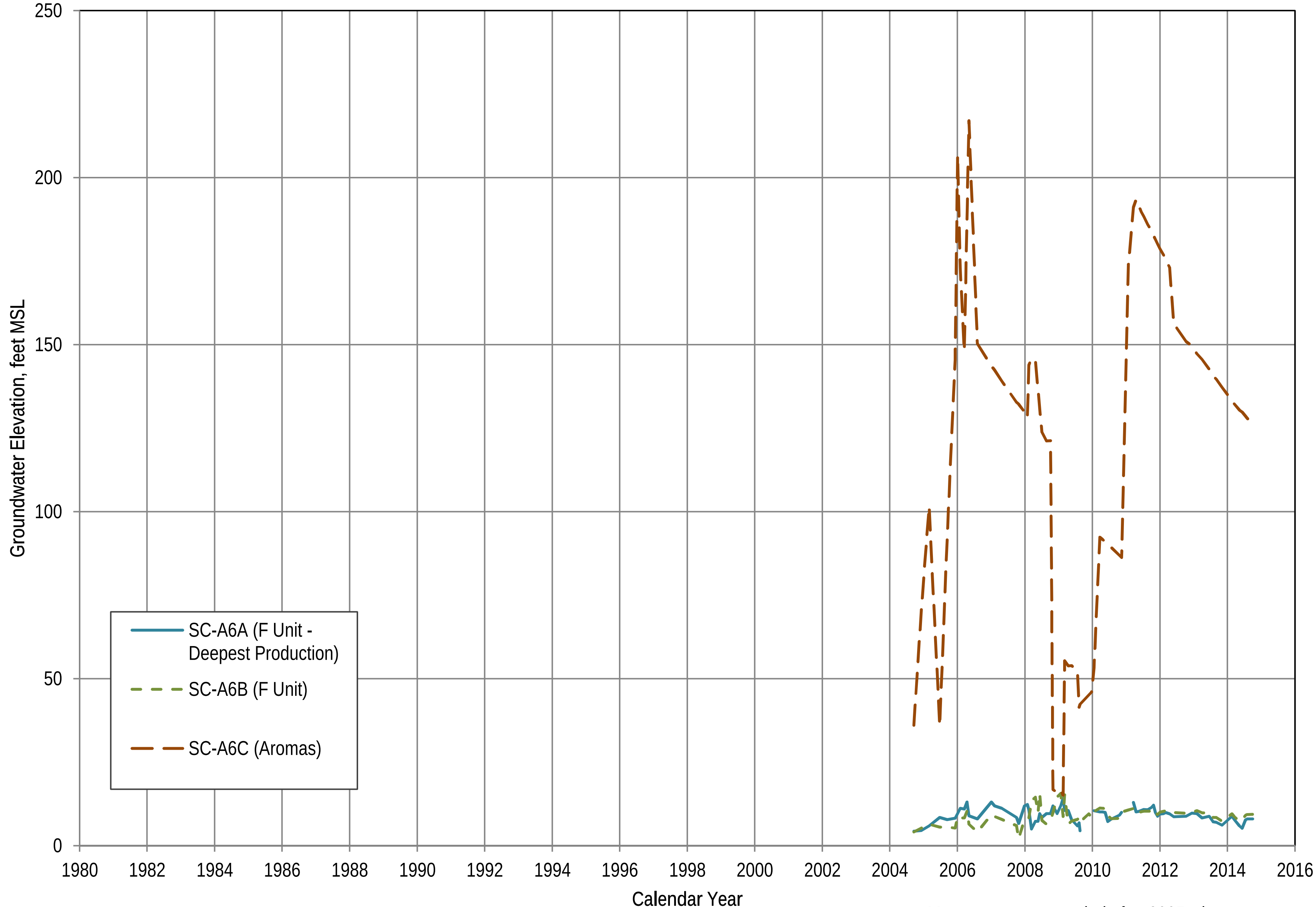
SC-A2 wells replaced in 2012
Groundwater Elevation, feet MSL
15
10
5
0
-5
1980
1981
1984
1985
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
Calendar Year
SC-A2A (F Unit - Deepest Production)
SC-A2B (F Unit)
SC-A2C (Aromas)
Protective Level
Combined pumping at San Andreas and Seascape in WY decreased to 376 AF after two years of increased pumping



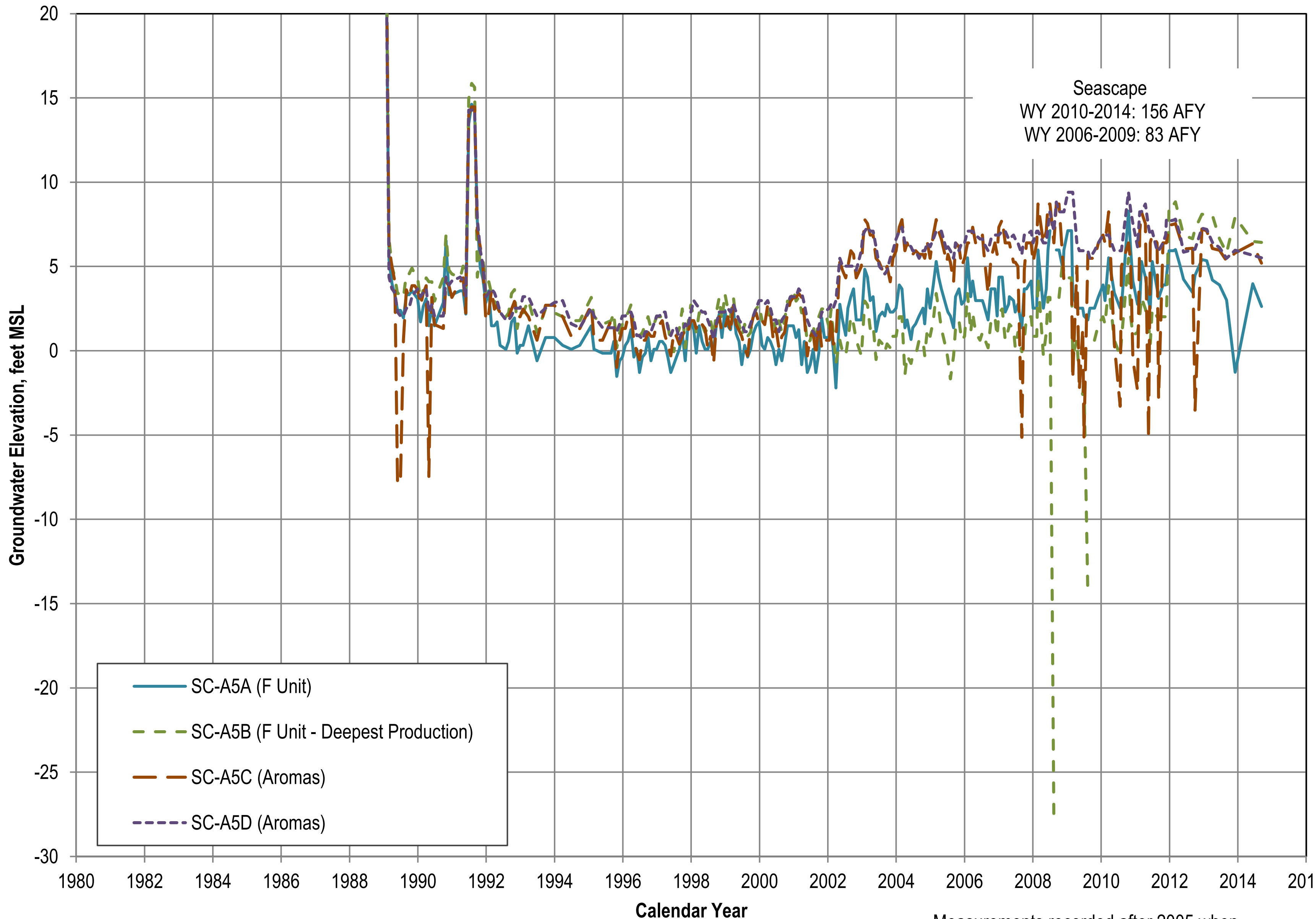
15
10
5
0
-5
Groundwater Elevation, feet MSL
Historical low SA IV pumping in
WY 2010-2014 after Sells went offline
SC-A3A (Aromas - Deepest Production)
SC-A3B (Aromas)
SC-A3C (Aromas)
Protective Level
1980
1981
1984
1985
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
Calendar Year



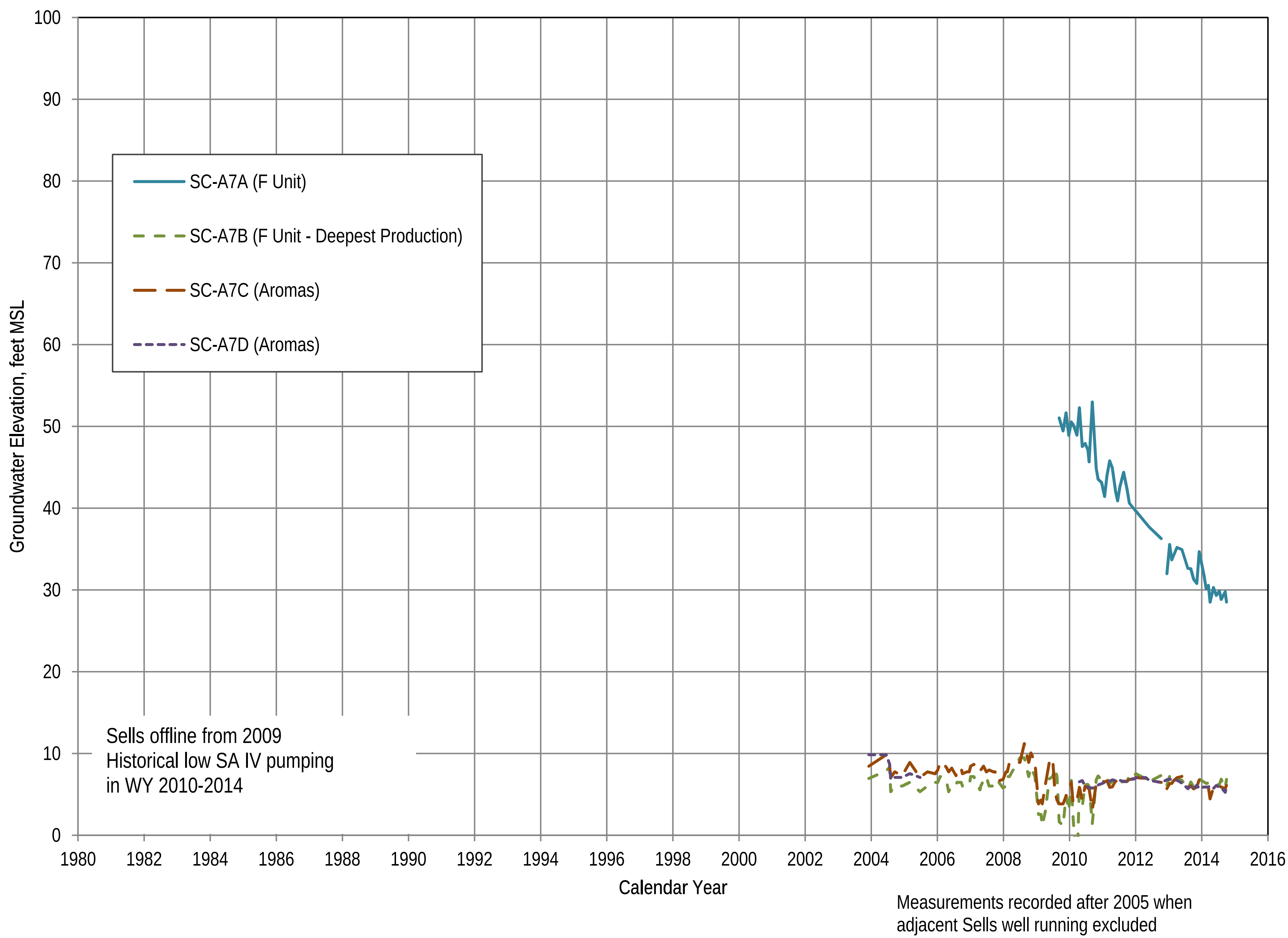
RPE revised for WY 2012 ARR
and applied to data series
Groundwater Elevation, feet MSL
10
5
0
-5
-10
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
Calendar Year
SC-A4A(F Unit)
SC-A4B (F Unit)
SC-A4C (Aromas)
SC-A4D (Aromas)
Protective Level



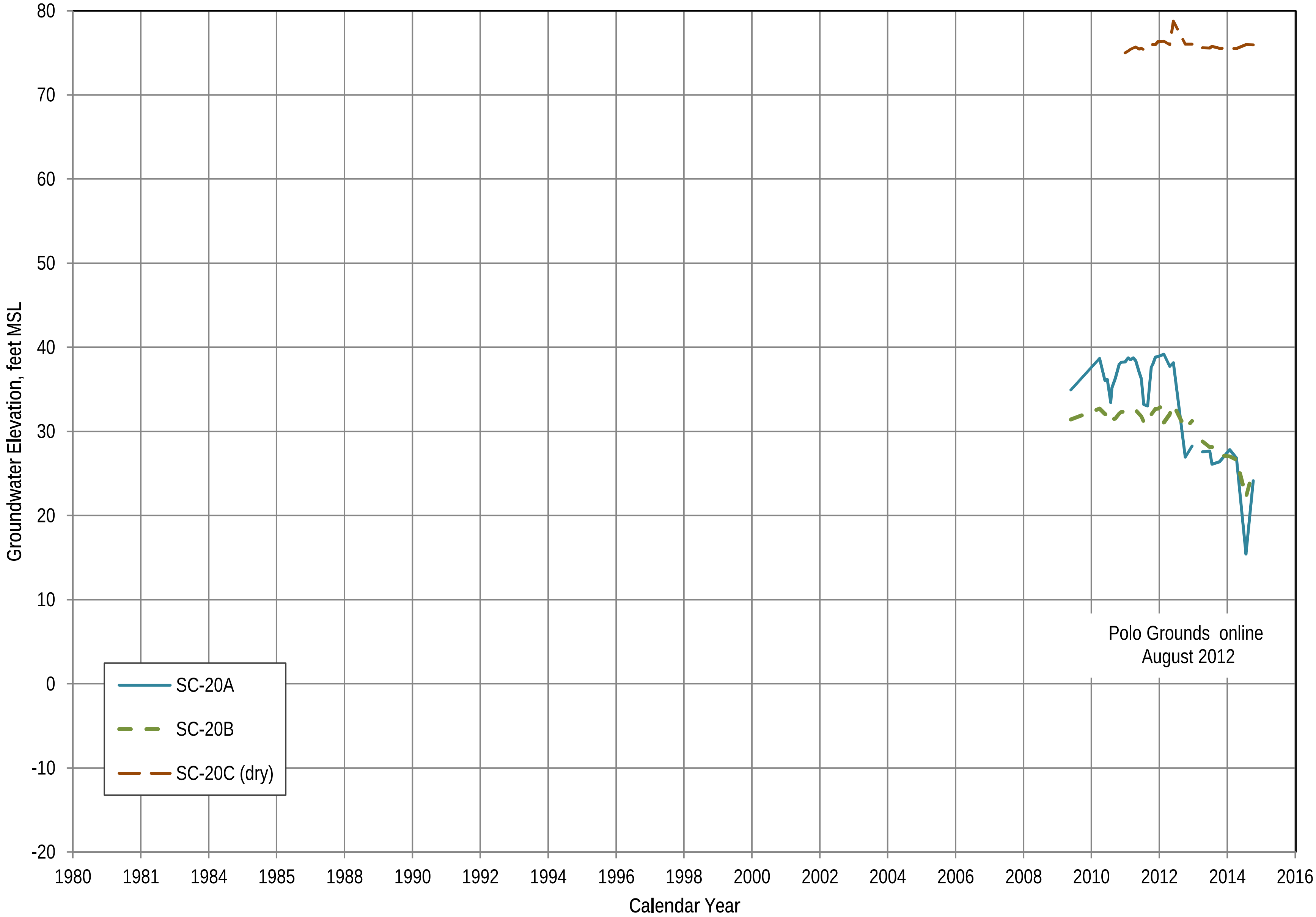
Measurements recorded after 2005 when adjacent Bonita well running excluded

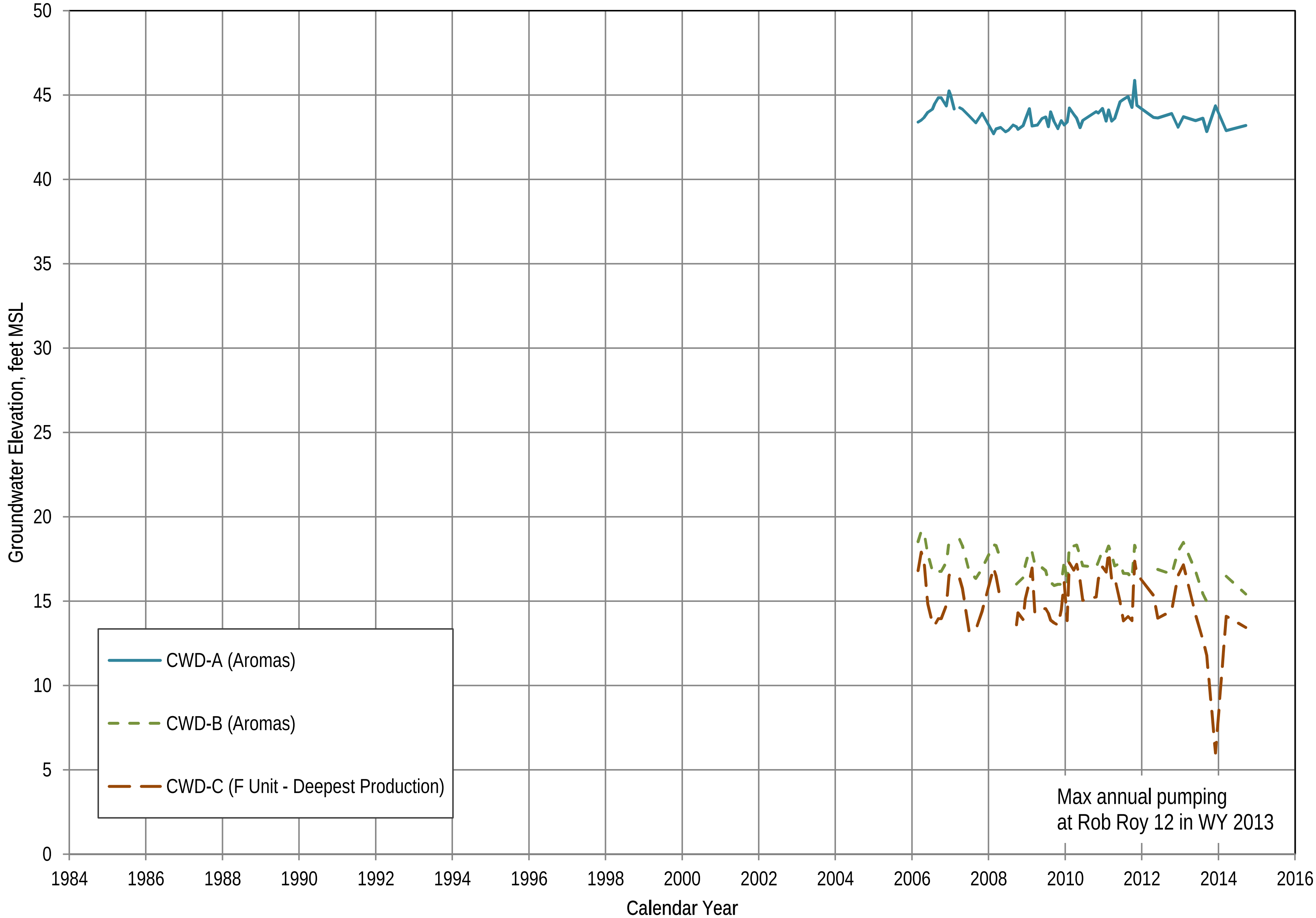


Measurements recorded after 2005 when adjacent Seascape well running excluded

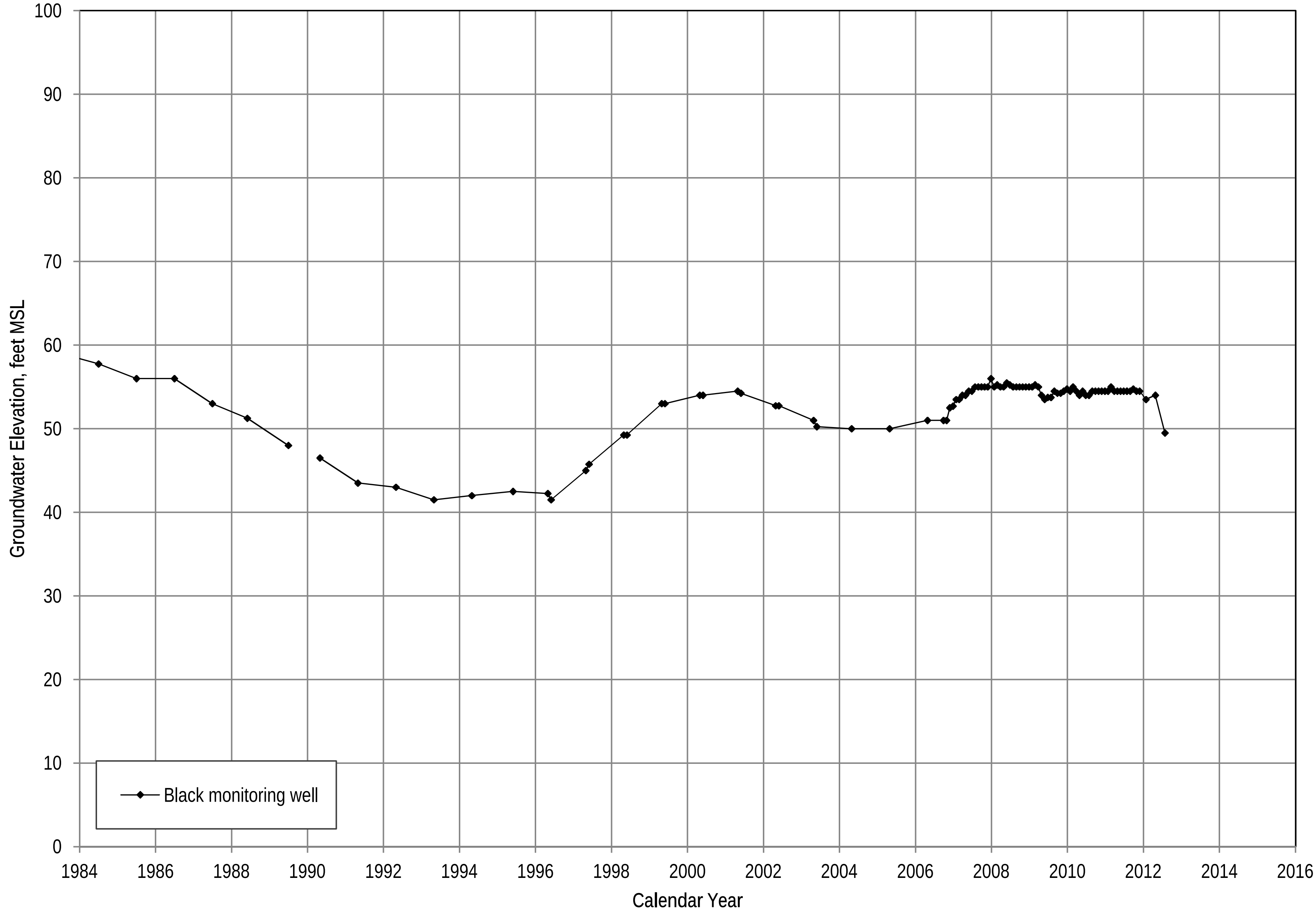


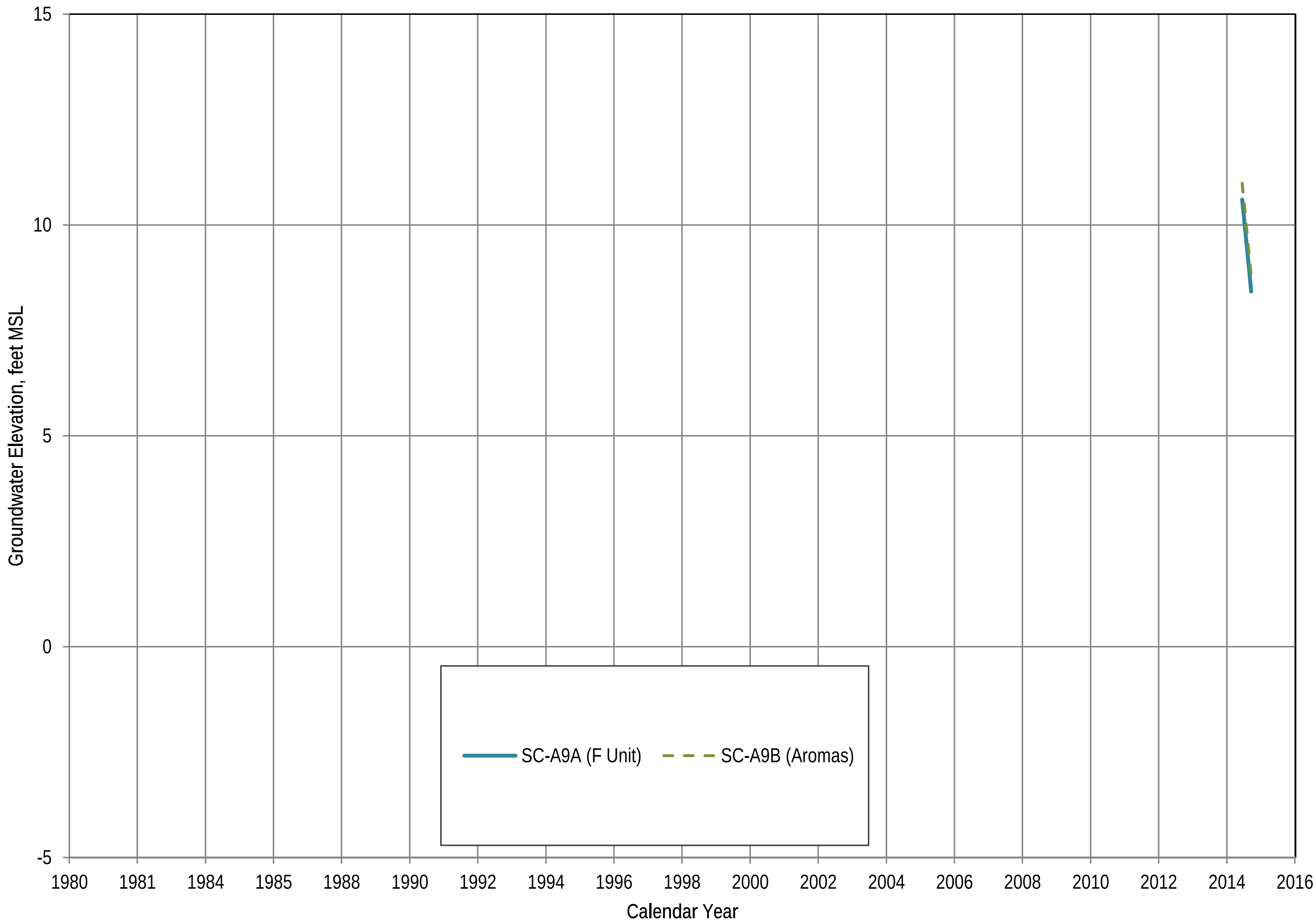
100
90
80
70
60
50
40
30
20
10
0
Groundwater Elevation, feet MSL
SC-A7A (F Unit)
SC-A7B (F Unit - Deepest Production)
SC-A7C (Aromas)
SC-A7D (Aromas)
Sells offline from 2009
Historical low SA IV pumping
in WY 2010-2014
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
Calendar Year
Measurements recorded after 2005 when
adjacent Sells well running excluded


80
70
60
50
40
30
20
10
0
-10
-20
Groundwater Elevation, feet MSL
1980
1981
1984
1985
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
Calendar Year
Polo Grounds online
August 2012
SC-20A
SC-20B
SC-20C (dry)



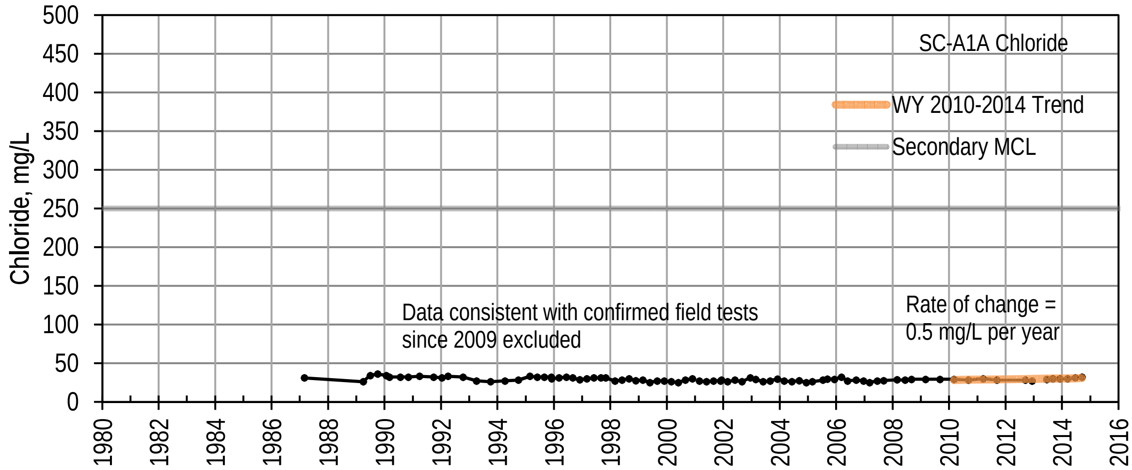
Adjacent to Rob Roy Well 12

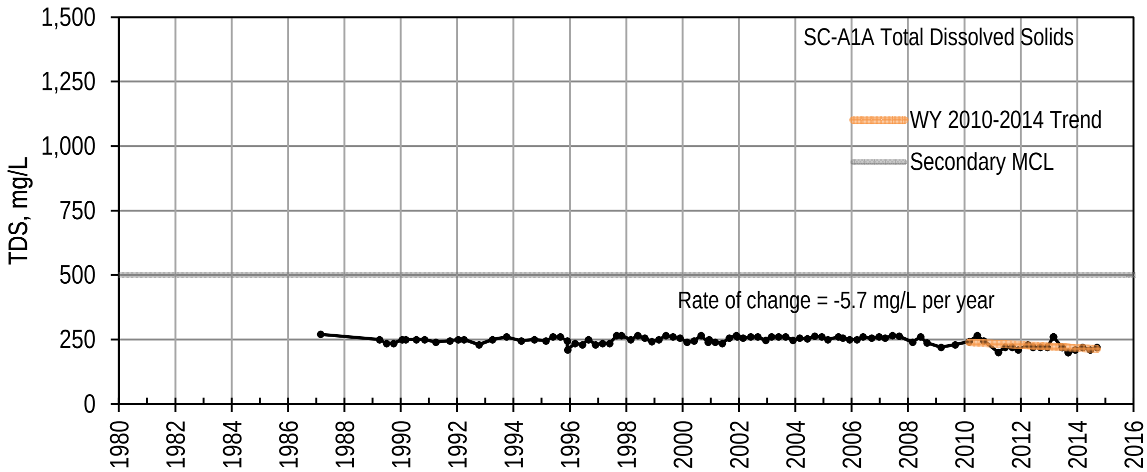

100
90
80
70
60
50
40
30
20
10
0
Groundwater Elevation, feet MSL
Black monitoring well
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
Calendar Year

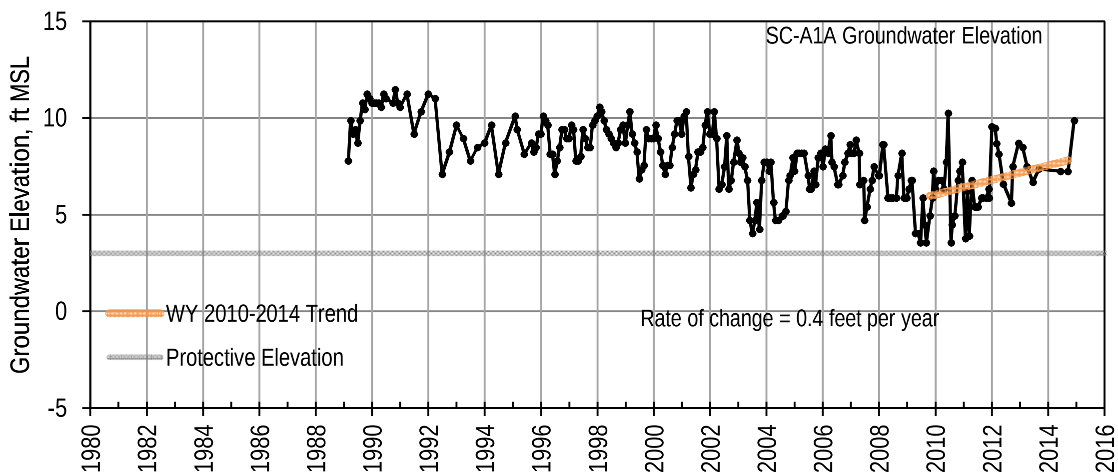

15
10
5
0
-5
Groundwater Elevation, feet MSL
1980
1981
1984
1985
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
Calendar Year
SC-A9A (F Unit)
SC-A9B (Aromas)

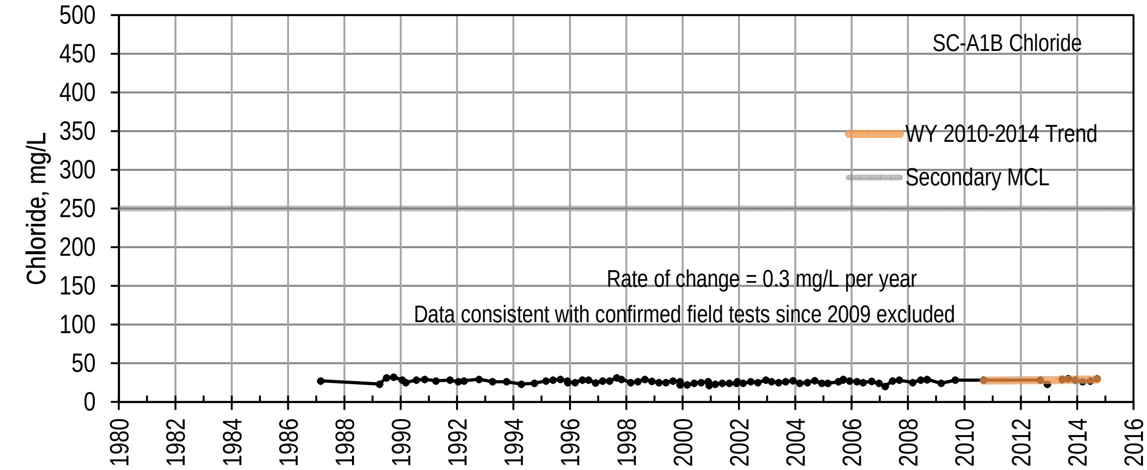
Chemographs and Single Well Hydrographs for Aromas Area

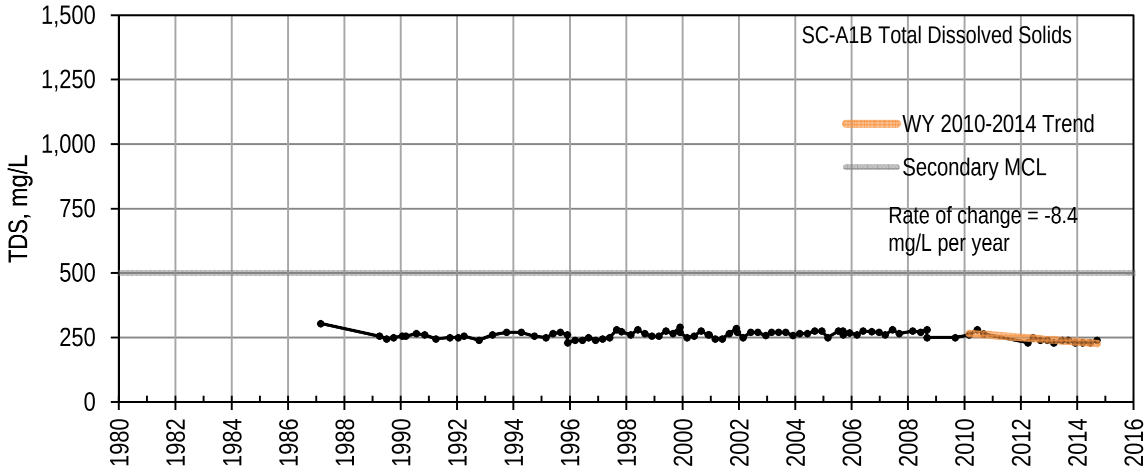
Trends shown on the hydrographs and chemographs are based on a linear fit to data in the specified time period.

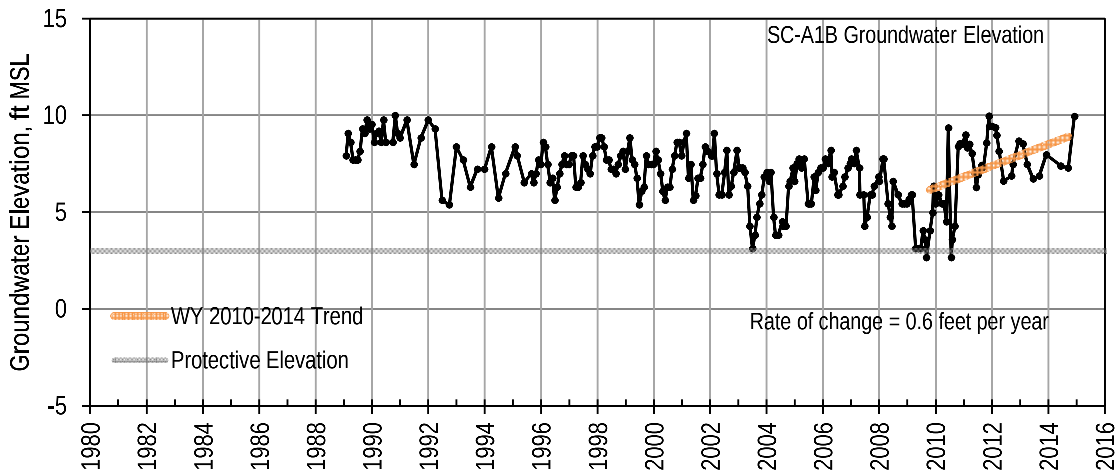

SC-A1A Chloride
WY 2010-2014 Trend
Secondary MCL
Chloride, mg/L
Data consistent with confirmed field tests
since 2009 excluded
Rate of change =
0.5 mg/L per year

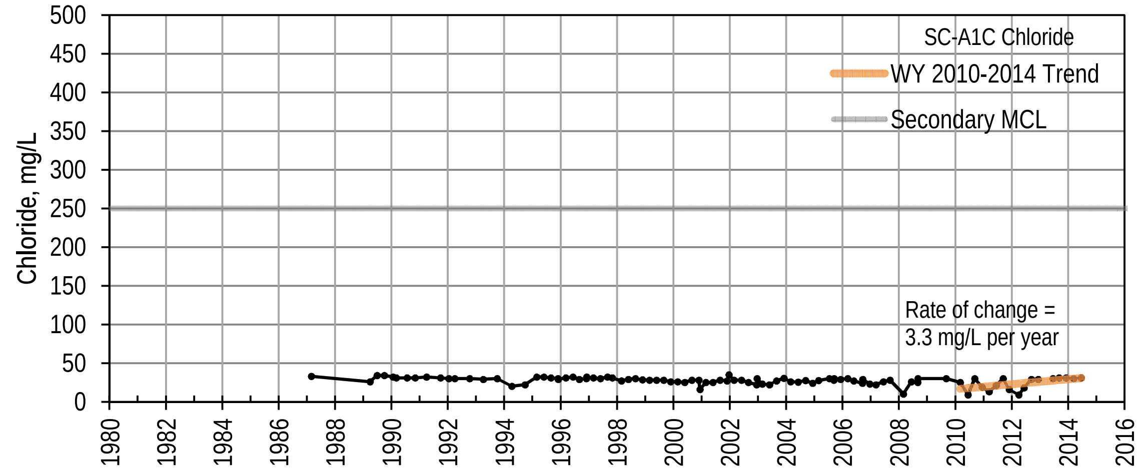

SC-A1A Total Dissolved Solids
WY 2010-2014 Trend
Secondary MCL
TDS, mg/L
Rate of change = -5.7 mg/L per year

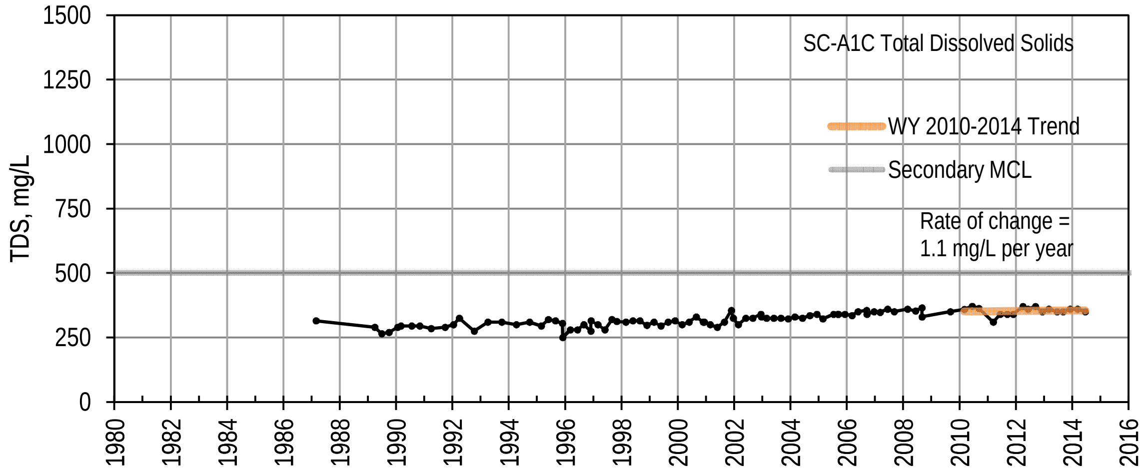

SC-A1A Groundwater Elevation
Groundwater Elevation, ft MSL
WY 2010-2014 Trend
Protective Elevation
Rate of change = 0.4 feet per year

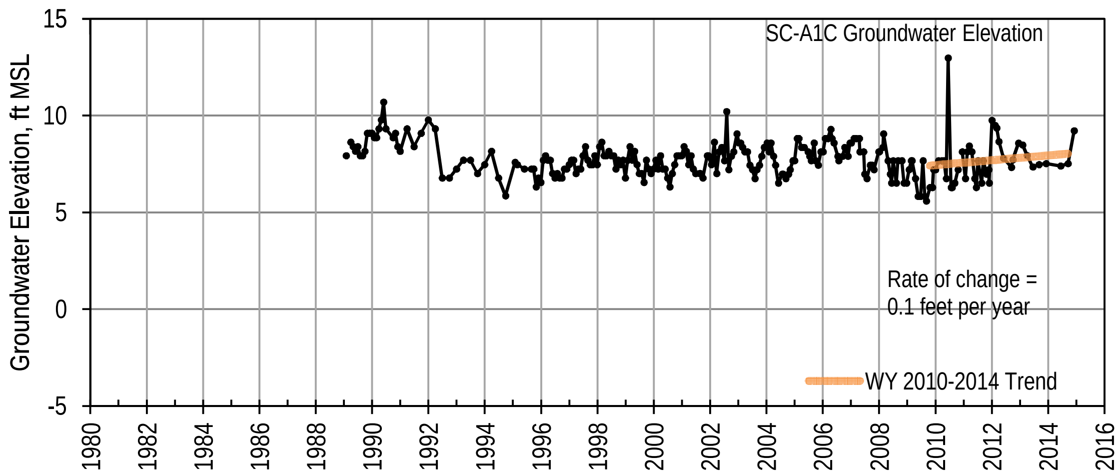

SC-A1B Chloride
WY 2010-2014 Trend
Secondary MCL
Rate of change = 0.3 mg/L per year
Data consistent with confirmed field tests since 2009 excluded
Chloride, mg/L

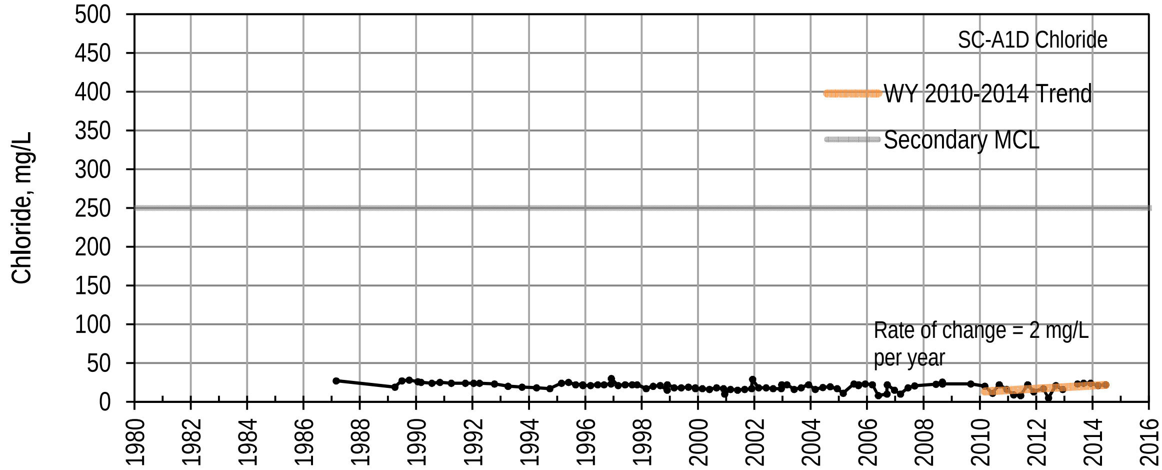

SC-A1B Total Dissolved Solids
WY 2010-2014 Trend
Secondary MCL
Rate of change = -8.4 mg/L per year
TDS, mg/L

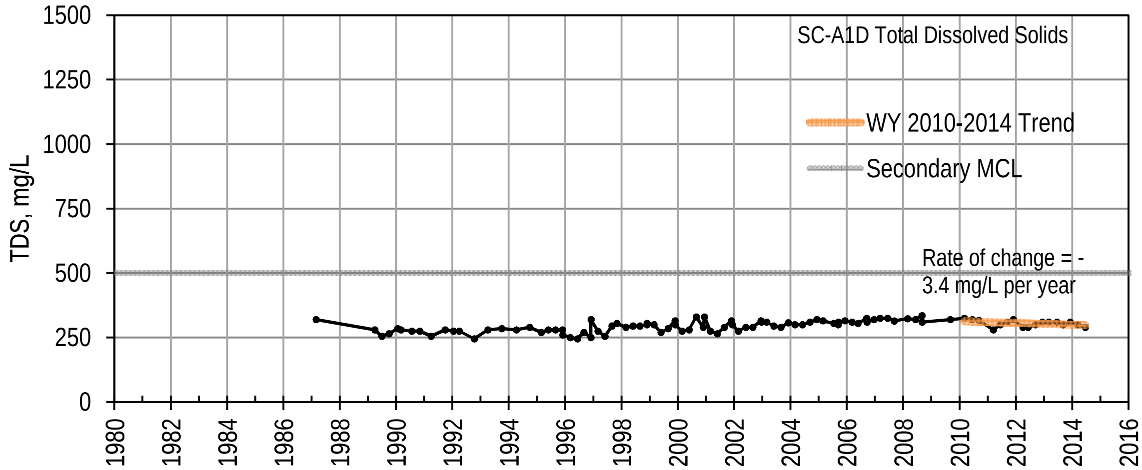

SC-A1B Groundwater Elevation
WY 2010-2014 Trend
Protective Elevation
Rate of change = 0.6 feet per year
Groundwater Elevation, ft MSL

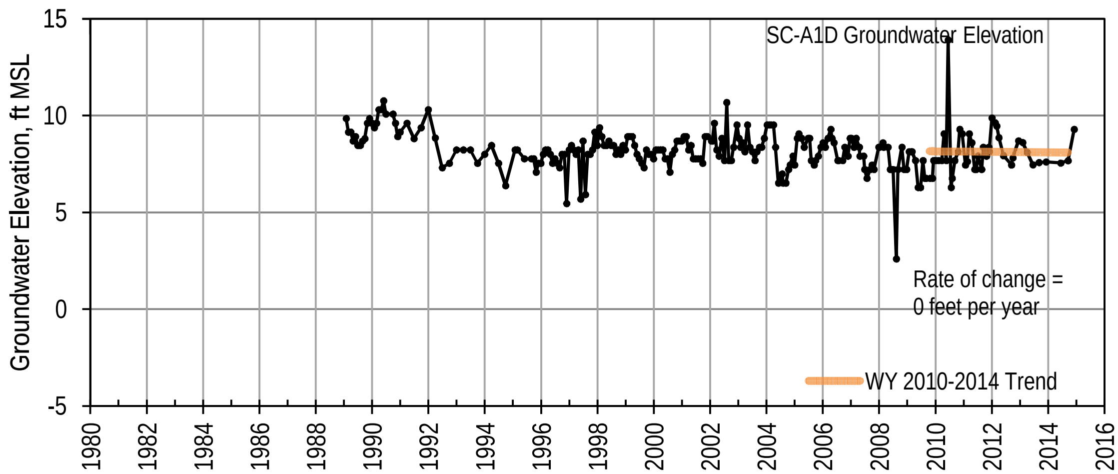

SC-A1C Chloride
WY 2010-2014 Trend
Secondary MCL
Rate of change =
3.3 mg/L per year
Chloride, mg/L

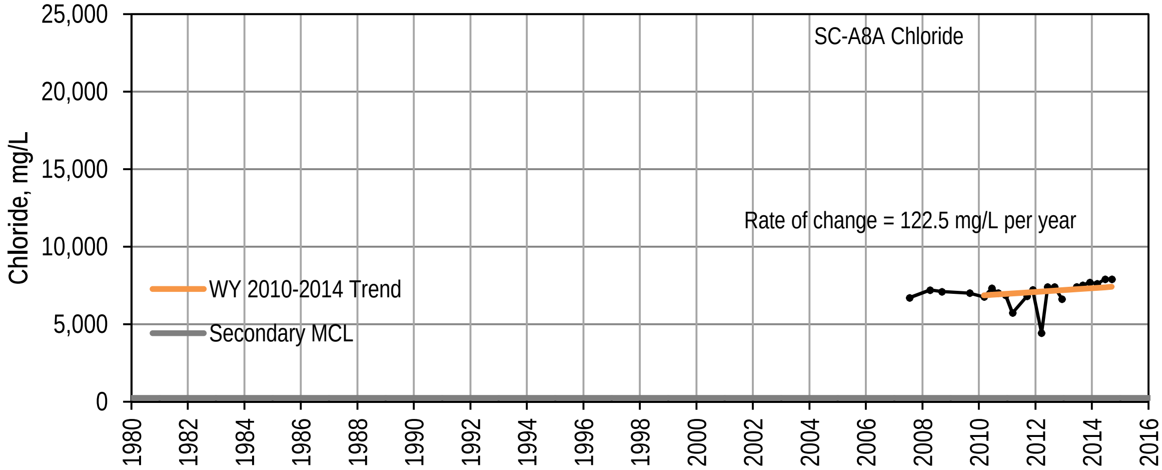

SC-A1C Total Dissolved Solids
WY 2010-2014 Trend
Secondary MCL
Rate of change =
1.1 mg/L per year
TDS, mg/L

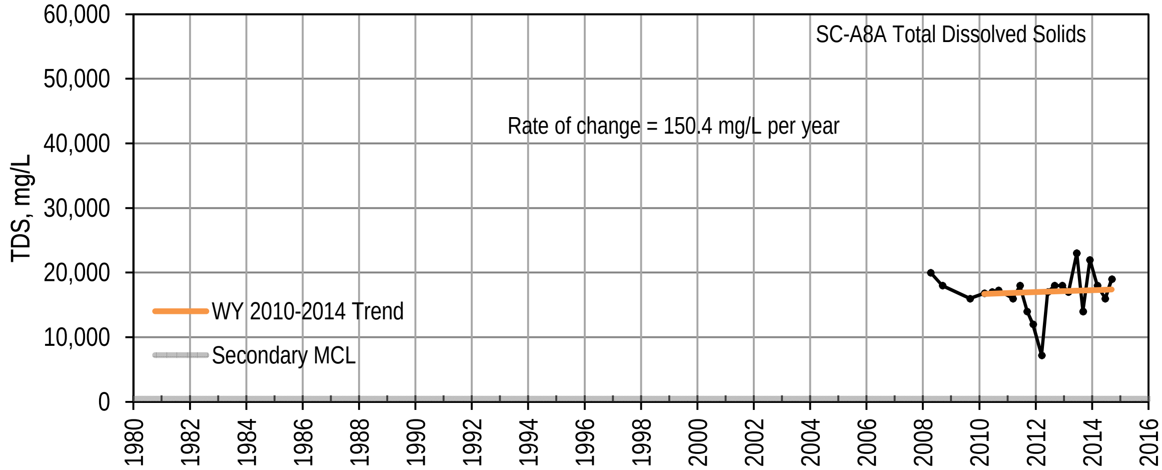

SC-A1C Groundwater Elevation
Rate of change =
0.1 feet per year
WY 2010-2014 Trend
Groundwater Elevation, ft MSL

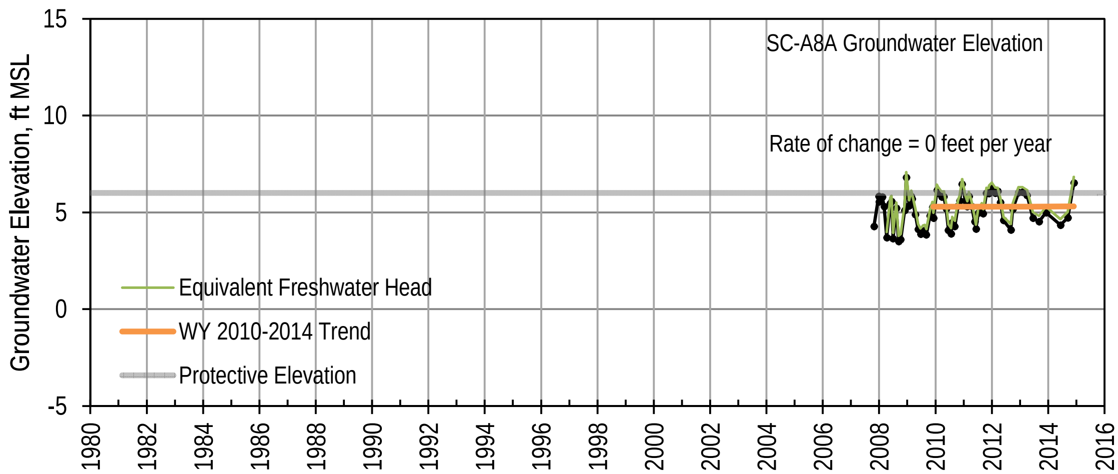

SC-A1D Chloride
WY 2010-2014 Trend
Secondary MCL
Rate of change = 2 mg/L per year
Chloride, mg/L
500
450
400
350
300
250
200
150
100
50
0
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016

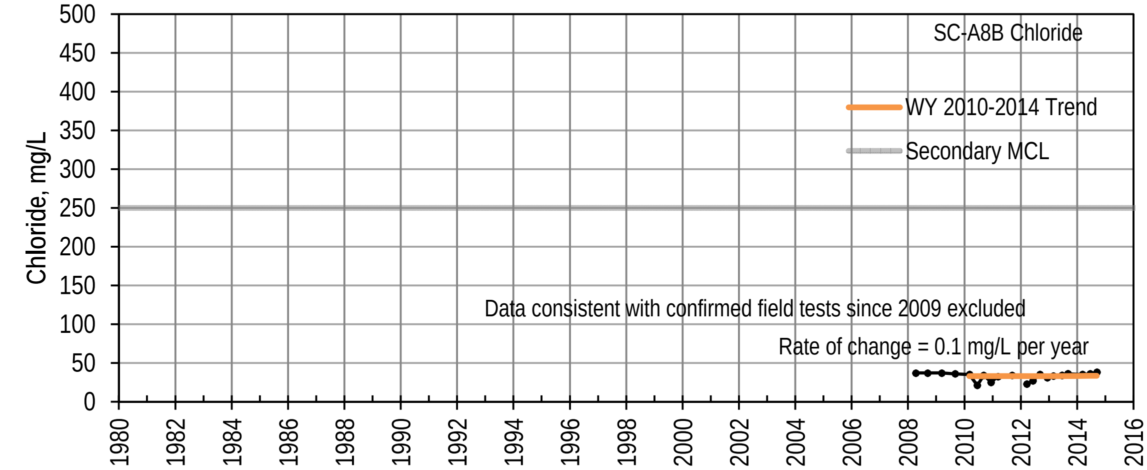

SC-A1D Total Dissolved Solids
WY 2010-2014 Trend
Secondary MCL
Rate of change = -3.4 mg/L per year
TDS, mg/L
1500
1250
1000
750
500
250
0
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016

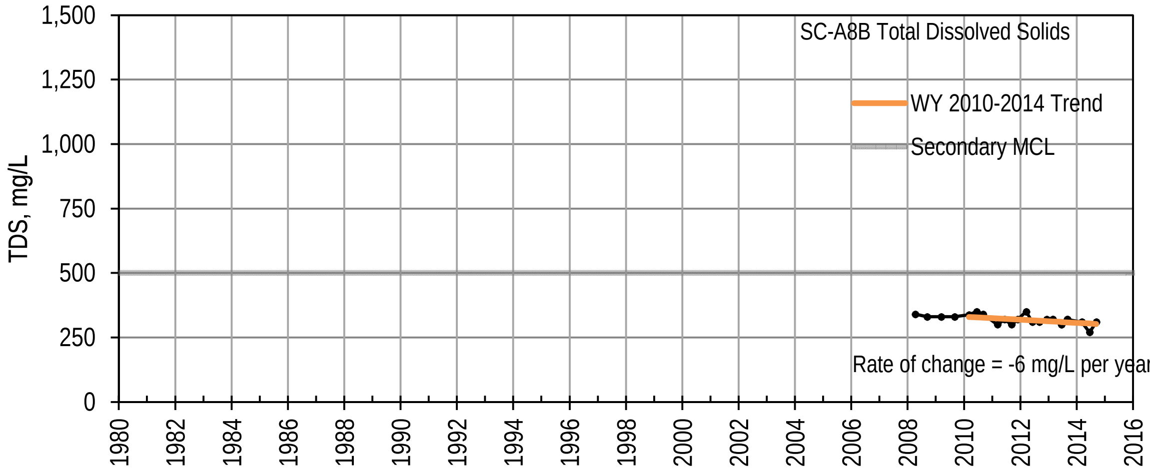

SC-A1D Groundwater Elevation
Rate of change = 0 feet per year
WY 2010-2014 Trend
Groundwater Elevation, ft MSL
15
10
5
0
-5
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016

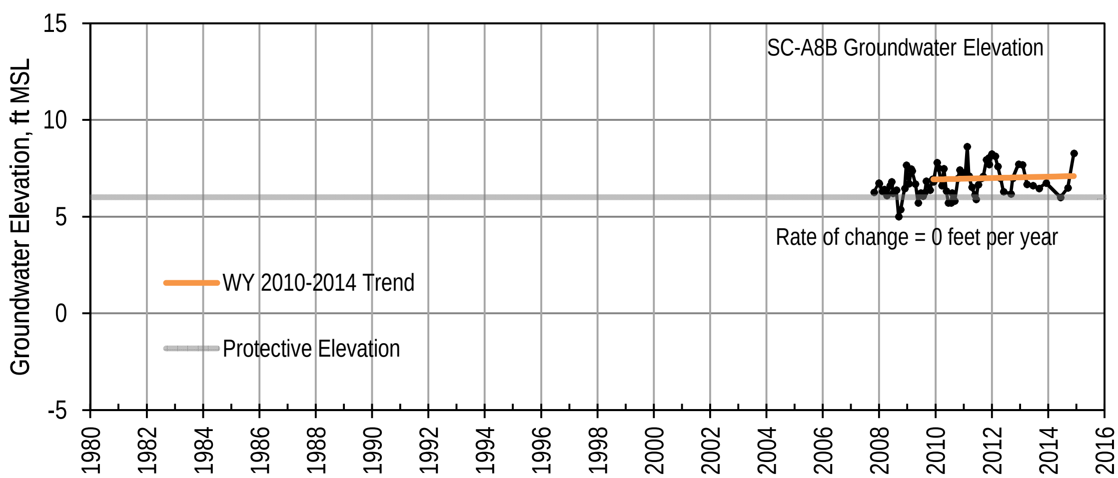

SC-A8A Chloride
Chloride, mg/L
Rate of change = 122.5 mg/L per year
WY 2010-2014 Trend
Secondary MCL
25,000
20,000
15,000
10,000
5,000
0
1980 1982 1984 1986 1988 1990 1992 1994 1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016

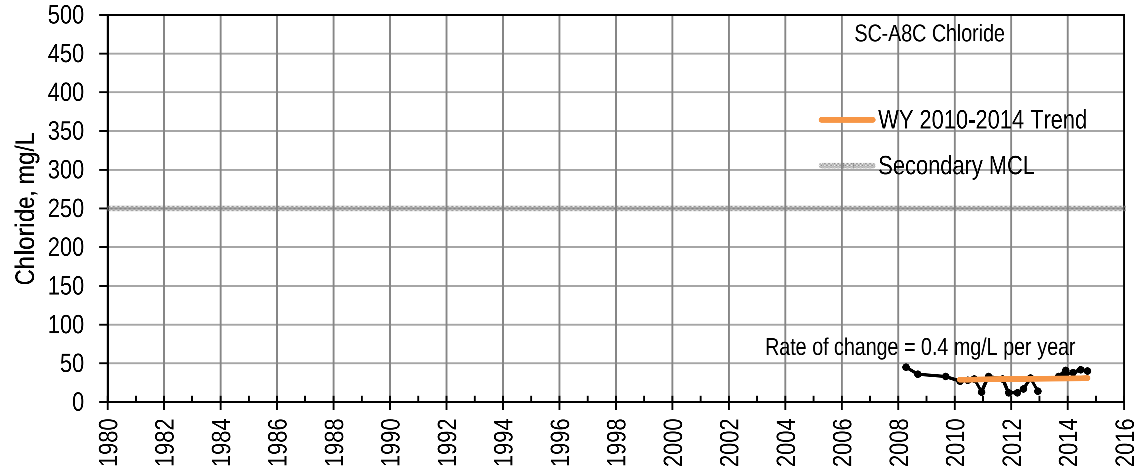

SC-A8A Total Dissolved Solids
TDS, mg/L
Rate of change = 150.4 mg/L per year
WY 2010-2014 Trend
Secondary MCL
60,000
50,000
40,000
30,000
20,000
10,000
0
1980 1982 1984 1986 1988 1990 1992 1994 1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016

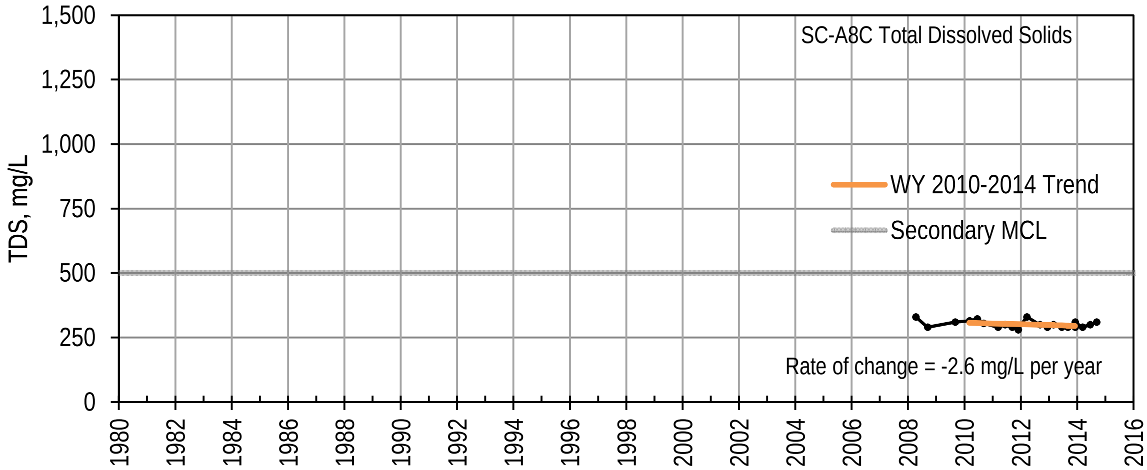

SC-A8A Groundwater Elevation
Groundwater Elevation, ft MSL
Rate of change = 0 feet per year
Equivalent Freshwater Head
WY 2010-2014 Trend
Protective Elevation
15
10
5
0
-5
1980 1982 1984 1986 1988 1990 1992 1994 1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016

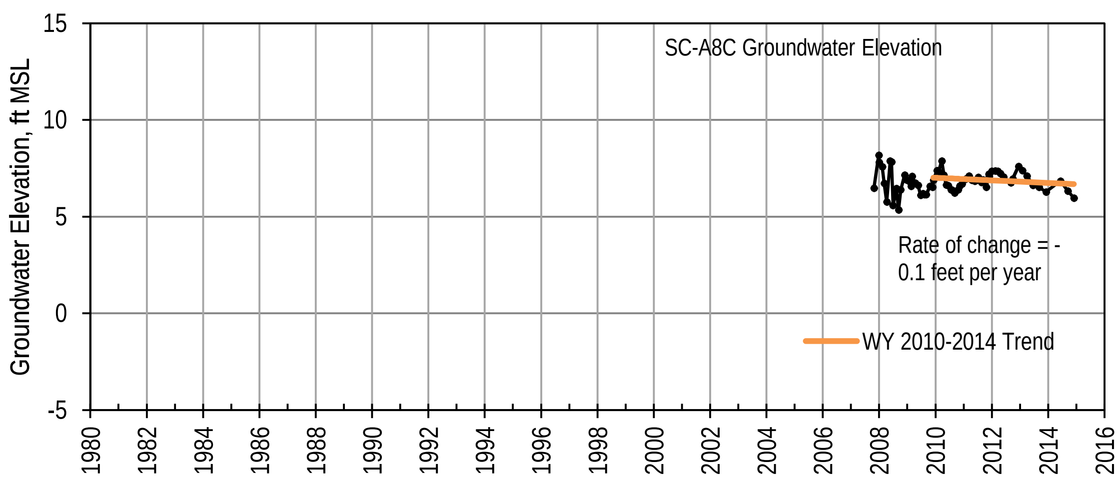

SC-A8B Chloride
WY 2010-2014 Trend
Secondary MCL
Data consistent with confirmed field tests since 2009 excluded
Rate of change = 0.1 mg/L per year
Chloride, mg/L

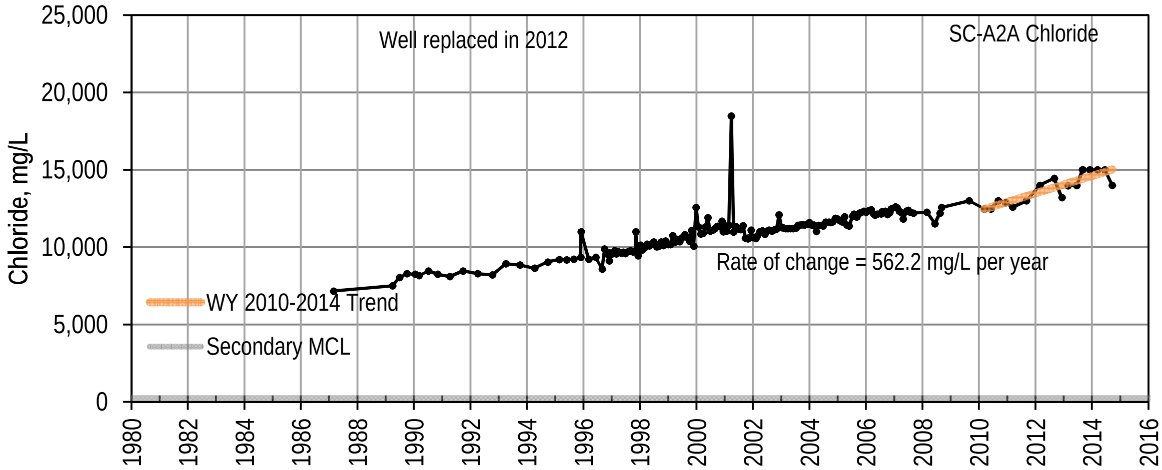

SC-A8B Total Dissolved Solids
WY 2010-2014 Trend
Secondary MCL
Rate of change = -6 mg/L per year
TDS, mg/L


SC-A8B Groundwater Elevation
Rate of change = 0 feet per year
WY 2010-2014 Trend
Protective Elevation
Groundwater Elevation, ft MSL

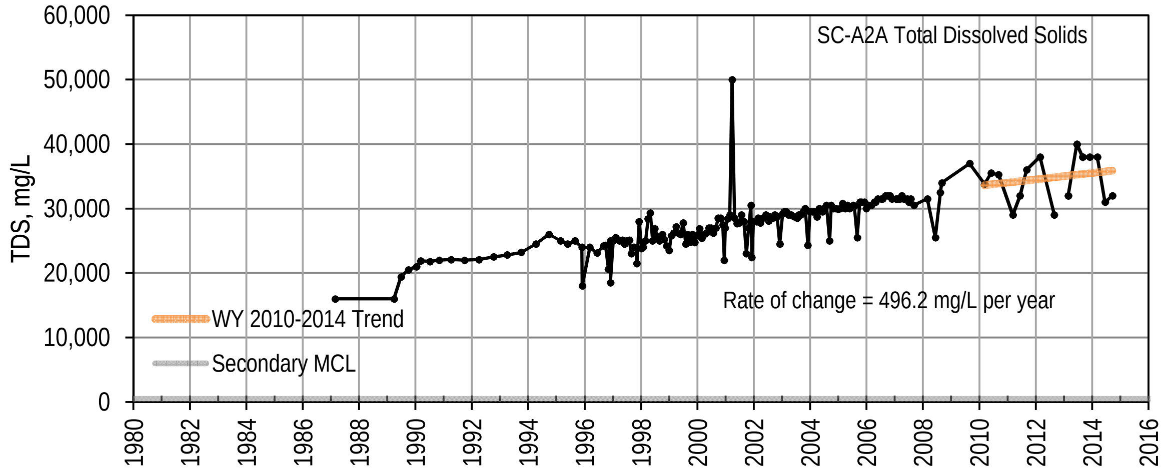

SC-A8C Chloride
WY 2010-2014 Trend
Secondary MCL
Rate of change = 0.4 mg/L per year
Chloride, mg/L


SC-A8C Total Dissolved Solids
WY 2010-2014 Trend
Secondary MCL
Rate of change = -2.6 mg/L per year
TDS, mg/L

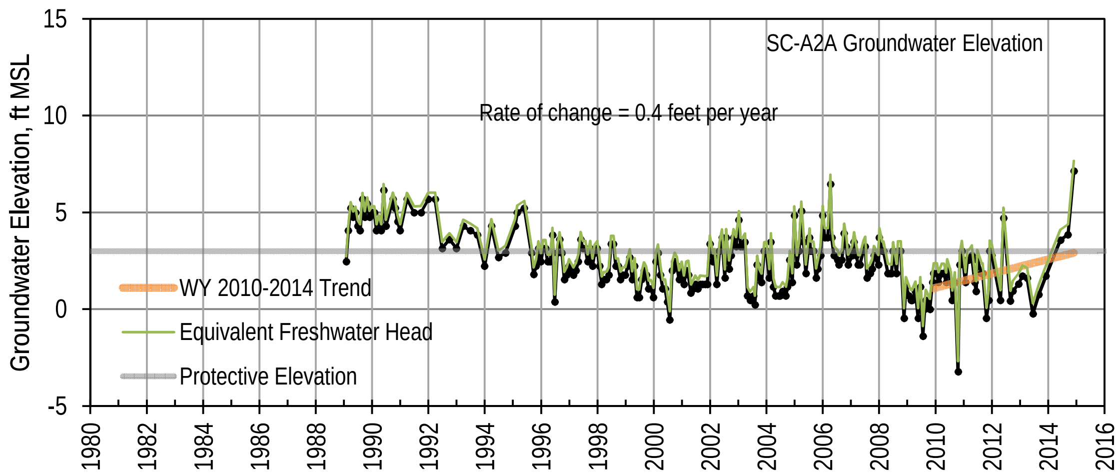

SC-A8C Groundwater Elevation
Rate of change = -
0.1 feet per year
WY 2010-2014 Trend
Groundwater Elevation, ft MSL



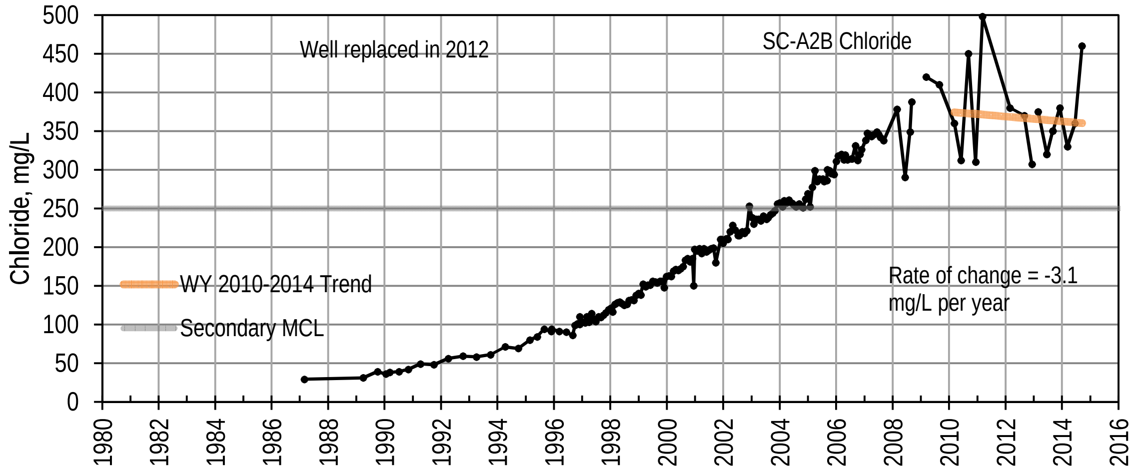
SC-A2A Chloride
Well replaced in 2012
Chloride, mg/L
Rate of change = 562.2 mg/L per year
WY 2010-2014 Trend
Secondary MCL



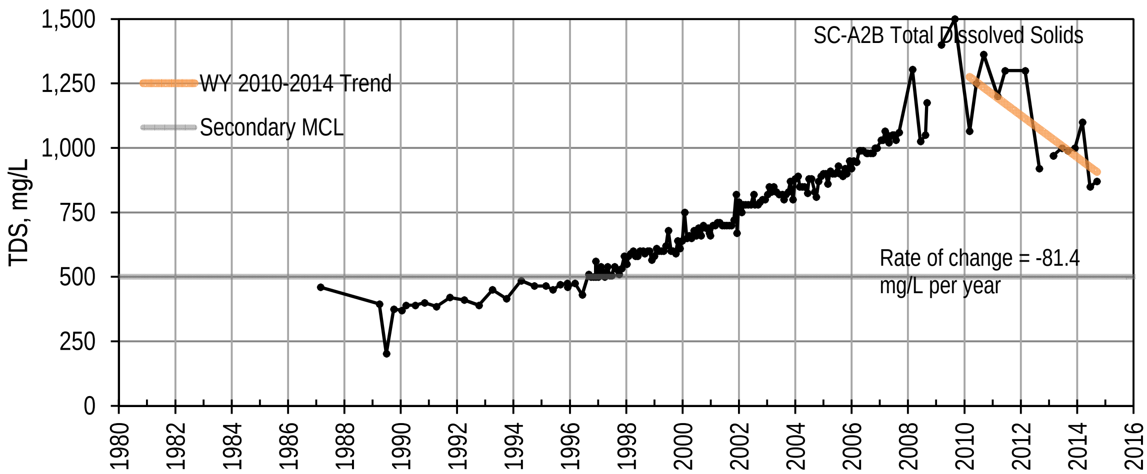
SC-A2A Total Dissolved Solids
TDS, mg/L
Rate of change = 496.2 mg/L per year
WY 2010-2014 Trend
Secondary MCL



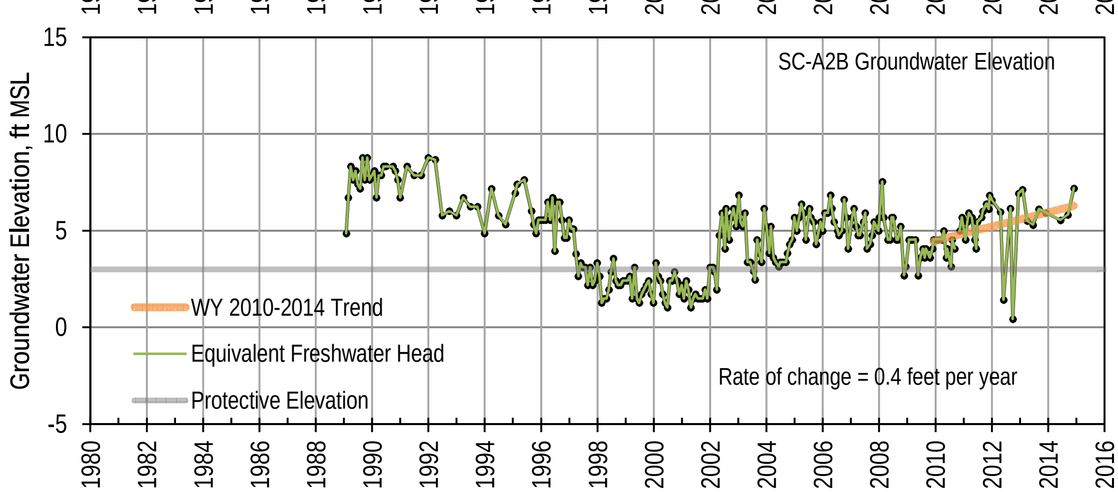
SC-A2A Groundwater Elevation
Groundwater Elevation, ft MSL
Rate of change = 0.4 feet per year
WY 2010-2014 Trend
Equivalent Freshwater Head
Protective Elevation



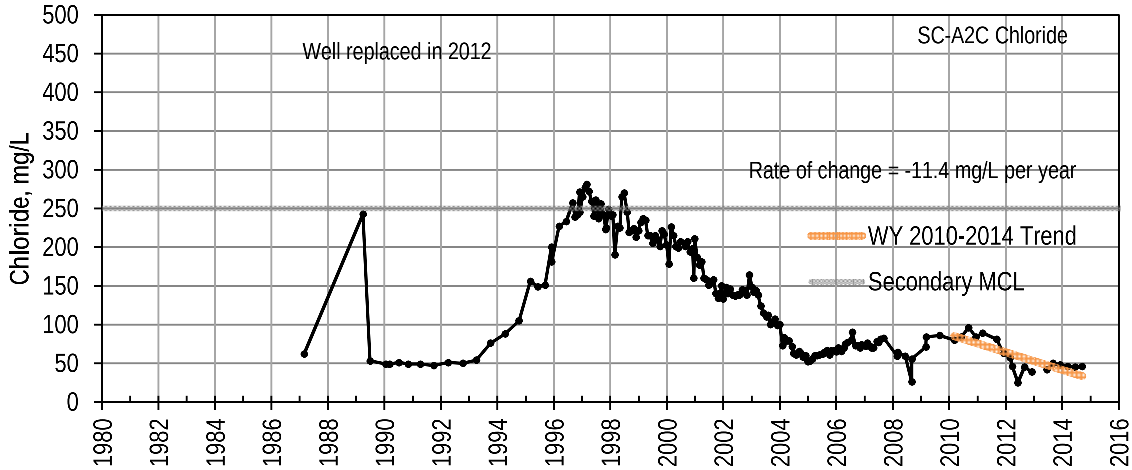
SC-A2B Chloride
Well replaced in 2012
Chloride, mg/L
WY 2010-2014 Trend
Secondary MCL
Rate of change = -3.1 mg/L per year



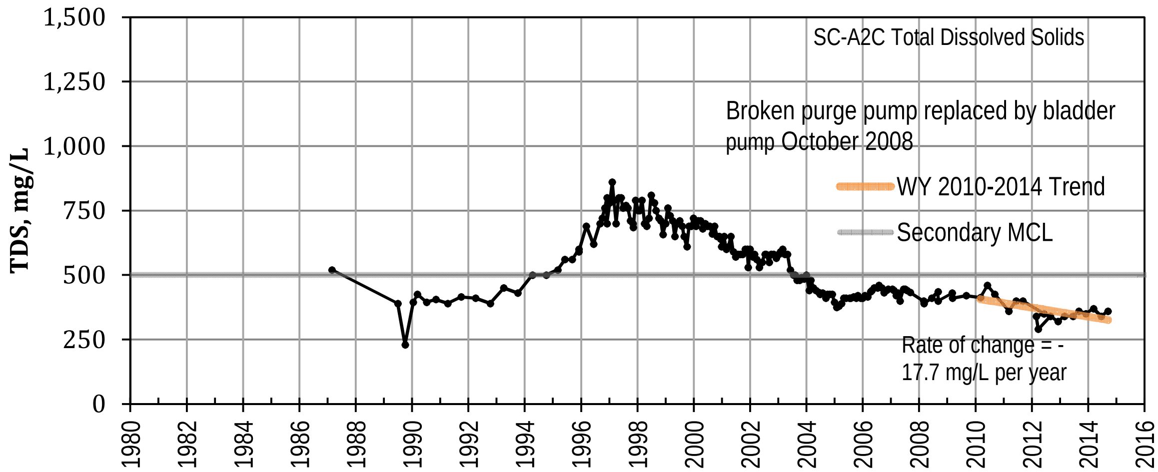
SC-A2B Total Dissolved Solids
TDS, mg/L
WY 2010-2014 Trend
Secondary MCL
Rate of change = -81.4 mg/L per year



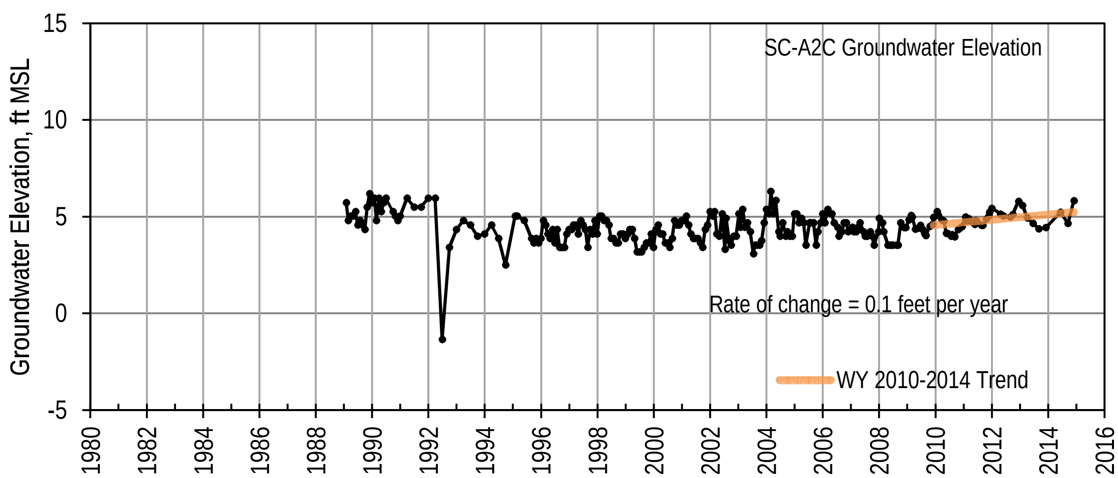
SC-A2B Groundwater Elevation
Groundwater Elevation, ft MSL
WY 2010-2014 Trend
Equivalent Freshwater Head
Protective Elevation
Rate of change = 0.4 feet per year



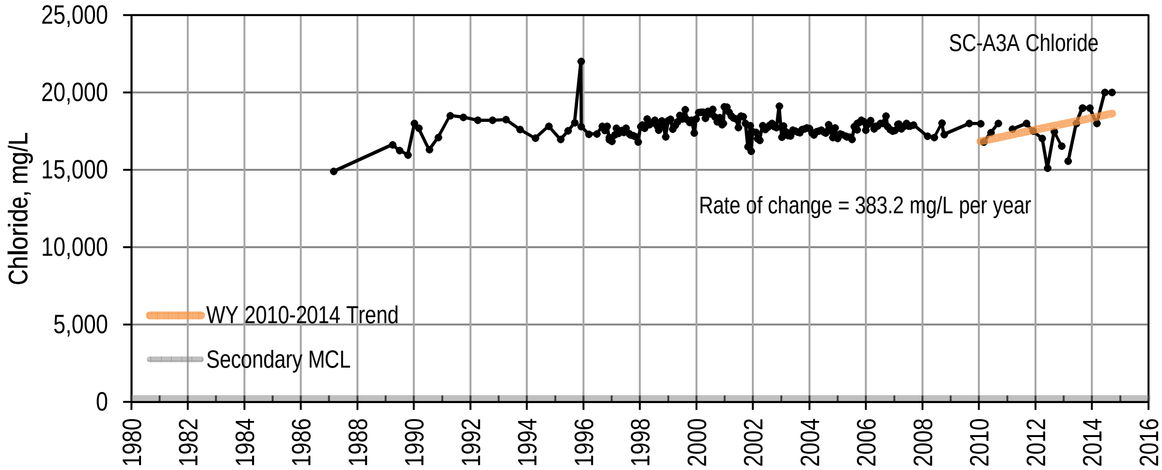
SC-A2C Chloride
Well replaced in 2012
Rate of change = -11.4 mg/L per year
WY 2010-2014 Trend
Secondary MCL
Chloride, mg/L

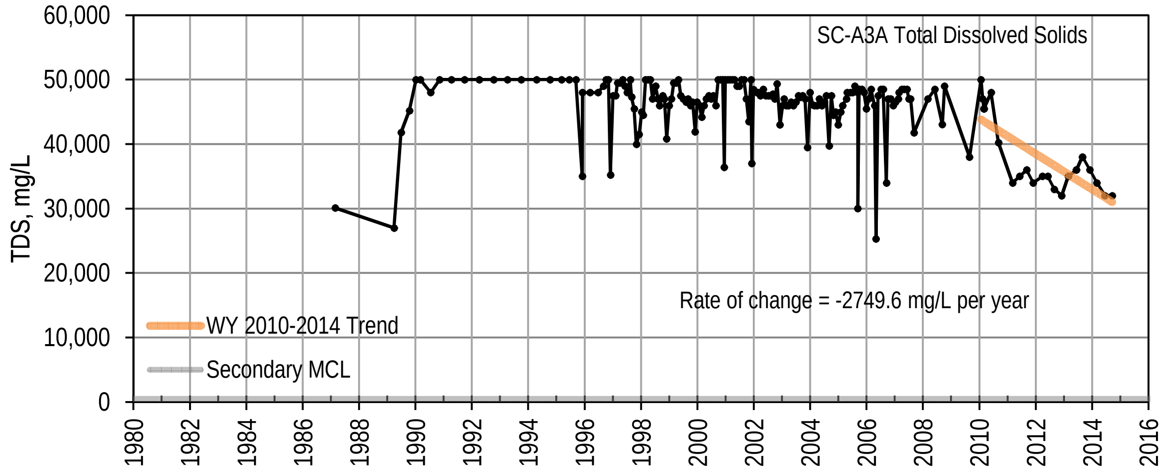


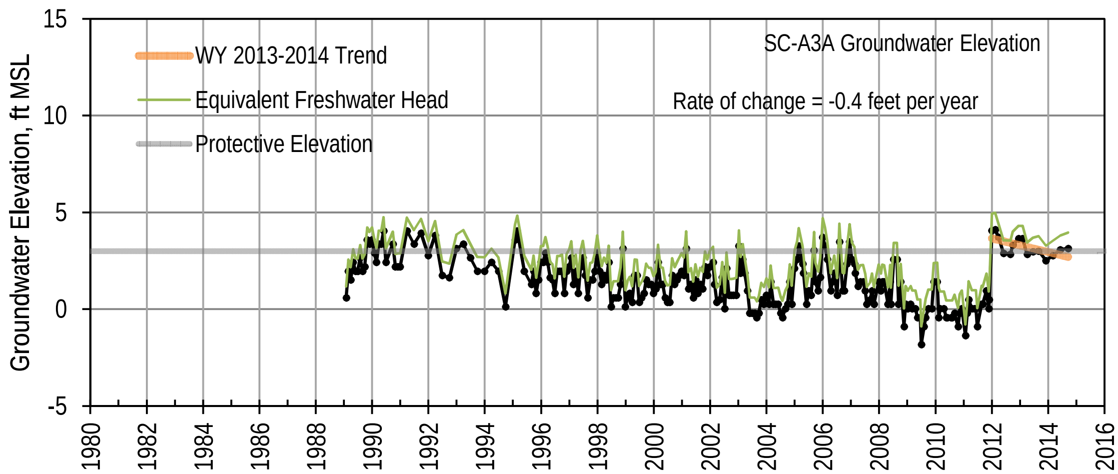
SC-A2C Total Dissolved Solids
Broken purge pump replaced by bladder pump October 2008
WY 2010-2014 Trend
Secondary MCL
Rate of change = -17.7 mg/L per year
TDS, mg/L

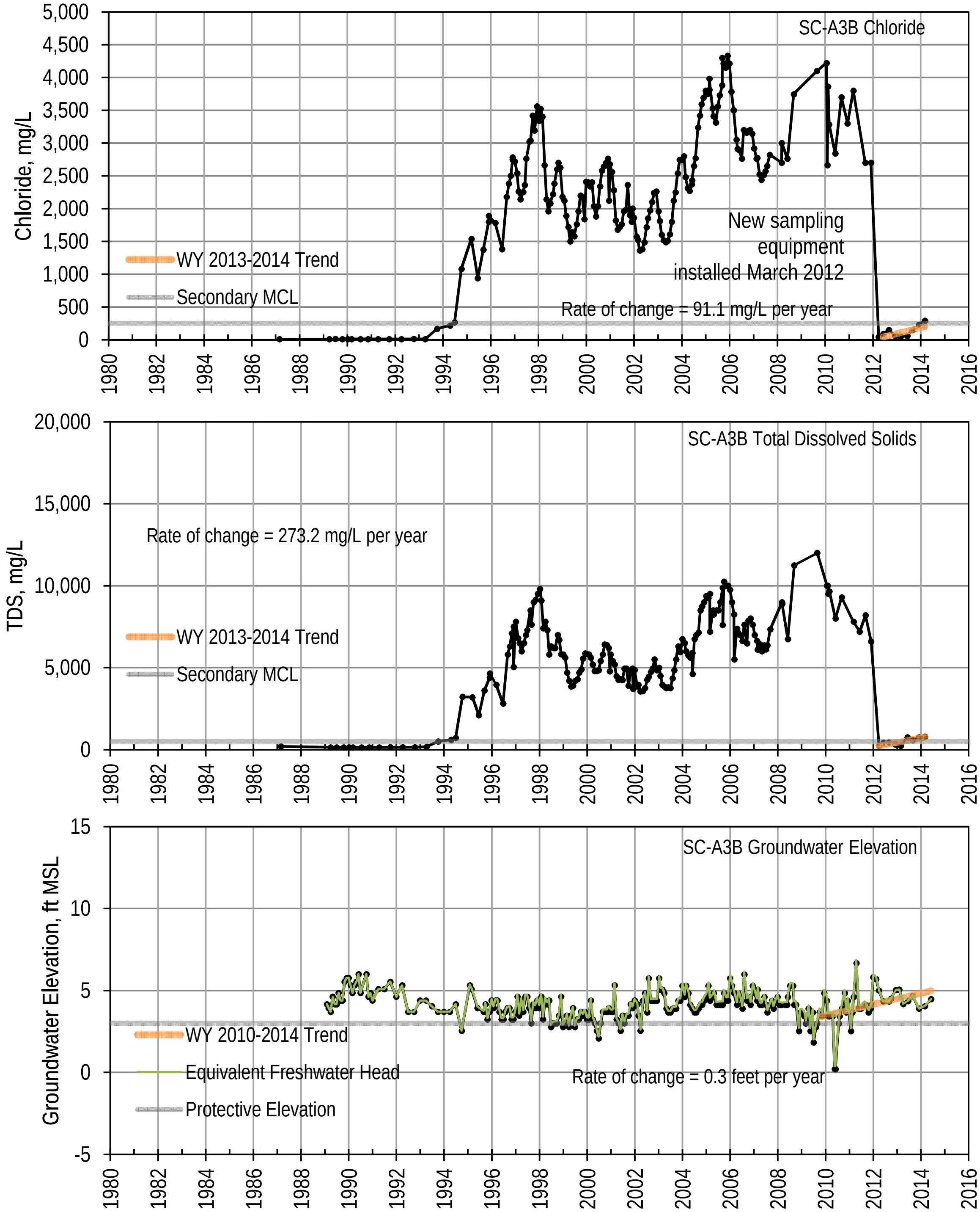


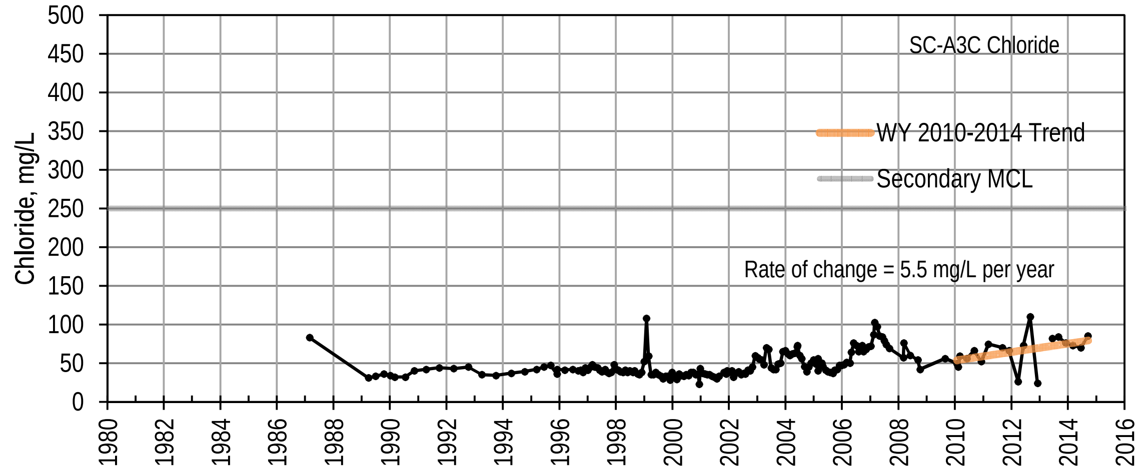
SC-A2C Groundwater Elevation
Rate of change = 0.1 feet per year
WY 2010-2014 Trend
Groundwater Elevation, ft MSL


SC-A3A Chloride
Rate of change = 383.2 mg/L per year
WY 2010-2014 Trend
Secondary MCL
Chloride, mg/L

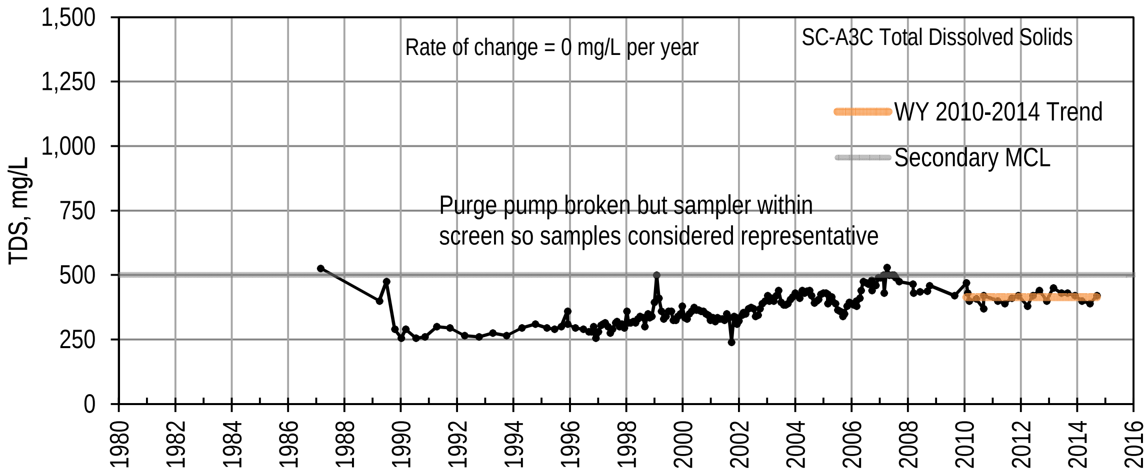

SC-A3A Total Dissolved Solids
Rate of change = -2749.6 mg/L per year
WY 2010-2014 Trend
Secondary MCL
TDS, mg/L


SC-A3A Groundwater Elevation
WY 2013-2014 Trend
Equivalent Freshwater Head
Protective Elevation
Rate of change = -0.4 feet per year
Groundwater Elevation, ft MSL

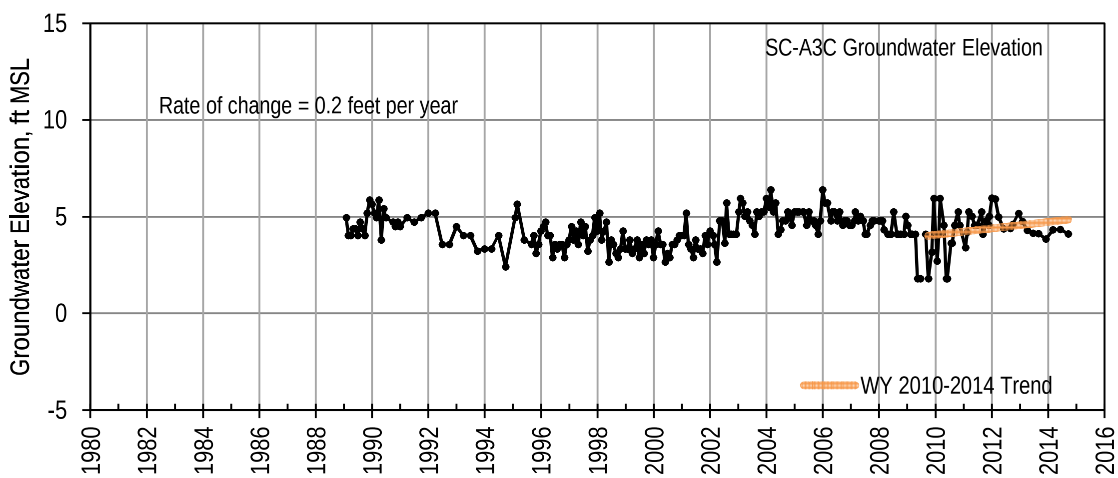

SC-A3B Chloride
Chloride, mg/L
5,000
4,500
4,000
3,500
3,000
2,500
2,000
1,500
1,000
500
0
WY 2013-2014 Trend
Secondary MCL
New sampling equipment installed March 2012
Rate of change = 91.1 mg/L per year
1980 1982 1984 1986 1988 1990 1992 1994 1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016
SC-A3B Total Dissolved Solids
TDS, mg/L
20,000
15,000
10,000
5,000
0
Rate of change = 273.2 mg/L per year
WY 2013-2014 Trend
Secondary MCL
1980 1982 1984 1986 1988 1990 1992 1994 1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016
SC-A3B Groundwater Elevation
Groundwater Elevation, ft MSL
15
10
5
0
-5
WY 2010-2014 Trend
Equivalent Freshwater Head
Protective Elevation
Rate of change = 0.3 feet per year
1980 1982 1984 1986 1988 1990 1992 1994 1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016



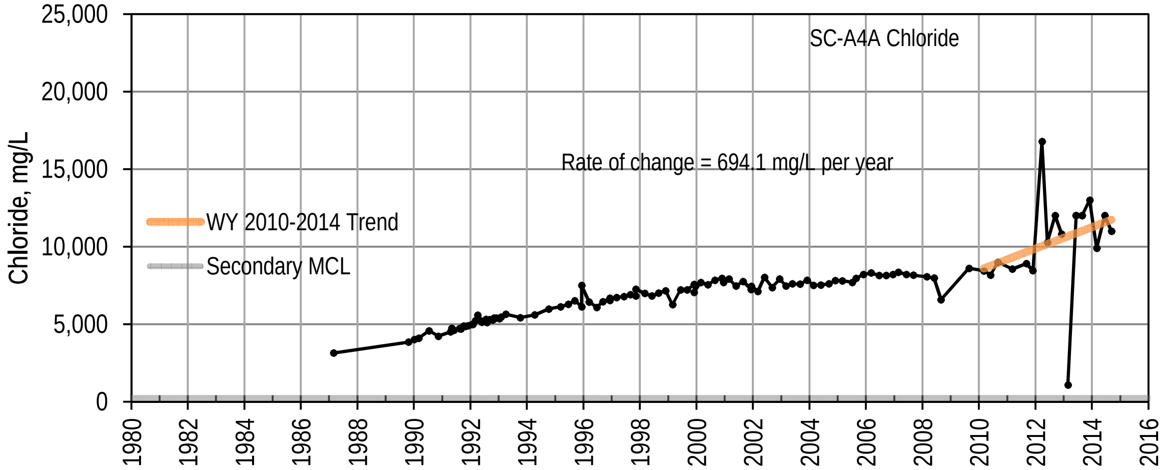
SC-A3C Chloride
WY 2010-2014 Trend
Secondary MCL
Rate of change = 5.5 mg/L per year
Chloride, mg/L

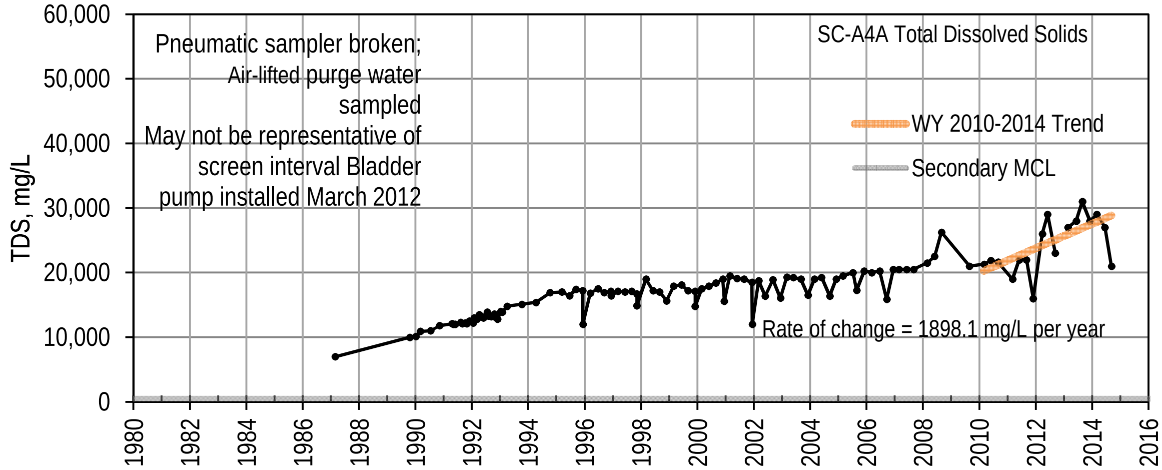


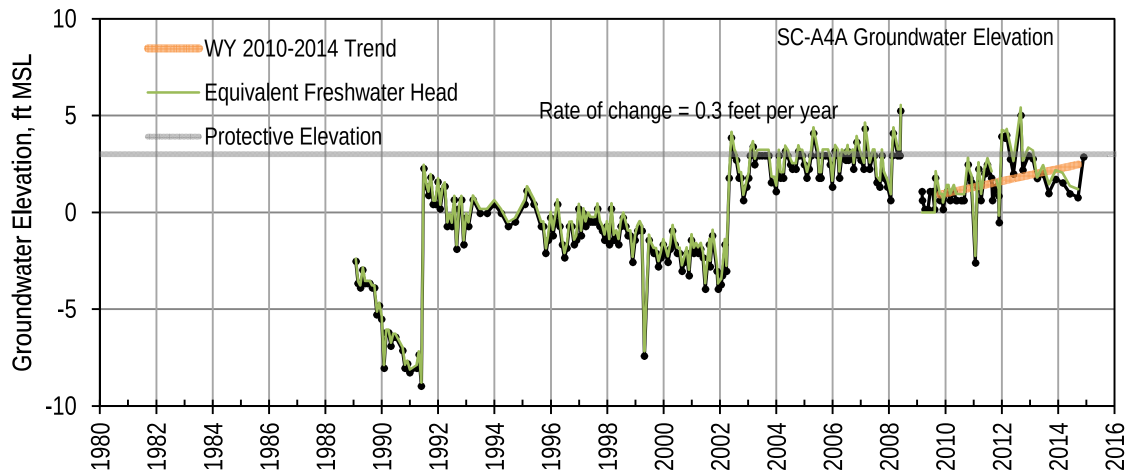
Rate of change = 0 mg/L per year
SC-A3C Total Dissolved Solids
WY 2010-2014 Trend
Secondary MCL
Purge pump broken but sampler within screen so samples considered representative
TDS, mg/L

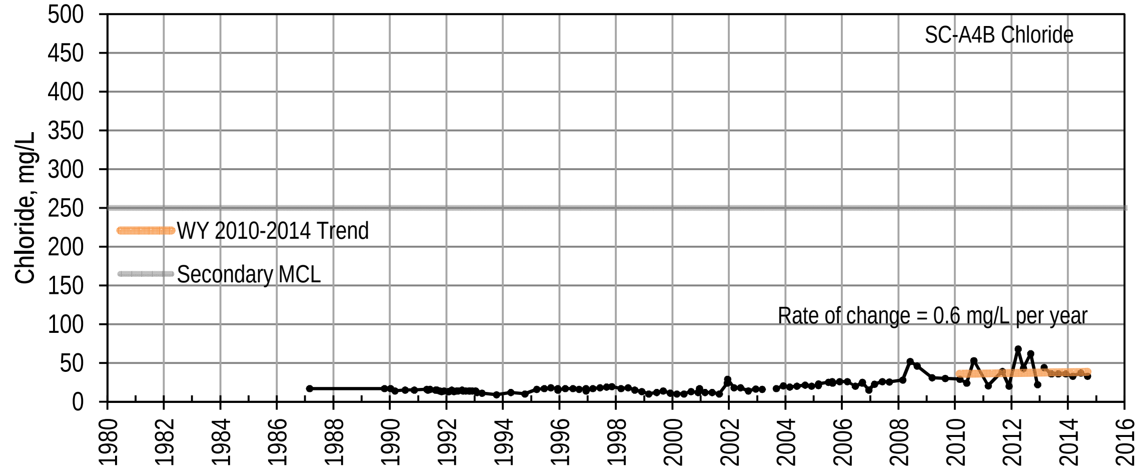


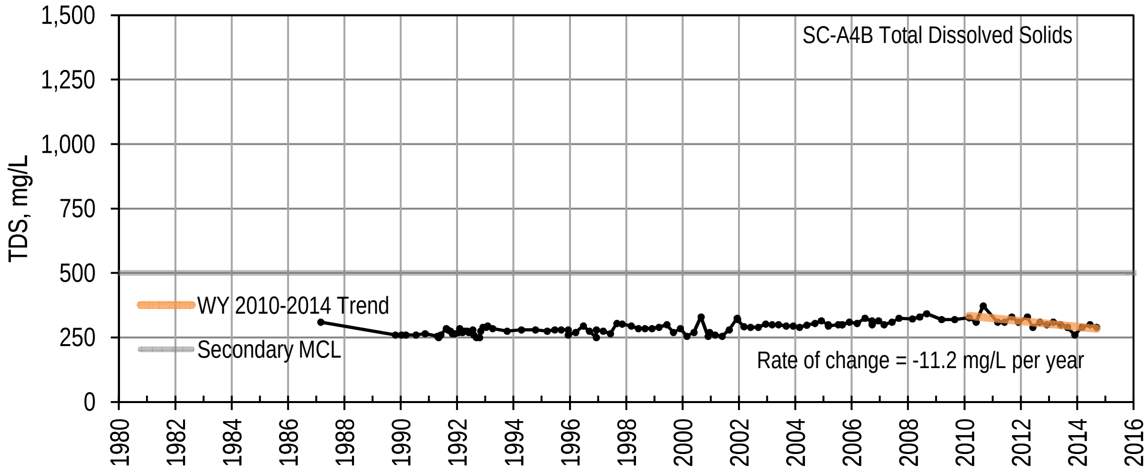
SC-A3C Groundwater Elevation
Rate of change = 0.2 feet per year
WY 2010-2014 Trend
Groundwater Elevation, ft MSL

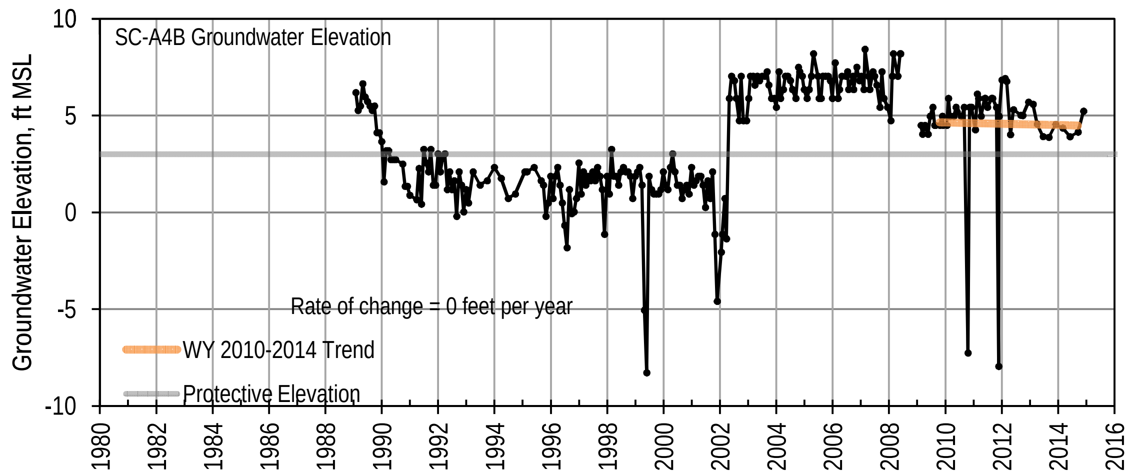

SC-A4A Chloride
Rate of change = 694.1 mg/L per year
WY 2010-2014 Trend
Secondary MCL
Chloride, mg/L
25,000
20,000
15,000
10,000
5,000
0
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016

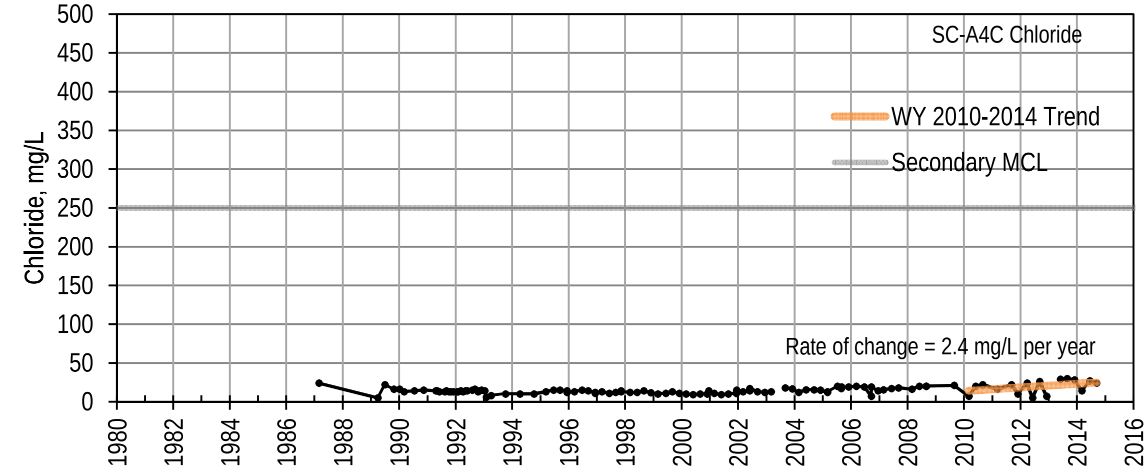

SC-A4A Total Dissolved Solids
Pneumatic sampler broken; Air-lifted purge water sampled
May not be representative of screen interval Bladder pump installed March 2012
WY 2010-2014 Trend
Secondary MCL
Rate of change = 1898.1 mg/L per year
TDS, mg/L
60,000
50,000
40,000
30,000
20,000
10,000
0
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016

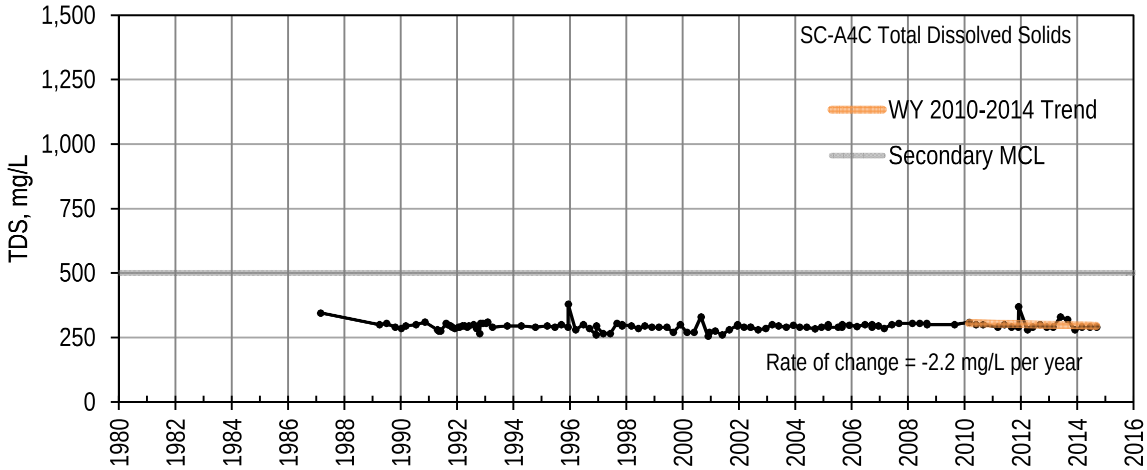

SC-A4A Groundwater Elevation
WY 2010-2014 Trend
Equivalent Freshwater Head
Protective Elevation
Rate of change = 0.3 feet per year
Groundwater Elevation, ft MSL
10
5
0
-5
-10
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016

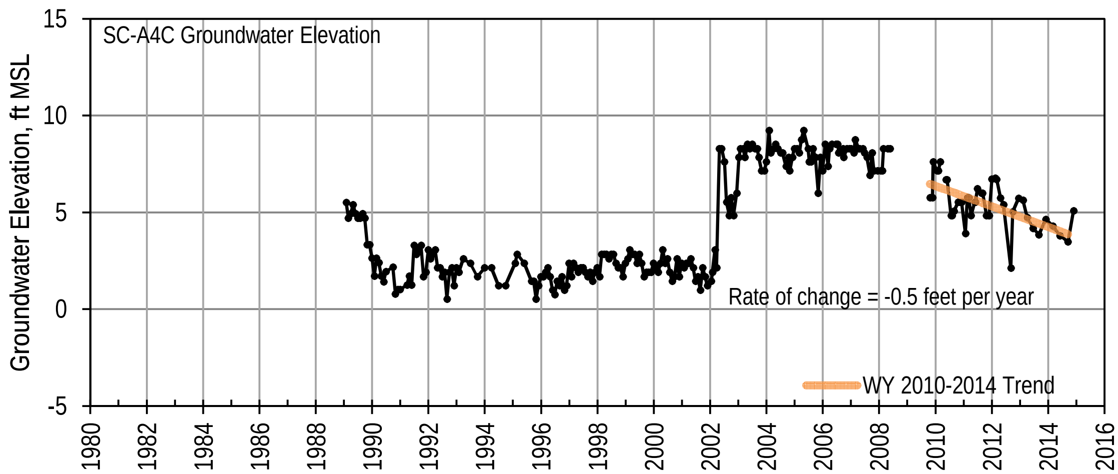

SC-A4B Chloride
Chloride, mg/L
WY 2010-2014 Trend
Secondary MCL
Rate of change = 0.6 mg/L per year

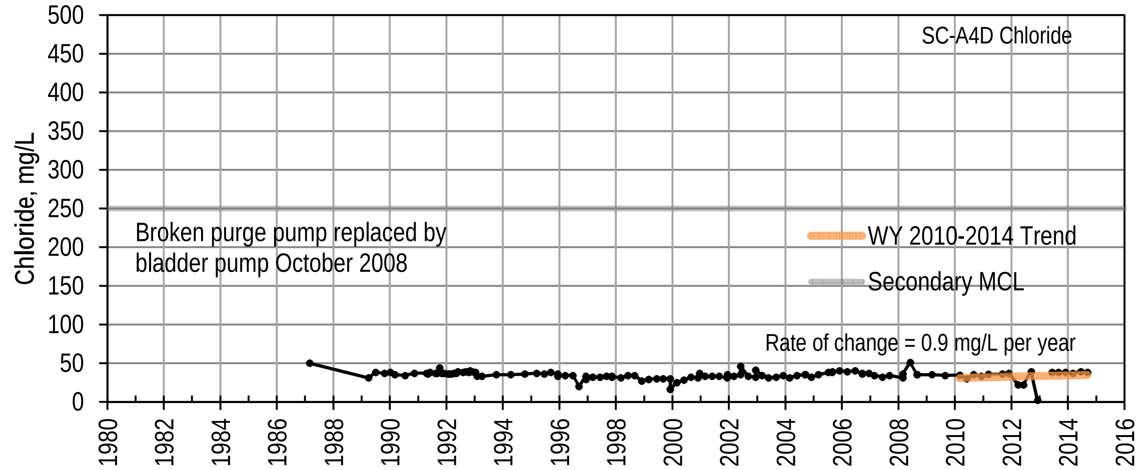

SC-A4B Total Dissolved Solids
TDS, mg/L
WY 2010-2014 Trend
Secondary MCL
Rate of change = -11.2 mg/L per year

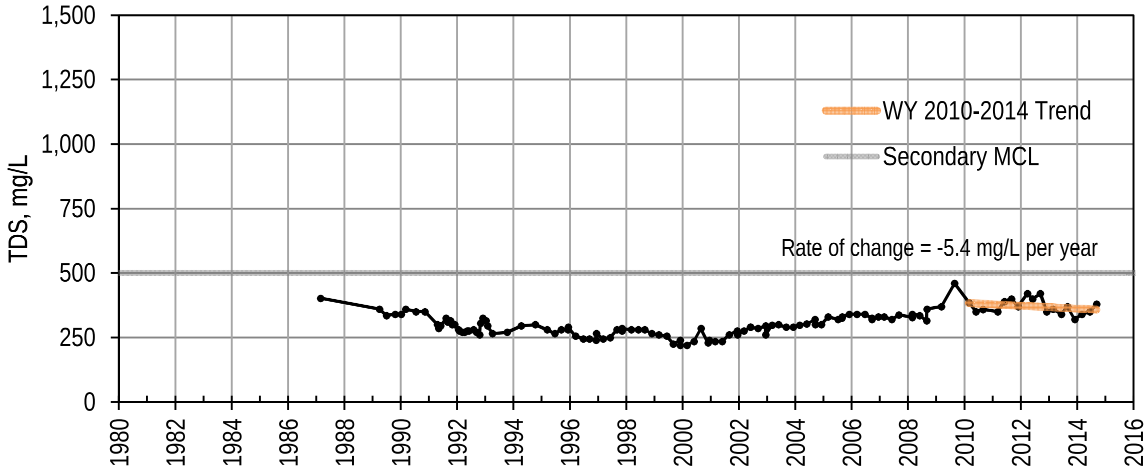

SC-A4B Groundwater Elevation
Groundwater Elevation, ft MSL
Rate of change = 0 feet per year
WY 2010-2014 Trend
Protective Elevation

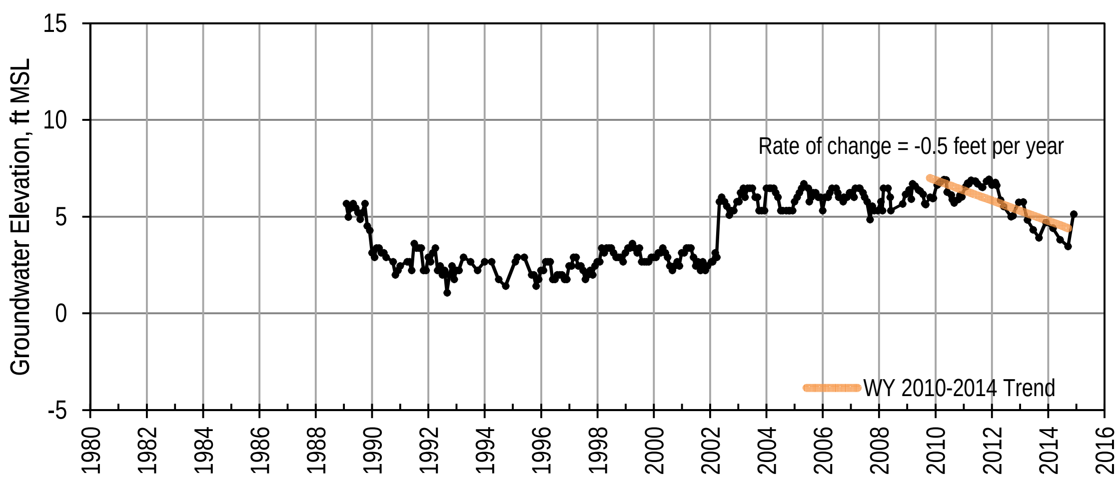

SC-A4C Chloride
WY 2010-2014 Trend
Secondary MCL
Chloride, mg/L
Rate of change = 2.4 mg/L per year

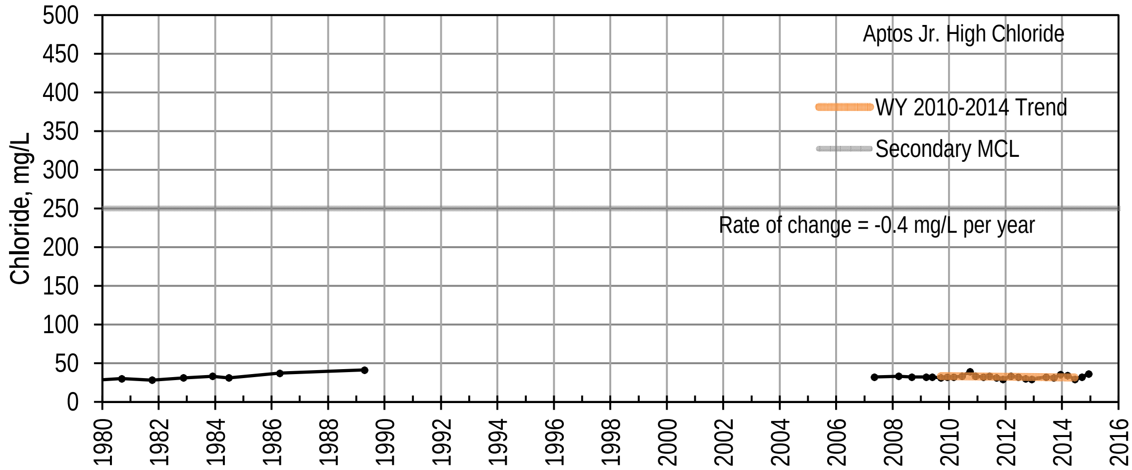

SC-A4C Total Dissolved Solids
WY 2010-2014 Trend
Secondary MCL
TDS, mg/L
Rate of change = -2.2 mg/L per year

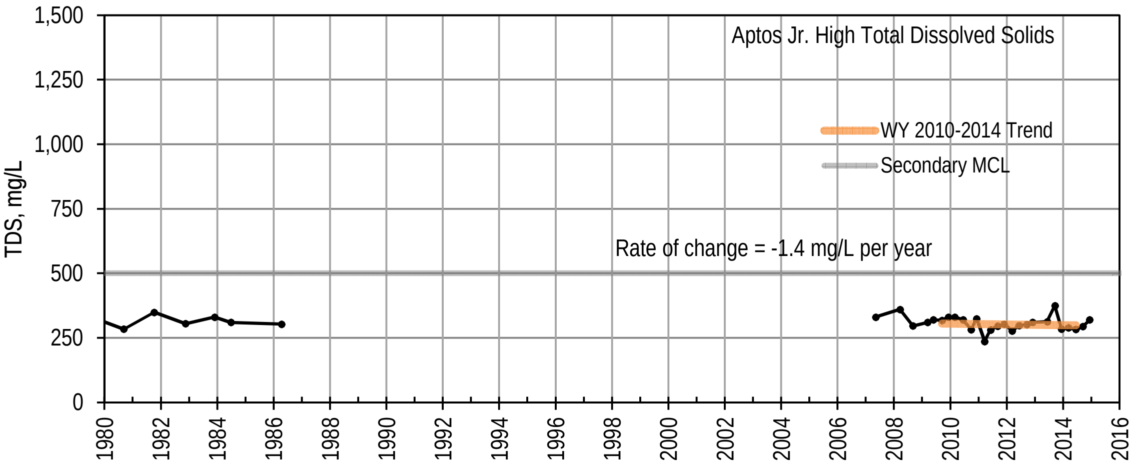

SC-A4C Groundwater Elevation
Groundwater Elevation, ft MSL
Rate of change = -0.5 feet per year
WY 2010-2014 Trend

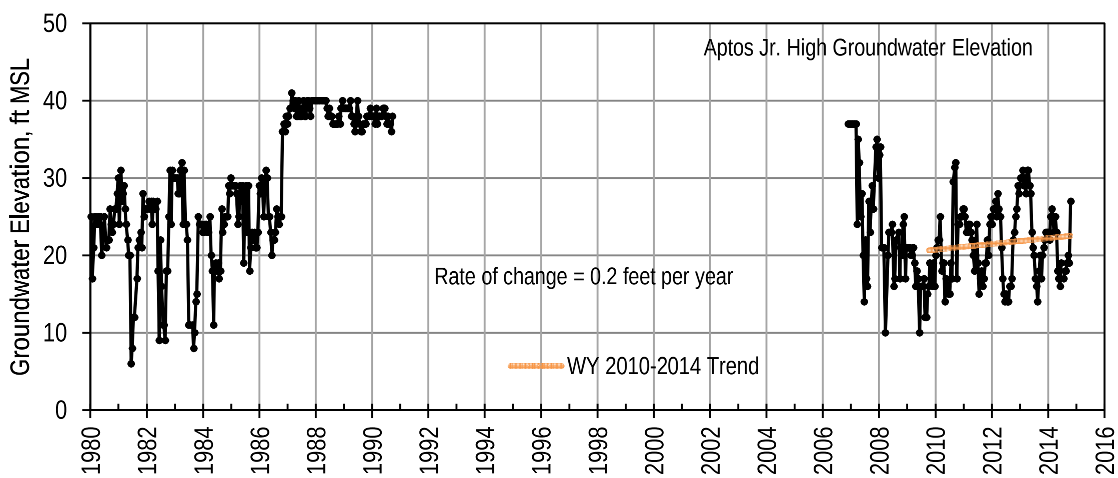

SC-A4D Chloride
Chloride, mg/L
Broken purge pump replaced by
bladder pump October 2008
WY 2010-2014 Trend
Secondary MCL
Rate of change = 0.9 mg/L per year
500
450
400
350
300
250
200
150
100
50
0
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016

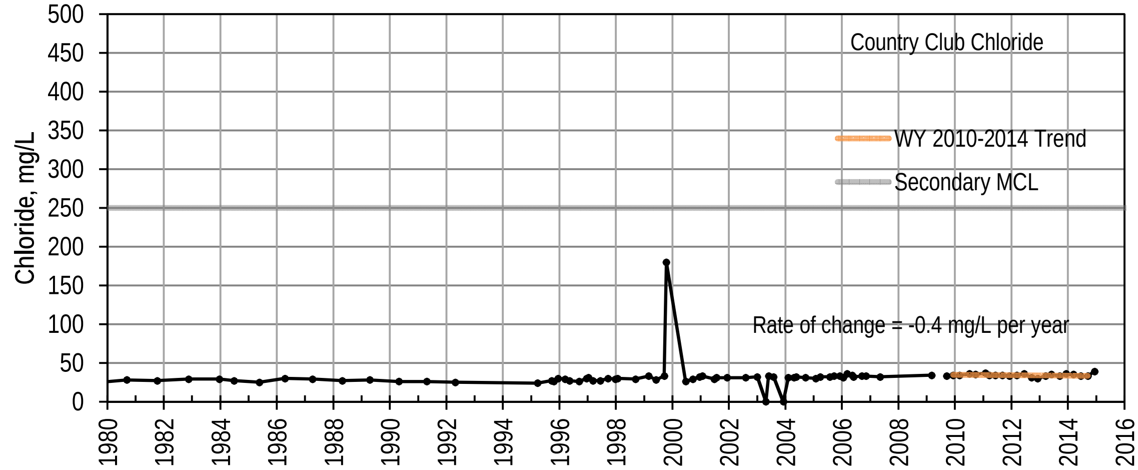

TDS, mg/L
WY 2010-2014 Trend
Secondary MCL
Rate of change = -5.4 mg/L per year
1,500
1,250
1,000
750
500
250
0
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016

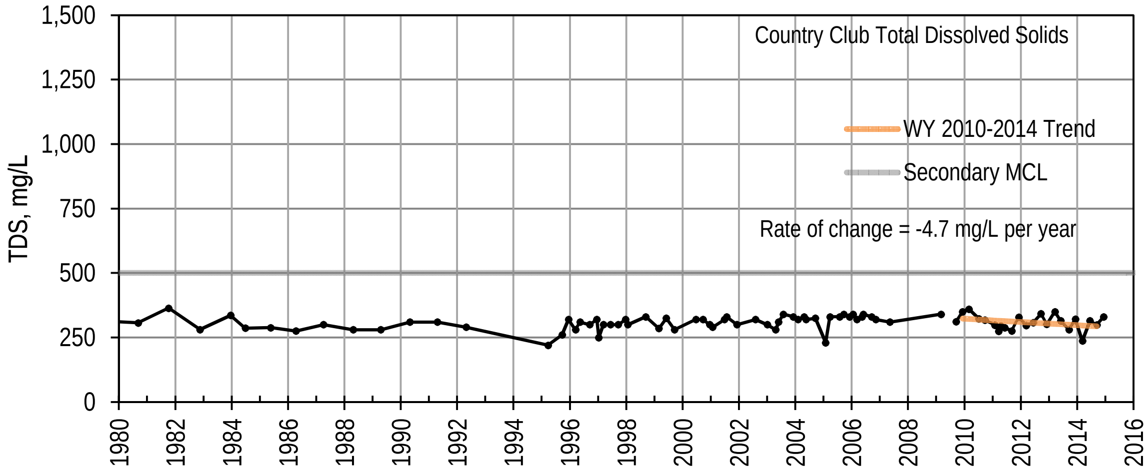

Groundwater Elevation, ft MSL
Rate of change = -0.5 feet per year
WY 2010-2014 Trend
15
10
5
0
-5
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016

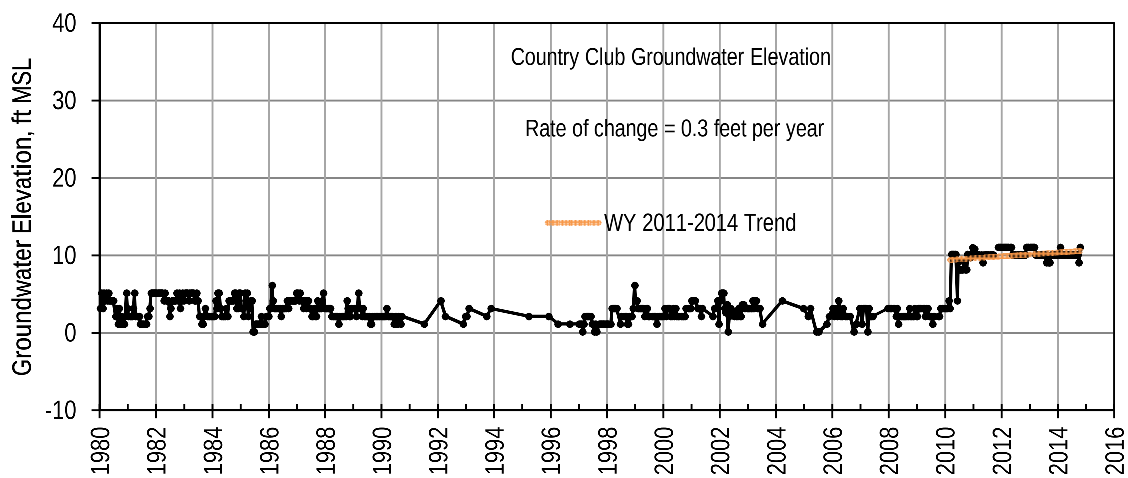

Aptos Jr. High Chloride
WY 2010-2014 Trend
Secondary MCL
Rate of change = -0.4 mg/L per year
Chloride, mg/L

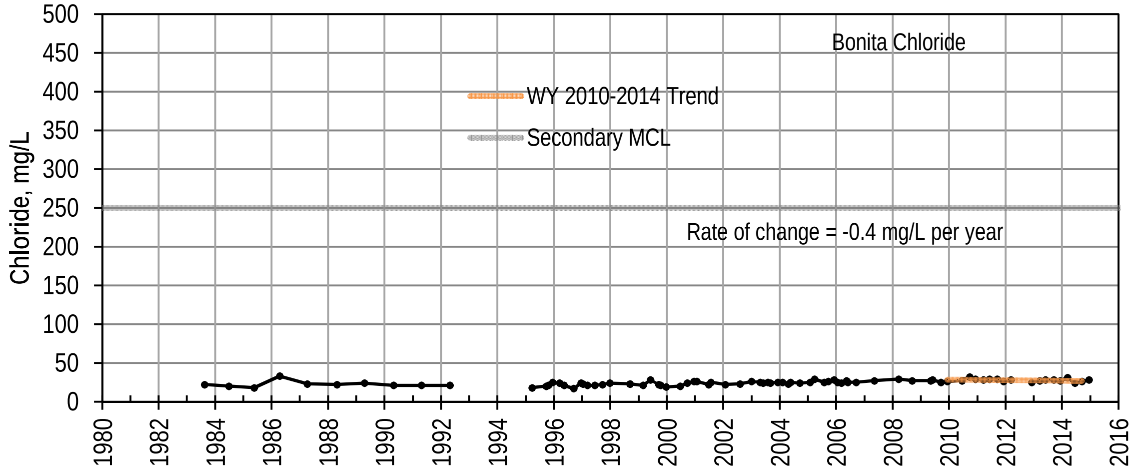

Aptos Jr. High Total Dissolved Solids
WY 2010-2014 Trend
Secondary MCL
Rate of change = -1.4 mg/L per year
TDS, mg/L

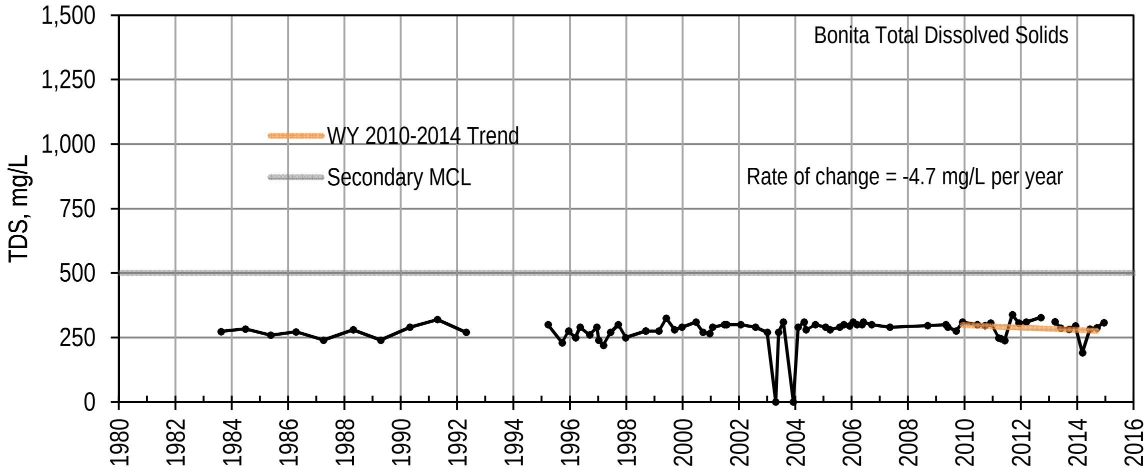

Aptos Jr. High Groundwater Elevation
Rate of change = 0.2 feet per year
WY 2010-2014 Trend
Groundwater Elevation, ft MSL

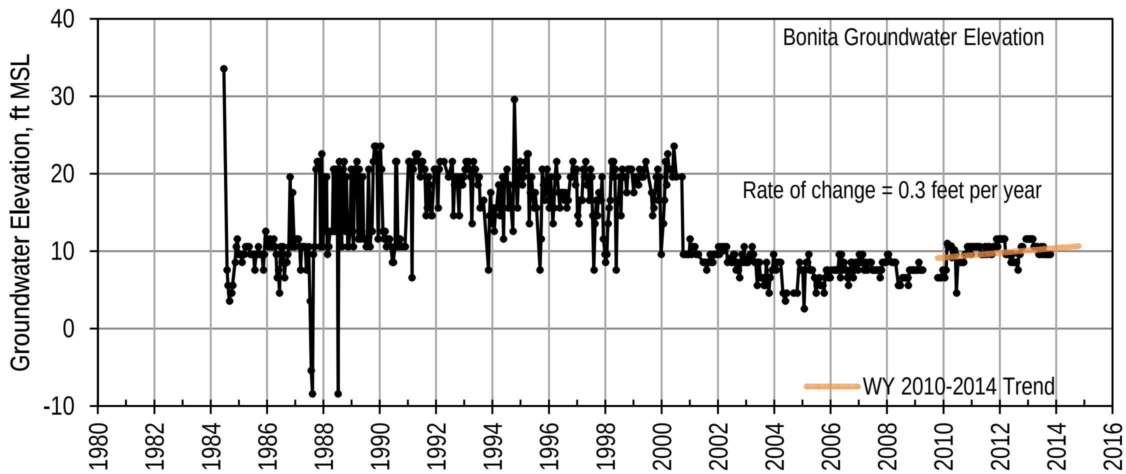

Country Club Chloride
WY 2010-2014 Trend
Secondary MCL
Rate of change = -0.4 mg/L per year
Chloride, mg/L

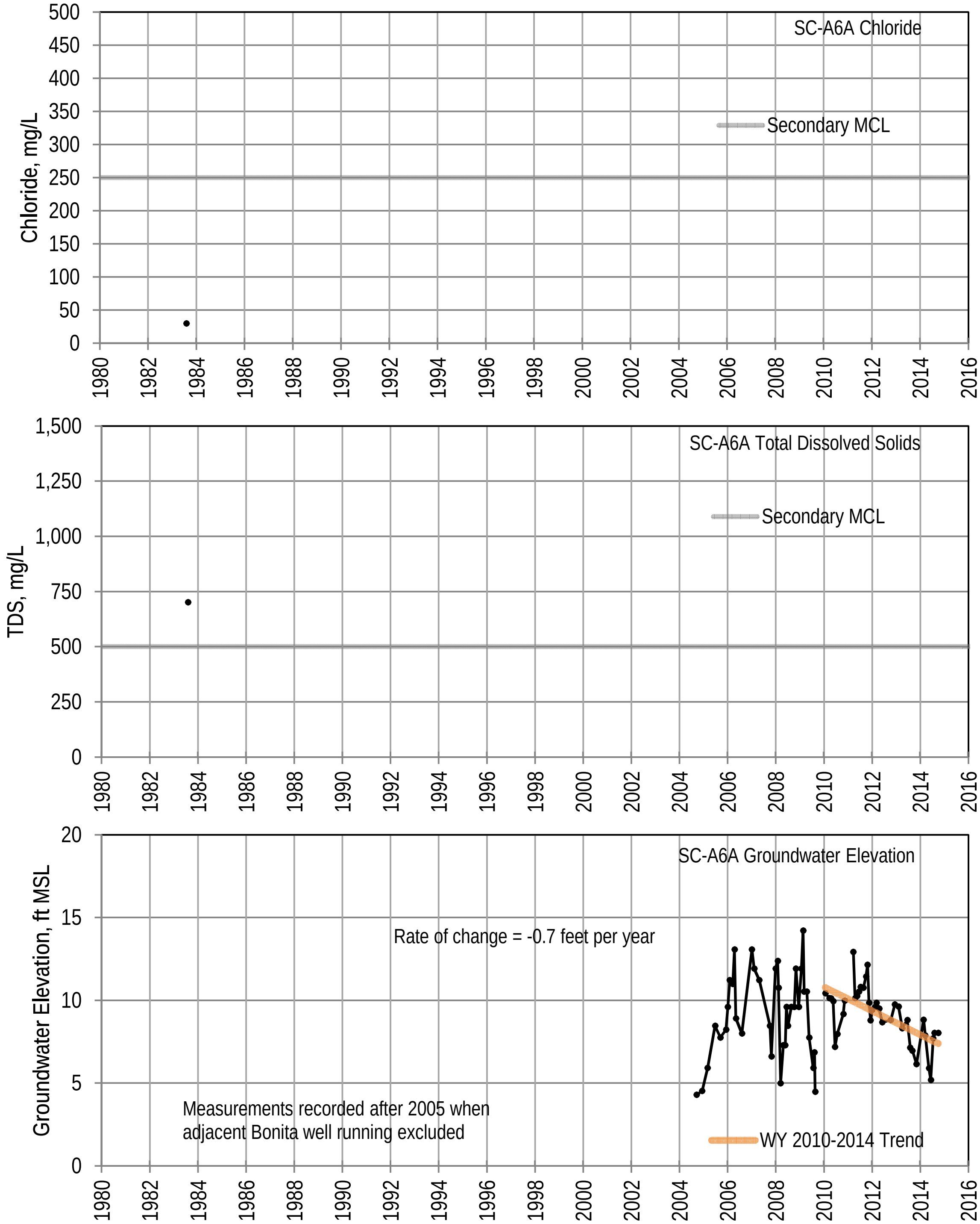

Country Club Total Dissolved Solids
WY 2010-2014 Trend
Secondary MCL
Rate of change = -4.7 mg/L per year
TDS, mg/L

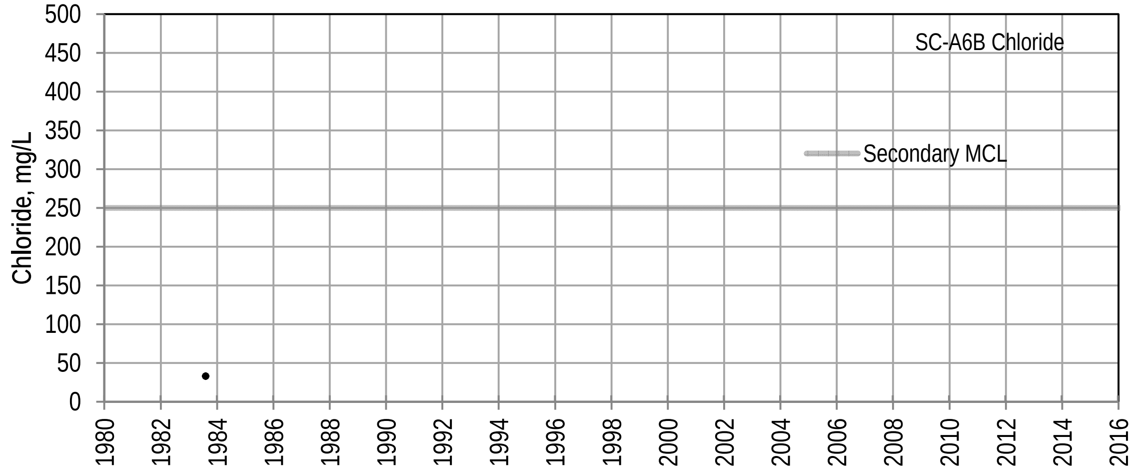

Country Club Groundwater Elevation
Rate of change = 0.3 feet per year
WY 2011-2014 Trend
Groundwater Elevation, ft MSL

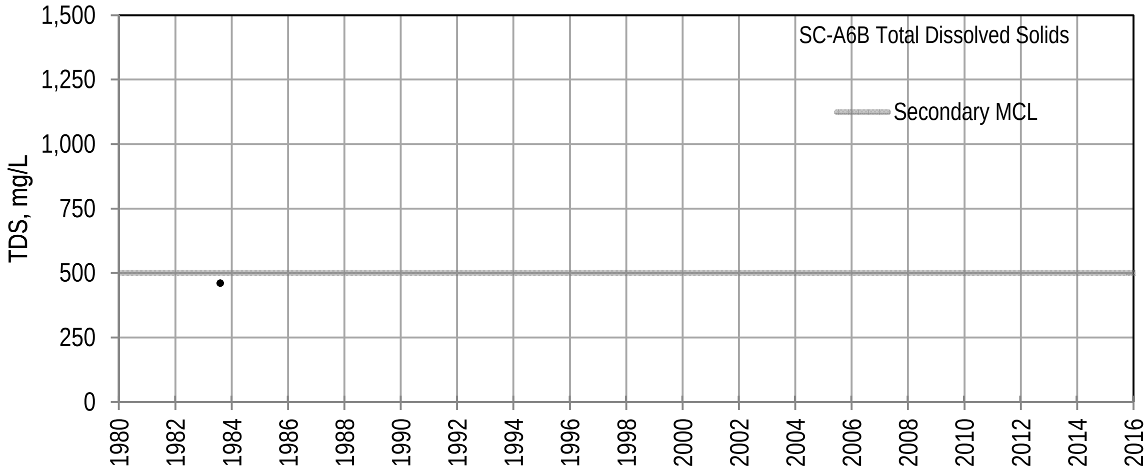

Bonita Chloride
WY 2010-2014 Trend
Secondary MCL
Rate of change = -0.4 mg/L per year
Chloride, mg/L

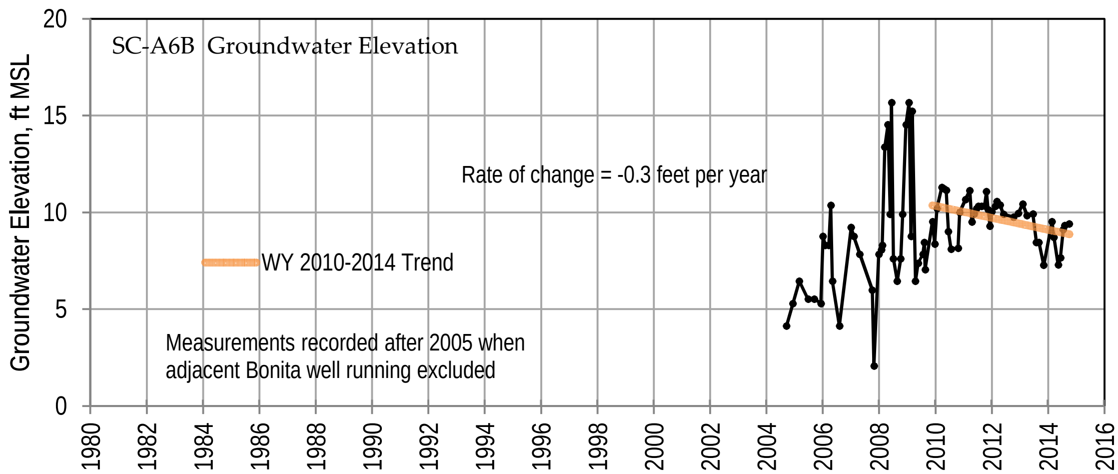

Bonita Total Dissolved Solids
WY 2010-2014 Trend
Secondary MCL
Rate of change = -4.7 mg/L per year
TDS, mg/L

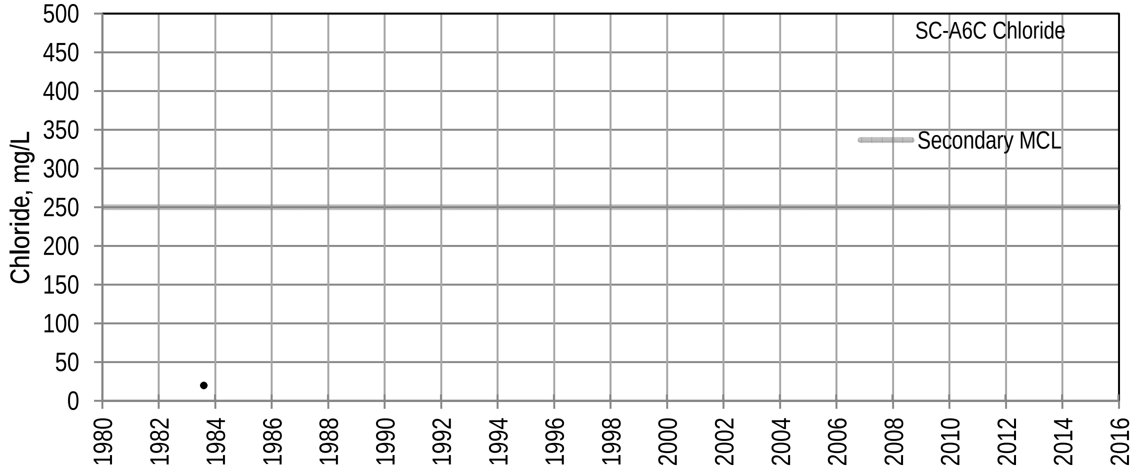

Bonita Groundwater Elevation
Rate of change = 0.3 feet per year
WY 2010-2014 Trend
Groundwater Elevation, ft MSL

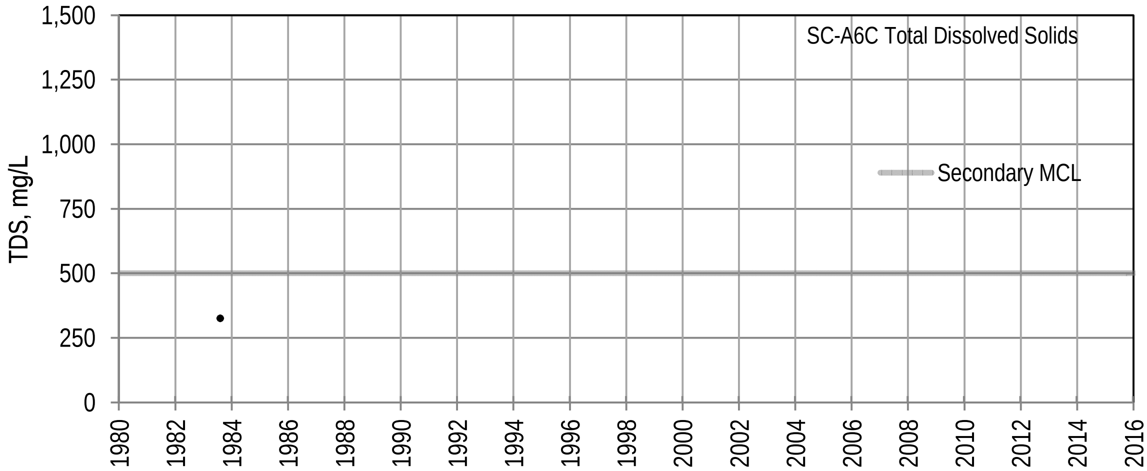

SC-A6A Chloride
Secondary MCL
Chloride, mg/L
0
50
100
150
200
250
300
350
400
450
500
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
SC-A6A Total Dissolved Solids
Secondary MCL
TDS, mg/L
0
250
500
750
1,000
1,250
1,500
SC-A6A Groundwater Elevation
Rate of change = -0.7 feet per year
Measurements recorded after 2005 when
adjacent Bonita well running excluded
WY 2010-2014 Trend
Groundwater Elevation, ft MSL
0
5
10
15
20


SC-A6B Chloride
Secondary MCL
Chloride, mg/L
500
450
400
350
300
250
200
150
100
50
0
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016

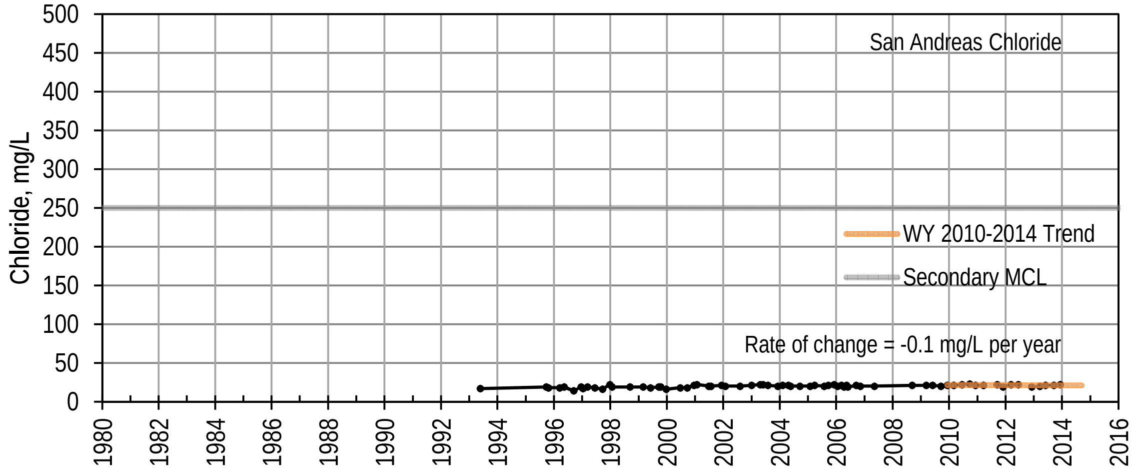

SC-A6B Total Dissolved Solids
Secondary MCL
TDS, mg/L
1,500
1,250
1,000
750
500
250
0
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016

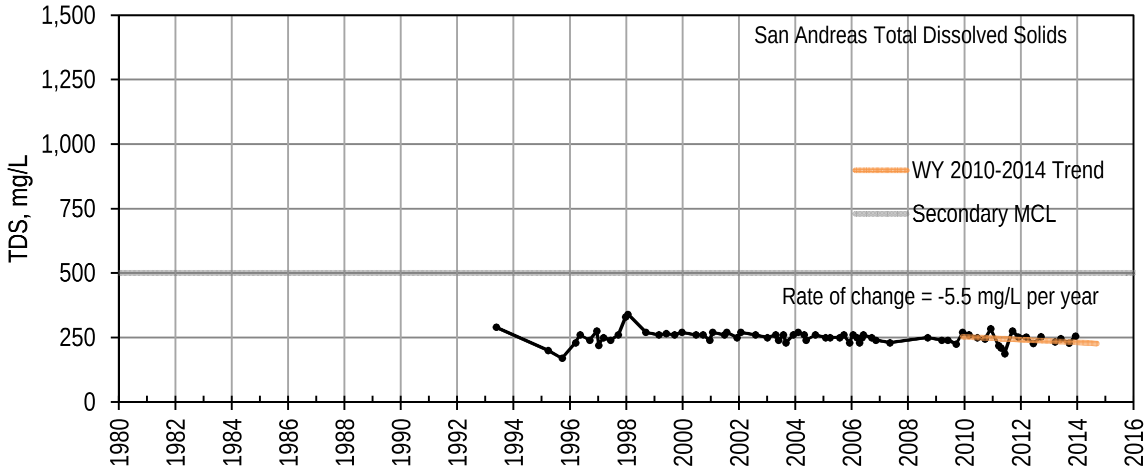

SC-A6B Groundwater Elevation
Rate of change = -0.3 feet per year
WY 2010-2014 Trend
Measurements recorded after 2005 when
adjacent Bonita well running excluded
Groundwater Elevation, ft MSL
20
15
10
5
0
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016

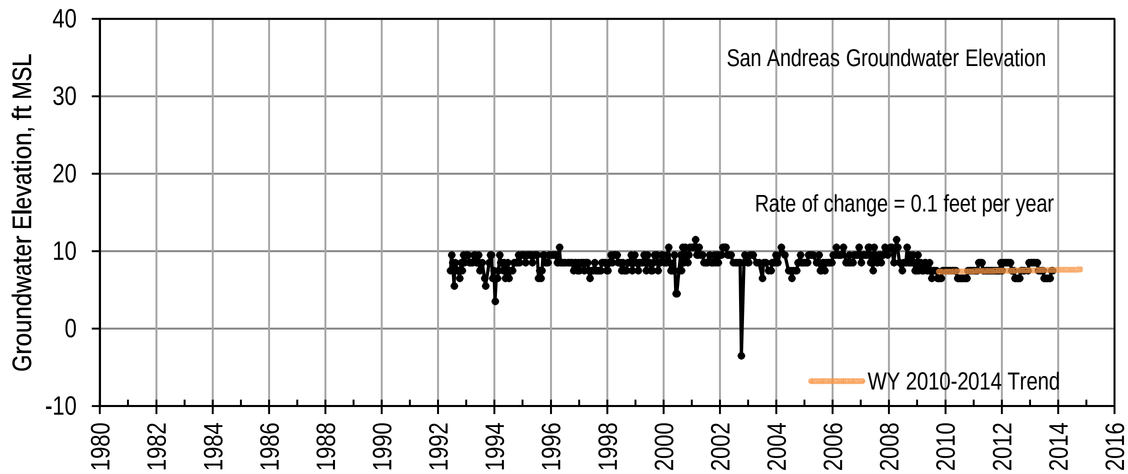

SC-A6C Chloride
Secondary MCL
Chloride, mg/L
500
450
400
350
300
250
200
150
100
50
0
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016

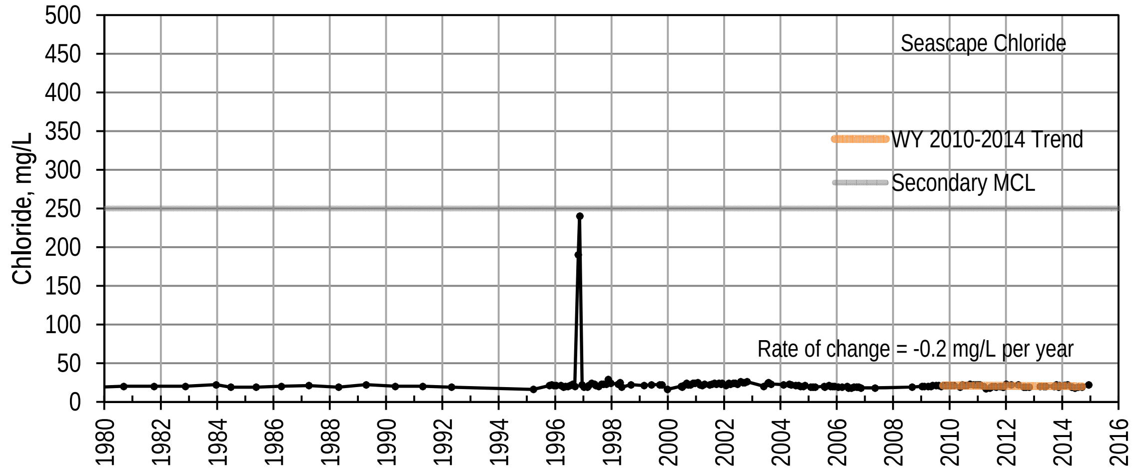

SC-A6C Total Dissolved Solids
Secondary MCL
TDS, mg/L
1,500
1,250
1,000
750
500
250
0
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016

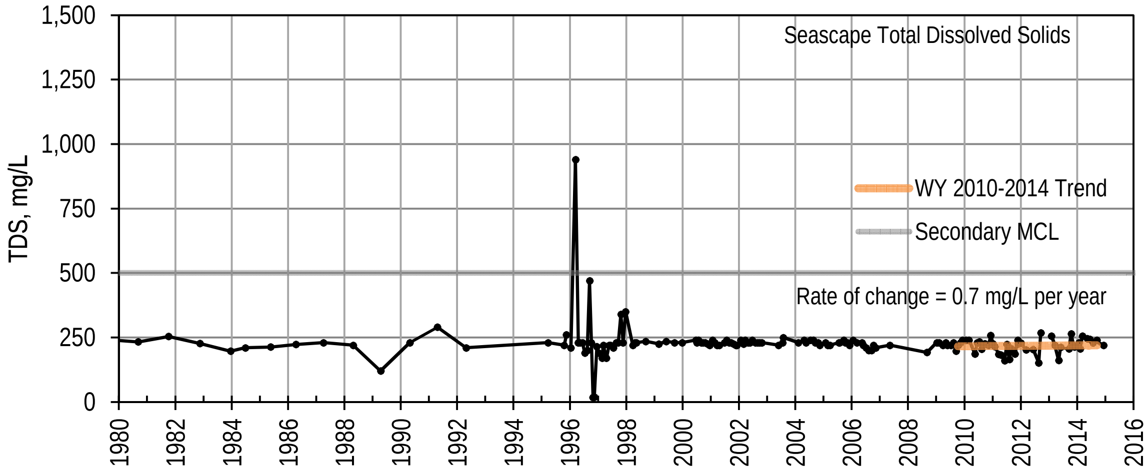

SC-A6C Groundwater Elevation
WY 2010-2014 Trend
Rate of change = 5.2 feet per year
Measurements recorded after 2005 when
adjacent Bonita well running excluded
Groundwater Elevation, ft MSL
250
200
150
100
50
0
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016

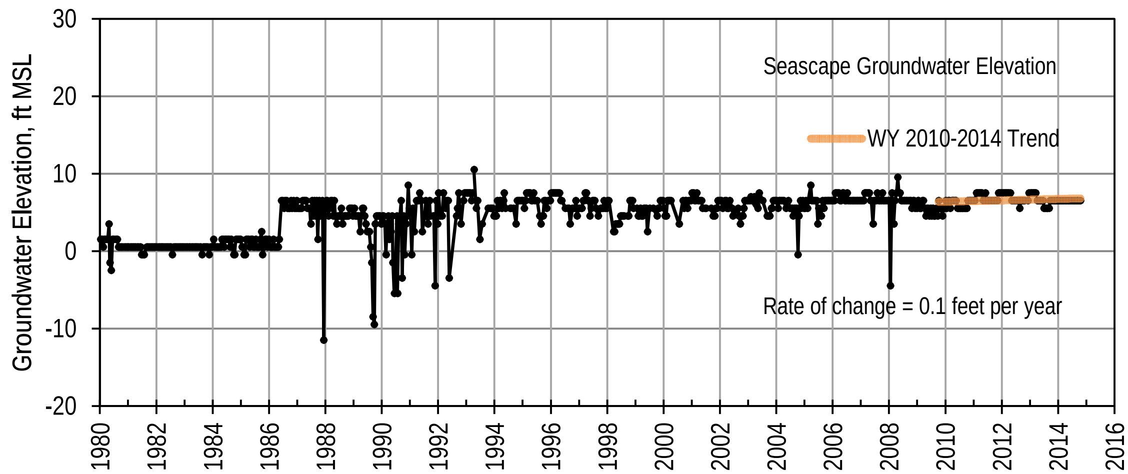

San Andreas Chloride
Chloride, mg/L
500
450
400
350
300
250
200
150
100
50
0
WY 2010-2014 Trend
Secondary MCL
Rate of change = -0.1 mg/L per year
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016

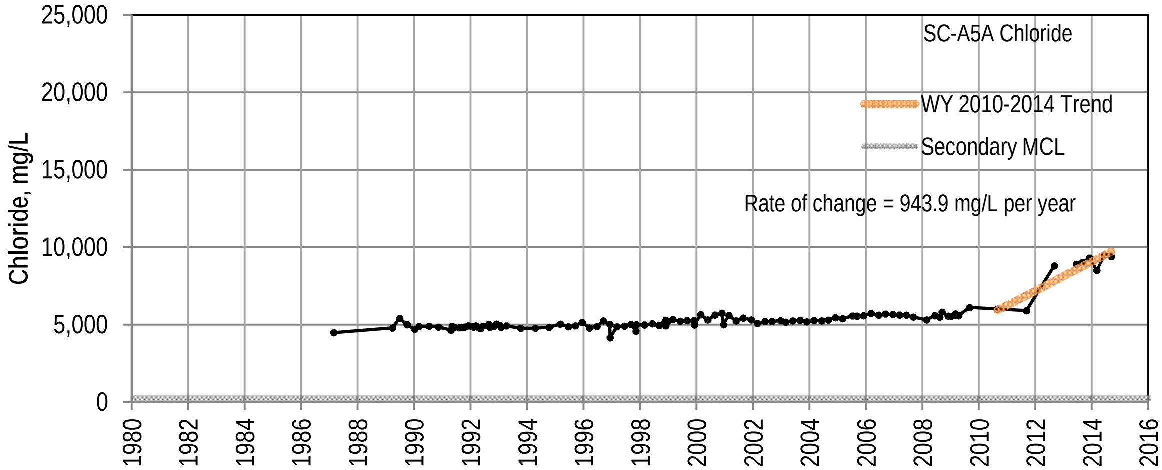

San Andreas Total Dissolved Solids
TDS, mg/L
1,500
1,250
1,000
750
500
250
0
WY 2010-2014 Trend
Secondary MCL
Rate of change = -5.5 mg/L per year
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016

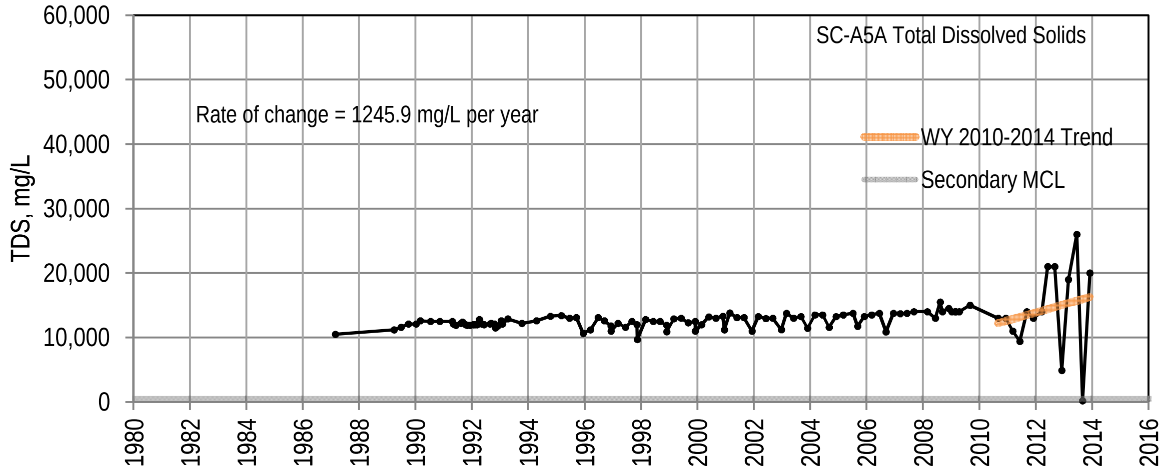

San Andreas Groundwater Elevation
Groundwater Elevation, ft MSL
40
30
20
10
0
-10
Rate of change = 0.1 feet per year
WY 2010-2014 Trend
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016

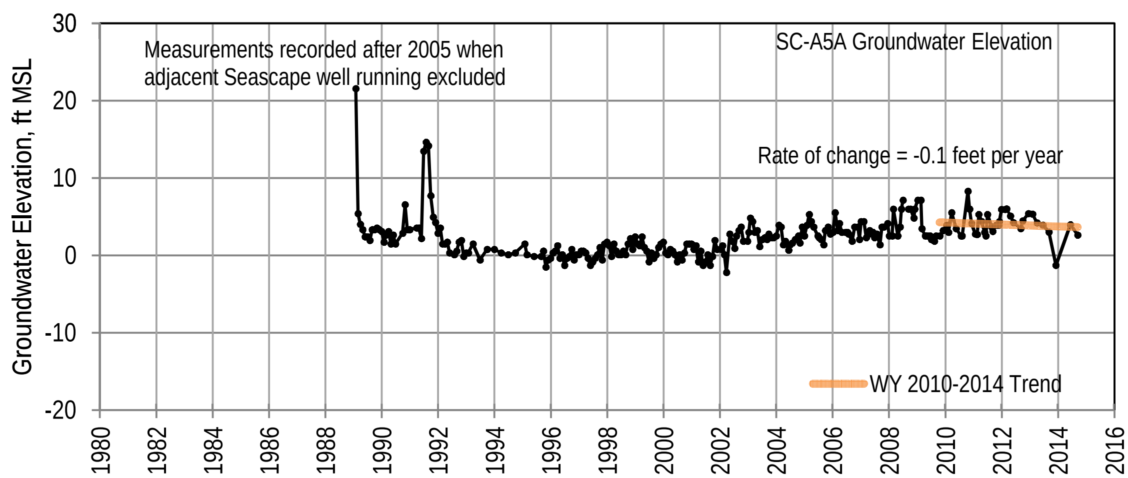

Chloride, mg/L
Seascape Chloride
WY 2010-2014 Trend
Secondary MCL
Rate of change = -0.2 mg/L per year

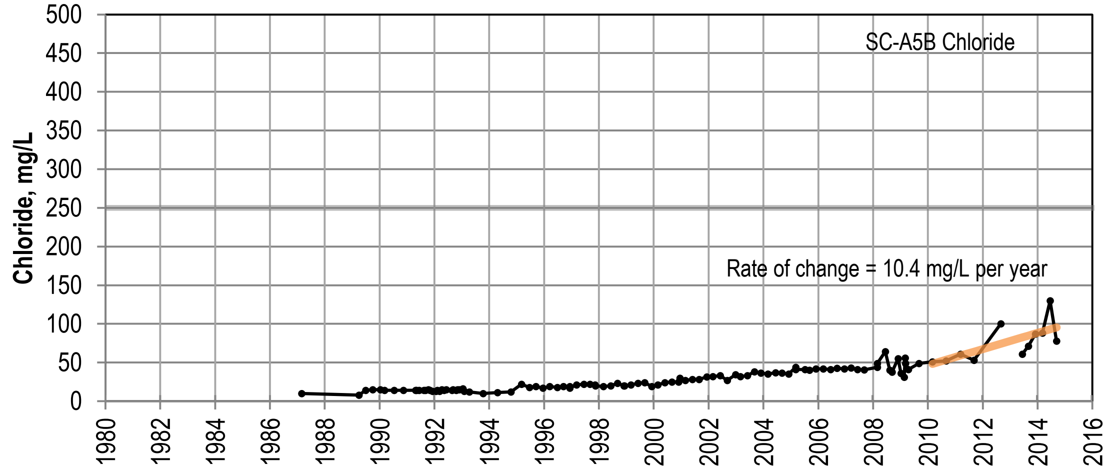

TDS, mg/L
Seascape Total Dissolved Solids
WY 2010-2014 Trend
Secondary MCL
Rate of change = 0.7 mg/L per year

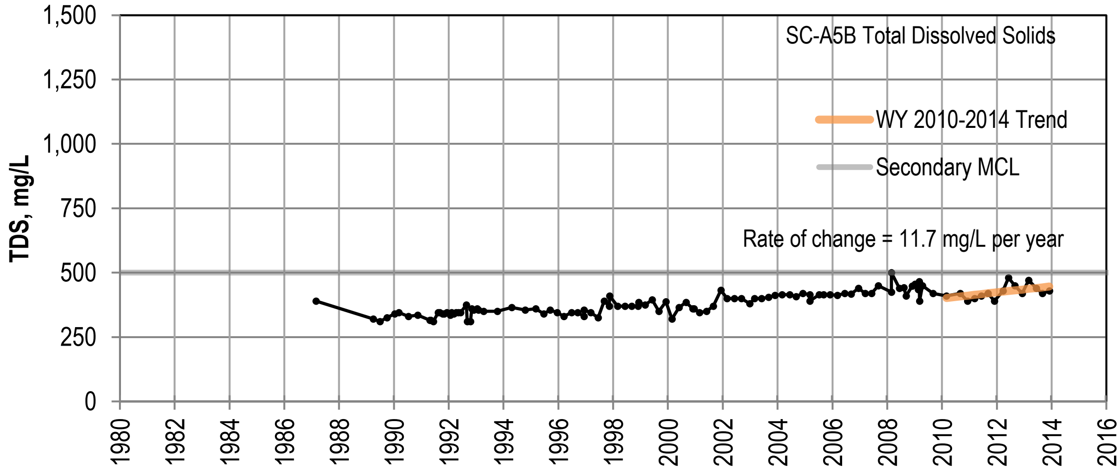

Groundwater Elevation, ft MSL
Seascape Groundwater Elevation
WY 2010-2014 Trend
Rate of change = 0.1 feet per year

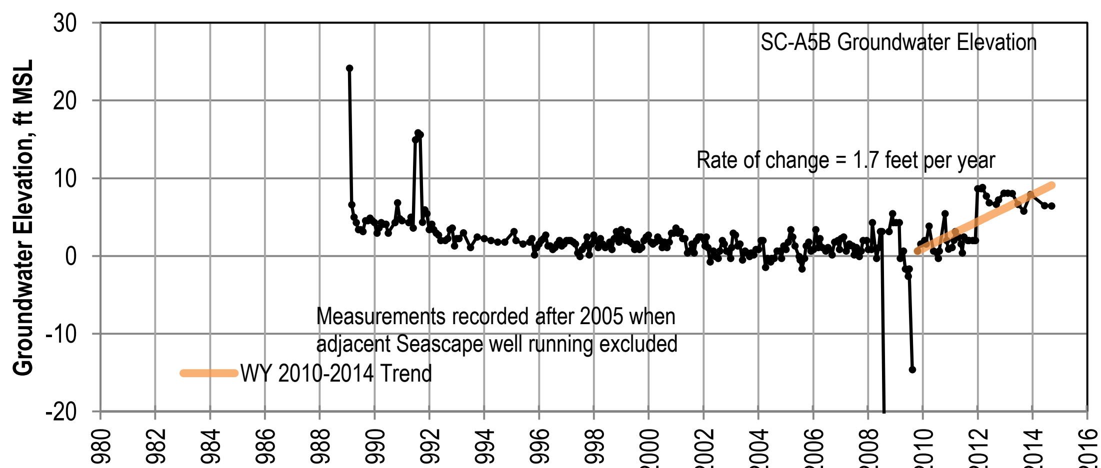

SC-A5A Chloride
WY 2010-2014 Trend
Secondary MCL
Rate of change = 943.9 mg/L per year
Chloride, mg/L
25,000
20,000
15,000
10,000
5,000
0
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016

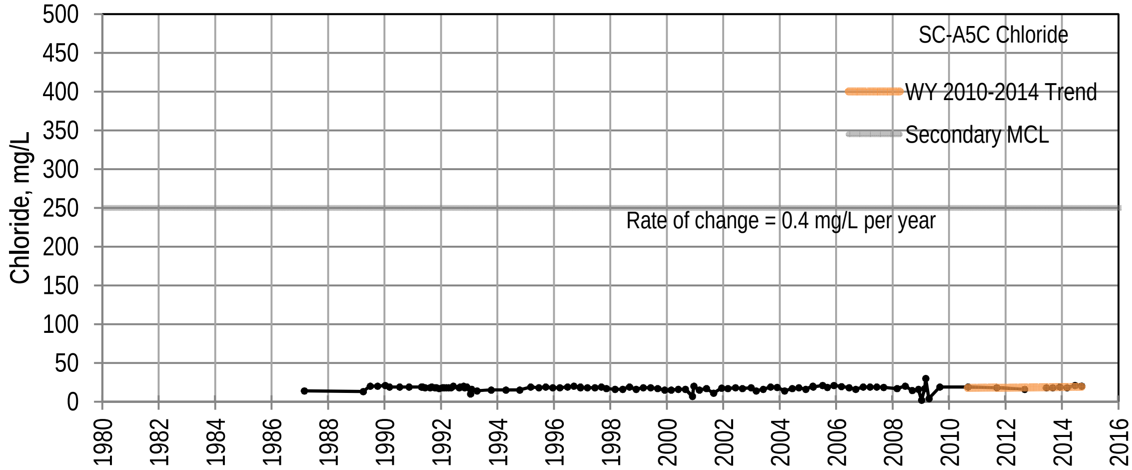

SC-A5A Total Dissolved Solids
Rate of change = 1245.9 mg/L per year
WY 2010-2014 Trend
Secondary MCL
TDS, mg/L
60,000
50,000
40,000
30,000
20,000
10,000
0
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016

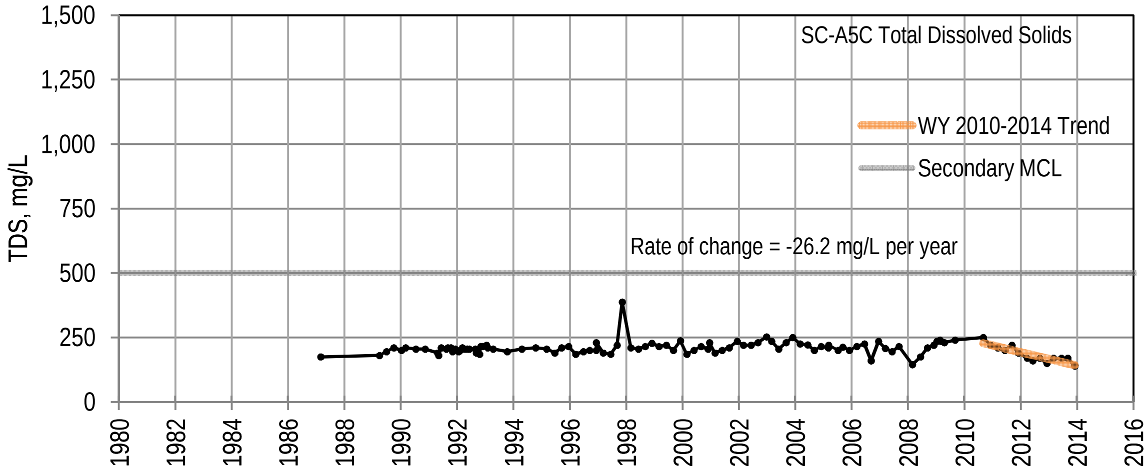

Measurements recorded after 2005 when
adjacent Seascape well running excluded
SC-A5A Groundwater Elevation
Rate of change = -0.1 feet per year
WY 2010-2014 Trend
Groundwater Elevation, ft MSL
30
20
10
0
-10
-20
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016

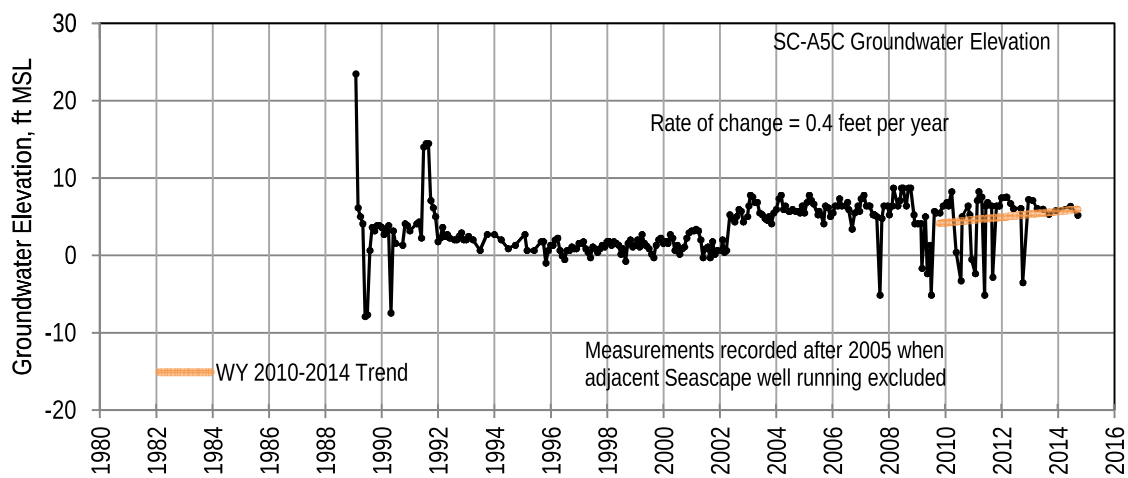

SC-A5B Chloride
Chloride, mg/L
Rate of change = 10.4 mg/L per year
500
450
400
350
300
250
200
150
100
50
0
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016

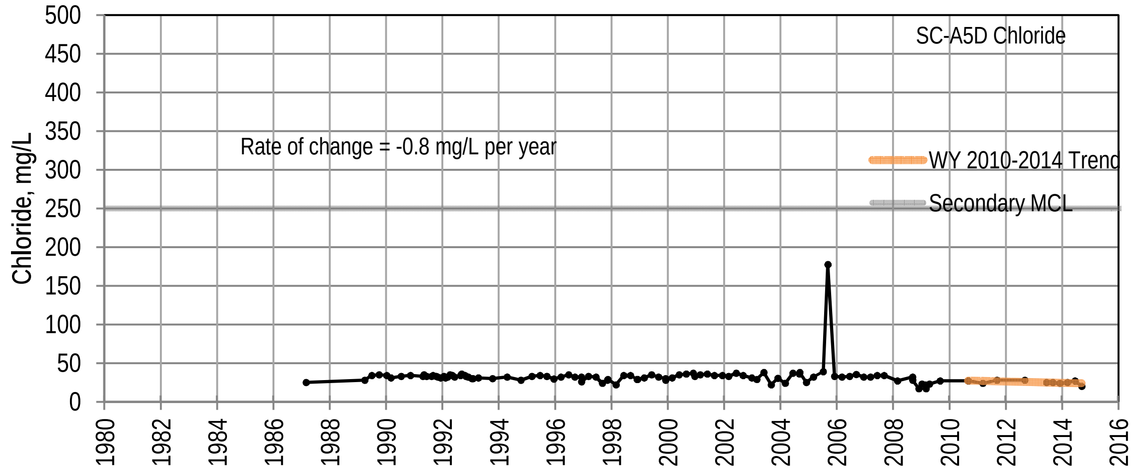

SC-A5B Total Dissolved Solids
TDS, mg/L
WY 2010-2014 Trend
Secondary MCL
Rate of change = 11.7 mg/L per year
1,500
1,250
1,000
750
500
250
0

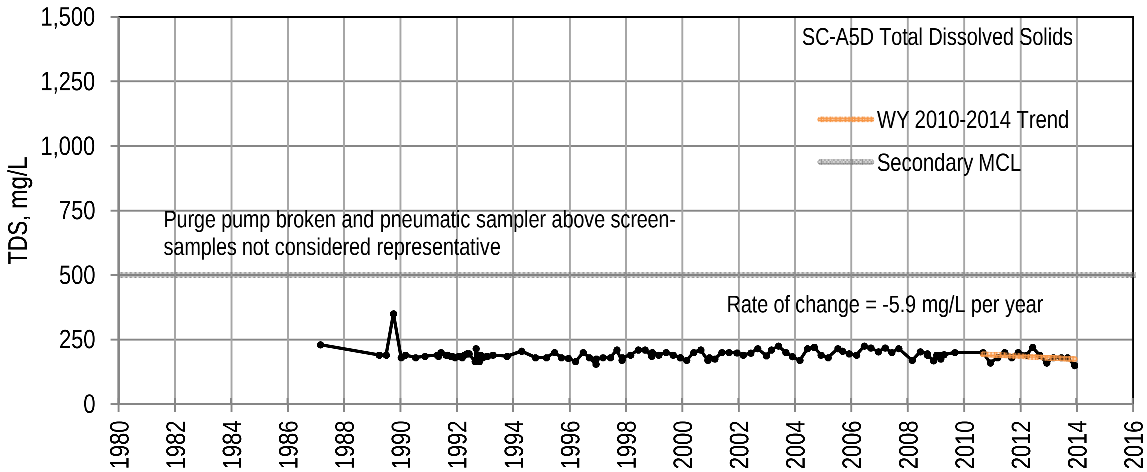

SC-A5B Groundwater Elevation
Groundwater Elevation, ft MSL
Rate of change = 1.7 feet per year
Measurements recorded after 2005 when adjacent Seascape well running excluded
WY 2010-2014 Trend
30
20
10
0
-10
-20

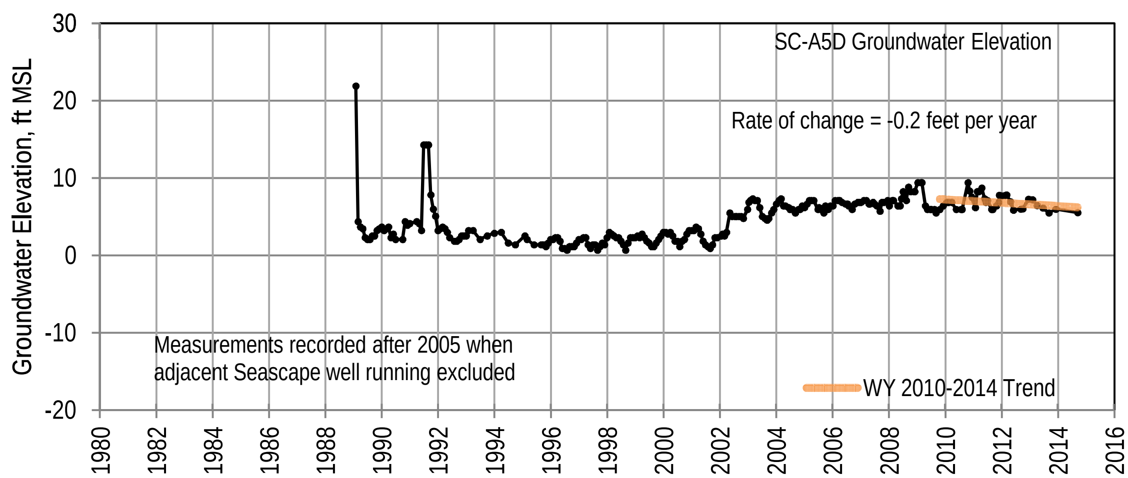

SC-A5C Chloride
WY 2010-2014 Trend
Secondary MCL
Rate of change = 0.4 mg/L per year
Chloride, mg/L
500
450
400
350
300
250
200
150
100
50
0
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016

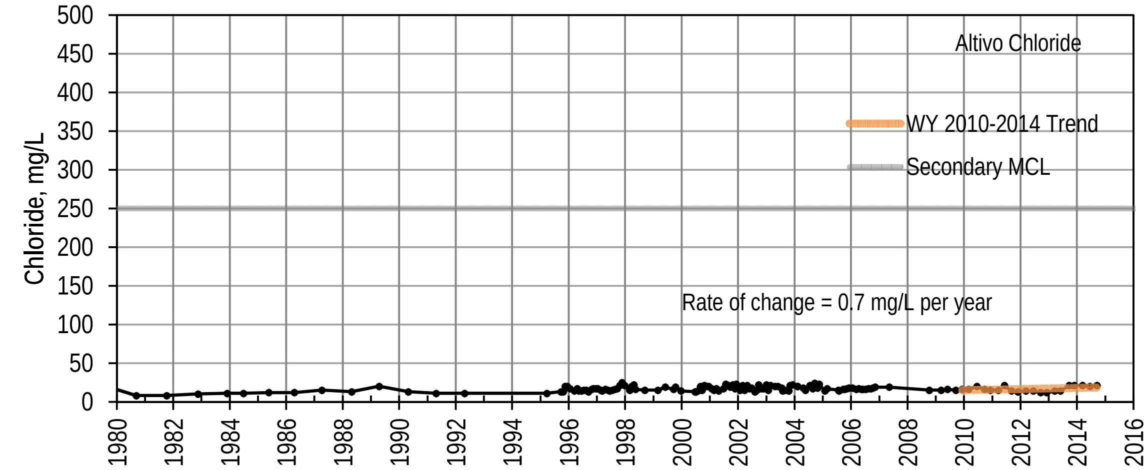

SC-A5C Total Dissolved Solids
WY 2010-2014 Trend
Secondary MCL
Rate of change = -26.2 mg/L per year
TDS, mg/L
1,500
1,250
1,000
750
500
250
0
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016

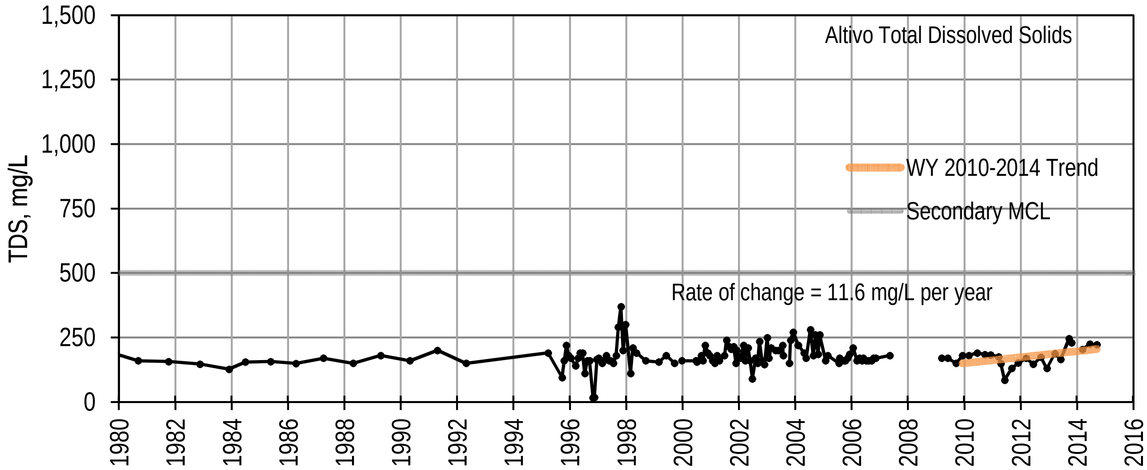

SC-A5C Groundwater Elevation
Rate of change = 0.4 feet per year
WY 2010-2014 Trend
Measurements recorded after 2005 when
adjacent Seascape well running excluded
Groundwater Elevation, ft MSL
30
20
10
0
-10
-20
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016

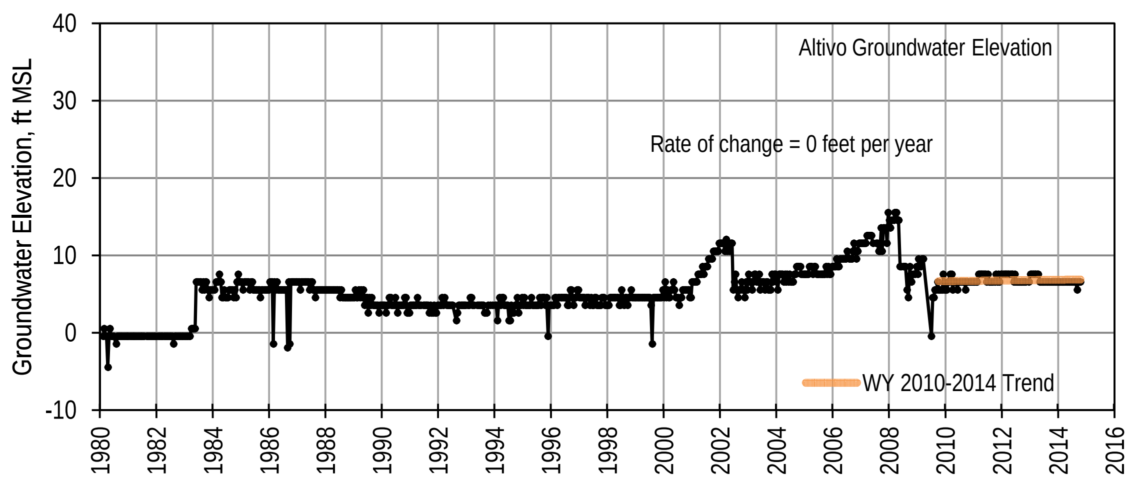

SC-A5D Chloride
Rate of change = -0.8 mg/L per year
WY 2010-2014 Trend
Secondary MCL
Chloride, mg/L
500
450
400
350
300
250
200
150
100
50
0
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016

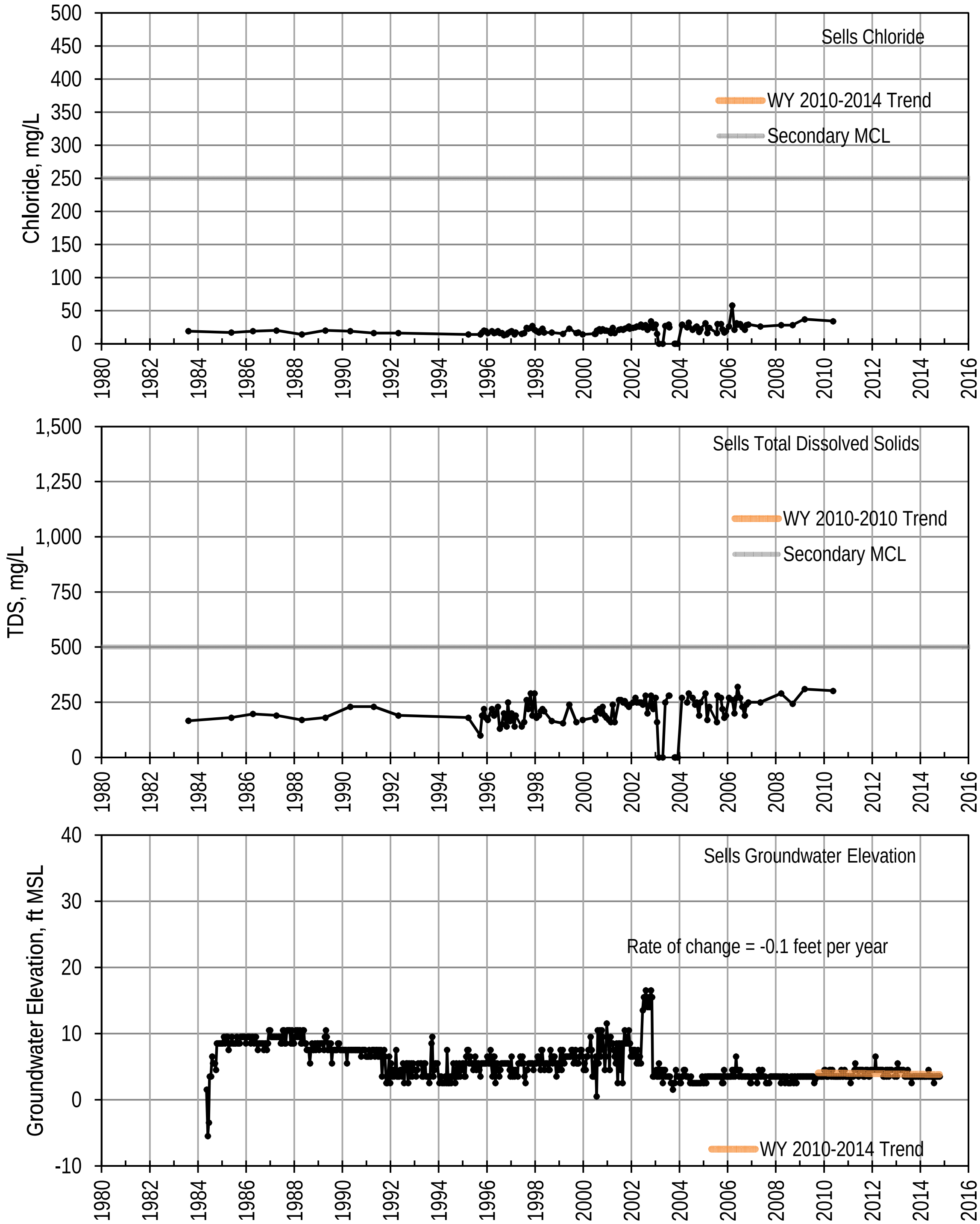

SC-A5D Total Dissolved Solids
WY 2010-2014 Trend
Secondary MCL
Purge pump broken and pneumatic sampler above screen-
samples not considered representative
Rate of change = -5.9 mg/L per year
TDS, mg/L
1,500
1,250
1,000
750
500
250
0
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016

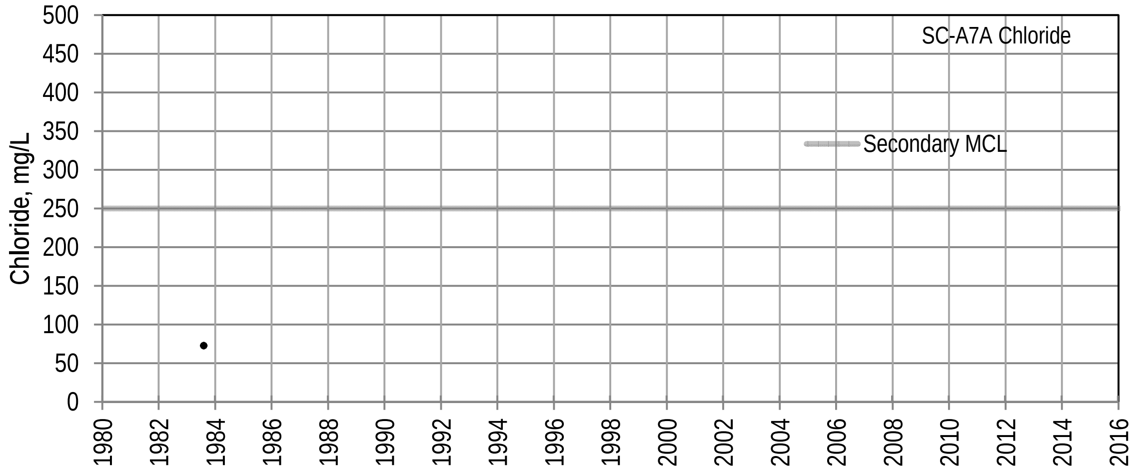

SC-A5D Groundwater Elevation
Rate of change = -0.2 feet per year
Measurements recorded after 2005 when
adjacent Seascape well running excluded
WY 2010-2014 Trend
Groundwater Elevation, ft MSL
30
20
10
0
-10
-20
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016

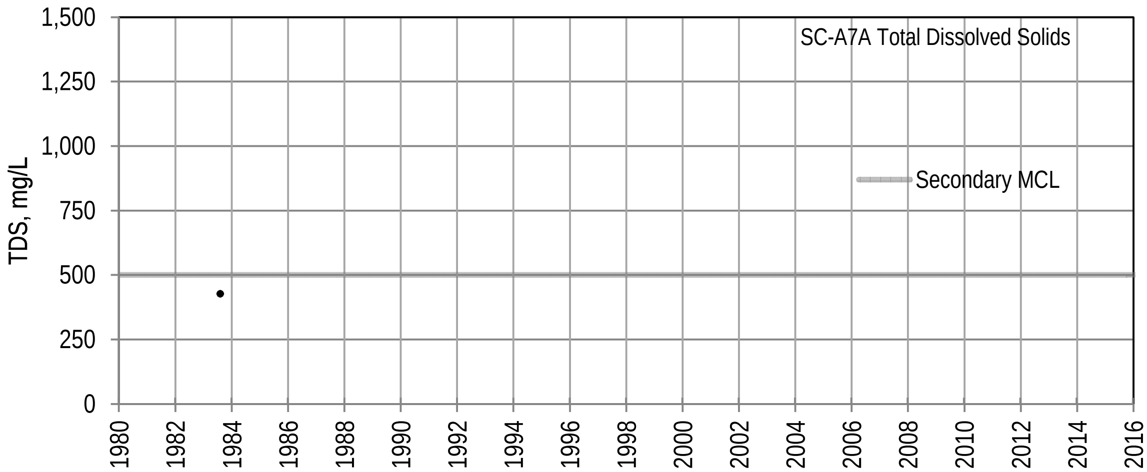

Altivo Chloride
WY 2010-2014 Trend
Secondary MCL
Rate of change = 0.7 mg/L per year
Chloride, mg/L
500
450
400
350
300
250
200
150
100
50
0
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016

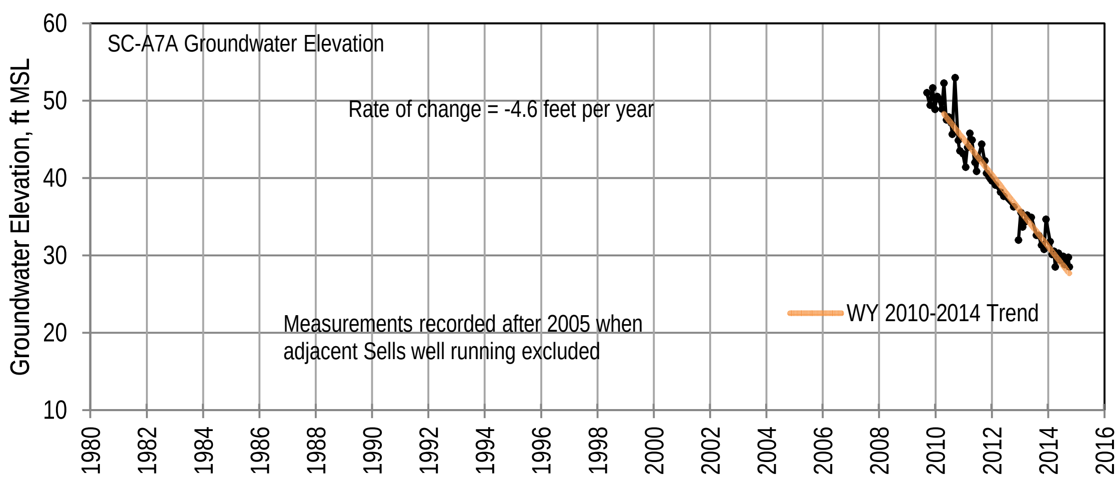

Altivo Total Dissolved Solids
WY 2010-2014 Trend
Secondary MCL
Rate of change = 11.6 mg/L per year
TDS, mg/L
1,500
1,250
1,000
750
500
250
0
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016

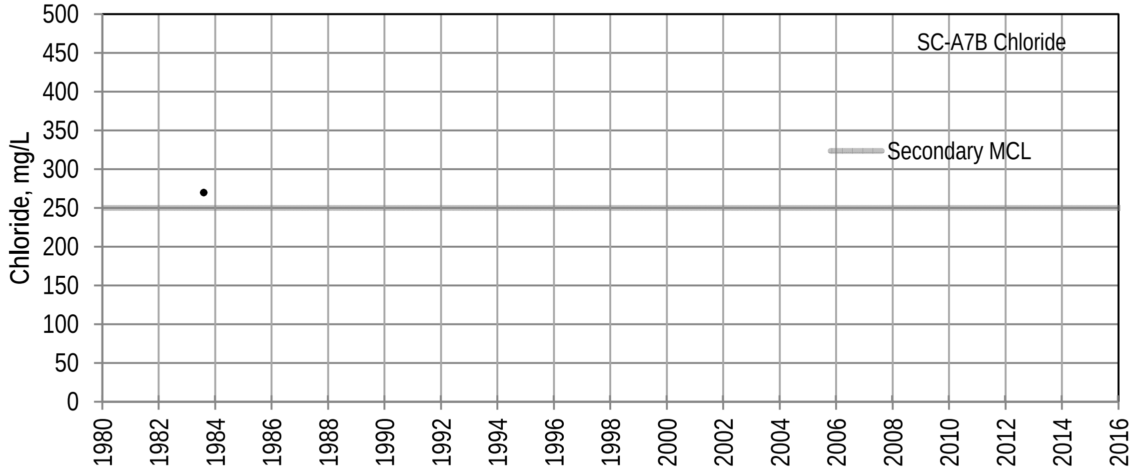

Altivo Groundwater Elevation
Rate of change = 0 feet per year
WY 2010-2014 Trend
Groundwater Elevation, ft MSL
40
30
20
10
0
-10
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016

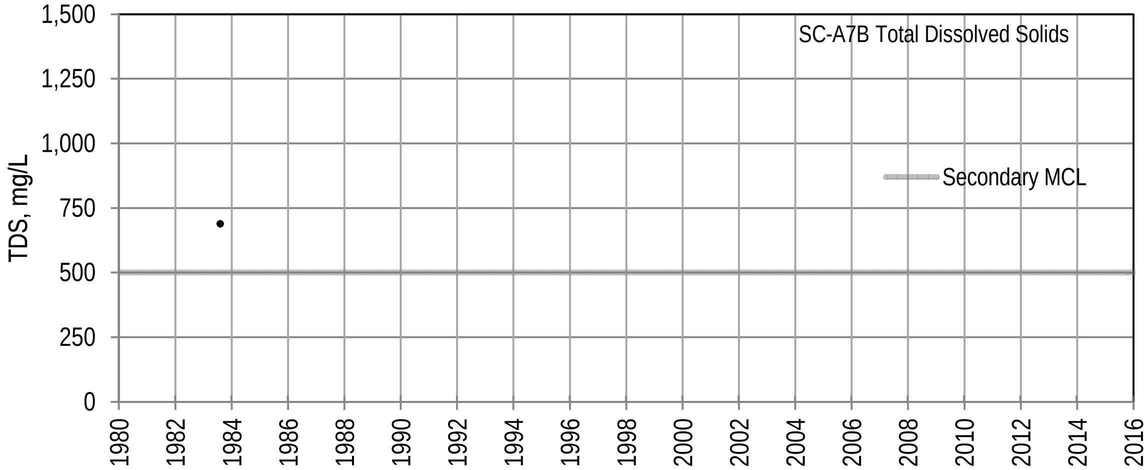

Sells Chloride
WY 2010-2014 Trend
Secondary MCL
Chloride, mg/L
0
50
100
150
200
250
300
350
400
450
500
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
Sells Total Dissolved Solids
WY 2010-2010 Trend
Secondary MCL
TDS, mg/L
0
250
500
750
1,000
1,250
1,500
Sells Groundwater Elevation
Rate of change = -0.1 feet per year
WY 2010-2014 Trend
Groundwater Elevation, ft MSL
-10
0
10
20
30
40

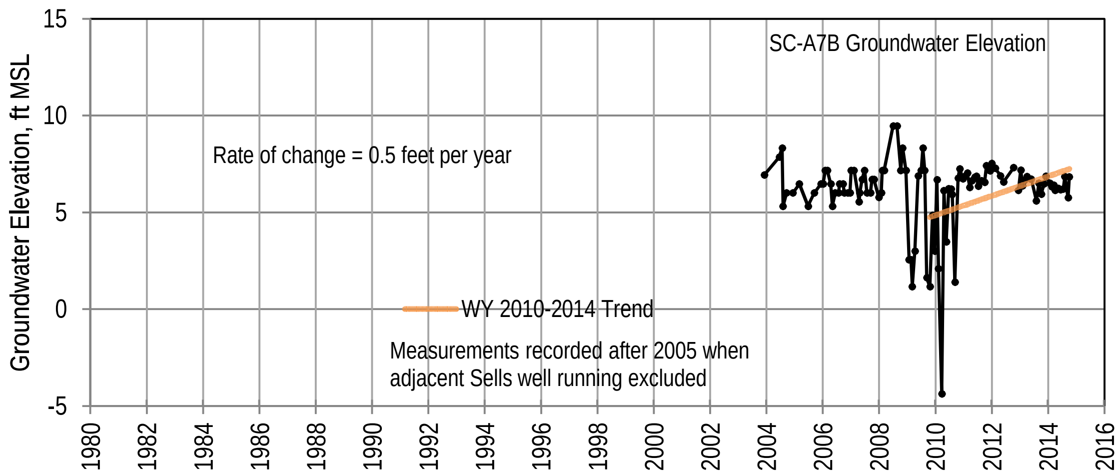

SC-A7A Chloride
Secondary MCL
Chloride, mg/L
500
450
400
350
300
250
200
150
100
50
0
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016

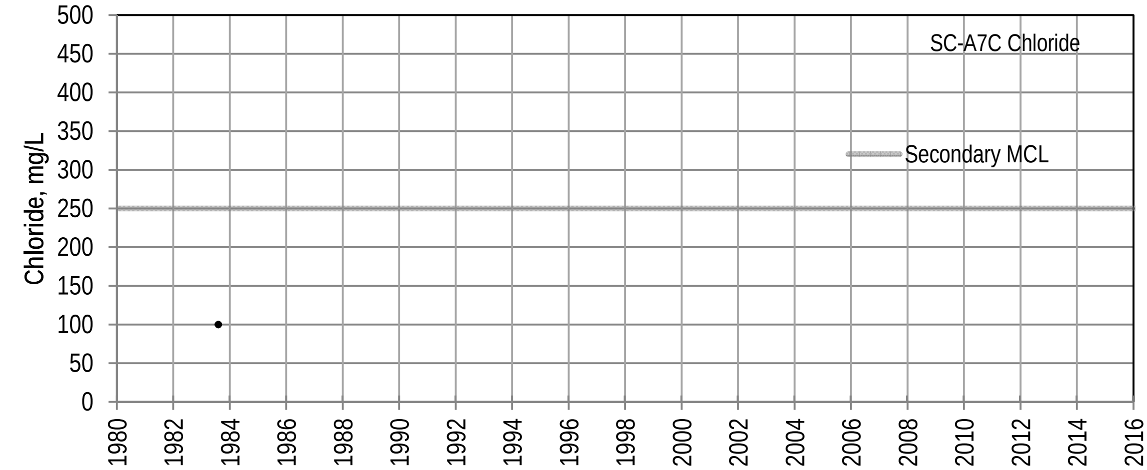

SC-A7A Total Dissolved Solids
Secondary MCL
TDS, mg/L
1,500
1,250
1,000
750
500
250
0
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016


SC-A7A Groundwater Elevation
Rate of change = -4.6 feet per year
WY 2010-2014 Trend
Measurements recorded after 2005 when
adjacent Sells well running excluded
Groundwater Elevation, ft MSL
60
50
40
30
20
10
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016

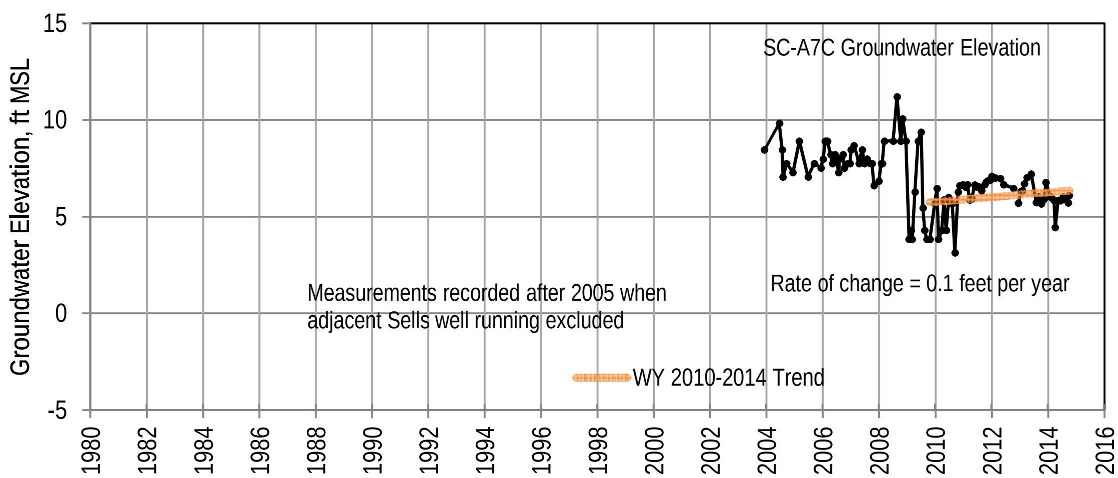

SC-A7B Chloride
Secondary MCL
Chloride, mg/L

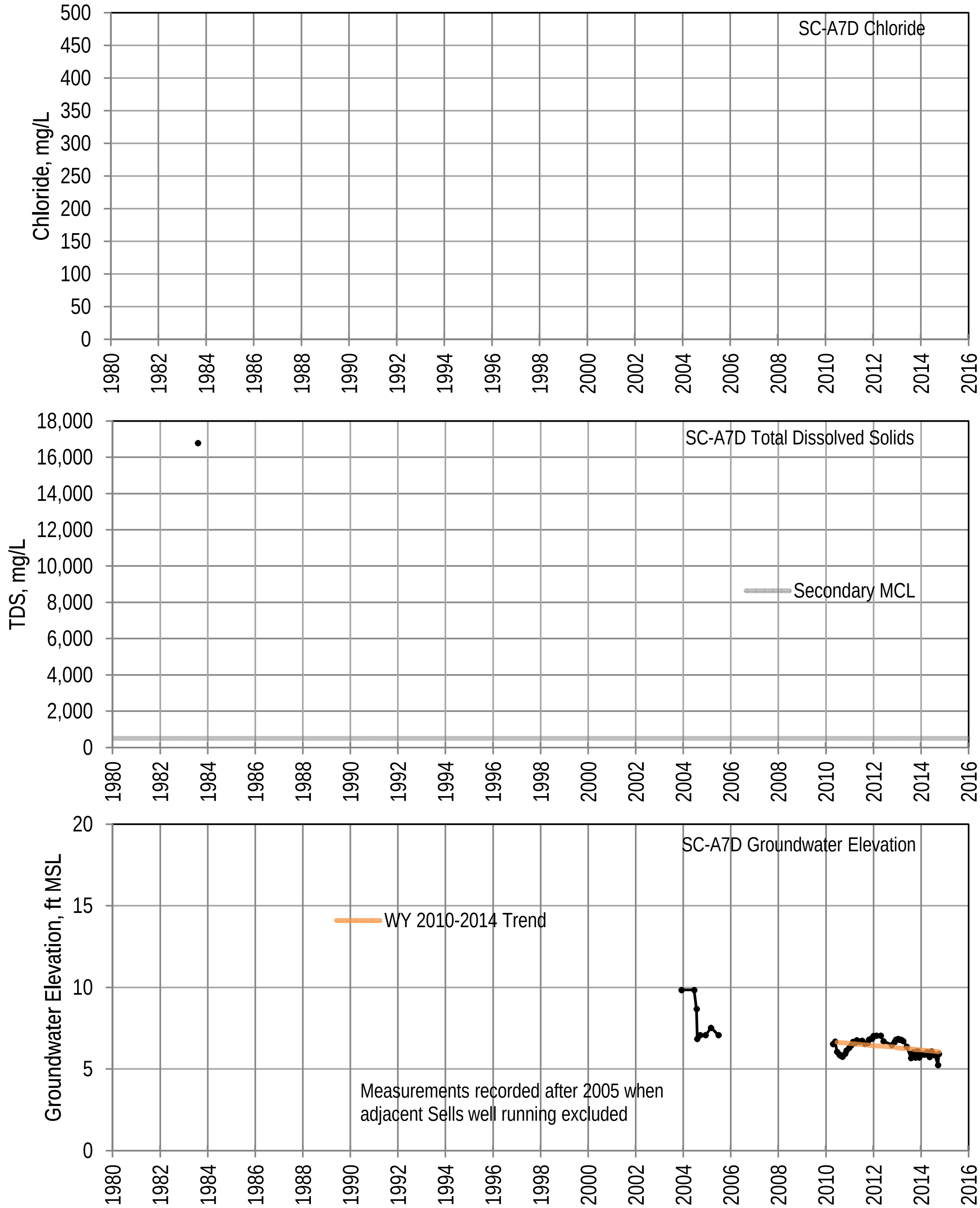

SC-A7B Total Dissolved Solids
Secondary MCL
TDS, mg/L

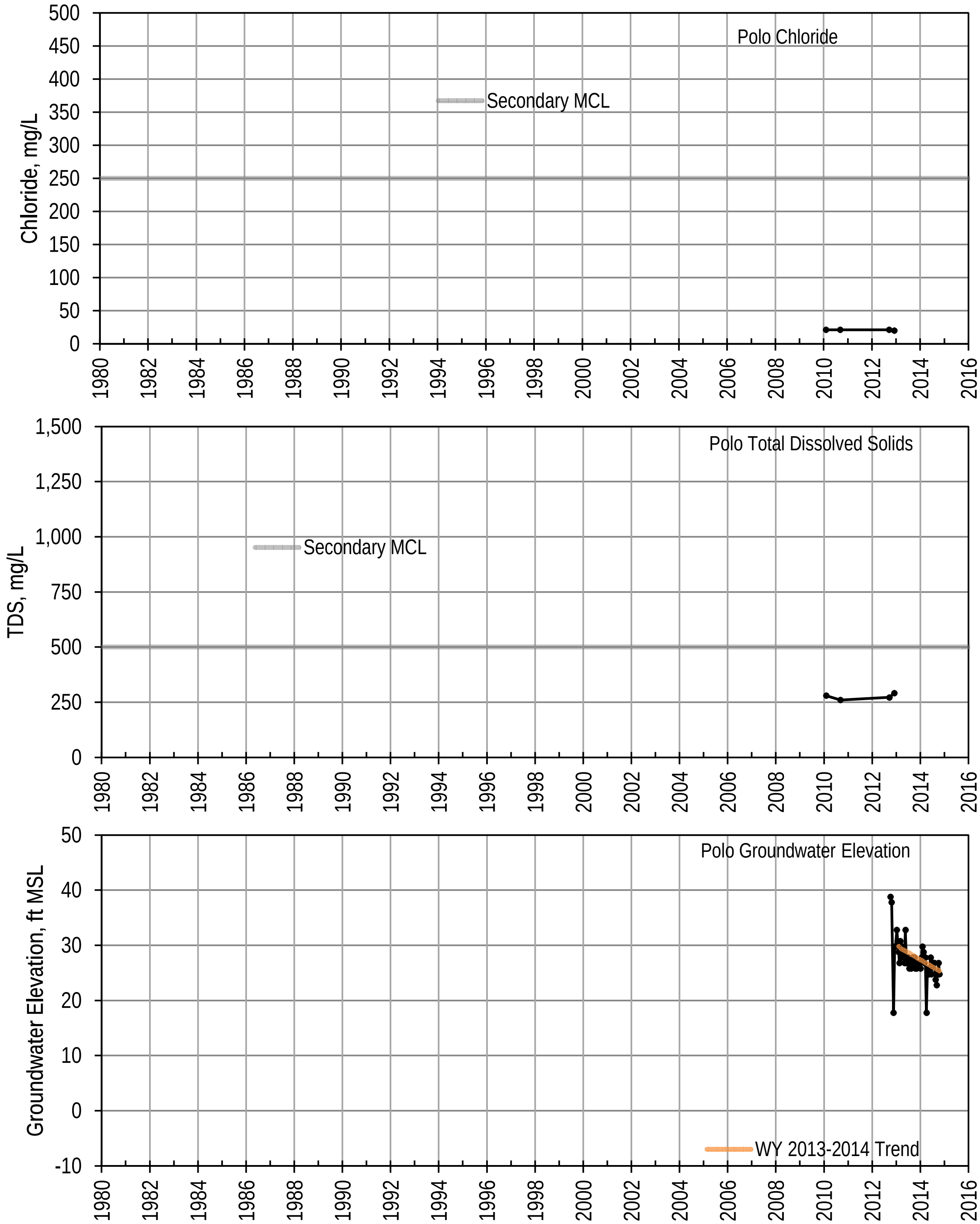

SC-A7B Groundwater Elevation
Rate of change = 0.5 feet per year
WY 2010-2014 Trend
Measurements recorded after 2005 when adjacent Sells well running excluded
Groundwater Elevation, ft MSL


SC-A7C Chloride
Secondary MCL
Chloride, mg/L
500
450
400
350
300
250
200
150
100
50
0
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016

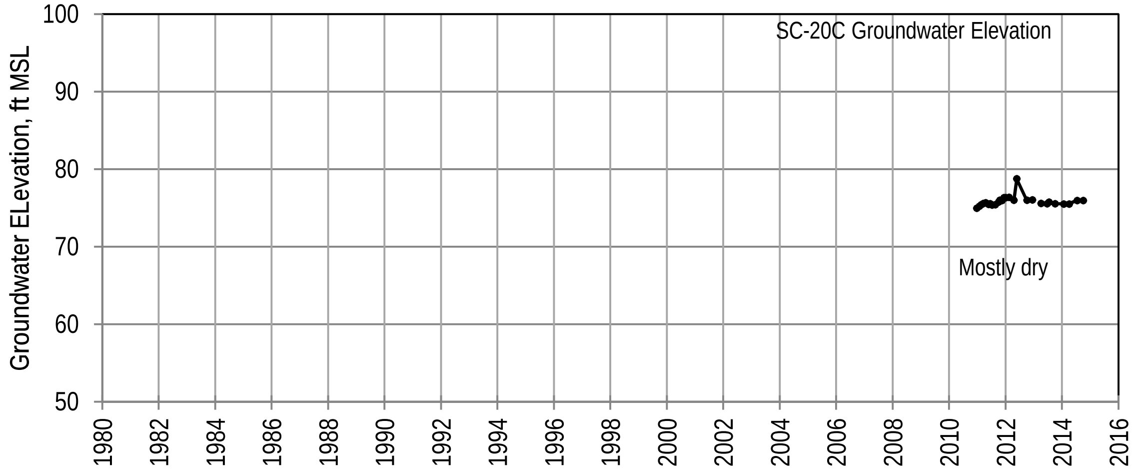

SC-A7C Total Dissolved Solids
Secondary MCL
TDS, mg/L
1,500
1,250
1,000
750
500
250
0
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016

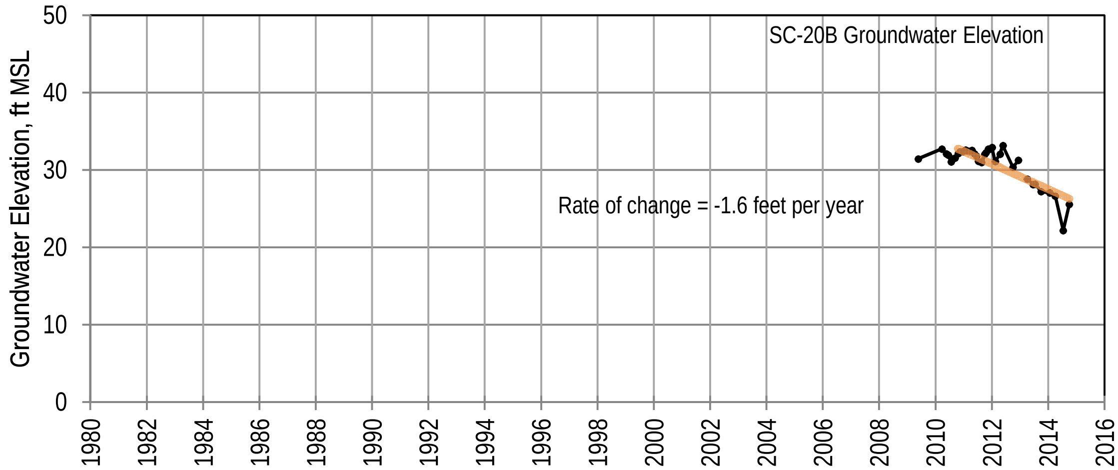

SC-A7C Groundwater Elevation
Groundwater Elevation, ft MSL
Measurements recorded after 2005 when
adjacent Sells well running excluded
Rate of change = 0.1 feet per year
WY 2010-2014 Trend
15
10
5
0
-5
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016

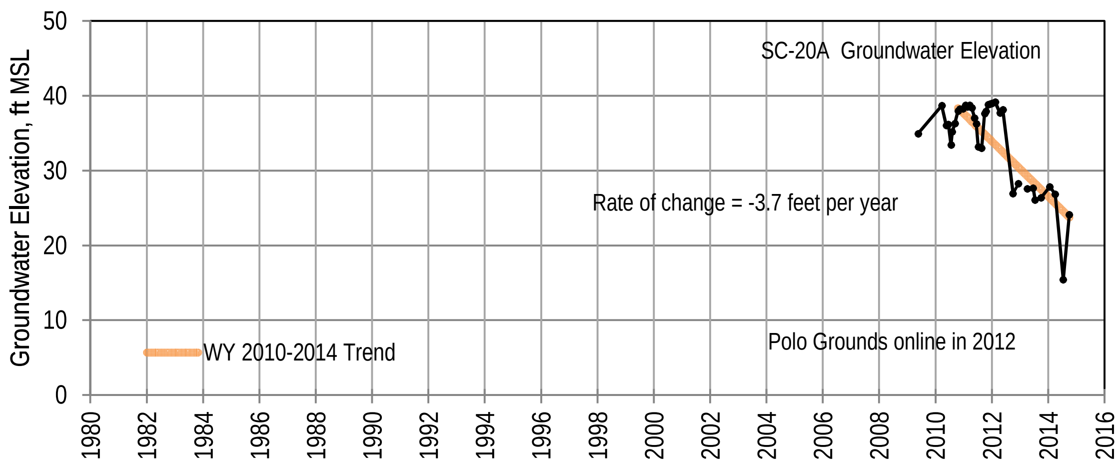

SC-A7D Chloride
Chloride, mg/L
0
50
100
150
200
250
300
350
400
450
500
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
SC-A7D Total Dissolved Solids
TDS, mg/L
0
2,000
4,000
6,000
8,000
10,000
12,000
14,000
16,000
18,000
Secondary MCL
SC-A7D Groundwater Elevation
Groundwater Elevation, ft MSL
0
5
10
15
20
WY 2010-2014 Trend
Measurements recorded after 2005 when adjacent Sells well running excluded

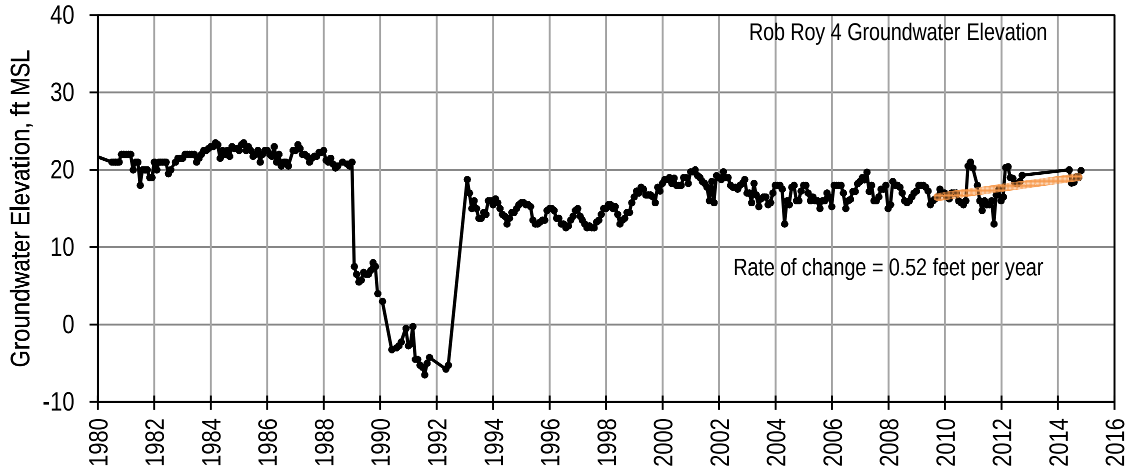


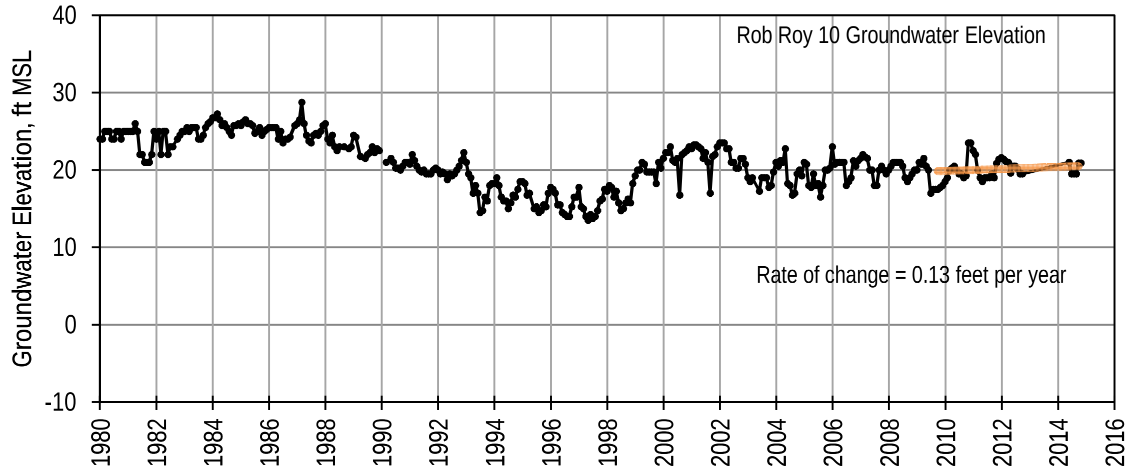
Polo Chloride
Secondary MCL
Chloride, mg/L
500
450
400
350
300
250
200
150
100
50
0
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
Polo Total Dissolved Solids
Secondary MCL
TDS, mg/L
1,500
1,250
1,000
750
500
250
0
Polo Groundwater Elevation
Groundwater Elevation, ft MSL
50
40
30
20
10
0
-10
WY 2013-2014 Trend

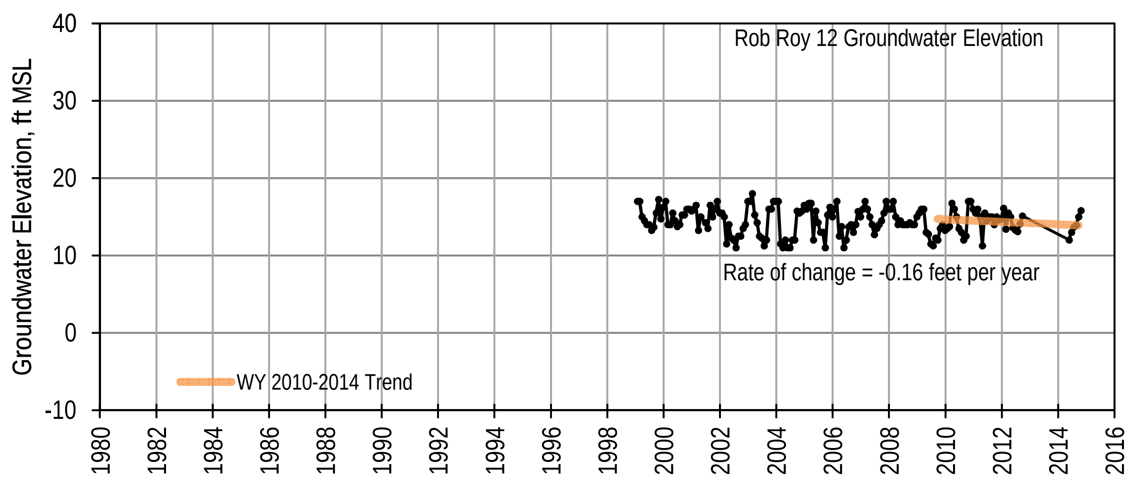

SC-20C Groundwater Elevation
Mostly dry
Groundwater ELevation, ft MSL
100
90
80
70
60
50
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016

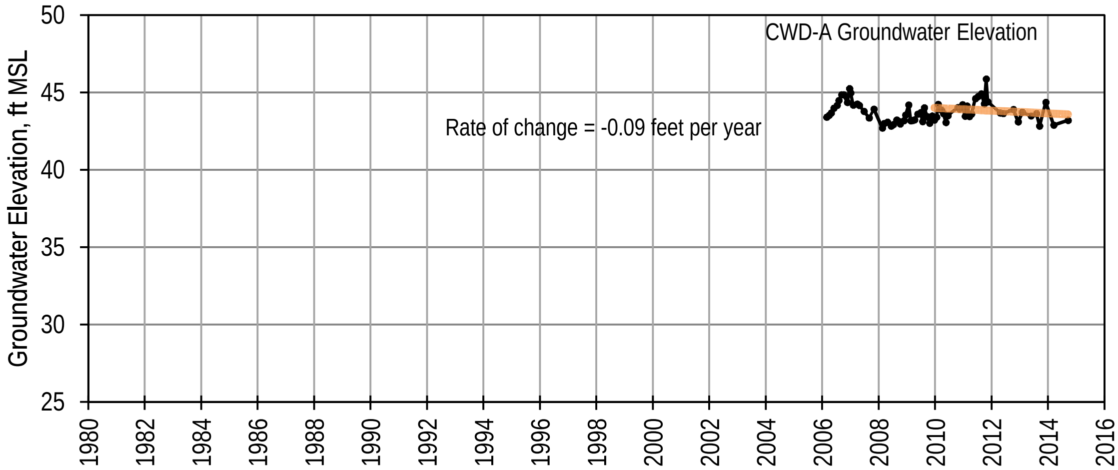

SC-20B Groundwater Elevation
Rate of change = -1.6 feet per year
Groundwater Elevation, ft MSL
50
40
30
20
10
0
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016

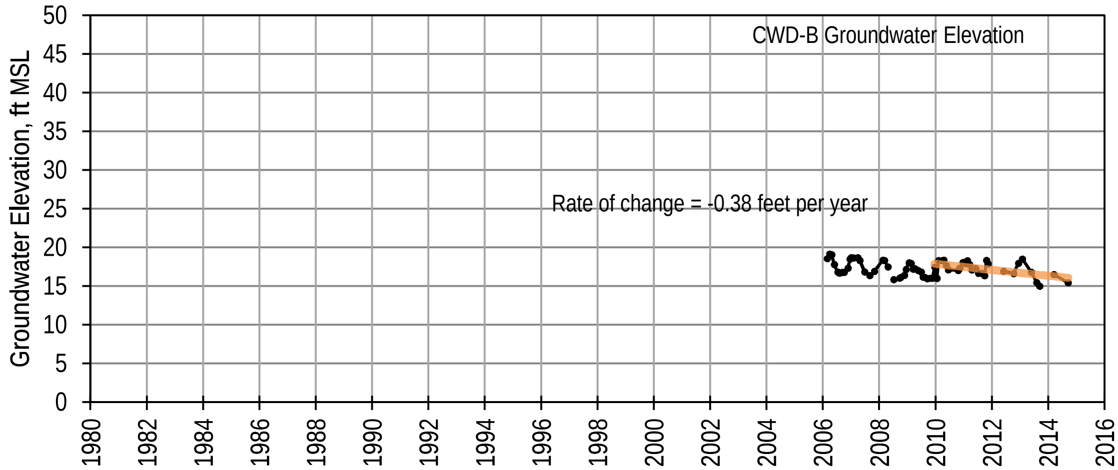

SC-20A Groundwater Elevation
Rate of change = -3.7 feet per year
WY 2010-2014 Trend
Polo Grounds online in 2012
Groundwater Elevation, ft MSL
50
40
30
20
10
0
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016

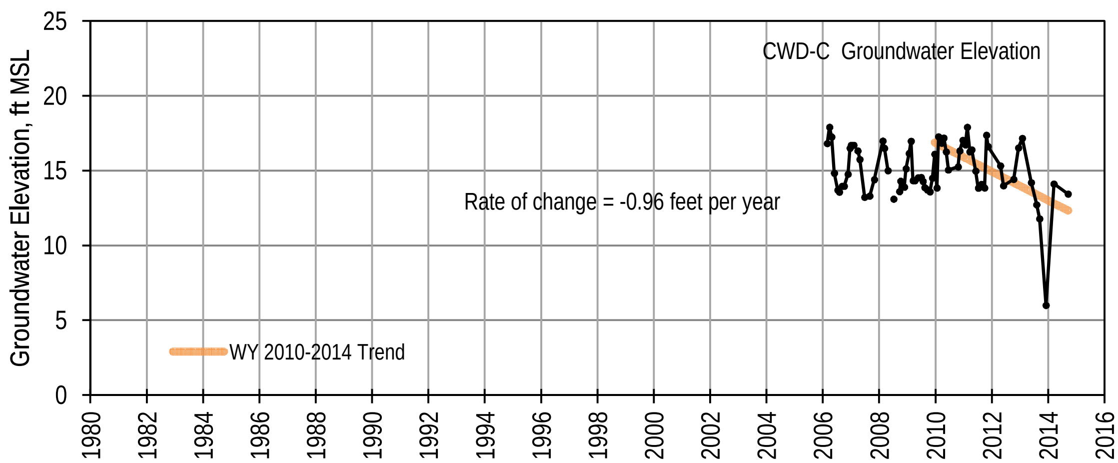

Rob Roy 4 Groundwater Elevation
Rate of change = 0.52 feet per year
Groundwater Elevation, ft MSL
40
30
20
10
0
-10
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016

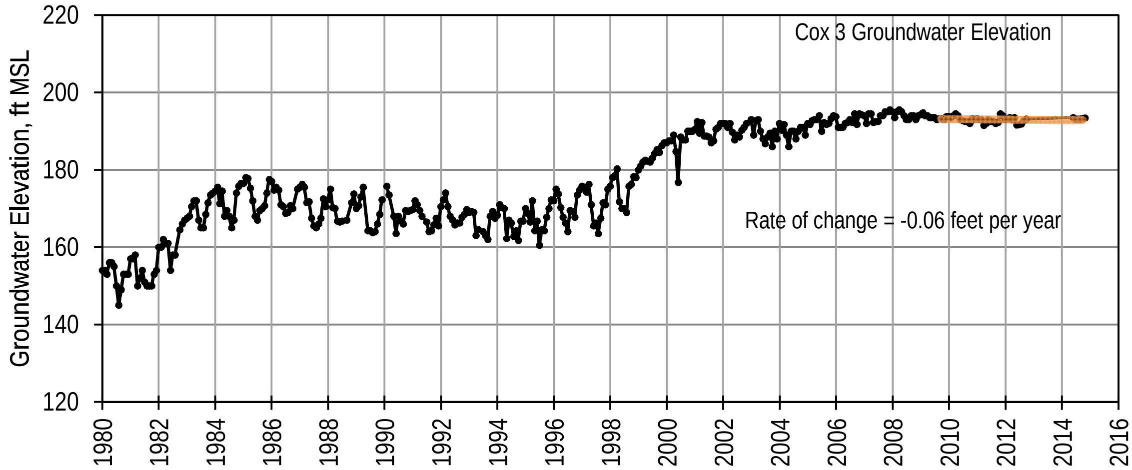

Rob Roy 10 Groundwater Elevation
Rate of change = 0.13 feet per year
Groundwater Elevation, ft MSL
40
30
20
10
0
-10
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016

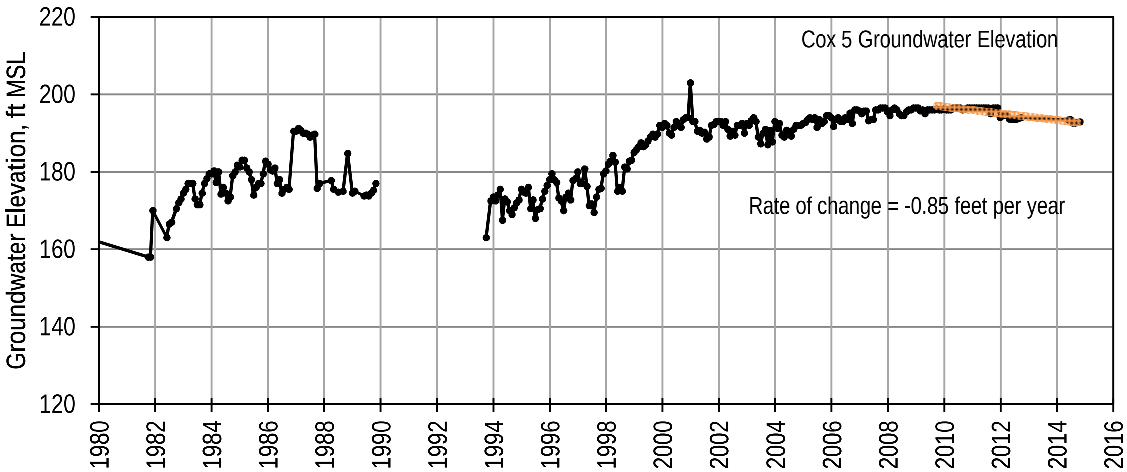

Rob Roy 12 Groundwater Elevation
Rate of change = -0.16 feet per year
WY 2010-2014 Trend
Groundwater Elevation, ft MSL
40
30
20
10
0
-10
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016

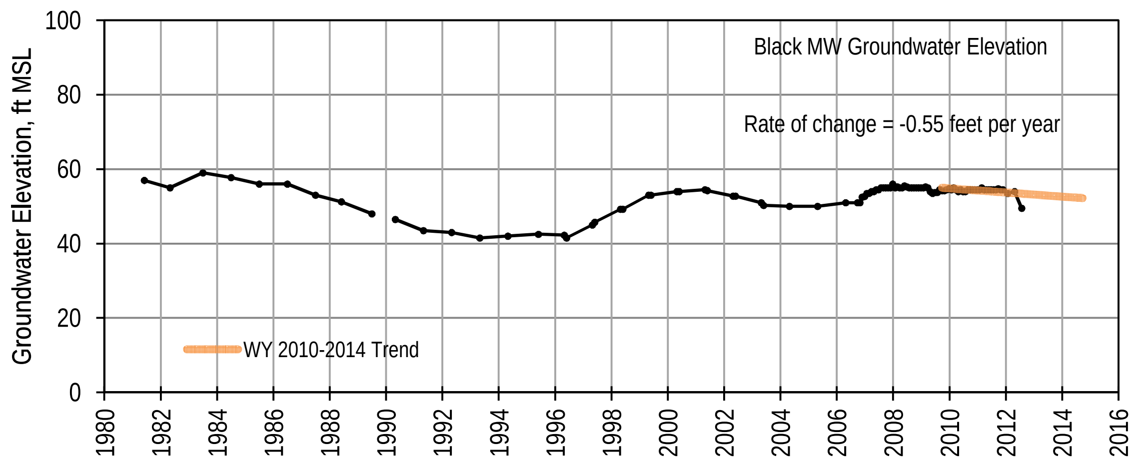

CWD-A Groundwater Elevation
Rate of change = -0.09 feet per year
Groundwater Elevation, ft MSL
50
45
40
35
30
25
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016

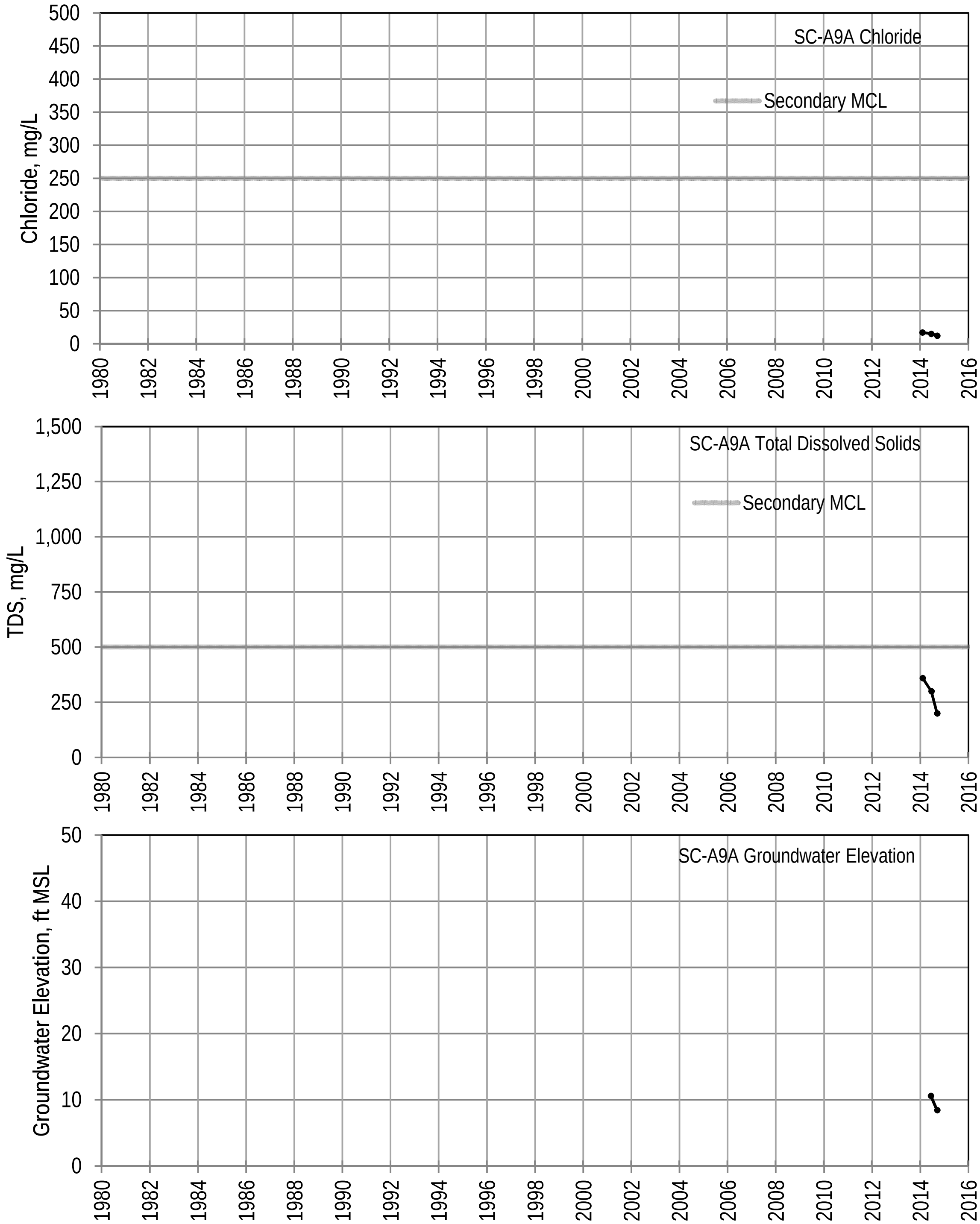

CWD-B Groundwater Elevation
Rate of change = -0.38 feet per year
Groundwater Elevation, ft MSL
50
45
40
35
30
25
20
15
10
5
0
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016


CWD-C Groundwater Elevation
Rate of change = -0.96 feet per year
WY 2010-2014 Trend
Groundwater Elevation, ft MSL
25
20
15
10
5
0
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016

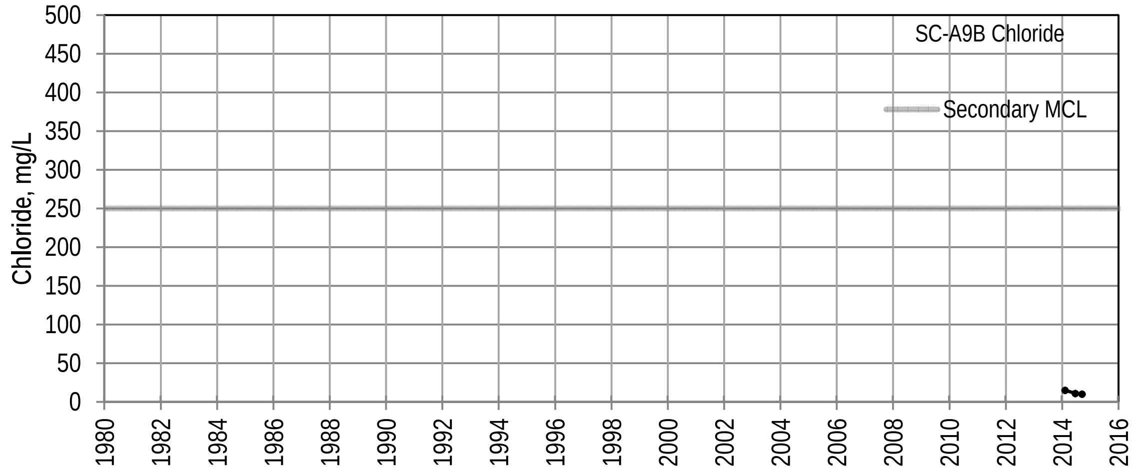

Cox 3 Groundwater Elevation
Rate of change = -0.06 feet per year
Groundwater Elevation, ft MSL
220
200
180
160
140
120
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016

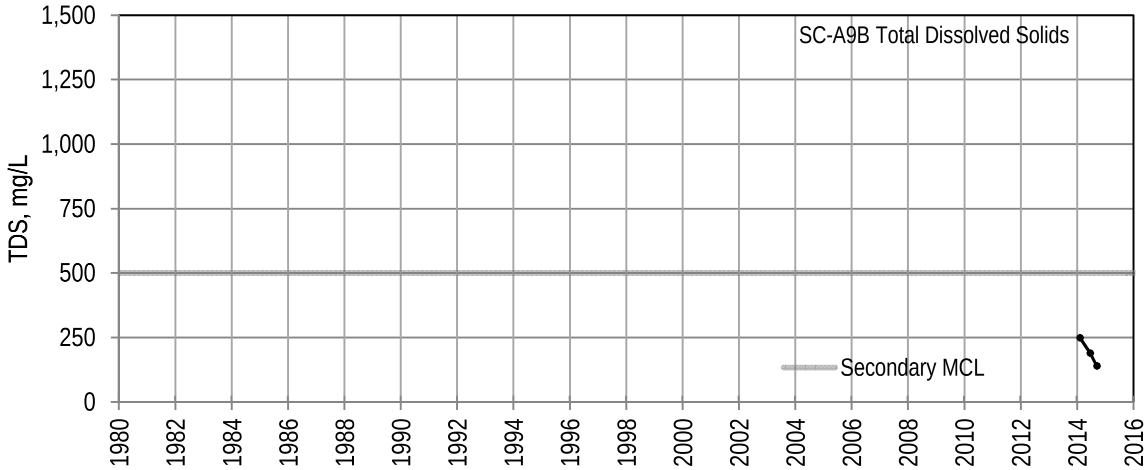

Cox 5 Groundwater Elevation
Rate of change = -0.85 feet per year
Groundwater Elevation, ft MSL
220
200
180
160
140
120
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016

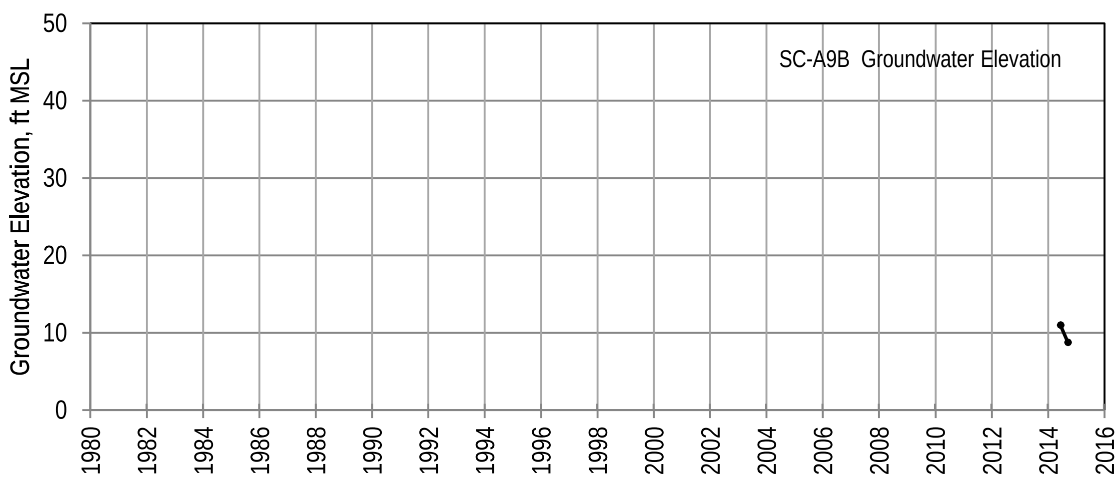

Black MW Groundwater Elevation
Rate of change = -0.55 feet per year
WY 2010-2014 Trend
Groundwater Elevation, ft MSL
100
80
60
40
20
0
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016



SC-A9A Chloride
Secondary MCL
Chloride, mg/L
SC-A9A Total Dissolved Solids
Secondary MCL
TDS, mg/L
SC-A9A Groundwater Elevation
Groundwater Elevation, ft MSL


SC-A9B Chloride
Secondary MCL
Chloride, mg/L
500
450
400
350
300
250
200
150
100
50
0
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016


SC-A9B Total Dissolved Solids
Secondary MCL
TDS, mg/L
1,500
1,250
1,000
750
500
250
0
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016


SC-A9B Groundwater Elevation
Groundwater Elevation, ft MSL
50
40
30
20
10
0
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016

SECTION 6
GROUNDWATER MANAGEMENT PLAN
IMPLEMENTATION STATUS

6.1 STATUS OF BASIN MANAGEMENT OBJECTIVES

The 2007 Groundwater Management Plan (SqCWD and CWD, 2007) listed nine Basin Management Objectives (BMOs) for meeting three basin management goals. The BMOs are specific criteria defining the desired state of the basin. The status of each of the BMOs during Water Year 2014 is summarized in Table and expanded upon below. Each BMO in the Groundwater Management Plan (GMP) is listed, along with an assessment of how well the objective was met in Water Year 2014. Revisions to the BMOs were proposed and approved by the Basin Implementation Group (BIG) in 2013. The official update of the GMP requires approval of SqCWD and CWD Board of Directors, but the assessment is based on the revised objective to reflect current groundwater management. Specific basin management activities, or elements, are discussed in Section 6.2.

Table 6-1: Status of Basin Management Objectives

Number	Basin Management Objective	Status
Goal 1:Ensure water supply reliability for current and future beneficial uses		
1-1	Pump Within the Sustainable Yield	Pumping exceeds recovery goals.
1-2	Develop alternative water supplies to achieve a long-term balance between recharge and withdrawals to meet current and future demand	Alternatives such as water transfers and recycled water being evaluated.
1-3	Manage groundwater storage for future beneficial uses and drought reserve	Depends on achieving BMOs 1-1, 1-2, and 2-2.
Goal 2: Maintain water quality to meet current and future beneficial uses		
2-1	Meet existing water quality standards for beneficial uses, such as drinking water standards.	Drinking water standards met.
2-2	Maintain groundwater levels to prevent seawater intrusion	Achieved at 6 of 14 coastal well locations.
2-3	Prevent and monitor contaminant pathways	Activities ongoing.
Goal 3: Prevent adverse environmental impacts		
3-1	Maintain or Enhance the Quantity and Quality of Groundwater Recharge by participating in land use planning process	Activities ongoing.
3-2	Avoid alteration of stream flows that would adversely impact the survival of populations of aquatic and riparian organisms	Soquel Creek monitoring ongoing.
3-3	Protect the structure and hydraulic characteristics of the groundwater basin by avoiding withdrawals that cause subsidence	No subsidence reported.

BMO 1-1: PUMP WITHIN THE SUSTAINABLE YIELD

- In early 2012, SqCWD updated its estimates for its post-recovery pumping yields, which are meant to protect the Aromas and Purisima areas against seawater intrusion after groundwater levels recover to protective elevations. These long term pumping yields are referred to as post-recovery pumping yields to clarify that the basin needs to be recover before the yields can be used as an annual pumping target. Post-recovery pumping yields are based on modeled offshore flows required to protect against seawater intrusion, along with estimated recharge, non-District consumptive use, and District consumptive use factors (HydroMetrics WRI, 2012). Using the assumption that septic return flow in SqCWD will not change, the post-recovery pumping yield estimated for the Purisima area is 2,890 acre-feet per year as opposed to the pumping goal of 3,000 acre-feet per year in the GMP. The post-recovery pumping yield estimated for the Aromas area is 1,440 acre-feet per year; compared to the pumping goal of 1,800 acre-feet per year in the GMP. Similar to the GMP, these yield estimates assume that only SqCWD would reduce pumping to maintain groundwater levels at protective elevations after recovery.

- To recover groundwater levels to protective elevations, pumping must be reduced below the estimated post-recovery pumping yields. The SqCWD pumping goal based on the post-recovery pumping yield assuming no change to septic return flow is to limit pumping to 3,250 acre-feet per year, 2,400 acre-feet per year from the Purisima area and 850 acre-feet per year from the Aromas area, in order to recover the basin within 20 years (HydroMetrics WRI, 2012). The planning goal for recovery assumes that only SqCWD would reduce pumping to achieve recovery. The estimated recovery time frame also assumes average annual recharge does not change from what has been estimated based on current and historical data.

- SqCWD's total groundwater pumping for Water Year 2014 was 3,761 acre-feet. SqCWD pumped 2,378 acre-feet from the Purisima area (Service Areas I and II). Pumping was less than the post-recovery pumping yield estimate of 2,800 acre-feet per year for the Purisima area for the fifth straight year as well as falling below the pumping goal to recover the basin within 20 years. SqCWD pumped 1,326 acre-feet from the Aromas area (Service Areas III and IV including Aptos Jr. High and the Polo

Grounds well). Annual production fell below the post-recovery pumping yield estimate of 1,330 acre-feet per year but remains above the recovery pumping goal of 850 acre-feet per year.

- CWD's groundwater pumping for Water Year 2014 was 0 acre-feet in the Purisima Formation and 500 acre-feet in the Aromas Red Sands, which meets CWD's target objectives for pumping within the sustainable yield.

- CWD has been within its pumping targets consistently over the last 40 years.

- The City of Santa Cruz pumped 611 acre-feet from the Purisima area in calendar year 2014. This amount is less than the 645 maximum amount of City pumping included in the cooperative groundwater management agreement between the City and SqCWD (SqCWD and City, 2015).

- The City of Santa Cruz pumped 511 acre-feet in Water Year 2014, which is below the 520 acre-feet per year annual average included in the cooperative groundwater management agreement between the City and SqCWD (SqCWD and City, 2015).

- SqCWD, CWD and the City of Santa Cruz's target pumping are within the context of a total estimated pumping in the basin. Other pumpers in the Soquel-Aptos Area include the City of Santa Cruz, small water systems, and private domestic and agricultural wells.

- There have been no updates on pumping estimates for private well pumping for the Purisima area since the GMP was enacted. Estimates for the Aromas area have been extracted from a land use study developed for CWD’s groundwater model and totaled 108 acre-feet per year greater than was estimated at the time of the GMP (HydroMetrics WRI and Kennedy/Jenks, 2014).

- The County has compiled more recent information on small water system consumption and connections and pumping estimates have been provided for Polo Grounds Park in 2007 and Cabrillo College in 2009 and 2015. Irrigation pumping at Polo Grounds Park ceased before 2012 as the well was converted to SqCWD use. Changes in estimates for non-water agency pumping are not great or certain enough to warrant changing water agency pumping goals at this time.

- Measured pumping amounts do not meet numerical targets proposed as revision for this BMO in the GMP as the basin remains in overdraft and pumping will need to be reduced yields to recover groundwater levels in the basin to protective elevations (BMO 2-2).

BMO 1-2: DEVELOP ALTERNATIVE WATER SUPPLIES TO ACHIEVE A LONG-TERM BALANCE BETWEEN RECHARGE AND WITHDRAWALS TO MEET CURRENT AND FUTURE DEMAND

- The pilot plant for the Santa Cruz Water Department/Soquel Creek Water District (SCWD²) Regional Seawater Desalination Project completed testing in April 2009. The pilot study report was issued in 2010. A report on technology innovations and system optimization was issued in 2011.

- Environmental review and design were initiated for the Regional Seawater Desalination Project. The draft EIR was published in 2013 and public comments were published in a Public Review Summary Report. A schedule for response to comments has not been set.

  The Regional Seawater Desalination Project is on hold. The City of Santa Cruz is increasing the involvement of the community in water supply issues before making critical decisions involving future water supplies.

- In 2014, SqCWD performed a preliminary evaluation of alternative supply and identified groundwater replenishment using recycled water and water transfer projects to evaluate further.

- In 2014, the City of Santa Cruz Water Supply Advisory Committee began evaluating alternative supply options.

- SqCWD approved its 2012 Integrated Resources Plan Update (SqCWD, 2012), which evaluated other alternative water supplies such as off-stream diversion of Soquel Creek, satellite reclamation plants for providing recycled water, desalination by SqCWD only, the Glenwood Reservoir and transfer of surplus water from the San Lorenzo River by the City of Santa Cruz. The Plan Update concluded that desalination by SqCWD only and the Soquel Creek off-stream reservoirs have potential for future consideration if $SCWD^2$ does not materialize.

- The 2012 Integrated Resources Plan Update also evaluated using mandatory water restrictions to reduce consumption for typical residential customers by 35% in order to meet pumping goals. The Plan Update concluded that this alternative has potential for future consideration if $SCWD^2$ does not materialize.

- The County continues to evaluate the feasibility and benefits of interties and water transfers among water agencies in northern Santa Cruz County. Information about using excess winter flows in the San Lorenzo River to potentially meet 30% of SqCWD's winter demand was presented in 2011 (Khalsa, 2011). The evaluation includes a legal assessment of various water rights options for the water transfers (Nguyen, 2013). A final report is expected to be issued in 2015. SqCWD supports this continued evaluation but recognizes that a transfer may not provide enough water by itself to meet this BMO. With upgrades of diversion facilities and treatment facilities, as well as new water rights, potential annual average yield from transfers to SqCWD could be 1000-1700 af/yr, based on information presented to the SqCWD Board in November, 2013 (Ricker)

- SqCWD, CWD, and the City of Santa Cruz continue to maintain and update their conservation programs to reduce current and future demand.

BMO 1-3: MANAGE GROUNDWATER STORAGE FOR FUTURE BENEFICIAL USES AND DROUGHT RESERVE

- Groundwater levels remain below protective elevations (BMO 2-2) in much of the basin therefore water was not stored for future beneficial uses and drought reserve.

- The GMP states that "achieving this objective is likely to depend on first achieving BMO 1-1 and BMO 1-2 since storing surplus water will not be possible without first eliminating overdraft conditions and developing alternative supplies." BMO 1-1 has not been met because pumping is above goals to achieve recovery and eliminate overdraft. Options to develop alternative water supplies under BMO 1-2 are being re-evaluated with the regional desalination project on hold.

BMO 2-1: MEET EXISTING WATER QUALITY STANDARDS FOR BENEFICIAL USES, SUCH AS DRINKING WATER STANDARDS

- Drinking water from SqCWD, CWD, and City of Santa Cruz municipal wells was tested according to Title 22 requirements. In Water Year 2014, raw groundwater pumped by SqCWD and the City of Santa Cruz from the Purisima Formation met all water quality standards except for iron, manganese, color and turbidity. Raw groundwater from the Purisima Formation was treated to meet water quality standards for these constituents; all delivered water met drinking water standards. In Water Year 2014, groundwater pumped by SqCWD from the Aromas Red Sands met all drinking water standards except for the standard for Chromium VI which became effective July 1, 2014. SqCWD conducted a successful pilot treatment project in 2013 that showed it will be able to meet this standard and meet the basin management objective for the Aromas Red Sands aquifer. Water delivered by CWD from its Purisima Formation and Aromas Red Sands sources met all drinking water standards.

- Groundwater from SqCWD monitoring wells was tested regularly for indications of seawater intrusion. TDS and chloride concentrations in Aromas monitoring wells show long term seawater intrusion. No new intrusion was detected in monitoring wells that were previously un-impacted.

- Groundwater in two City of Santa Cruz monitoring wells has had TDS and chloride concentrations that suggest seawater intrusion since the wells were installed in 2004. Only the Soquel Point Medium monitoring well currently has chloride concentrations above the secondary MCL.

- Groundwater from SqCWD's Sells well showed concentrations at or just under the maximum contaminant limit for nitrates starting in 2009. The Sells well was taken out of service in April 2009.

BMO 2-2: MAINTAIN GROUNDWATER LEVELS TO PREVENT SEAWATER INTRUSION

- Water Year 2014 groundwater levels at one of the five SqCWD coastal monitoring well clusters in the Purisima area met protective elevations as outlined in *Groundwater Levels to Protect against Seawater Intrusion and Store Freshwater Offshore* (HydroMetrics LLC, 2009b) and proposed as revisions to this BMO. Average groundwater levels at well SC-1A have been above protective elevations since Water Year 2010.

- Water Year 2014 groundwater levels at three of the five SqCWD coastal monitoring well clusters in the Aromas area met protective elevations as revised in *Revised Protective Elevations and Outflows for the Aromas Area and Updated Water Balance for the Soquel-Aptos Groundwater Basin* (HydroMetrics WRI, 2012) and proposed as revisions to this BMO. Average groundwater levels at the northwestern SC-A1 well cluster have been above revised protective elevations for most of the monitoring record. Average groundwater levels at the southeastern SC-A2 and SC-A3 well clusters rose above protective elevations in Water Years 2014 and 2012, respectively.

- Water Year 2014 groundwater levels at City of Santa Cruz coastal monitoring wells met target elevations in the cooperative groundwater management agreement between SqCWD and the City (2015) at two of the City's three coastal well clusters. Average groundwater levels at the Moran Lake well have been above protective elevations since the well was installed in 2004. Average groundwater levels at the Pleasure Point well have been above protective elevations in Water Years 2010 through 2014.

- Groundwater levels will not meet all protective elevations until BMO 1-2 is achieved, and pumping in the basin is maintained below post-recovery pumping yields.

BMO 2-3: PREVENT AND MONITOR CONTAMINANT PATHWAYS

- SqCWD and CWD continue to implement the well abandonment requirements in Santa Cruz County's well ordinance.

- Santa Cruz County used Proposition 50 bond funding to implement a well destruction program in 2012.

- SqCWD has not updated its Drinking Water Source Assessment and Protection (DWSAP) reports (Todd Engineers, 2002 and LSCE, 2002) since the GMP has been enacted. California DHS recommends review and update of DWSAP reports every five years (California DHS, 1999), and an update of the potentially contaminating activities near SqCWD's wells will be completed in 2015.

- SqCWD submitted a DWSAP reports for the Aptos Jr. High and Polo Grounds wells to State Department of Public Health in 2011 (HydroMetrics WRI, 2011b and 2011c).

- CWD submitted updated DWSAP reports (Johnson, 2009) to State Department of Public Health in Water Year 2009.

- SqCWD will submit a DWSAP report for the O'Neill Ranch well in 2014.

BMO 3-1: MAINTAIN OR ENHANCE THE QUANTITY AND QUALITY OF GROUNDWATER RECHARGE BY PARTICIPATING IN LAND USE PLANNING PROCESSES

- SqCWD and CWD continue to support Santa Cruz County efforts to review land use proposals in Primary Recharge Areas and identify projects to enhance groundwater recharge. SqCWD has a representative on the Technical Advisory Committee for these efforts. Santa Cruz County requires all new development and redevelopment projects to maintain or exceed pre-development stormwater infiltration rates.

- CWD continued to maintain much of its area as a primary recharge area.

BMO 3-2: AVOID ALTERATION OF STREAMFLOWS THAT WOULD ADVERSELY IMPACT THE SURVIVAL OF POPULATIONS OF AQUATIC AND RIPARIAN ORGANISMS

- SqCWD continued to monitor streamflow and shallow groundwater levels near Soquel Creek.

- SqCWD's finalized its Well Master Plan EIR in 2011 (ESA, 2011). The EIR includes measures for monitoring streamflow at Soquel Creek and Aptos Creek, and pumping modifications if baseflow depletion related to future pumping from the proposed O'Neill Ranch Well and Austrian Way Well are detected.

- SqCWD submitted a stream monitoring and adaptive management plan for Soquel Creek to Santa Cruz County and National Marine Fisheries Service and began implementation of the plan in partnership with the City of Santa Cruz. The first reports evaluating baseline conditions before the O'Neill Ranch and Beltz #12 wells come online will be submitted to the County and National Marine Fisheries Service in 2015.

BMO 3-3: PROTECT THE STRUCTURE AND HYDRAULIC CHARACTERISTICS OF THE GROUNDWATER BASIN BY AVOIDING WITHDRAWALS THAT CAUSE SUBSIDENCE

- No subsidence has been reported since the GMP was enacted

6.2 STATUS OF BASIN MANAGEMENT ELEMENTS

The Soquel-Aptos Basin Groundwater Management Plan Update includes 14 elements. Elements are the specific projects, programs, and policies that are planned for management of the Basin. Action items were identified for each element. This section provides a summary and status of the action items included in each element. Status descriptions were provided by SqCWD, CWD, City of Santa Cruz, Santa Cruz County, and Pajaro Valley Water Management Agency.

Action items that have been identified since the Groundwater Management Plan Update are added. The Water Year report where the action item is first identified is included in parantheses.

ELEMENT 1: GROUNDWATER MONITORING

1. ***Continue and expand existing regional groundwater monitoring programs***

   SqCWD and CWD continued measuring groundwater levels and sampling groundwater quality from their network of monitoring and production wells as described in the GMP.

   SqCWD has expanded its network by adding monitoring wells:

   - In Water Year 2008, quarterly groundwater level measurements were initiated at the SC-19 well at Austrian Way and monthly groundwater level measurements and quarterly water quality measurements were initiated at the three SC-A8 wells located at Dolphin Drive and Sumner Avenue.
   - In Water Year 2009, SqCWD installed three SC-20 monitoring wells at Polo Grounds Park using Proposition 50 bond funding. Data loggers were installed in these new wells to continuously record groundwater levels.
   - In Water Year 2012, SqCWD installed new monitoring wells at the Cornwell Road Tank Site (SC-21) and on 41st Ave in the Western Purisima (SC-22). SqCWD also began monitoring the newly installed O'Neill Ranch production well in 2012.
   - In Water Year 2014, SqCWD installed new monitoring wells at the Larkin Valley Tank Site (SC-A9) and on Quail Run Road in the Eastern Purisima (SC-23).

   The City of Santa Cruz continued measuring groundwater levels and sampling groundwater quality at its network of monitoring wells. In early 2010, the City of Santa Cruz expanded its network when it installed monitoring wells at three new locations: Coffee Lane Park, Cory Street, and Auto Plaza Drive. In 2012, the City installed monitoring wells at 30th Avenue and Elda Lane, converted the former Beltz 7 production well to two monitoring wells, and replaced the deep monitoring well at Soquel Point. Groundwater levels are measured monthly and groundwater quality is sampled semi-annually at all City of Santa Cruz's monitoring wells. In 2013, the City installed a deeper monitoring well at Cory Street to monitor the Tu unit that supplies the City's Beltz #12 well and SqCWD's O'Neill Ranch well.

Santa Cruz County Environmental Health Services monitors groundwater levels in approximately 35 private and small water system wells constructed in the Purisima and Aromas aquifers. Wells are measured semi-annually (spring and fall). County monitoring of these wells was discontinued after SqCWD started monitoring the wells for potential impacts of pumping at the Polo Grounds well.

2. *Continue shallow Groundwater Monitoring Program*

SqCWD continued to monitor groundwater levels in shallow wells along Soquel Creek. In 2012, SqCWD installed a new shallow well on Soquel Wharf Road, the first shallow well on the west side of the Creek. Monitoring of the Simon shallow well was suspended in 2011 but an agreement to recommence monitoring was obtained in 2012. Equipment for monitoring groundwater levels in shallow wells was installed and tested in 2012 at the Main Street, Soquel Wharf Road, and Nob Hill shallow wells. In Water Year 2014 a replacement shallow groundwater monitoring well was installed at the Nob Hill site.

3. *Share and consolidate monitoring data among all agencies overlying the Soquel-Aptos Area Basin*

In 2009, the state enacted legislation (SBX7-6) implementing the California Statewide Groundwater Elevation Monitoring (CASGEM) program, requiring submittal of groundwater level data for all groundwater basins in the state. Groundwater elevation data from the Soquel-Aptos basin are being submitted to the State as part of the County-wide data submittals. With the support of the Basin Advisory Group, Santa Cruz County is the reporting entity for all groundwater basins in the County. PVWMA staff has developed a framework for the database that will be used to submit the data to the state. County staff prepared and submitted the coordinated monitoring plan to the state in 2011 (Khalsa, 2011). County staff continues to coordinate submission of CASGEM data (Nguyen, 2015).

Additional data are shared by SqCWD, CWD, Pajaro Valley Water Management Agency, the City of Santa Cruz, and Santa Cruz County in an ad-hoc manner. SqCWD's file transfer system is used for the agencies to upload and download data.

4. ***Analyze data and assess the adequacy of the monitoring well network annually***

Analyses of groundwater data are discussed in Sections 3-5.

In Water Year 2008, SqCWD began implementing recommendations in the *Evaluation of Water Quality Monitoring Network and Recommendations for Improvement* (HydroMetrics LLC, 2007) by installing new bladder pump equipment for sampling and identifying monitoring wells that need to be replaced.

In Water Year 2009, SqCWD replaced the three SC-3 monitoring wells at Escalona Drive because they were providing unreliable data. Monitoring wells SC-8F, SC-9A, and SC-A2 were replaced in 2012, along with wells SC-9C and SC-9E. Wells SC-9B and SC-9D were destroyed and not replaced, as SC-9C and SC-9E provide more representative data of the aquifer units.
Monitoring wells at Cherryvale (SC-10), Porter Gulch (SC-11), and Main Street (SC-18) were replaced in the past year with a new deeper well installed at Cherryvale (SC-10AAA).

Based on an Assessment and Informational Update of the Groundwater Management Program, SqCWD's board approved a plan in 2009 for retrofitting existing monitoring wells with groundwater level data loggers and bladder pumps. Groundwater level loggers and bladder pumps are currently installed in the SC-1, SC-3R, SC-5RA, SC-8R (except SC-8RE which is artesian), SC-9R, SC-10R, SC-11R, SC-18R, SC-21, SC-22, SC-23, SC-A1, SC-A2R, SC-A3, SC-A4, SC-A5, SC-A8, and SC-A9 wells. SC-5RB only has a bladder pump installed. SC-20 only has groundwater level loggers installed.

5. ***Coordinate with other groundwater resource agencies to develop uniform data collection procedures and data sharing protocols***

Minimum standards for monitoring protocols have not yet been set for all agencies in the Soquel-Aptos Area Basin.

SqCWD continued to support Santa Cruz County efforts to create a GIS well layer for information about private wells in Santa Cruz County. The database has information on about 6,000 private wells throughout the County. The County provided a GIS layer of monitored private wells for use in this annual report.

The County has begun development of a coordinated database for water resources data through the Integrated Regional Water Management Plan using Proposition 50 funds.

6. ***Develop an outreach program to obtain groundwater level data from private pumpers within the Soquel-Aptos area***

   In 2008, Santa Cruz County established a voluntary groundwater monitoring program with private well owners in the Soquel-Aptos basin and provided the data for use in this annual report.

   As part of the Well Master Plan EIR, SqCWD is including a voluntary monitoring and mitigation program for private wells within 1,000 meters of new SqCWD production wells (ESA, 2010). The program includes collection of production and groundwater level data at private wells to monitor for restrictive effects related to pumping of a new SqCWD well. Thirteen private wells near the Polo Grounds well enrolled in the program and monitoring at these wells commenced in 2012. Eight private wells near the O'Neill Ranch well enrolled in the program and monitoring at these wells commenced in 2013.

ELEMENT 2: SURFACE WATER MONITORING

1. ***Monitor stream gauges on Soquel Creek to identify and track changes in baseflow conditions***

   SqCWD continued to monitor streamflow and temperature at the Upper Soquel Creek and West Branch stream gauges. Data loggers record stream elevations every 15 minutes, and the data are downloaded and converted to daily values once a month. SqCWD continued to contribute toward the cost to operate and maintain the Soquel Creek Stream Gauging Station at Bridge Street along with Santa Cruz County and the U.S. Geological Survey.

   The County conducted a sediment monitoring program on Soquel Creek and the West Branch from 2008-2011.

   SqCWD's Well Master Plan EIR contains plans for monitoring streamflow on Soquel Creek (ESA, 2011). A stream monitoring and adaptive management plan was submitted to the resource agencies in 2012. The Soquel Wharf Road shallow well and Nob Hill stream water level gauge were installed downstream of the O'Neill Ranch and City of Santa Cruz Beltz #12 wells. In its response to comments on Beltz #12 EIR, the City committed to partner with SqCWD in developing and implementing the plan (Almond, 2011). The first report on baseline data prior to the two new production wells coming online will be submitted to the resource agencies in 2015.

2. ***Monitor rainfall in the Soquel-Aptos Area Basin to establish rainfall-runoff relationship***

SqCWD continued to collect rainfall data at the Mancarti and Kraeger/Longridge Rain Gauges within the Soquel Creek Watershed. Data loggers record values every 15 minutes, and the data are downloaded and converted to daily values once a month.

SqCWD, CWD, and the City of Santa Cruz cooperatively funded a study to estimate the spatial and temporal variation in deep groundwater recharge. The study used daily rainfall data at four coop climate stations in and around the Soquel-Aptos Basin in addition to the Mancarti and Kraeger/Longridge gauges (Figure 2-1) to estimate deep recharge.

SqCWD has installed a weather station at its Main Street wells site as part of the Soquel Creek monitoring and adaptive management plan. The station monitors rainfall data.

3. ***Monitor selected shallow wells adjacent to creeks to identify and quantify stream aquifer interactions. Coordinate a meeting with SqCWD and the County of Santa Cruz to discuss future analysis of the shallow well monitoring data from 2003 – 2006***

SqCWD continued to measure shallow groundwater levels at the four monitoring sites along the eastern side of Soquel Creek: Simons, Balogh, Main Street, and Nob Hill. A new shallow well on the western side of Soquel Creek was installed at Soquel Wharf Road in 2012.

Analysis of these shallow groundwater levels was provided in the *Water Year 2007 Annual Review and Report* (HydroMetrics LLC, 2009a). Santa Cruz County is on the Basin Advisory Group that reviewed the analysis. Shallow well water levels will also be presented in the Soquel Creek monitoring and adaptive management reports.

4. ***Analyze stream gauge data, rainfall data, and shallow monitoring data annually***

Data from the above three monitoring programs were analyzed in the *Water Year 2007 Annual Review and Report* (HydroMetrics LLC, 2009a). Additional analysis is not included in this report, but further analysis will be included in reports for the Soquel Creek monitoring and adaptive management plan. Additional reporting may be necessary in the future as the surface water monitoring program is expanded to other creeks such as Aptos Creek.

5. ***Support stream monitoring and management activities along Aptos Creek and Valencia Creek***

The County has maintained a program of streamflow and sediment monitoring on Valencia Creek from September 2008 to September 2011.

SqCWD's Well Master Plan EIR contains measures for monitoring streamflow on Aptos Creek, including installation of a new streamflow gauge downstream of the proposed Austrian Way well (ESA, 2011).

The Aptos Creek pathogen TMDL has been adopted by the Regional Water Quality Control Board. The sediment TMDL for the Aptos watershed is on hold because management measures are being implemented through the Santa Cruz County Stormwater Management Program (Briggs, 2007). Stormwater management plans for the County were approved by the Regional Water Quality Control Board in 2009 and implementation activities are ongoing.

The County, City of Santa Cruz and Scotts Valley Water District recently received Proposition 84 stormwater grant to implement projects to reduce stormwater runoff and increase groundwater recharge by infiltrating runoff from impervious surfaces. These projects will be implemented in 2015 (Nguyen, 2015).

SqCWD continued its ongoing funding and review of stream habitat and juvenile salmonid (steelhead and coho salmon) monitoring in the Soquel and Aptos Creek watersheds as part of the Santa Cruz County Stream Habitat and Juvenile Salmonid Sampling Program.

ELEMENT 3: SUBSIDENCE MONITORING

1. Develop and implement a GPS based subsidence monitoring program

SqCWD and CWD have not initiated work to develop and implement a subsidence monitoring program.

2. Analyze data and assess the frequency of the subsidence monitoring

This action item cannot be performed until a subsidence monitoring program is implemented.

3. Review other means of subsidence measuring and monitoring

SqCWD and CWD have not reviewed alternate means of measuring and monitoring subsidence.

ELEMENT 4: INTERAGENCY COORDINATION

1. Develop and secure a supplemental source of supply with the City of Santa Cruz

The pilot plant for the Santa Cruz Water Department/Soquel Creek Water District (SCWD^2) Regional Seawater Desalination Project completed testing in 2009. Environmental review and design were initiated for the Regional Seawater Desalination Project in 2010. A Notice of Preparation and Initial Study for Environmental Impact Report of the Regional Seawater Desalination Project was issued in November 2010. A scoping report was issued in February 2011 that summarizes public comment on the proposed scope and content of the Environmental Impact Report. The Draft EIR is scheduled was published in 2013 and public comments were published in a Public Review Summary Report. However, the project is on hold while the City of Santa Cruz is increasing the involvement of the community in water supply issues.

2. Continue to cooperatively manage groundwater under the provisions of the Soquel Aptos Groundwater Management Alliance (SAGMA)

SAGMA makes up most of the Basin Advisory Group that meets annually and reviews this annual report.

3. ***Expand the Soquel-Aptos Groundwater Management Authority to include other water resource agencies that have jurisdiction within the Soquel-Aptos area***

   The Joint Powers Authority was amended in 2015 to include the City of Santa Cruz and Santa Cruz County in the Soquel-Aptos Groundwater Management Comittee.

4. ***Continue to support the USGS GAMA project and work cooperatively with USGS, State, and regional agencies to improve statewide monitoring***

   The Groundwater Ambient Monitoring and Assessment Program (GAMA) last tested private and public wells in the Soquel-Aptos area in 2005 (Kulongoski and Belitz, 2007). The GAMA program intends to sample a subset of these wells every three years to establish groundwater quality trends. SqCWD and CWD will support the USGS as it conducts new sampling at wells in the Soquel-Aptos area.

5. ***Continue to support the USGS Soquel Creek Stream Gauging Station***

   SqCWD continues to contribute toward the cost to operate and maintain the Soquel Creek Stream Gauging Station at Bridge Street in Soquel.

6. ***Continue to participate and support the Northern Santa Cruz County Integrated Regional Water Management Plan (IRWMP)***

   Proposition 50 funding for projects identified in the IRWMP has reimbursed the 2009 construction of monitoring wells at the Polo Grounds Park. SqCWD used Proposition 50 funding to convert the Polo Grounds irrigation well to a municipal well. Santa Cruz County used funding for abandoned well destruction and projects to enhance groundwater recharge.

   A Proposition 84 planning grant for IRWMP studies was approved by the State in 2011. Included in the approved studies was the Aromas and Purisima Groundwater Basin Management Study. This study was conducted by CWD and evaluated maximizing the developable yield in CWD's Cox Well Field; addressed concerns about Chromium VI in the CWD service area; and addressed regional Aromas water quality and overdraft concerns. This study was completed in early 2014. This grant is also supporting the next phase of developing opportunities for transfer of surplus water from the San Lorenzo River by the City of Santa Cruz to allow reduction in groundwater pumping.

In Water Year 2014 the Resource Conservation District of Santa Cruz County worked with landowners and agency partners to complete over 70 habitat improvement projects through the Integrated Watershed Restoration Programs (IWRP). These projects included wetland restoration, fish barrier removal, rural road upgrades, stream habitat improvement and community education (Nguyen, 2015).

An update of the IRWM Plan was completed in August 2014 using Proposition 84 funding.

7. ***Support implementation of Pajaro Valley Water Management Agency's (PVWMA) Basin Management Plan and PVWMA/City of Watsonville efforts to develop the Watsonville Area Water Recycling Project***

SqCWD and CWD continue to support implementation of PVWMA's Basin Management Plan (BMP) and the Watsonville Area Water Recycling Project, which began operation in April 2009. In 2014, the recycled water facility produced approximately 2,861 acre-feet of recycled water, and in total 4,685 acre-feet of blended irrigation supply was delivered to growers connected to the CDS. Between 2009 and 2014, approximately 13,212 acre-feet of recycled water was produced and 20,465 acre-feet of blended water was delivered by the Coastal Distribution System. In April of 2014, the PVWMA Board of Directors certified the Basin Management Plan Update Environmental Impact Report and adopted the Basin Management Plan Update. The Conservation and Customer Service Field Manager of SqCWD served on an ad-hoc BMP Committee composed of 21 community members between 2010 and 2014. Implementation of Phases I & II of the BMP Update, which includes a combination of projects and programs aimed at optimizing existing water supply facilities, developing new water supply facilities utilizing local surface water supplies and implementing a conservation / irrigation efficiency program, is expected to reduce an offset in the water budget by 12,100 acre-feet per year to balance the basin and reduce seawater intrusion by 90%.

8. ***Support PVWMA efforts to develop a numerical model of the Pajaro Valley groundwater basin***

PVWMA has developed the Pajaro Valley Hydrologic Model, a numerical model of the Pajaro Valley basin. SqCWD had a representative on the model's Technical Advisory Committee, which approved the final model in 2010. SqCWD and CWD also provided data for the model. The model was used in the update to PVWMA's Basin Management Plan. An update of the model by the USGS commenced in 2014.

9. ***Support the Central Coast Regional Water Quality Control Board's (RWQCB) Implementation Strategy for the Aptos Watershed Sediment Total Maximum Daily Load (TMDL) Report***

RWQCB decided in 2007 to implement management measurements for sediment impairment of the Aptos watershed through the Santa Cruz County Stormwater Management Program (Briggs, 2007). The State Water Resources Control Board approved the County's Storm Water Management Plan in Water Year 2009. The County completed a draft runoff and pollution control ordinance, draft stormwater construction best management practices manual, and updates to design criteria for stormwater management in 2012. SqCWD and CWD continue to support the County's implementation of stormwater management.

10 (2012). Develop and implement cooperative management agreements to monitor and mitigate impacts from operating new municipal wells.

In 2011, SqCWD and CWD agreed on cooperative groundwater management to monitor and mitigate any impacts on CWD's wells from operating the Polo Grounds well, which is being converted from park irrigation to municipal use. Implementation of the agreement has commenced and the baseline report for conditions prior to operation of the Polo Grounds well was issued in 2013.

SqCWD and the City of Santa Cruz have developed plans to monitor and mitigate impacts from operating the O'Neill Ranch and Beltz #12 wells as part of the EIRs for those wells. In 2015, SqCWD and CWD agreed on cooperative groundwater management for the western part of the Purisima area.

11 (2010). Coordinate on water resource data and technical studies.

SqCWD and CWD staff participated with County staff in a 2009 joint meeting of the County Water Advisory Commission and the Commission on the

Environment to discuss local issues related to water supply and climate change. The County sponsored a U.S. Geological Survey study of climate change effects on County hydrology, which was completed in 2012.

SqCWD, CWD, and the City of Santa Cruz cooperatively funded a study to estimate the spatial and temporal variation in deep groundwater recharge that was completed in 2011 (HydroMetrics WRI, 2011a).

SqCWD, CWD, the City of Santa Cruz, and PVWMA are working with the County to provide groundwater level data for submission to the state under the new California Statewide Groundwater Elevation Program (CASGEM).

Representatives from the County, SqCWD, and PVWMA served on the Technical Advisory Committee for CWD's Aromas and Purisima Groundwater Basin Management Study.

The agencies of the Basin Advisory Group are coordinating on water resource data that will be used for the groundwater model. There is also coordination with a subcommittee of the stakeholder advisory group on private well water use data.

11 (2013). Support County efforts to engage non-municipal groundwater users

The County formed stakeholder advisory group to improve small water systems and private well owners' participation in groundwater management of the basin. SqCWD and CWD provided technical support to the County in this effort.

The County Water Resources Laboratory has a program to offer free nitrate testing to residents with individual private wells (Nguyen, 2015).

ELEMENT 5: DEVELOP A SUPPLEMENTAL SOURCE OF SUPPLY

1. Develop and secure a supplemental water supply suitable for implementing a conjunctive use program

The pilot plant for the Santa Cruz Water Department/Soquel Creek Water District (SCWD[2]) Regional Seawater Desalination Project completed testing in April 2009. A Notice of Preparation and Initial Study for Environmental Impact Report of the Regional Seawater Desalination Project was issued in

November 2010. The Draft EIR was published in 2013 and public comments were published in a Public Review Summary Report. However, the project is on hold due to concerns about the level of community support for the project.

In 2014, SqCWD performed a preliminary evaluation of alternative supply options and identified groundwater replenishment using recycled water and water transfer projects to evaluate further.

In 2014, the City of Santa Cruz Water Supply Advisory Committee began evaluating alternative supply options.
The County is is completing recommendations for conjunctive use and water transfers using a Proposition 84 IRWM Planning Grant.

2. *Explore and pursue funding opportunities for supplemental supply projects*

SqCWD and CWD supported the IRWMP that was awarded Proposition 50 funding for intake study costs related to the desalination plant. SqCWD also received grant funding in 2008 to study the feasibility and cost-effectiveness of constructing satellite reclamation plants to provide recycled water. The recommendation from this study concluded that construction of satellite reclamation plants to provide recycled water is not cost-effective and SqCWD would need to obtain additional funding to pursue the project (Black and Veatch, 2009).

SqCWD participated with the County and City of Santa Cruz in the evaluation and feasibility of the potential to utilize the City of Santa Cruz facilities to divert and treat excess winter streamflow from the San Lorenzo River to SqCWD during the months of November through April to allow reduction in groundwater pumping and in lieu recharge. The County's work on the project was funded by a Prop 84 IRWM Planning grant.

In 2014, the Santa Cruz IRWM region applied for drought funding under Proposition 84 to explore groundwater recharge with recycled water and make more efficient use of the City of Santa Cruz supply. Although the application scored well, there was not enough funding to available for the Central Coast funding area (Nguyen, 2015).

ELEMENT 6: PROTECT EXISTING RECHARGE ZONES

1. ***Support existing Santa Cruz County efforts to update Groundwater Recharge Maps that identify primary groundwater recharge zones***

   SqCWD and CWD continue to support Santa Cruz County efforts to update these maps shown as Figure 6-1 to meet new state requirements to include a map of recharge areas in the GMP. The County has updated primary groundwater recharge maps using electronic GIS data on soils and geology. The County also has soil information to assist with identifying secondary recharge areas as needed.

   SqCWD, CWD, and the City of Santa Cruz cooperatively funded a study to estimate the spatial and temporal variation in deep groundwater recharge. The study used daily rainfall data at four coop climate stations in and around the Soquel-Aptos Basin in addition to the Mancarti and Kraeger/Longridge gauges to estimate deep recharge. This study identifies where most of the basin recharge takes place.

2. ***Support PVWMA's efforts to optimize recharge and recovery, and develop an ASR (Aquifer Storage and Retrieval) Project in the Aromas Red Sands***

   PVWMA has developed and is operating the Harkins Slough Managed Aquifer Recharge and Recovery Facility. This facility involves seasonal percolation of diverted Harkins Slough water into the Harkins Slough recharge basin for storage until the irrigation season, when it is extracted and delivered to the Coastal Distribution System (CDS) for distribution. The construction of the Harkins Slough diversion structure and recharge basin was completed in fall 2001. The facility has operated every year since 2002. Between 2002 and 2014, 7,064 acre feet of water have been diverted from Harkins Slough and pumped to the percolation pond. Recovery wells have extracted approximately 2,295 acre feet of diverted water for distribution in the CDS. The remaining water is in storage and left to recharge the underlying aquifers. A dry weather, brackish water flood event in January 2012 sent salty water over five miles upstream into Harkins Slough. The lack of rainfall due to the historic drought California is facing has largely prevented that brackish water from being flushed out of the system. As a result, diversions to the recharge basin have been limited. Recent studies performed by the University of California, Santa Cruz (hydrogeology), and Stanford University (geophysics) have improved staff's understanding of the hydrologic structure that controls recharge and recovery. SqCWD and CWD wrote letters of support for PVWMA's successful Local Grant Assistance (AB303) grant application to study the recharge processes beneath the pond with the goal of gaining better understanding of the fate of percolated water. The study, called the Harkins Slough Project Re-Operation Feasibility Study began in 2010 with the installation of three new monitoring wells and was completed in 2012. A result of that grant funded study, and the work completed by UCSC and Stanford, led PVWMA to drilling two new recovery wells in the summer of 2012. PVWMA continues to work on optimizing this facility.

PVWMA and its partners received approximately $5 million in drought relief funding under Proposition 84. This will help fund expanded storage and distribution for recycled water irrigation and improved irrigation efficiency (Nguyen, 2015).

3. ***Support future efforts to characterize recharge areas within the Soquel-Aptos area***

The data from the GAMA project (Kulongoski and Belitz, 2007) are expected to include chemical analyses that will help characterize recharge areas. A full review of these data to perform this characterization has not taken place.

SqCWD, CWD, and the City of Santa Cruz cooperatively funded a study to estimate the spatial and temporal variation in deep groundwater recharge (HydroMetrics WRI, 2011a). The study used daily rainfall data at four coop climate stations in and around the Soquel-Aptos Basin in addition to the Mancarti and Kraeger/Longridge gauges to estimate deep recharge. This study identifies where most of the basin recharge takes place.

4. ***Coordinate and expand efforts between groundwater management agencies and the County of Santa Cruz to establish regulations for land use within Primary Recharge Areas***

SqCWD and CWD continue to support County efforts to review land use proposals within Primary Recharge Areas.

Element 7: Enhance Groundwater Recharge

1. ***Enhance groundwater recharge with stormwater runoff***

SqCWD and CWD continue to support Santa Cruz County efforts to identify projects to enhance groundwater recharge. The County led a Proposition 50 funded effort to implement demonstration projects to restore groundwater infiltration from developed areas at Polo Grounds Park and Brommer Street Park within the Groundwater Management Area. Installation of two separate facilities at Polo Grounds Park was completed in 2011 and 2012. The County received a Prop 84 stormwater grant to construct the Brommer Street project and provide additional infiltration measures as a part of a new park development at the Heart of Soquel Park to be implemented in 2014. The Resource Conservation District of Santa Cruz County is also implementing a separate grant funded project to promote recharge through home drainage improvements, including outreach and technical assistance.

CWD supported Aptos High School with its recharge pond project in 2008.

In 2014, the County, City of Santa Cruz, and Scotts Valley Water District received a Proposition 84 stormwater grant to implement projects to reduce stormwater runoff and increase groundwater recharge by infiltrating runoff from impervious surfaces. This will be implemented in 2015 (Nguyen, 2015).

2. ***Develop and implement standards that require discretionary projects in primary recharge zones to maintain or increase a site's pre-development absorption of runoff***

SqCWD and CWD continue to support County efforts to develop a program that will include standards regulating impervious surfaces and provide measures to increase groundwater recharge. The County is working with RWQCB to develop requirements for Low Impact Development to address hydromodification impacts as required in the County's stormwater plan. The County adopted a runoff and pollution control ordinance, stormwater construction best practices manual, and updates to design criteria for stormwater runoff in 2012. The RWQCB has approved the County's program as meeting the state requirements, with some enhancements.

3. ***Support County of Santa Cruz efforts to prioritize potential sites for drainage facilities, and implement construction***

SqCWD and CWD continue to support County efforts to identify drainage facilities with potential for groundwater recharge.

4. ***Participate in public outreach and awareness for groundwater recharge***

   SqCWD and CWD supported the County and Resource Conservation District (RCD)'s implementation of the grant funded projects to promote recharge.

5. ***Investigate the water storage potential of the Aromas Red Sands***

   Potential projects for enhanced recharge in the Pleasant Valley/Freedom Blvd. area may be considered by SqCWD and CWD.

ELEMENT 8: MANAGE PUMPING

1. ***Locate, design, and install additional and replacement production wells to improve pumping distribution, disperse the basin's overall drawdown and improve operational flexibility***

   SqCWD published its draft EIR for the Well Master Plan in 2010. After responding to comments, SqCWD certified the EIR in 2011 and approved the Polo Grounds well, Cunnison Lane well, Granite Way well, O'Neill Ranch well, and Austrian Way well projects. SqCWD constructed a treatment plant for the Polo Grounds well and brought the well online in 2012. Construction of the O'Neill Ranch well was completed in 2012 and construction of a treatment plant for the well was completed in 2014. A replacement production well was installed at the Aptos Junior High School location for SqCWD in 2014.

2. ***Continue to encourage private well users located within critical groundwater areas of the Soquel-Aptos basin to discontinue pumping and connect to the local municipal water supply systems***

   SqCWD continued to use its Private Well Incentive Policy to encourage private well users located in critical groundwater areas to properly abandon their wells and connect to the District's distribution system.

   SqCWD has coordinated with the Pot Belly Beach Club to remove 19 residences from coastal wells and connect to the District's distribution system. This project was completed in 2011, although there are five additional homes that remain on existing wells and may be connected in the future.

3. ***Cooperatively work with City of Santa Cruz to develop a coordinated pumping plan for the City's Live Oak wells and SqCWD's Purisima wells***

SqCWD and the City of Santa Cruz met in 2010 to develop a cooperative groundwater management agreement. SqCWD revised its monitoring and mitigation plan in the Well Master Plan EIR (ESA, 2011) in response to comments from the City. The City sought and received feedback from SqCWD on its CEQA documentation for its proposed new inland well, Beltz #12. The Beltz #12 EIR was certified by the City in 2011 (Chambers Group, 2011). SqCWD's and the City's EIRs are consistent in the amount of planned future maximum pumping by the City from its existing coastal production wells and Beltz #12 will be 520 acre-feet per calendar year during non-critically dry years and 645 acre-feet per calendar year during critically dry years. The cooperative groundwater management agreement was finalized in 2015.

4. ***Analyze groundwater level/quality data and groundwater pumping data at least annually, and recommend changes to the groundwater pumping distribution as necessary***

This analysis is completed in Sections 2-5. SqCWD's consulting hydrologist has provided recommendations for pumping distribution to meet different pumping goals (HydroMetrics WRI, 2013).

SqCWD completed installing groundwater level transducers in all of its production wells in Water Year 2010. The transducers are connected to SqCWD's SCADA system, allowing SqCWD to adjust pumping based on current pumping groundwater levels.

ELEMENT 9: IDENTIFY AND MANAGE CUMULATIVE IMPACTS

1. ***Encourage sustainable pumping from non-agency groundwater users***

SqCWD worked with Cabrillo College, Trout Gulch Mutual, PureSource Mutual, Seascape Greens and Seascape Golf Course to improve water use efficiency and implement conservation opportunities.

2. ***Identify and manage well interference and manage groundwater storage for beneficial uses and drought reserve***

Groundwater levels in production wells are monitored to assess whether cones of depression from other wells have caused lowered groundwater levels that result in an appreciable diminution in the quantity or quality of water pumped by that well. Based on monitoring data, well interference between the three agencies that operate municipal production wells in the Soquel-Aptos Area Basin has not been identified as an issue at this time. Well interference has been identified as an issue within the SqCWD system. Well production has been affected at the Estates and T. Hopkins wells due to cumulative drawdown.

The Well Master Plan EIR includes monitoring and mitigation plans to address restrictive effects on nearby production wells after the Well Master Plan is implemented. The plans address private wells, the City of Santa Cruz's Live Oak well field, and CWD's Cox and Rob Roy well fields. Monitoring of private wells near the Polo Grounds well commenced in 2011. SqCWD installed monitoring wells on 41st Ave to monitor well interference between the City of Santa Cruz and SqCWD's production wells in 2012.

The potential for well interference between the newly installed SqCWD O'Neill Ranch well and City of Santa Cruz Beltz #12 well has been identified and the cooperative groundwater management agreement outlines a monitoring plan.

3. *Install new wells in locations that reduce cumulative impacts*

Cumulative effects of pumping the new wells in the Well Master Plan have been analyzed. Based on planned redistribution of pumping, the net cumulative effects of the Well Master Plan should be beneficial.

Two of the new wells in the Well Master Plan, the Austrian Way and Granite Way wells, are intended to alleviate the identified cumulative impacts that affect the production of the Estates and T. Hopkins wells.

The City of Santa Cruz certified its Environmental Impact Report (Chambers Group, 2011) for the Beltz #12 well at Research Park Drive and Cory Street to redistribute a portion of the City's projected drought year pumping to an inland location.

A replacement well at the Aptos Junior High site was installed in 2014 which will be used to shift pumping away from the coast and to reduce cumulative impacts from pumping in the area.

4. ***Continue to improve and quantify projected future demands from all groundwater users***

SqCWD updated projections of future demands in Water Year 2009 to support analyses for the Well Master Plan EIR. Future projected demand was reduced 410 acre-feet per year from projections in SqCWD's *Integrated Resources Plan* (ESA, 2006) based on recent demand reductions. Updated demand projections were documented in the updated Urban Water Management Plan (SqCWD, 2011).

ELEMENT 10: WATER CONSERVATION

1. ***Continue and update the existing water conservation programs for SqCWD.***

SqCWD continued a broad and multi-faceted water conservation program and added rebates for greywater, turf replacement and hot water recirculation devices. SqCWD adopted water use efficiency ordinances for indoor and outdoor use by new development and remodels, updated the water waste ordinance and began enforcement to prevent haulers from taking water from SqCWD bulk water stations outside the District. SqCWD also installed the first phase of a grant funded landscape demonstration project at its headquarters in 2010.

2. ***Continue and update the existing water conservation programs for CWD.***

CWD continued its existing water conservation programs and opened a drought tolerant demonstration garden in Water Year 2009.

3. ***Annually report estimated savings from the ongoing water conservation program.***

Water production by SqCWD in Water Year 2014 was the ninth straight year when production was at least 500 acre-feet less than the previous ten-year period average (1995-2004). Much of this continuing reduction is attributed to SqCWD's on-going conservation programs.

4 (2010). Support County wide ordinances promoting conservation.

The County has developed a water efficient landscape ordinance while implementing the state's water efficient landscape ordinance. The ordinance was presented to the County Planning Commission and Board of Supervisors in 2013. The County updated and expanded the County's water conservation ordinance in 2013. In 2009, amendments to the County well ordinance went into effect that resulted in increased water conservation by agricultural users and small water systems. New water use efficiency ordinances have been adopted for the SqCWD and City of Santa Cruz service areas. The County, SqCWD, the City of Santa Cruz, and the City of Capitola also worked with the local Greywater Alliance to establish procedures for use of greywater irrigation systems. SqCWD and CWD support these County efforts.

5 (2011). Develop Drought Curtailment Criteria.

SqCWD's Urban Water Management Plan 2010 (SqCWD, 2011) includes criteria for declaring drought curtailments. The criteria are multi-year rainfall totals through March of the current year and are based on results from the Soquel-Aptos Area Recharge Model (HydroMetrics WRI, 2011a), a PRMS model that estimates the spatial and temporal variation in deep groundwater recharge. Drought curtailments were declared in 2012 (Stage 1), 2013 (Stage 2), and 2014 (Stage 3).

ELEMENT 11: SUPPORT THE DEVELOPMENT AND UPDATE OF POLICIES AND ORDINANCES FOR WELL CONSTRUCTION, ABANDONMENT, AND DESTRUCTION

1. Support existing well construction and well destruction standards, including the recent revisions to the County of Santa Cruz Well Ordinance

SqCWD and CWD worked closely with Santa Cruz County to implement revisions to the water well ordinance that went into effect March 23, 2009. SqCWD followed the revised ordinance with its recent monitoring well replacement projects.

2. Support County of Santa Cruz's well destruction program

SqCWD and CWD support Santa Cruz County's abandoned well destruction program. With the support of the agencies through the IRWMP, the County used Proposition 50 water bond funding to destroy abandoned wells, an effort that was completed in 2012, and included destruction of 4 wells. One of the destroyed wells was at the County's Polo Grounds park near the well recently added to SqCWD's municipal supply.

Monitoring wells such as the SC-9 cluster and SC-8F were properly destroyed when they were replaced in 2012. SqCWD also destroyed SC-9, SC-8F, SC-5D, and SC-5E in 2012. In 2012, the monitoring well SC-5C was identified as needing to be sealed; the well cannot be fully destroyed since it shares a borehole with wells SC-5A and 5B. The former production well at Madeline has also been identified for destruction. In 2013-2014 monitoring wells such as the SC-10, SC-11 and SC-18 well clusters were properly destroyed after they were replaced.

3. ***Continue to implement SqCWD well destruction policy***

SqCWD continues to require property owners to properly destroy abandoned private wells before connecting to the SqCWD system.

Monitoring Well completions SC-10, SC-11 and SC-18 were properly destroyed in 2014.

4. ***Request Santa Cruz County Environmental Health Services establish a voluntary monitoring program of private wells, particularly in inland areas of the Soquel-Aptos groundwater management area***

The County has implemented this voluntary monitoring program of groundwater levels. Groundwater levels are being monitored semi-annually at wells in the inland areas of the groundwater management area and monthly at wells along Valencia Creek.

ELEMENT 12: WELLHEAD PROTECTION MEASURES

1. ***Periodically update and review the SqCWD and CWD Drinking Water Source Assessment and Protection (DWSAP) analysis and submittals.***

SqCWD has not updated DWSAP analysis and submittals (LSCE, 2002; Todd Engineers, 2002) since the GMP has been enacted. SqCWD submitted

DWSAPs for the Aptos Jr. High and Polo Grounds wells (HydroMetrics WRI, 2011b and 2011c). CWD submitted updated DWSAP reports (Johnson, 2009) to State Department of Public Health in Water Year 2009. SqCWD submitted a DWSAP for the O'Neill Ranch well in 2014 and will complete an update of the 2002 DWSAPs in 2015.

2. ***Continue to assist with and endorse Santa Cruz County's expanded wellhead protection programs.***

   SqCWD and CWD continue to support Santa Cruz County's programs for wellhead protection. Related programs not listed in the Groundwater Management Plan are the County's septic system management program and the RCD and Ecology Action's Livestock and Land program.

3. ***Support groundwater remediation activities.***

   SqCWD and CWD continue to support the State and Santa Cruz County's programs such as regulation of the cleanup and monitoring of sites with known or potential contamination by the Central Coast Regional Water Quality Control Board (RWQCB) and Santa Cruz County Department of Environmental Health, submittal of the MTBE Report to Public Water System Operators, and use of the State's Underground Storage Tank Cleanup Fund.

ELEMENT 13: PUBLIC EDUCATION

1. ***Maintain SqCWD's Public Information Program***

   In addition to its ongoing public information program, in 2010, SqCWD sponsored a demonstration garden on Wharf Rd. in Soquel, collaborated with other agencies and private non-profit organizations on the Green Gardner Program.

2. ***Maintain SqCWD School Education Program***

   SqCWD continued to conduct its robust school education program including assemblies, classroom teaching and teacher training.

3. ***Maintain CWD Public Education Programs***

CWD continued to conduct its public education programs and completed development of a drought tolerant demonstration garden in Water Year 2009.

4. *Support and participate in regional programs*

SqCWD continued to support and participate in regional programs, such as outreach for the Integrated Regional Water Management Plan.

SqCWD and the County provided staff and consultant support for County efforts to develop a stakeholder advisory group to engage small water systems and private well owners. Group meetings included educational programs.

ELEMENT 14: IMPROVE GROUNDWATER BASIN MANAGEMENT TOOLS

1. *Continue to improve and quantify sustainable yield estimates*

SqCWD and CWD have continued to improve and update their sustainable yield estimates. Post-recovery pumping yields based on modeled offshore flows required to achieve groundwater elevations protective against seawater intrusion have been developed (HydroMetrics WRI, 2012). The post-recovery pumping yields are based on recently developed estimates for recharge (HydroMetrics WRI, 2011a), modifications of prior estimates for consumptive use (Johnson et al., 2004), and outflows to Pajaro Valley. The estimated post-recovery pumping yield for the Purisima area is 2,890 acre-feet per year. The estimated post-recovery pumping yield for the Aromas area is 1,440 acre-feet per year. A peer review in 2014 evaluated these estimates and concluded that these estimates are on the low end of a plausible range (Todd, 2014). Scoping for develop of groundwater model that will refine sustainable yield estimates took place in 2014.

2. *Establish water levels that protect the groundwater basin against seawater intrusion*

SqCWD has established protective groundwater elevations at its coastal monitoring wells that protect against seawater intrusion. The protective groundwater elevations are documented in *Groundwater Levels to Protect against Seawater Intrusion and Store Freshwater Offshore* (HydroMetrics LLC, 2009b). Protective groundwater elevations for the Aromas area were revised to maintain the freshwater-salt water interface at its current location in the monitoring wells (HydroMetrics WRI, 2012).

3. ***Assist state, federal, or local wildlife and fisheries agencies as they develop water flow or water quality requirements for riparian and aquatic organisms***

   SqCWD continued its ongoing funding and review of stream habitat and juvenile salmonid (steelhead and coho salmon) monitoring in the Soquel and Aptos Creek watersheds as part of the Santa Cruz County Stream Habitat and Juvenile Salmonid Sampling Program. SqCWD and CWD also support the County's new policy for management of large woody material in county streams.

   County staff completed riparian assesment and stream condition surveys for Bean, Zayante, and Branciforte Creeks and portions of Soquel, Lompico and Mountain Charlie Gulch Creeks (Nguyen, 2015).

   The City of Santa Cruz released significant flows for fish in Laguna Creek and the Lower San Lorenzo River during much of 2014 (Nguyen, 2015).

4. ***Maintain and enhance data collection and management.***

   Data collection has been enhanced by installing new sampling equipment in several of SqCWD's wells. SqCWD and CWD have also installed groundwater level transducers in production wells to facilitate real-time management of pumping.

   SqCWD and CWD continue to update the agencies' databases and Geographical Information Systems. Calendar year 2009 and future data for all water quality constituents analyzed by SqCWD are now stored in a new WaterTrax database.

5. ***Ensure data sharing among regional water agencies***

   A formal process for data sharing among regional water agencies has been developed for the California Statewide Groundwater Elevation Monitoring (CASGEM) program. Data were also provided for this report by SqCWD, CWD, the City of Santa Cruz, and Santa Cruz County. SqCWD's file transfer protocol (FTP) site is used for the agencies to upload and download data.

6. Explore methods to collect data from non-agency groundwater users

The County has implemented a voluntary monitoring program of groundwater levels at private wells. SqCWD's Well Master Plan EIR includes a voluntary monitoring and mitigation program for private wells within 1,000 meters of new SqCWD production wells (ESA, 2010) that will collect production and groundwater level data at private wells. Monitoring of private wells near the Polo Grounds well commenced in 2011.

7. Prepare a subregional groundwater model for CWD's Rob Roy Well Field

A subregional model for the Aromas area was prepared for CWD as a tool to delineate well capture zones in the updated DWSAP reports (Johnson, 2009). This model was adapted for CWD's Proposition 84 funded basin management study in 2013

8. Provide data and technical assistance to Pajaro Valley Water Management Agency (PVWMA) Groundwater Basin Model

PVWMA is finalizing the Pajaro Valley Hydrologic Model, a numerical model of the Pajaro Valley basin. SqCWD had a representative on the Technical Advisory Committee, which met in 2010 to approve the final model. The model is being used for the Basin Management Plan.

9. Explore opportunities to expand existing groundwater models to cover the Soquel-Aptos area

Two models were finalized in 2011 that may provide opportunities to develop a groundwater model that covers the Soquel-Aptos area: the Soquel-Aptos Area Recharge Model, a PRMS model that estimates the spatial and temporal variation in deep groundwater recharge, and the Pajaro Valley Hydrologic Model, a MODFLOW model of the Pajaro Valley basin. Results from the PRMS model was used in the adaptation of CWD's DWSAPs model for its Proposition 84 funded basin management study, which was completed in 2013.

Scoping for development a groundwater model based on the PRMS model and CWD's model for the Soquel Aptos basin occurred in 2014.

10. Explore methods to measure and locate the seawater/freshwater interface

Methods to locate the seawater/freshwater interface have not been explored. Estimated travel times for the interface were presented to SqCWD in 2012. Stanford University presented preliminary results for locating the seawater/freshwater interface in the Aromas area based on geophysics study. SqCWD is evaluating options for additional geophysics work to locate the seawater/freshwater interface, including offshore in the Purisima area, in 2014-2015.

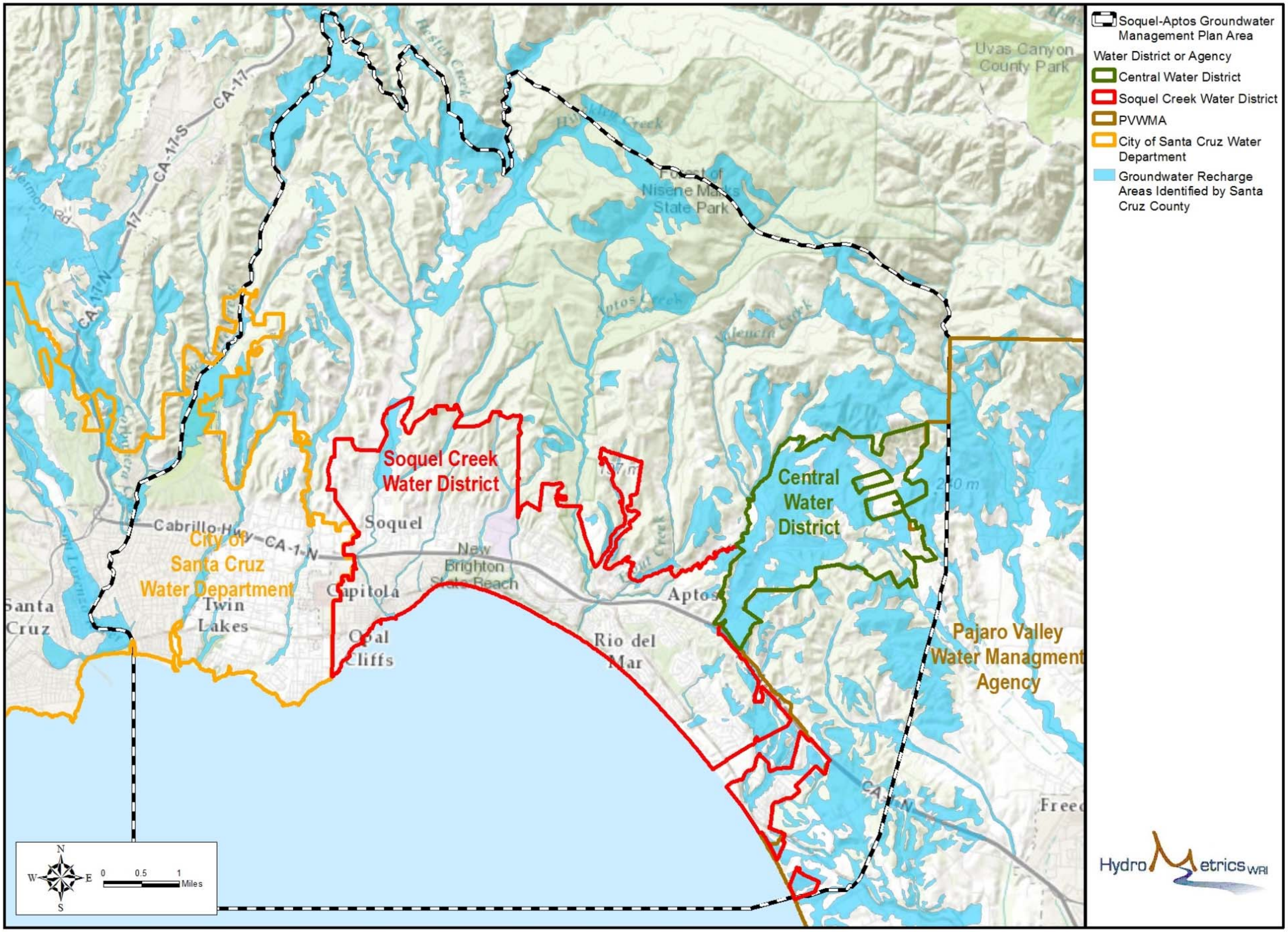


Figure 6-1: Groundwater Recharge Areas Identified by Santa Cruz County

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SECTION 7
BASIN MANAGEMENT ACTION PRIORITIES AND RECOMMENDATIONS

7.1 BASIN MANAGEMENT ACTION PRIORITIES

This section lists the top priorities for projects and programs to achieve BMOs. BMO 2-2, maintain groundwater levels to prevent seawater intrusion, is the best indicator of the status of basin management. This objective has not been met, so the highest priorities are given to projects that will help raise coastal groundwater levels to prevent seawater intrusion. The priority list is focused on projects and programs that have not yet begun implementation. The list does not include a number of ongoing projects that support basin management objectives. The exclusion of ongoing projects from this list should not be considered a recommendation to change any of those ongoing projects.

1. **Secure Supplemental Supply (Element 5, BMO 1-2).** BMO 2-2 and other BMOs rely on successfully securing a supplemental supply and achieving BMO 1-2. The regional desalination plant is currently on hold and alternate supply options are being evaluated. Conservation can be viewed as a new water supply, and the updated Integrated Resources Plan (SqCWD, 2012) emphasizes continued implementation of existing and new conservation and drought management programs. In 2014, SqCWD identified water transfers and groundwater replenishment with recycled water to evaluate further. A transfer of San Lorenzo River winter surplus flows from City of Santa Cruz to SqCWD is being evaluated but is unlikely to meet SqCWD's full supplemental supply for recovering the basin and achieving BMO 2-2. The City of Santa Cruz has also formed a Water Supply Advisory Committee to evaluate supplemental supply options.

2. **Monitor Tu Unit (Unit Below Purisima Formation) as SqCWD O'Neill Ranch well and City of Santa Cruz Beltz 12 well come online. (Element 8).** Groundwater level data collected during pump testing of these wells indicate that recharge of the Tu unit supplying these wells may be limited. Groundwater levels in the Tu unit should be closely monitored as these wells come online and pumping managed to prevent well interference. In addition, groundwater levels at wells screened in the Tu unit should be mapped to evaluate flow directions in the Tu unit

3. Use Groundwater Level Logger Data in Groundwater Management (Element 1). SqCWD, CWD, and the City of Santa Cruz have implemented equipment to continuously collect groundwater level data. Logger data from all three agencies should be included in a data management system that will facilitate the expanded use of the data in groundwater management should be expanded. Initial uses will include calculation of average groundwater levels at all coastal monitoring well sites for comparison with protective, target, and minimum elevations and implementation of the cooperative groundwater management agreement between SqCWD and the City.

4. Monitor Effects of 4th Consecutive Dry Year (Element 1). Water Year 2015 will likely be the fourth consecutive below average rainfall year. Monitoring effects of the drought will include assessing basin storage response to reduced recharge and evaluating groundwater level response in the Western Purisima to planned increases in pumping by the City of Santa Cruz due to lower surface water availability.

5. Facilitate Formation of a Groundwater Sustainability Agency (Elements 4 and 13). As part of the process to develop a Groundwater Sustainability Agency as required by the Sustainable Groundwater Management Agency, expand on the County led effort to form a Mid-County groundwater stakeholder advisory committee to improve small water systems and private well owners' participation in groundwater management of the basin. This will likely involve facilitated meetings with stakeholders about GSA formation. .

6. Develop Groundwater Model (Element 14). Planning future management of the basin such as pumping reductions to recover the basin would be greatly enhanced with the predictive capabilities of a numerical groundwater model. Development of a groundwater model has commenced and should be completed by 2016.

7. Undertake Geophysics Study to Locate Seawater Interface (Element 14). Identifying the location of the seawater interface will assist with planning to prevent seawater intrusion in the Purisima and further advancement of seawater intrusion in the Aromas. Undertaking onshore geophysics studies should be undertaken over 2015-2016 with feasible offshore studies evaluated for possible implementation in 2016-2017.

7.2 CURRENT DATA INADEQUACIES

The following is a list of the main data inadequacies that could be addressed to enhance basin understanding and management.

- Non-agency pumping. As shown in Table 2-2 and Table 2-3, estimates of private pumpers are based on data from 1999 or earlier, more recent data is needed for a more complete analysis of basin pumping. The County has provided data on small water system consumption and estimates for private pumping in the Aromas area were developed as part of the Prop 84 planning grant funded CWD study.
- Verify pumping requirements for basin recovery. In 2012, SqCWD developed estimates of pumping rates and time frames necessary for achieving basin recovery. Uncertainties in these estimates may influence SqCWD's supplemental supply and basin management plans. Reducing the uncertainty may require better tools, such as a groundwater model, or verifying the effects of reduced pumping after SqCWD obtains a supplemental supply.

The current effort to develop a groundwater model will address both of these inadequacies. Estimates for non-agency pumping will be revised and mapped based on land use. Model simulations will be used to evaluate whether different pumping plans achieve basin recovery.

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SECTION 7
BASIN MANAGEMENT ACTION PRIORITIES AND RECOMMENDATIONS

7.1 BASIN MANAGEMENT ACTION PRIORITIES

This section lists the top priorities for projects and programs to achieve BMOs. BMO 2-2, maintain groundwater levels to prevent seawater intrusion, is the best indicator of the status of basin management. This objective has not been met, so the highest priorities are given to projects that will help raise coastal groundwater levels to prevent seawater intrusion. The priority list is focused on projects and programs that have not yet begun implementation. The list does not include a number of ongoing projects that support basin management objectives. The exclusion of ongoing projects from this list should not be considered a recommendation to change any of those ongoing projects.

1. Secure Supplemental Supply (Element 5, BMO 1-2). BMO 2-2 and other BMOs rely on successfully securing a supplemental supply and achieving BMO 1-2. The regional desalination plant is currently on hold and alternate supply options are being evaluated. Conservation can be viewed as a new water supply, and the updated Integrated Resources Plan (SqCWD, 2012) emphasizes continued implementation of existing and new conservation and drought management programs. It also identifies local supplemental supply alternatives for consideration instead of, or in addition to, the regional desalination project. These alternatives include a Soquel Creek diversion project, local-only desalination, site specific recycled water projects for non-potable irrigation use, and mandatory restrictions. A transfer of San Lorenzo River winter surplus flows from City of Santa Cruz to SqCWD is being evaluated but is unlikely to meet SqCWD's full supplemental supply for recovering the basin and achieving BMO 2-2. SqCWD is also evaluating injection of recycled water.

2. Monitor Tu Unit (Unit Below Purisima Formation) as SqCWD O'Neill Ranch well and City of Santa Cruz Beltz 12 well come online. (Element 8). Groundwater level data collected during pump testing of these wells indicate that recharge of the Tu unit supplying these wells may be limited. Groundwater levels in the Tu unit should be closely monitored as these wells come online and pumping managed to prevent well interference. In addition, groundwater levels at wells screened in the Tu unit should be mapped to evaluate flow directions in the Tu unit

3. Use Groundwater Level Logger Data in Groundwater Management (Element 1). SqCWD, CWD, and the City of Santa Cruz have implemented equipment to continuously collect groundwater level data. The use of the data in groundwater management should be expanded, starting with using the data to calculate average groundwater levels at the coast for comparison with protective elevations.

4. Monitor Effects of 3rd Consecutive Dry Year (Element 1). Water Year 2014 will likely be the third consecutive below average rainfall year. Monitoring effects of the drought will include assessing basin storage response to reduced recharge and evaluating groundwater level response in the Western Purisima to planned increases in pumping by the City of Santa Cruz due to lower surface water availability.

5. Initiate Groundwater Stakeholder Advisory Committee (Elements 4 and 13). With support from SqCWD and CWD, Santa Cruz County is leading an effort to form a Mid-County groundwater stakeholder advisory committeeto improve small water systems and private well owners' participation in groundwater management of the basin. Committee meetings will also provide a forum to share information about groundwater hydrology, protection against seawater intrusion, groundwater rights, data collection and monitoring, water use efficiency and basin sustainability.**6. Expand Groundwater Management Authority to Include Santa Cruz County and City of Santa Cruz (Element 4).** The County has important groundwater management responsibilities for the basin, particularly in oversight of non-municipal pumpers. The City is the largest pumper from the basin besides SqCWD and CWD.

7. Develop Groundwater Model (Element 14). Planning future management of the basin such as pumping reductions to recover the basin would be greatly enhanced with the predictive capabilities of a numerical groundwater model. Development of a groundwater model should be undertaken over 2014-2015.

8. Undertake Geophysics Study to Locate Seawater Interface (Element 14). Identifying the location of the seawater interface will assist with planning to prevent seawater intrusion in the Purisima and further advancement of seawater intrusion in the Aromas. Undertaking onshore geophysics studies should be undertaken over 2014-2015 with feasible offshore studies evaluated for possible implementation in 2015-2016.

7.2 CURRENT DATA INADEQUACIES

The following is a list of the main data inadequacies that could be addressed to enhance basin understanding and management.

- Non-agency pumping. As shown in Table 2-1 and Table 2-2, estimates of private pumpers are based on data from 1999 or earlier, more recent data is needed for a more complete analysis of basin pumping. The County has provided data on small water system consumption and estimates for private pumping in the Aromas area were developed as part of the Prop 84 planning grant funded CWD study.
- Verify pumping requirements for basin recovery. In 2012, SqCWD developed estimates of pumping rates and time frames necessary for achieving basin recovery. Uncertainties in these estimates may influence SqCWD's supplemental supply and basin management plans. Reducing the uncertainty may require better tools, such as a groundwater model, or verifying the effects of reduced pumping after SqCWD obtains a supplemental supply.

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SECTION 7
BASIN MANAGEMENT ACTION PRIORITIES AND RECOMMENDATIONS

7.1 BASIN MANAGEMENT ACTION PRIORITIES

This section lists the top priorities for projects and programs to achieve BMOs. BMO 2-2, maintain groundwater levels to prevent seawater intrusion, is the best indicator of the status of basin management. This objective has not been met, so the highest priorities are given to projects that will help raise coastal groundwater levels to prevent seawater intrusion.

1. Secure Supplemental Supply (Element 5, BMO 1-2). BMO 2-2 and other BMOs rely on successfully securing a supplemental supply and achieving BMO 1-2. The regional desalination plant is currently the most likely supplemental supply option. Conservation can be viewed as a new water supply, and the updated Integrated Resources Plan (SqCWD, 2012) emphasizes continued implementation of existing and new conservation and drought management programs. It also identifies local supplemental supply alternatives for consideration instead of, or in addition to, the regional desalination project. These alternatives include a Soquel Creek diversion project, local-only desalination, site specific recycled water projects for non-potable irrigation use, and mandatory restrictions. A transfer of San Lorenzo River winter surplus flows from City of Santa Cruz to SqCWD is being evaluated but is unlikely to meet SqCWD's full supplemental supply for recovering the basin and achieving BMO 2-2.

2. Well Master Plan (Element 8). SqCWD should continue to implement the Well Master Plan so that additional wells can be used to effectively manage pumping in the basin. For 2013, this involves completing construction of the O'Neill Ranch well treatment plant to remain on schedule to bring the well online in 2014.

3. Complete Cox Well Field Aromas and Purisima Groundwater Basin Management Study. Using funds from a Proposition 84 planning grant, CWD should complete its evaluation of installing a new well at CWD's Cox Well Field to address concerns about Chromium VI in the CWD service area in order to be positioned to apply for grant funds for implementation of its plan.

4. Implement Soquel Creek Stream Monitoring and Adaptive Management Plan (Element 2, BMO 3-2). Project approval of the O'Neill Ranch well is conditioned on implementing a plan to monitor Soquel Creek for reductions in baseflow from pumping. The plan was submitted to Santa Cruz County and National Marine Fisheries Service for comment, and approved by SqCWD's Board. The plan needs to be implemented in time to provide baseline data for the Creek before the O'Neill Ranch and the City of Santa Cruz's Beltz#12 wells are operational in 2014.

5. Implement O'Neill Well Monitoring and Mitigation Measure for Impacts to Nearby Wells (Element 9). SqCWD should continue to implement the monitoring and mitigation plan in the Well Master Plan EIR regarding potential effects on private wells and the City of Santa Cruz's well fields. Implementation of this plan began in 2012.

6. Cooperative Groundwater Management Agreement with City of Santa Cruz (Element 8). Plans by both agencies to bring online new wells in the shared portion of the basin in 2014 increase the importance of completing an agreement for groundwater management of the area.

7. Implement Polo Grounds Well Monitoring and Mitigation Plan (Element 9). SqCWD should continue to implement the monitoring and mitigation plan in the Well Master Plan EIR regarding potential effects on private wells and CWD's Cox and Rob Roy well fields from converting the Polo Grounds well to municipal use. Implementation of this plan began in 2011.

8. Implement Local Groundwater Assistance Grant (Element 1, Element 14). The State has released its scores for SqCWD's application for a Local Groundwater Assistance grant of $200,000. The grant would be used to install new monitoring wells at Quail Run and Larkin Valley Tank Sites.

9. Replace Aptos Jr. High well (Element 8). SqCWD's Aptos Jr. High well is an important well for groundwater management as it is relatively inland. However, it is in poor condition and should be replaced with a well designed and constructed using modern practices.

10. Replace identified monitoring wells (Element 1). To obtain useful groundwater data from the entire monitoring network, SqCWD should replace the monitoring wells SC-10 at Cherryvale, SC-11 at Porter Gulch and SC-18 at Main Street. Sampling equipment at SC-10 and SC-18 has failed and cannot be replaced. SC-11 has sanded up. Replacements will be with 2 inch wells to facilitate water quality sampling to monitor background aquifer conditions.

11. Update Groundwater Management Plan including Mapped Recharge Areas (Element 7). AB 359 requires local Groundwater Management Plans to include maps of recharge areas by 2013. Other updates to the GMP are recommended in Sections 2.3 and 6.2.

12. Comply with statewide groundwater monitoring requirement (Element 1). SqCWD and CWD activities meet the requirements of 2009 state water package for groundwater monitoring (CASGEM). Santa Cruz County is responsible for reporting data to the state and SqCWD and CWD should work with the County to meet reporting requirements.

13. Construct pump station on Soquel Drive to move water from Service Area II to III. To improve transfer of water in its system, SqCWD will be constructing a pump station on Soquel Drive to move water from its Service Area II to III. The pump station will have a pressure reducing valve and be bi-directional. The ability to transfer water between service areas will facilitate pumping redistribution to meet groundwater management objectives, especially after a supplemental supply is secured.

14. Develop intertie with City of Santa Cruz at O'Neill Ranch well. To provide flexibility for cooperative management of the Western Purisima, SqCWD should work with the City of Santa Cruz to develop an intertie between the two agencies' systems at the O'Neill Ranch well.

15. Manage well operation based on pumping water levels (Element 8). SqCWD should continue to manage pumping based on current groundwater level data measured by transducers installed in production wells to better manage pumping.

16. Formalize relationships with small water systems (Element 10). Cooperative relationships with Trout Gulch Mutual Water, Pure Source Water, and San Andreas Mutual Water Company to meter their wells and share data as well as implement conservation measures would help encourage those systems to pump sustainably. Additional relationships to monitor for impacts of SqCWD pumping on small water systems are being formalized through the Well Master Plan private well monitoring and mitigation program.

17. Continue to upgrade groundwater monitoring equipment (Element 1). SqCWD should continue to follow recommendations in *Evaluation of Water Quality Monitoring Network and Recommendations for Improvement* (HydroMetrics LLC, 2007) for replacing groundwater sampling equipment to improve sampling efficiencies. Upgrades should also include installing groundwater level loggers in the remaining monitoring wells without loggers.

7.2 CURRENT DATA INADEQUACIES

The following is a list of current data inadequacies that could be addressed to enhance basin understanding and management. Some of these inadequacies are being addressed by recently implemented programs or will be addressed by basin management action priorities listed in Section 7.1. It is recommended that SqCWD and CWD develop additional programs and projects to address remaining data inadequacies as they gain more priority.

- Non-agency pumping. As shown in Table 2-1 and Table 2-2, estimates of private pumpers are based on data from 1999 or earlier, more recent data is needed for a more complete analysis of basin pumping. The County has provided data on small water system consumption and estimates for private pumping in the Aromas area are being developed as part of the Prop 84 planning grant funded CWD study.
- Shallow groundwater levels. Basin-wide shallow groundwater level monitoring would help assess changes in basin storage. The County's recently implemented private well monitoring program is starting to provide data to assess this inadequacy. Also, a shallow well has been installed in a fifth location near Soquel Creek. Multi-year data from wells completed in the shallowest unit could help quantify changes in basin storage.
- Continuous groundwater level measurements in monitoring wells. These measurements are now being recorded in most SqCWD and CWD monitoring wells. These data could be evaluated for effects of tides, season, and pumping cycles. When a full year's worth of data is collected, more accurate annual averages can also be calculated.
- Verify pumping requirements for basin recovery. In 2012, SqCWD developed estimates of pumping rates and time frames necessary for achieving basin recovery. Uncertainties in these estimates may influence

SqCWD's supplemental supply and basin management plans. Reducing the uncertainty may require better tools, such as a groundwater model, or verifying the effects of reduced pumping after SqCWD obtains a supplemental supply.

- New monitoring wells between pumping wells. The monitoring network includes coastal wells, wells adjacent to pumping wells, and wells upland of pumping areas. There are no monitoring wells placed to monitor potential well interference between pumping areas except for wells recently installed by the City of Santa Cruz and SqCWD in the 41st Ave area. There are also no monitoring wells to assess inland advancement of seawater intrusion in the Aromas area. Implementation of SqCWD's Local Groundwater Assistance grant would help address this data gap.
- Tu unit groundwater level map. SqCWD and the City of Santa Cruz plan to bring the O'Neill Ranch and Beltz #12 wells, respectively, online in 2014. These wells will extract from the Tu unit. Groundwater levels at monitoring wells screened in the Tu unit, including newly installed SC-22 and 30th Ave wells, should be mapped to evaluate flow in the Tu unit.

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SECTION 7
BASIN MANAGEMENT ACTION PRIORITIES AND RECOMMENDATIONS

7.1 BASIN MANAGEMENT ACTION PRIORITIES

This section lists the top priorities for projects and programs to achieve BMOs. BMO 2-2, maintain groundwater levels to prevent seawater intrusion, is the best indicator of the status of basin management. This objective has not been met, so the highest priorities are given to projects that will help raise coastal groundwater levels to prevent seawater intrusion.

1. Secure Supplemental Supply (Element 5, BMO 1-2). BMO 2-2 and other BMOs rely on successfully securing a supplemental supply and achieving BMO 1-2. The regional desalination plant is currently the most likely supplemental supply option. The Integrated Resources Plan (ESA, 2006) adopted by SqCWD emphasizes continued implementation of existing and new conservation and drought management programs regardless of developing a supplemental supply. It also identifies local supplemental supply alternatives for consideration instead of, or in addition to, the regional desalination project: a Soquel Creek diversion project, local-only desalination, and/or site specific recycled water projects for non-potable irrigation use. A transfer of San Lorenzo River winter surplus flows from City of Santa Cruz to SqCWD is being evaluated but is unlikely to meet SqCWD's full supplemental supply for recovering the basin and achieving BMO 2-2.

2. Well Master Plan (Element 8). SqCWD should continue to implement the Well Master Plan so that additional wells can be used to effectively manage pumping in the basin.

3. Apply for Local Groundwater Assistance Grant (Element 1, Element 14). The State has released its Proposal Solicitation Package for Local Groundwater Assistance grants of up to $250,000 for fiscal year 2011-2012. The application submittal deadline is July 13, 2012. SqCWD should evaluate applying for the grant to assist with groundwater management. Possible uses for the funds include development of a groundwater model or installation of new or replacement monitoring wells.

4. Conduct Cox Well Field Aromas and Purisima Groundwater Basin Management Study. Using funds from a Proposition 84 planning grant, CWD should evaluate maximizing the developable yield in CWD's Cox Well Field to address concerns about Chromium VI in the CWD service area, and to address SqCWD's Aromas water quality and overdraft concerns.

5. Polo Grounds Well Monitoring and Mitigation Plan (Element 9). SqCWD should continue to implement the monitoring and mitigation plan in the Well Master Plan EIR regarding potential effects on private wells and CWD's Cox and Rob Roy well fields from converting the Polo Grounds well to municipal use. Implementation of this plan began in 2011.

6. Implement Soquel Creek Stream Monitoring and Adaptive Management Plan (Element 2, BMO 3-2). Project approval of the O'Neill Ranch well is conditioned on implementing a plan to monitor Soquel Creek for reductions in baseflow from pumping. The plan needs to be submitted to Santa Cruz County and National Marine Fisheries Service for comment, approved by SqCWD's Board, and implemented in time to provide baseline data for the Creek before the O'Neill Ranch and the City of Santa Cruz's Beltz#12 wells are operational.

7. Implement O'Neill Well Monitoring and Mitigation Measure for Impacts to Nearby Wells (Element 9). SqCWD should continue to implement the monitoring and mitigation plan in the Well Master Plan EIR regarding potential effects on private wells and the City of Santa Cruz's well fields. Implementation of this plan began with the construction of monitoring wells on 41st Avenue.

8. Cooperative Groundwater Management Agreement with City of Santa Cruz (Element 8). Plans by both agencies to install new wells in the shared portion of the basin increase the importance of an agreement for groundwater management of the area.

9. Continue to upgrade groundwater monitoring equipment (Element 1). SqCWD should continue to follow recommendations in *Evaluation of Water Quality Monitoring Network and Recommendations for Improvement* (HydroMetrics LLC, 2007) for replacing groundwater sampling equipment to improve sampling efficiencies. Upgrades should also include installing groundwater level loggers in more monitoring wells.

10. Comply with statewide groundwater monitoring requirement (Element 1). SqCWD and CWD activities meet the requirements of 2009 state water package for groundwater monitoring (CASGEM). Santa Cruz County is responsible for reporting data to the state and SqCWD and CWD should work with the County to meet reporting requirements.

11. Construct pump station on Soquel Drive to move water from Service Area II to III. To improve transfer of water in its system, SqCWD will be constructing a pump station on Soquel Drive to move water from its Service Area II to III. The pump station will have a pressure reducing valve and be bi-directional. The ability to transfer water between service areas will facilitate pumping redistribution to meet groundwater management objectives, especially after a supplemental supply is secured.

12. Survey elevations of monitoring wells that have not been surveyed (Element 1). Accurate groundwater level elevations depend on accurate survey information for well reference points. The SC-11, SC-A6, and SC-A7 monitoring wells do not have reference point elevations. The SC-11 wells at Porter Gulch are the highest priority for surveying because there is no nearby production well with survey information.

13. Replace identified monitoring wells (Element 1). To obtain useful groundwater data from the entire monitoring network, SqCWD should replace the monitoring wells SC-10 at Cherryvale and SC-11 at Porter Gulch. Sampling equipment at SC-10 has failed and cannot be replaced. SC-11 has sanded up. Replacements will be with 2 inch wells to facilitate water quality sampling to monitor background aquifer conditions.

14. Manage well operation based on pumping water levels (Element 8). SqCWD should continue to manage pumping based on current groundwater level data measured by transducers installed in production wells to better manage pumping.

15. Formalize relationships with small water systems (Element 10). Cooperative relationships with Trout Gulch Mutual Water, Pure Source Water, and San Andreas Mutual Water Company to meter their wells and share data as well as implement conservation measures would help encourage those systems to pump sustainably. Additional relationships to monitor for impacts of SqCWD pumping on small water systems are being formalized through the Well Master Plan private well monitoring and mitigation program.

16. Update Groundwater Management Plan with Mapped Recharge Areas (Element 7). AB 359 requires local Groundwater Management Plans to include maps of recharge areas by 2013. SqCWD and CWD should plan to update their GMP with recharge area maps developed by the County and/or information from the Soquel-Aptos recharge study (HydroMetrics WRI, 2011a).

7.2 Current Data Inadequacies

The following is a list of current data inadequacies that could be addressed to enhance basin understanding and management. Some of these inadequacies are being addressed by recently implemented programs or will be addressed by basin management action priorities listed in Section 7.1. It is recommended that SqCWD and CWD develop additional programs and projects to address remaining data inadequacies as they gain more priority.

- Non-agency pumping. As shown in Table 2-1 and Table 2-2, estimates of non-agency pumpers are based on data from 1999 or earlier, more recent data is needed for a more complete analysis of basin pumping.
- Shallow groundwater levels. Basin-wide shallow groundwater level monitoring would help assess changes in basin storage. The County's recently implemented private well monitoring program is starting to provide data to assess this inadequacy. Multi-year data from wells completed in the shallowest unit could help quantify changes in basin storage.
- Continuous groundwater level measurements in monitoring wells. These measurements are being recorded in several SqCWD and CWD monitoring wells. The effects of tides, season, and pumping cycles could be evaluated by installing groundwater level transducers in more monitoring wells.
- Pumping requirements for basin recovery. It is unknown what the reduction in pumping and expected time-frame is for the basin to recover to elevations protective against seawater intrusion. Reducing pumping to gather data for this question may require a supplemental supply.
- New monitoring wells between pumping wells. The monitoring network includes coastal wells, wells adjacent to pumping wells, and wells upland of pumping areas. There are no monitoring wells placed to monitor potential well interference between pumping areas except for wells

recently installed by the City of Santa Cruz and SqCWD in the 41st Ave area. There are also no monitoring wells to assess inland advancement of seawater intrusion in the Aromas area.

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SECTION 7
BASIN MANAGEMENT ACTION PRIORITIES AND RECOMMENDATIONS

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1. Secure Supplemental Supply (Element 5, BMO 1-2). BMO 2-2 and other BMOs rely on successfully securing a supplemental supply and achieving BMO 1-2. The regional desalination plant is currently the most likely supplemental supply option. The Integrated Resources Plan (ESA, 2006) adopted by SqCWD emphasizes continued implementation of existing and new conservation and drought management programs regardless of developing a supplemental supply. It also identifies local supplemental supply alternatives for consideration instead of or in addition to, the regional desalination project: a Soquel Creek diversion project, local-only desalination, and/or site specific recycled water projects for nonpotable irrigation use.

2. Well Master Plan (Element 8). SqCWD should complete project approval for the Well Master Plan so that additional wells can be installed to effectively manage pumping in the basin.

3. Polo Grounds Well Monitoring and Mitigation Plan (Element 9). SqCWD should implement the monitoring and mitigation plan in the Well Master Plan EIR regarding potential restrictive effects on private wells and CWD's Cox and Rob Roy well fields from converting the Polo Grounds well to municipal use. Implementation of this plan begins before the Polo Grounds conversion in order to obtain baseline monitoring data. SqCWD and CWD should finalize a cooperative groundwater management agreement for this shared portion of the basin.

4. Cooperative Groundwater Management Agreement with City of Santa Cruz (Element 8). Plans by both agencies to install new wells in the shared portion of the basin increase the importance of an agreement for groundwater management of the area.

5. Conduct Cox Well Field Aromas and Purisima Groundwater Basin Management Study. Using funds from a Proposition 84 planning grant, CWD should evaluate maximizing the developable yield in CWD's Cox Well Field to address concerns about Chromium VI in the CWD service area and SqCWD's Aromas water quality and overdraft concerns.

6. Replace identified monitoring wells (Element 1). To obtain useful groundwater data from all of the monitoring network, SqCWD should replace the monitoring wells SC-8F and SC-9A as they are sanded up to 100 feet. Since all SC-9 completions are in the same boring as SC-9A and are at risk of being sanded up, SqCWD should replace all SC-9 completions with the necessary completions for monitoring aquifer conditions.

7. Continue to upgrade groundwater monitoring equipment (Element 1). SqCWD should continue to follow recommendations in *Evaluation of Water Quality Monitoring Network and Recommendations for Improvement* for replacing groundwater sampling equipment to improve sampling efficiencies. Upgrades should also include installing groundwater level loggers in more monitoring wells.

8. Comply with statewide groundwater monitoring requirement (Element 1). SqCWD and CWD activities meet the requirements of 2009 state water package for groundwater monitoring (CASGEM). Santa Cruz County is responsible for reporting data to the state and SqCWD and CWD should work with the County to meet reporting requirements.

9. Reassess Sustainable Yield Estimates (Element 14). Data from this report, the groundwater recharge study and the PVWMA model can be used to reassess sustainable yield estimates last revised in 2009 (HydroMetrics LLC, 2009c). These estimates can be used for long-term water supply planning.

10. Evaluate results from time series analysis of groundwater level data (Element 1). Dr. Raquel Prado of UC Santa Cruz is expected to perform time series analysis of historical groundwater level data from SqCWD's monitoring wells. The results of the study should be evaluated to assess implications for groundwater management.

11. Manage well operation based on pumping water levels (Element 8). SqCWD should continue to manage pumping based on current groundwater level data measured by transducers installed in production wells to better manage pumping.

12. Formalize relationships with small water systems (Element 10). Cooperative relationships with small water systems to meter their wells and share data as well as implement conservation measures would help encourage those systems to pump sustainably. Additional relationships to monitor for impacts of SqCWD pumping on small water systems are being formalized through the Well Master Plan private well monitoring and mitigation program.

13. Survey elevations of monitoring wells that have not been surveyed (Element 1). Accurate groundwater level elevations depend on accurate survey information for well reference points. The SC-11, SC-A6, and SC-A7 monitoring wells do not have reference point elevations. The SC-11 wells at Porter Gulch are the highest priority for surveying because there is no nearby production well with survey information.

7.2 Current Data Inadequacies

The following is a list of current data inadequacies that could be addressed to enhance basin understanding and management. Some of these inadequacies are being addressed by recently implemented programs or will be addressed by basin management action priorities listed in Section 7.1. It is recommended that SqCWD and CWD develop additional programs and projects to address remaining data inadequacies as they gain more priority.

- Non-agency pumping. As shown in Table 2-1 and Table 2-2, estimates of non-agency pumpers are based on data from 1999 or earlier, more recent data is needed for a more complete analysis of basin pumping.
- Shallow groundwater levels. Basin-wide shallow groundwater level monitoring would help assess changes in basin storage. The County's recently implemented private well monitoring program is starting to provide data to assess this inadequacy. Multi-year data from wells completed in the shallowest unit could help quantify changes in basin storage.

- Continuous groundwater level measurements in monitoring wells. These measurements are being recorded in several SqCWD and CWD monitoring wells. The effects of tides, season, and pumping cycles could be evaluated by installing groundwater level transducers in more monitoring wells.
- Pumping requirements for basin recovery. It is unknown what the reduction in pumping and expected time-frame is for the basin to recover to elevations protective against seawater intrusion. Reducing pumping to gather data for this question may require a supplemental supply.
- New monitoring wells between pumping wells. The monitoring network includes coastal wells, wells adjacent to pumping wells, and wells upland of pumping areas. There are no monitoring wells placed to monitor potential well interference between pumping areas except for wells recently installed by the City of Santa Cruz. There are also no monitoring wells to assess inland advancement of seawater intrusion in the Aromas area.

SECTION 7
BASIN MANAGEMENT ACTION PRIORITIES AND RECOMMENDATIONS

7.1 BASIN MANAGEMENT ACTION PRIORITIES

This section lists the top priorities for projects and programs to achieve BMOs. BMO 2-2, maintain groundwater levels to prevent seawater intrusion, is the best indicator of the status of basin management. This objective has not been met so the highest priorities are given to projects that will help raise coastal groundwater levels to prevent seawater intrusion.

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2. Well Master Plan (Element 8). SqCWD should complete the Well Master Plan EIR so that additional wells can be installed to effectively manage pumping in the basin.

3. Conduct Groundwater Recharge Estimation Study (Element 14). Previous deep groundwater recharge estimates are fixed recharge estimates that cannot easily be divided into sub-regions or extrapolated to other areas, and do not provide information for estimating changes in recharge over time resulting from rainfall or land use variation. A study that estimates the spatial and temporal variation in deep groundwater recharge occurring in the source areas of the municipal production wells should be conducted.

4. Replace identified monitoring wells (Element 1). To obtain useful groundwater data from all of the monitoring network, SqCWD should replace the monitoring wells SC-8F and SC-9A as they are sanded up to 100 feet. All SC-

9 completions are in the same boring as SC-9A and are at risk of being sanded up so SqCWD should replace all SC-9 completions.

5. Manage well operation based on pumping water levels (Element 8). SqCWD should continue to install groundwater level transducers in production wells to better manage pumping based on current pumping and non-pumping groundwater levels. This project will be completed by June 2010.

6. Comply with statewide groundwater monitoring requirement (Element 1). SqCWD and CWD activities meet the requirements of 2009 state water package for groundwater monitoring. SqCWD and CWD should work together and with other local agencies to meet reporting requirements.

7. Continue to upgrade groundwater monitoring equipment (Element 1). SqCWD should continue to follow recommendations in *Evaluation of Water Quality Monitoring Network and Recommendations for Improvement* for replacing groundwater sampling equipment to improve sampling efficiencies. Upgrades should also include installing groundwater level loggers in more monitoring wells.

8. Formalize relationships with small water systems (Element 10). Small water systems and private wells may pump a significant portion of the sustainable yield, particularly in the Aromas area. Cooperative relationships with small water systems to meter their wells and share data as well as implement conservation measures would help encourage those systems to pump sustainably.

9. Survey elevations of monitoring wells that have not been surveyed (Element 1). Accurate groundwater level elevations depend on accurate survey information for well reference points. The SC-11, SC-A6, and SC-A7 monitoring wells do not have reference point elevations. The SC-11 wells at Porter Gulch are the highest priority for surveying because there is no nearby production well with survey information. SqCWD should survey these wells, probably when wells are replaced or monitoring wells are installed at Polo Grounds.

7.2 CURRENT DATA INADEQUACIES

The following is a list of current data inadequacies that could be addressed to enhance basin understanding and management. Some of these inadequacies are being addressed by recently implemented programs or will be addressed by basin management action priorities listed in Section 7.1. It is recommended that SqCWD and CWD develop additional programs and projects to address remaining data inadequacies as they gain more priority.

- Non-agency pumping. As shown in Table 2-1 and Table 2-2, estimates of non-agency pumpers are based on data from 1999 or earlier, more recent data is needed for a more complete analysis of basin pumping.
- Groundwater recharge estimates. Deep recharge estimates need to be refined to further evaluate the estimate of sustainable yield and to determine what impacts changing land use has on groundwater recharge.
- Shallow groundwater levels. Basin-wide shallow groundwater level monitoring would help assess changes in basin storage. The County's recently implemented private well monitoring program is starting to provide data to assess this inadequacy. Multi-year data from wells completed in the shallowest unit could help quantify changes in basin storage.
- Continuous groundwater level measurements in monitoring wells. These measurements are being recorded in several SqCWD and CWD monitoring wells. The effects of tides, season, and pumping cycles could be evaluated by installing groundwater level transducers in more monitoring wells.
- Pumping requirements for basin recovery. It is unknown what the reduction in pumping and expected time-frame is for the basin to recover to elevations protective against seawater intrusion. Reducing pumping to gather data for this question may require a supplemental supply.
- New monitoring wells between pumping wells. The monitoring network includes coastal wells, wells adjacent to pumping wells, and wells upland of pumping areas. There are no monitoring wells placed to monitor potential well interference between pumping areas except for wells recently installed by the City of Santa Cruz. However, future production wells are planned for the two well locations currently between pumping areas. There are also no monitoring wells to assess inland advancement of seawater intrusion in the Aromas area.

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SECTION 8
REFERENCES

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