**2012 Annual Monitoring Report**

# Northern Cities Management Area

Submitted to: The Northern Cities
Management Area Technical Group

City of Arroyo Grande, City of Grover Beach, City of Pismo Beach, and the Oceano Community Services District, San Luis Obispo County, California

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Robert Almy, PG
Project Director

Samuel Schaefer, PE
Water Resources Engineer

# 2012 Annual Monitoring Report

for the

## Northern Cities Management Area

April 2013

This report was prepared by the staff of GEI Consultants, Inc. under the supervision of professionals whose signatures appear hereon. The findings or professional opinions were prepared in accordance with generally accepted professional engineering and geologic practice.

PROFESSIONAL GEOLOGIST
ROBERT ALMY
No. 3802
STATE OF CALIFORNIA

REGISTERED PROFESSIONAL ENGINEER
SAMUEL W. SCHAEFER
C 66337
EXP 6-30-2014
CIVIL
STATE OF CALIFORNIA

Robert Almy, PG
Project Director

Samuel W. Schaefer, PE
Senior Engineer

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# 1 Introduction

This report summarizes hydrologic conditions during the calendar year 2012 in the Northern Cities Management Area (NCMA) of the Santa Maria Groundwater Basin in San Luis Obispo County California. This report was prepared on behalf of four public agencies, specifically the City of Arroyo Grande (Arroyo Grande), City of Grover Beach (Grover Beach), City of Pismo Beach (Pismo Beach) and the Oceano Community Services District (Oceano CSD), (Northern Cities). These agencies, along with local land owners, the County of San Luis Obispo (County), and the San Luis Obispo County Flood Control & Water Conservation District (FC&WCD) have managed local surface water and groundwater resources since the late 1970s to preserve the long-term integrity of water supplies.

This longstanding approach was formalized in the 2002 Management Agreement among the Northern Cities, Northern Landowners, and Other Parties, and incorporated in the 2005 Settlement Stipulation for the Santa Maria Groundwater Basin Adjudication (Stipulation). The June 30, 2005 Stipulation was agreed upon by numerous parties, including the Northern Cities; the "Settlement Agreement" attached to the Stipulation included the Management Agreement of 2002.. The approach was then adopted by the Superior Court of California, County of Santa Clara, in its *Judgment After Trial*, entered January 25, 2008 (Judgment). Subsequent appeals have upheld the Court's Judgement.

Figure 1 shows the four Northern Cities relative to the Santa Maria Groundwater Basin, as defined in the adjudication and as defined as the Santa Maria River Valley groundwater basin (Basin 3-12) by the Department of Water Resources (DWR). As shown in Figure 2, the Northern Cities Management Area (NCMA) represents the northernmost portion of the Santa Maria Groundwater Basin. Adjoining the NCMA to the southeast is the Nipomo Mesa Management Area (NMMA), while the Santa Maria Valley Management Area encompasses the remainder of the groundwater basin.

The Judgment orders the stipulating parties to comply with all terms of the Stipulation. The 2002 Settlement Agreement is generally affirmed as part of the Judgment and its terms incorporated into the Stipulation. However provisions of the Stipulation supersede the 2002 Settlement Agreement in the areas of continuing jurisdiction and groundwater monitoring, reporting. As specified in the Judgment, the Northern Cities agencies conduct groundwater monitoring in the Northern Cities Management Area. In accordance with requirements of the Judgment, the agencies comprising the NCMA group collect and analyze data pertinent to water supply and demand, including:

- Land and water uses in the basin
- Sources of supply to meet those uses

- Groundwater conditions (including water levels and water quality)

The Monitoring Program gathers and compiles pertinent information on a calendar year basis through requests to public agencies, necessary field work, and from online sources. Periodic reports such as Urban Water Management Plans (UWMP) prepared by the Cities of Arroyo Grande, Grover Beach and Pismo Beach provide information on planning to meet future demand. Annual data are added to the comprehensive Northern Cities Management Area Database (NCMA DB) and analyzed. Results of the data compilation and analysis for calendar year 2012 are documented and discussed in this Annual Report.

# 2 Climate Conditions

Each year climatological and hydrologic (stream flow) data for the NCMA are added to the NCMA data base. Figure 4 shows monthly rainfall and evapotranspiration for 2012, and for comparison, average monthly historical rainfall and evapotranspiration. These data are discussed below.

## 2.1 Precipitation

Historical rainfall data have been compiled on a monthly basis for the National Oceanic and Atmospheric Administration (NOAA) Pismo Beach station for 1949 to 2005, while precipitation data from 2005 to present are available from a County-operated rain gage in Oceano. Figure 3 is a composite graph combining data from the two stations and illustrating annual rainfall totals from 1950 through 2012 (on a calendar year basis). Annual average rainfall for the NCMA is approximately 16 inches.

Below average rainfall occurred during the months of January, February and March with slightly above average rain in April 2012. Virtually no rain fell in the months from June through September with below average rainfall in October and November. December had slightly above average rainfall and for the year the total was 10.90 inches, only 66.7 percent of the average annual rainfall. Figure 3 plots annual rainfall and exhibits several multi-year drought cycles (i.e. 1984-1990) followed by cycles of above average rainfall (i.e. March 1991 to March 1998). With the exception of 2010, the period 2007 through 2012 has experienced below average annual rainfall. The average rainfall 2007 through 2012 (including 2010) is 12.86 inches, 79% of the average.

Most rainfall typically occurs from November through April. The year 2012 was marked by substantially lower than average rainfall in January, February, and November, while rainfall only in the months of April and December were above average. The remaining months, most of which were in the dry season, experienced little or no rainfall. Since rainfall only exceeded evapotranspiration in April, 2012, deep percolation, thus groundwater recharge, would not have occurred.

## 2.2 Evapotranspiration

The California Irrigation Management Information System (CIMIS) maintains weather stations in locations throughout the state in order to provide real time wind speed, humidity and evapotranspiration data. Nipomo and San Luis Obispo stations have gathered data since 2006 and 1986, respectively. Monthly ET data from the two stations is shown in Figure 4 for 2012 and average conditions. Evapotranspiration rate affects recharge potential of rainfall and the amount of outdoor water use (irrigation). In all months, with the exception of

December, ET exceeded rainfall, indicating the recharge to groundwater from direct precipitation in 2012 was low or nonexistent.

# 3 Water Demand

Water demand refers to the total amount of water used to satisfy various needs. In the NCMA, water is primarily used to satisfy urban demand and applied irrigation demand. The third category, rural demand includes small community water systems, domestic, recreational and agriculture-related businesses and is relatively minor. Table 1 presents water demands for urban uses, applied irrigation, and rural uses. The values shown in Table 1 represent water demand in acre-feet per year (AFY). Comparing demand to available supply (Section 4) allows development and comparison of water source options under a given set of conditions.

**Table 1. Total Demand for Groundwater and Surface Water, AFY**

| Year | Arroyo Grande | Grover Beach | Pismo Beach | Oceano CSD | Total Urban | Applied Irrigation | Rural Water | Total Demand |
|---|---|---|---|---|---|---|---|---|
| **2005** | *3,460* | *2,082* | *2,142* | *931* | 8,615 | 2,056 | 36 | **10,707** |
| **2006** | *3,425* | *2,025* | *2,121* | *882* | 8,453 | 2,056 | 36 | **10,545** |
| **2007** | *3,690* | *2,087* | *2,261* | *944* | 8,982 | 2,742 | 36 | **11,760** |
| **2008** | *3,579* | *2,051* | *2,208* | *933* | 8,771 | 2,742 | 36 | **11,549** |
| **2009** | *3,315* | *1,941* | *2,039* | *885* | 8,180 | 2,742 | 36 | **10,958** |
| **2010** | *2,956* | *1,787* | *1,944* | *855* | 7,542 | 2,056 | 38 | **9,636** |
| **2011** | *2,922* | *1,787* | *1,912* | *852* | 7,473 | 2,742 | 38 | **10,253** |
| **2012** | 3,022 | 1,757 | 2,029 | 838 | 7,646 | 2,742 | 41 | **10,429** |
| **Average** | 3,296 | 1,940 | 2,082 | 890 | 8,208 | 2,485 | 37 | **10,730** |

## 3.1 Urban Demand

Actual urban water demands are presented in Table 1 for each of the Northern Cities from 2005 through 2012. These demand values reflect reported Lopez Lake and State Water Project (SWP) purchases and groundwater production data, which are incorporated in the NCMA database. These water demand values represent all water used within the entire service areas of the four agencies comprising Northern Cities, including the portions of Arroyo Grande and Pismo Beach that extend outside the NCMA (Figure 2). Urban demand amounts reported include water delivered to municipal customers and all other water used by the respective municipal agency as well as system losses.

## 3.2 Applied Irrigation Demand

Applied Irrigation Demand (Table 1) is an in-direct measurement that requires a method for estimating Annual Gross Irrigation Water Requirement (AGIR). The San Luis Obispo County Water Master Plan uses a crop-specific method for calculating AGIR in acre-feet per year per acre (AFY/acre), based on crop evapotranspiration, effective rainfall, leaching requirements, irrigation efficiency, and frost protection. Calculation of the AGIR, which is then used to estimate the applied water for irrigation for an aggregated area, is described in the following equation:

AGIR (Ft) = [(Crop ET – Effective Rainfall) / ((1-Leaching Requirement) x Irrigation Efficiency)] + Frost Protection Water

The calculated crop-specific applied water is multiplied by specific crop acres to obtain the irrigation demand for a given crop type. The individual crop demands are then summed for the agricultural area of interest.

In the NCMA, representative land use survey information that was utilized in previous annual reports by Todd Engineers provides an estimate of agriculture water use based on acres aggregated by crop type. Recently, the San Luis Obispo County Department of Agriculture compiled an estimate of irrigated acres with spatial information, compatible with use in GIS. A view displaying the agriculture land for 2012 that is irrigated is presented at the end of this report as Figures 16. The 2012 irrigated acres totaled 1,485 acres, about 7-percent less that reported in the previous Todd Engineer's annual reports. A visual observation comparing the views indicates the lower irrigated acres is likely due to the recent survey recognizing unfarmed areas as it delineates roads and farmsteads within the agriculture area, thus, the total acres classified as irrigated acres is less.

For comparison purposes to the past reports, the water use is estimated based on the 1,485 acres identified by the SLO County Department of Agriculture as irrigated land in 2012, multiplied by a representative annual water use value of (21.86 inches) obtained from tabled values published by the Irrigation and Training Research Center (ITRC) in Cal Poly for Miscellaneous Field Crops and Strawberries, drip irrigation method, and a dry year. The two estimates are slightly more than 1-percent different.

Based on the SLO Department of Agriculture acres and ITRC water use: 1,485 acres x 21.86 inches = 2,705 acre-feet. This compares close to the estimate based on Todd Engineer's method for a dry year, 2,742 acre-feet.

Based on this comparison, the method used to estimate agricultural water use for 2012 remains the same as for the previous annual report. The annual irrigation demand for the NCMA remains based on the crop acres represented by an aggregated category multiplied by the estimated gross irrigation requirements per acre from the San Luis Obispo County Water Master Plan.

The estimate of gross irrigation requirements is varied by precipitation year type based on the San Luis Obispo County Water Master Plan Update which includes low, average, and high estimates of irrigation demand by crop type for each of the Water Planning Areas (WPAs) in the County. The range in estimated irrigation demands is based upon climactic conditions and average irrigation efficiency, and includes double cropping for the category truck crops. Since the Water Master Plan Update does not include gross irrigation requirements for turf grass, the values for pasture grass were applied to turf grass areas in the NCMA to estimate their applied irrigation demand, recognizing that pasture grass is the most similar to turf grass. The representative gross irrigation requirements for crop groups are presented in Table 2.

As stated in the previous Annual Report, the areal extent of cultivated agricultural areas in the NCMA was quantified using a past land use survey by the San Luis Obispo County Agricultural Commission. Based on observation of the agricultural land use in views developed with recent land use survey information, the agriculture land use in the NCMA for 2012 has remained consistent with previous years. Given this observation, the estimated agriculture acreage remains based on agriculture land use survey data and the methods used by Todd Engineers. For the 2012 estimate, the land use acres remain the same and were used to calculate the applied irrigation demand as identified in the previous annual report. The areas with irrigated turf grass have been previously identified by public works personnel within the Northern Cities. The acreages of these areas have been measured from publically available aerial photographs using GIS software tools.

**Table 2. Gross Irrigation Requirement for WPA 5 by Crop Group**

| Crop Type | Low Annual Demand (AFY/acre) | Average Annual Demand (AFY/acre) | High Annual Demand (AFY/acre) |
|---|---|---|---|
| **Alfalfa** | 2.5 | 2.9 | 3.3 |
| **Nursery** | 1.4 | 1.7 | 2.1 |
| **Pasture** | 2.6 | 3.0 | 3.5 |
| **Turf Grass** | 2.6 | 3.0 | 3.5 |
| **Citrus** | 1.3 | 1.6 | 1.9 |
| **Deciduous** | 2.6 | 2.9 | 3.2 |
| **Truck (vegetable)** | 1.2 | 1.4 | 1.6 |
| **Vineyard** | 0.9 | 1.1 | 1.4 |

Based on the previous year estimates, there are about 1,600 acres of irrigated agriculture within the NCMA of which approximately four acres are in nursery crops, and the remainder is truck crops such as broccoli, onions, and strawberries, the total acres for irrigated crops in the NCMA. There is a combined total of 44 acres of irrigated turf grass at the Oceano Elementary School, Arroyo Grande High School, Harloe Elementary School, and the Le Sage Riviera Golf Course. For 2012, the annual precipitation and evapotranspiration have been compared to average conditions to determine if the year in question had a low, average, or high irrigation water demand.

For this evaluation, average irrigation efficiencies are assumed for the NCMA. Therefore, the annual irrigation demand for each crop type is assumed to be dependent only on that year's precipitation and evapotranspiration. The range of demand estimates for all applied irrigation uses are as follows:

- Wet years: 2,056 AFY (2005, 2006, and 2010)
- Average years: 2,397 AFY (2004)
- Dry years: 2,742 AFY (2007, 2008, 2009, 2011, and 2012)

## 3.3 Rural Demand

In the NCMA rural water demand refers to uses not designated as urban demand or applied irrigation demand and includes small community water systems, individual domestic system, recreational uses and agriculture-related business systems. Small community water systems using groundwater in the NCMA were identified initially through review of a list of water purveyors compiled in the 2007 San Luis Obispo County Integrated Regional Water Management Plan. These include the Halcyon Water System, Ken Mar Gardens, and Pacific Dunes RV Resort. The Halcyon Water System serves 35 homes in the community of Halcyon, while Ken Mar Gardens provides water supply to 48 mobile homes on South Halcyon Road. The Pacific Dunes RV Resort, with 215 RV sites, provides water supply to a largely transitory population and nearby riding stable. In addition, about 25 homes and businesses have been identified through inspection of aerial photographs of rural areas within NCMA. Irrigation of schools and parks from privately operated wells is included in the applied irrigation demand section. Two mobile home communities, Grande Mobile and Halcyon Estates, are served by Oceano CSD through the distribution system of Arroyo Grande. The demand summary of Oceano CSD includes these two communities. Based on prior reports, it is assumed that the number of private wells is negligible within the service areas of the four Northern Cities. The estimated rural water demand is shown in Table 3.

**Table 3. Estimated Rural Water Demand**

| Groundwater User | No. of Units | Estimated Water Demand, AFY per Unit | Estimated Water Demand, AFY | Notes |
|---|---|---|---|---|
| Halcyon Water System | 35 | 0.40 | 14 | *1* |
| Ken Mar Gardens | 48 | 0.24 | 11.3 | *2* |
| Pacific Dunes RV Resort | 215 | 0.03 | 6 | *3* |
| Rural Users | 25 | 0.40 | 10 | *1* |
| **Current Estimated Rural Use** | | | **41** | |

1 - Water demand/unit based on 2000 and 2005 Grover Beach water use per connection, 2005 UWMP.

2 - Demand based on metered water usage.

3 - Water demand/unit assumes 50 percent annual occupancy and 0.06 AFY per occupied site.

## 3.4 Changes in Water Demand

In general, urban water demand has varied (Table 1), with the average water use from 2005 to 2012 being 8,208 AFY. The years 2009 through 2012 have been consistently below the average which may be attributed to the relatively slower economy and the conservation activities implemented by the Northern Cities in response to the dry years of 2008 and 2009 and the potential threat of seawater intrusion. In the applied irrigation category, agricultural acreage has remained fairly constant. Thus annual water demand for applied irrigation varies mostly with weather conditions. Acknowledging the variability due to weather conditions (see Table 1), applied irrigation water demand is not expected to change significantly, given the relative stability of applied irrigation acreage and cropping patterns in the NCMA south of Arroyo Grande Creek. Changes in rural demand have not been significant.

# 4 Water Supply Sources

Section 4 provides an overview of NCMA water supply sources, presents groundwater conditions that occurred in 2012, and discusses threats to water supply.

## 4.1 Sources of Supply

There are three major sources of water that supply the NCMA. These are the Lopez Lake, the State Water Project Coastal Branch, and groundwater pumping. Each source of supply has a defined delivery volume which varies from year to year based on a number of factors. Both supply and demand are discussed below; demand is discussed in more detail in Section 5.0.

### *4.1.1 Lopez Lake Supply*

Lopez Lake and Water Treatment Plant is operated by FC&WCD Zone 3 and serves water to all four agencies in the NCMA as well as making releases for habitat conservation and agricultural purposes. The safe yield of Lopez Lake is 8,730 AFY, which reflects the amount of sustainable water supply during a drought of defined severity. Of this yield, 4,530 AFY have been apportioned by agreements to contractors, including each of the Northern Cities plus County Service Area (CSA) 12 (in the Avila Beach area). Zone 3 entitlements are summarized in Table 4. Of the safe yield, 4,200 AFY is available for release downstream to maintain flows in Arroyo Grande Creek and provide groundwater recharge.

**Table 4. Zone 3 Contractor Water Entitlement (AFY)**

| Contractor | Water Entitlement, (AFY) |
|---|---|
| City of Arroyo Grande | 2,290 |
| City of Grover Beach | 800 |
| City of Pismo Beach | 896 |
| Oceano CSD | 303 |
| CSA 12 (not in NCMA) | 241 |
| **Total** | **4,530** |
| *Downstream Releases* | *4,200* |
| *Safe Yield of Lopez Lake* | *8,730* |

Source: SLO County FC&WCD, Zone 3 UWMP 2005 Update

During 2012 the total discharge from Lopez Lake was 9014.66 AF, of which 4723.25 AF was delivered to NCMA contractors and 4147.35 AF was released downstream to maintain flow in Arroyo Grande Creek (individual deliveries are shown in Table 7). In the past, when management of releases resulted in a portion of the 4,200 AFY remaining in the reservoir, the water was offered to the contractors as surplus water. Surplus water was available in 2012; the NCMA agencies received 2714.51 AF of delivery of surplus water from Lopez Lake.[1]

#### 4.1.2 State Water Project

Pismo Beach and Oceano CSD have contracts with the FC&WCD to receive water from the SWP. The FC&WCD serves as the SWP contractor, providing the imported water to local retailers through the Coastal Branch pipeline. Pismo Beach has a contractual allocation of 1,240 AFY while Oceano CSD has a contractual allocation of 750 AFY. In addition to its original allocation, Pismo Beach holds 1240 AFY of additional allocation with FC&WCD. (The FC&WCD holds SWP allocation in excess of the amount contracted for delivery to local agencies.) The additional allocation held by Pismo Beach (sometimes referred to as a "drought buffer") is available to augment requests when the state wide SWP allocations are insufficient to meet local needs.

In response to drought in SWP source areas, the initial (February) allocation to SWP contractors for 2012 was 50 percent of contractual allocation amounts, which was subsequently increased to 60 percent in April, and ultimately 65 percent in May based on the amount of water in SWP facilities and expected operational constraints in the Delta. However, due to the nature of its contractual arrangements, FC&WCD needed to request only a fraction of its entire 25,000 AF allocation in 2012 to satisfy local contractors. The requested amount met all of the local purveyors' requests. Unlike many water agencies in California that have experienced substantial restrictions in SWP deliveries, Pismo Beach and Oceano CSD (the only SWP participants in the NCMA) were both able to receive 100 percent of their requested 2012 SWP allocation. Pismo Beach actually took delivery of 896.6 AF, while Oceano CSD took delivery of 738.4 AF, for a total of 1,635.0 AF of SWP water (Table 7).

#### 4.1.3 Groundwater

Each of the NCMA agencies have established groundwater supplies using wells which draw from developed aquifers in the northern portion of the NCMA. Groundwater also supplies applied irrigation and rural uses in the NCMA. Groundwater use in the NCMA is governed by the Judgment and the 2002 Settlement Agreement which establishes that groundwater will continue to be allotted and independently managed by the "Northern Parties" (Northern Cities, NCMA overlying owners, and the FC&WCD). The Settlement Agreement initially allots 57 percent of groundwater safe yield to agriculture and 43 percent to the cities and stipulates that any increase or decrease in groundwater yield will be shared by the cities and

[1] Lopez Lake provides water to County Service Area 12. Not all of County Service Area 12 is within the NCMA; these figures are for deliveries to the NCMA only.

landowners on a pro rata basis. However the Judgment after Trial, filed January 25, 2008 states:

> *4. (a) The Northern Cities have a prior and paramount right to produce 7,300 acre-feet of water per year from the Northern Cities Area of the Basin; and (b) the Non-Stipulating parties have no overlying, appropriative, or other right to produce any water supplies in the Northern Cities Area of the Basin.*

A safe yield value of 9,500 AFY for the NCMA groundwater basin was cited in the 2002 Groundwater Management Agreement among the Northern Cities with allotments for applied irrigation (5,300 AFY), subsurface outflow to the ocean (200 AFY), and urban use (4,000 AFY). The Management Agreement's safe yield allotment for urban use was subdivided as follows:

- City of Arroyo Grande 1,202 AFY
- City of Grover Beach 1,198 AFY
- City of Pismo Beach 700 AFY
- Oceano Community Services District 900 AFY

According to the "Water Balance Report" prepared for NCMA in 2007 (Todd Engineers, 2007), the *Groundwater Management Agreement*'s subdivision for applied irrigation is higher than the actual applied irrigation groundwater use and the amount designated for subsurface outflow is unreasonably low. Since the amount of agriculture expansion is not significant and the long term increased use is unlikely, the current balance of water use between agriculture and municipal uses has been sustainable for the last 40 years. Maintenance of subsurface outflow along the coast is essential to preventing seawater intrusion. While the minimum subsurface outflow needed to prevent seawater intrusion is unknown, a regional outflow on the order of 3,000 AFY has been estimated as a reasonable approximation (Todd Engineers, 2007).

The 2002 Management Agreement provides that the various urban parties' allotments can be increased when land within the corporate boundaries is converted from agricultural uses to urban uses, referred to as an agricultural conversion credit. Agricultural credits for the Cities of Arroyo Grande and Grover Beach did not change from 2011. The agricultural credit for 2012 for Arroyo Grande and Grover Beach and are 121 AFY and 209 AFY, respectively, for a total of 330 AFY.

### *4.1.4 Developed Water*

As defined in the Stipulation, "developed water" is "Groundwater derived from human intervention" and includes "Lopez Lake Water, Return Flow, and recharge resulting from storm water percolation ponds." Return flows result from deep percolation of water used in irrigation that is in excess of plant needs. Return flows result from outdoor uses of Lopez

Lake and SWP deliveries. These return flows have not been recently estimated, but would be considered part of the groundwater basin yield.

In 2008, the Cities of Arroyo Grande, Grover Beach, and Pismo Beach prepared storm water management plans; the cities currently are working with the Central Coast Regional Water Quality Control Board to address local storm water quality issues. In order to control storm water runoff, each City anticipates development of retention or detention ponds associated with new development that may provide groundwater recharge. No new ponds were installed in the NCMA and no new data were available for 2012 so previous estimates of recharge were used in this report. Estimated recharge values should be updated and refined as new recharge facilities are installed and as additional information on flow rates, pond size, infiltration rates, and tributary watershed area becomes available.

Construction of recharge basins or other means to increase groundwater recharge could substantially augment the yield of the groundwater basin and thus warrant provision of recharge credits to one or more of the Northern Cities. Pursuant to the Settlement Agreement, recharge credits would be based on a mutually-accepted methodology to evaluate the amount of recharge. This would involve quantification of such factors as Lopez Lake and State Water Recharge, storm water runoff amounts, determination of effective recharge under various conditions, and methods to document actual recharge to developed aquifers.

### *4.1.5 Water Use by Supply Source*

Table 5 summarizes the water supplies currently available to the Northern Cities in terms of Lopez Lake entitlements, SWP allocations, groundwater allotments, and agricultural credits. In addition to directly available supplies, 2012 was the 4th year of a 5 year agreement between Arroyo Grande and Oceano CSD for the temporary purchase of groundwater or Lopez Lake supplies. The category of “Other Supplies” includes groundwater outside the NCMA boundaries.

**Table 5. Available Urban Water Supplies, 2012, AFY**

| Urban Area | Lopez Lake Entitlement | SWP Allocation | Groundwater Allotment | Ag Credit | Temporarily Purchased | Other Supplies | Total |
|---|---|---|---|---|---|---|---|
| Arroyo Grande | 2,290 | 0 | 1,202 | 121 | 200 | 160 | **3,973** |
| Grover Beach | 800 | 0 | 1,198 | 209 | 0 | 0 | **2,207** |
| Pismo Beach | 896 | 1,240 | 700 | 0 | 0 | 0 | **2,836** |
| Oceano CSD | 303 | 750 | 900 | 0 | -200 | 0 | **1,753** |
| **Total** | **4,289** | **1,990** | **4,000** | **330** | **0** | **160** | **10,769** |

Figure 5 illustrates the water use by supply source for each NCMA city since 1999. The graphs reveal changes in water supply availability and use over time, including the increased use of SWP water (to a maximum in 2001) and reduced and less variable Lopez Lake water use due to the unavailability of Lopez Lake surplus flows from 2002 to 2008. No recycled water was available in 2012. Plans have been developed to provide recycled water facilities. See Section 6.2.5.

Figure 6 shows total NCMA water use for each supply source: Lopez Lake, SWP, and groundwater. As shown, the full amount of Lopez Lake supply (4,289 AFY) is currently used (augmented by surplus water as available). In 2001 through 2003, SWP supplies (1,850 AFY) were used to the maximum extent. From 2004 to 2008, SWP use decreased to just over 1,100 AFY, mostly reflecting a partial shift by Pismo Beach from SWP to groundwater supply. This changed in 2009 and 2010 when Pismo Beach increased SWP use and significantly decreased groundwater use to provide a more economical water supply and to ease the burden on the groundwater basin during the drought (see Figure 5). In 2012 Pismo Beach took delivery of 896.56 AF of SWP water and pumped 22.50 AF from the groundwater basin. In 2012 Oceano CSD took delivery of 738.58 AF of SWP water and pumped 58.88 AF from the groundwater basin.

Total NCMA groundwater use is shown in Figure 6. Estimated applied irrigation and rural uses are added to the urban uses detailed in Figure 5. From 1999 through 2012, total estimated groundwater use averaged approximately 5,087 AFY and exceeded 6,000 AFY in 2007 and 2008. With an estimated safe yield of 9,500 AFY, the remaining groundwater represents storage and outflow to the ocean, an unknown but major portion of which is needed to repel seawater intrusion. The overall groundwater use in 2009 was slightly above average, though in 2010, 2011, and 2012 overall groundwater use was significantly reduced and remained below average.

## 4.2 Groundwater Conditions

The NCMA groundwater monitoring program comprises: 1) compilation of groundwater elevation data from San Luis Obispo County, 2) water quality and groundwater elevation monitoring data from the network of sentry wells in the NCMA, 3) water quality data from the California Department of Public Health (DPH), and 4) groundwater elevation data from municipal pumping wells. Analysis of this data is summarized below in accordance with the July 2008 *Northern Cities Monitoring Program*.

### *4.2.1 Groundwater Monitoring Network*

Approximately 145 wells within the NCMA were monitored by the County at some time during the past few decades. The County currently monitors 38 wells on a semi-annual basis (April and October), including five “sentry well” clusters (piezometers) located along the coast and a newly constructed monitoring well (County Well #3) along the boundary between the NCMA and NMMA (Figure 7). The County monitors more than 70 additional wells in southern San Luis Obispo County. Following the findings of the 2008 Annual Report, the Northern Cities initiated a quarterly sentry well monitoring program to supplement the County's semi-annual schedule. The quarterly monitoring well measurements include County Well #3.

To monitor overall changes in groundwater conditions, representative wells within the NCMA were selected for preparation of hydrographs and evaluation of water level changes. Wells were selected based on the following criteria:

- Part of the County's current monitoring program
- Detailed location information available
- Geographically distributed
- Long and relatively complete record

It should be noted that many of the wells that have been measured are production wells that were not designed for monitoring purposes and may be screened in various producing zones. Moreover, many of the wells are active production wells or located near active wells and thus are subject to localized pumping effects that result in measurements that are lower than the "static" or more broadly representative water level. These effects are not always apparent at the time of measurement. As a result, the data cannot easily be identified as representing static groundwater levels in specific zones (e.g., unconfined or deep confined). Hence, the data should be considered as a whole in developing a general representation of groundwater conditions.

The "sentry wells", shown on Figure 7, are a critical element of the groundwater monitoring network; they provide an early warning system to identify and quantify potential seawater intrusion episodes in the basin. Each sentry well comprises a cluster of multiple wells allowing for the measurement of groundwater elevation and quality from discrete depths. Also shown on Figure 7 is the Oceano CSD Observation well, a dedicated monitor well cluster located just seaward of Oceano CSD production wells 7 and 8. Figure 8 shows the depth and well names of the sentry well clusters and the Oceano CSD observation well cluster. The wells are divided into three basic depth categories: shallow, intermediate, and deep. Since the initiation of the sentry well monitoring program 16 quarterly events have been completed; with one each in May, August, and October 2009 and winter, spring, summer and fall 2010, 2011, and 2012 as well as January 2013. (The January 2013 data will be included in the 2013 annual report.) These monitoring events include collection of synoptic groundwater elevation data and water quality samples for laboratory analysis.

### *4.2.2 Groundwater Levels*

Groundwater elevation data is gathered from the network of wells listed in Table 6a and 6b and other wells in the NCMA. Water level measurements in these wells were used to monitor effects of groundwater use, groundwater recharge, and as an indicator of risk of seawater intrusion. Analysis of these groundwater elevation data has included development of groundwater surface contour maps, hydrographs, and an index of key sentry well levels over time (Figures 9 through 12).

Contoured groundwater elevations for the April (Spring 2012) and November (Fall 2012) monitoring events, including data from the County of San Luis Obispo, are shown on Figures 9a and 9b. Figure 9a shows groundwater elevations for spring 2012 highest in the eastern portion of the NCMA and approximately 10 to 15 feet above sea level along the shore line. A comparison with 2011 Spring contours shows that spring 2012 water levels were generally lower in the areas near and south of Arroyo Grande Creek.

Groundwater elevations in November 2012 (Figure 9b) were highest in the eastern portion of the NCMA near Arroyo Grande and Highway 101. Groundwater elevations were above mean sea level (msl) throughout the NCMA during the November monitoring event. Water level elevations were approximately 5 to 10 feet above sea level along the shoreline. Although this remains higher than groundwater elevations as compared to October 2008 and October 2009, levels are below those measured in fall 2011. There remains an apparent depression in the water table in the so-called “pumping trough” which is located south of the municipal well fields and in the vicinity of, and south of, lower Arroyo Grande Creek. In particular, Water elevation in the vicinity of the confluence of Los Berros Creek and Arroyo Grande Creek is approximately 10 feet below levels measured in fall 2011.

Figure 10 shows the locations of selected wells whose data are included in Appendix B. Hydrographs shown on Figure 10 illustrate long-term changes in groundwater levels in the NCMA. To provide geographic context, hydrographs from wells located just east of the NCMA in the Nipomo Mesa Management Area (NMMA) are presented as well. Noting that these hydrographs represent localized conditions at each well, most of the hydrographs indicate that groundwater elevations have historically varied over a range of about 20 feet above mean sea level and in the case of two inland wells, 40 feet.

The upper left and middle left portions of Figure 10 shows paired hydrographs for four wells located near a persistent pumping trough. (It should be noted that these wells are near municipal well fields and, depending on duration of pumping, water levels may remain below levels in other areas of the basin for prolonged periods of time.) Although the data sets are incomplete, the hydrographs show that, throughout the record, groundwater elevations in these wells have generally been above mean sea level. However, an area of lower groundwater elevations (“trough”) beneath the active well field became more pronounced during the period of reduced rainfall in 2007 and 2008. These wells remained above sea level in 2012.

Most of the hydrographs in Figure 10 show that groundwater elevations have recovered and remained at levels similar to 2006 (a wet year); this cycle shows the result of drought and increased pumping followed by recovery caused by increased rainfall and decreased pumping (see Figure 6). Although somewhat above sea level, a depression in groundwater levels persists in the area of the trough suggesting that the recharge and withdrawals are near balance in the area. Changes in groundwater elevations within the NCMA that occurred from October 2008 to October 2012 have been evaluated in the preparation of this report. Overall, water elevations within the NCMA are below those reported for 2011 but remain above elevations reported in 2008 and 2009.

The sentry well clusters are the essential tool for tracking critical groundwater elevation changes at the coast. As shown by the hydrographs for the five sentry well clusters in Figure 11, the sentry wells provide a long history of groundwater elevations. In addition, groundwater elevations in these wells are monitored quarterly as part of the sentry well monitoring program. The deepest wells in the clusters adjacent to the NCMA urban area (wells 24B03, 30F03, and 30N02) are also screened at depths closely matching the screened depths of most local pumping wells. Hence, measured water elevations in these deepest wells reflect the net effect of changing groundwater recharge and discharge conditions in the most-used aquifer zone.

Averaging the groundwater elevations from these three wells provides a single, representative index for tracking the status of the basin. Historical variation of this index is shown as the average deep sentry well elevations on Figure 12a. Figure 12a clearly shows three years of drought followed by recovery in this highly-developed aquifer zone. Specifically, the graph shows that this index has improved significantly since the 2008 Annual Report and remains above the recommended level of 7.5 ft. (NAVD 88).

In order to measure potential short term water level fluctuations due to pumping, tidal fluctuation or other factors, the NCMA group approved installation of pressure and electrical conductivity transducers in the deepest wells at three of the sentry well locations (32S/12E-24B03; 32S/13E-30F03; and 32S/13E-30N02). In addition, a transducer was placed in well 32S/12E-24B01 to measure changes in water levels and salinity in the shallow groundwater that may be influenced by storms and other coastal processes. Since April 20, 2011 the measurement interval has been 30 minutes (Figures 12b through 12e).

Data from the continuous monitoring sensors shows water level changes of 0.2 to 1.6 ft in 6 hours with larger changes occurring in multi-day time frames. Water level changes exhibit timing that is similar to ocean tides measured in nearby Port San Luis. In the cases of 32S/12E-24B01, 32S/12E-24B03, and 32S/13E-30N02, fluctuations also reflect longer term variation in the tidal range.

To provide more detail regarding seasonal and other groundwater level changes in the area between the NCMA and NMMA, detailed water level monitoring was initiated in April 2012. A continuous monitor was also placed in the new County Monitoring Well #3 in April 2012. Data were collected in July and November of 2012 (Figure 12f). The well shows cyclical water level fluctuations, but the fluctuations do not appear related to tidal cycles. In spring 2012 the detailed data reveals daily fluctuations of as much as 1 foot and declines of up to 3 feet per week during May and September 2012. Recovery of 3 feet occurred within a week of the September decline (Figure 12f). The water level measurements reported in Tables 1 and 2 need to be interpreted with this in mind.

Detailed data from continuous monitors suggests the rainfall events of March and April 2012 caused a modest rise in water levels. Detailed data suggests the water levels began to rise in mid to late September.

### *4.2.3 Water Quality*

Water is used in several ways in the NCMA; each use requires a certain minimum water quality. Since contaminants from seawater intrusion or anthropogenic sources can potentially lower the quality of water in the basin, water quality is monitored at several locations in the NCMA. In the NCMA area, water quality data are available from dedicated monitoring wells, from water supply wells and from surface water. Four well clusters located along the coast were originally installed by the California Department of Water Resources to monitor for seawater intrusion. Each of these “sentry well” locations has two or three individual wells (piezometers) completed at different depths. In addition, the Oceano CSD observation well cluster (located near Highway 1 in Oceano) includes four individual piezometers. Water quality information from each of the sentry wells and the Oceano CSD monitoring wells as well as County monitoring well #3, is gathered quarterly. In addition to the monitoring wells, consolidated water quality information from the DPH for local municipal wells was reviewed.

#### 4.2.3.1 Sentry Wells

Four separate monitoring events occurred in 2012, with each piezometer in the sentry wells and in the Oceano CSD well measured in January, April, July, and November 2012. During each event, the wells were all sampled in accordance with ASTM International Standard D4448-01. Water quality data from these events and available historical data from these wells are presented on Tables 6a and 6b. Since water quality trends are used to monitor for seawater intrusion, data collected in 2012 were added to previous data and the variation of selected constituents have been plotted against time. (Other geochemical plots are discussed below.) Figure 13 and Figure 14 are meant to show variation of chloride and TDS concentration, respectively, in 2012. Data contained in Table 6a shows a wide variation in water quality during the years 2009 through 2012. However, samples obtained in 2012 show less variation and general improvement in overall quality compared to 2009. Todd Engineers (2010) suggested the observed *variation in water quality data could be due to a number of factors including: variable permeability of geologic materials, potential mixing with seawater, ion exchange in clay-rich units, and variability in surface recharge sources, such as Arroyo Grande and Meadow Creeks.* Changes in groundwater demand since 2009 and abundant rainfall in 2011 may have contributed to groundwater quality becoming relatively stable in 2011 and 2012. These factors are discussed in more detail in Section 5.

In 2012 water quality was similar to results from the same season in 2011. With the exception of shallow well 32S/12E-24B01, no wells showed evidence of higher TDS or Chloride which may be indicators of seawater intrusion. Several wells showed maintained or improved of water quality compared to 2008, 2009 and 2010 monitoring results. Key observations are discussed below.

Sentry well cluster 32S/13E 30N is located west of Highway 1 in Oceano and includes three piezometers. The sentry well cluster is also in an area of sufficient groundwater production to cause a broad lowering of the water table (called a pumping trough by Todd Engineers 2010). The deep and intermediate level piezometers at this location showed low groundwater levels in 2008 and 2009. Data from this sentry well cluster was interpreted to indicate localized seawater intrusion affecting the deep zone (30N02) and, to a lesser extent, the middle zone (30N03) in 2009.

Data collected in 2010 from piezometers 30N02 and 30N03 show geochemical signatures of seawater intrusion on Schoeller geochemical plots (Figure 15). (A Schoeller diagram is a graphical representation of common cation and anion concentrations in water expressed in milliequivalents per liter (meq/l). Because several samples may be plotted on the same graph, variation in hydrogeochemical water characteristics may be easily recognized.) The most recent water quality data from this well cluster (January, April, July and October 2012) shows a signature similar to the historical signature of groundwater in 30N02.

These water quality changes indicate that the local interface/mixing zone between seawater and fresh groundwater remains seaward of the sentry wells. The location of the seawater interface is not known due to the heterogeneity of the aquifer; the only indication of the location of the interface would be when one or more monitored wells show an increase in TDS along with a geochemical signature resembling seawater. Based on experience in the NCMA, retreat of the interface may be reversed, and again become shoreward, if seaward gradients are reduced or reversed. These changes may be brought on by reduced recharge (e.g. drought conditions) or if pumping exceeds available groundwater supply, or both. Ongoing sentry well monitoring is necessary to provide an early warning of future migration of the interface.

The shallow well in sentry well cluster 32S/12E 24B has historically contained brackish water. This sentry well is located in the northwestern corner of the basin in Pismo Beach. The shallow well (24B01) shows a similar geochemical signature to that of seawater. Water samples from this well historically have shown high sodium and chloride concentrations. While these data have been interpreted by the California Department of Water Resources to be the result of solution of residual marine and evaporative salts indigenous to the geologic environment in this part of the basin, there may be another source. The location of 32S/12E 24B is near the lagoon at the mouth of Pismo Creek. This area is subject to storm surge and local flooding during storm and high sea conditions. The water sample from the shallow

## Table 6a: Northern Cities Sentry Well Water Quality Data Summary

| | | | | | | | (-1) | (+1) | (+1) | (+2) | (+2) | (-1) | (-2) | | | | | | (+2) | | | | | | (+2) | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Well | Construction | Top of Casing Elevation (feet NAVD) | Date | Depth to Water (feet) | Groundwater Elevation (feet NAVD) | Total Dissolved Solids (mg/L) | Chloride (mg/L) | Sodium (mg/L) | Potassium (mg/L) | Calcium (mg/L) | Magnesium (mg/L) | Bicarbonate (as CaCO3) (mg/L) | Sulfate (mg/L) | Nitrate (mg/L) | Total Kjeldahl Nitrogen (mg/L) | Boron (mg/L) | Fluoride (mg/L) | Iodide (mg/L) | Manganese (mg/L) | Bromide (mg/L) | Alkalinity, Total (as CaCO3) (mg/L) | Carbonate (as CaCO3) (mg/L) | Hydroxide (as CaCO3) (mg/L) | Specific Conductance (umhos/cm) | Iron (mg/L) | Bromide / Chloride Ratio | Chloride / Bromide Ratio |
| 32S/12E-24B01 | Screened from 48-65' - 2-inch diameter | **13.58** | | | | | | | | | | | | | | | | | | | | | | | | | |
| | Height of steel casing added to the concrete pad elevation | 2.88 | 10/29/2012 | 5.92 | 7.66 | 2,950 | 1200 | 590 | 34 | 150 | 160 | 360 | 200 | <0.25 | 2.4 | 0.18 | <0.5 | <0.01 | 1.10 | 11 | 360 | <10 | <10 | 4,750 | 0.78 | 0.0092 | 109 |
| | Pad elevation NAVD 88 | 10.70 | 7/23/2012 | 5.79 | 7.79 | 3,010 | 1400 | 530 | 30 | 120 | 130 | 397 | 210 | <0.05 | 2.1 | 0.15 | <0.1 | 0.041 | 0.86 | 3 | 397 | <10 | <10 | 4,720 | 1.4 | 0.0021 | 467 |
| | TOC elevation prior to renovation (Approximate) | 10.7 | 4/18/2012 | 5.58 | 8.00 | 3,000 | 1500 | 450 | 27 | 120 | 120 | 400 | 230 | <0.1 | 2 | 0.13 | 0.13 | <0.01 | 0.89 | 3.12 | 400 | <10 | <10 | 4,660 | 0.6 | 0.0021 | 481 |
| | | | 1/11/2012 | 5.72 | 7.86 | 2,750 | 1200 | 520 | 30 | 140 | 140 | 400 | 170 | <0.1 | 4 | 0.18 | 0.1 | 0.033 | 0.94 | 3.2 | 400 | <10 | <10 | 4,560 | 0.55 | 0.0027 | 375 |
| | | | 11/21/2011 | 5.80 | 7.78 | 2,740 | 1200 | 410 | 25 | 130 | 120 | 380 | 200 | <0.3 | 2.3 | 0.13 | <0.6 | 0.053 | 0.9 | 2.73 | 380 | <10 | <10 | 4,470 | 0.7 | 0.0023 | 440 |
| | | | 7/26/2011 | 6.38 | 7.20 | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| | | | 7/25/2011 | NA | NA | 3,690 | 1199.9 | 530 | 33 | 140 | 150 | 380 | 200.2 | <0.05 | 1.8 | 0.14 | <0.1 | 0.053 | 0.91 | 3.281 | 380 | <5 | <5 | 4,900 | 0.73 | 0.0027 | 366 |
| | | | 4/20/2011 | 6.40 | 7.18 | 2,810 | 1214 | 500 | 27 | 140 | 130 | 400 | 216 | <0.05 | 1.7 | 0.24 | 0.18 | 0.067 | 0.95 | 3.3 | 400 | <2.0 | <2.0 | 4,430 | NA | 0.0027 | 368 |
| | | | 1/24/2011 | 5.78 | 7.42 | 2,380 | 1100 | 370 | 24 | 110 | 120 | 380 | 180 | <0.15 | 1.8 | 0.16 | <0.3 | 0.63 | 0.68 | 2.8 | 380 | <2.0 | <2.0 | 4,020 | 0.89 | 0.0025 | 393 |
| | | | 10/28/2010 | NA | NA | 2,330 | 960 | 390 | 25 | 140 | 140 | 350 | 160 | <0.1 | 3.9 | 0.15 | <0.1 | NA | 0.75 | 2.6 | 350 | <10 | <10 | 3,860 | 1.3 | 0.0027 | 369 |
| | | | 10/21/2010 | 6.37 | 7.21 | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| | | | 7/27/2010 | 6.48 | 7.1 | 616 | 43 | 52.5 | 6.21 | 115 | 44.7 | 341 | 160 | < 0.10 | 2.9 | 0.063 | < 0.10 | 0.11 | 0.274 | 0.18 | 341 | < 1.0 | < 1.0 | 1,000 | 9.34 | 0.0042 | 239 |
| | | | 4/27/2010 | 3.84 | 6.86 | 676 | 47 | 54.7 | 4.60 | 107 | 43.6 | 327 | 140 | < 0.10 | 0.98 | 0.0714 | < 0.10 | < 0.10 | 0.0458 | 0.18 | 327 | < 1.0 | < 1.0 | 990 | 4.06 | 0.0038 | 261 |
| | | | 1/27/2010 | 3.13 | 7.57 | 694 | 55 | 56.2 | 6.80 | 123 | 43.2 | 340 | 150 | 0.40 | 1.7 | 0.12 | < 0.10 | 0.33 | 0.875 | 0.19 | 340 | < 1.0 | < 1.0 | 1,000 | 16.6 | 0.0035 | 289 |
| | | | 10/19/2009 | 2.28 | 8.42 | 766 | 140 | 121 | 16.7 | 111 | 52.4 | 303 | 150 | 0.25 | 2.8 | 0.0959 | 0.11 | < 0.10 | 0.208 | 0.47 | 303 | < 1.0 | < 1.0 | 1,200 | 7.79 | 0.0034 | 298 |
| | | | 8/20/2009 | 3.25 | 7.45 | 705 | 94 | 86.8 | 11.7 | 116 | 35.6 | 286 | 150 | 0.21 | 2.7 | NA | < 0.10 | 0.12 | 0.248 | 0.38 | 286 | < 1.0 | < 1.0 | 1,000 | 7.15 | 0.0040 | 247 |
| | | | 5/12/2009 | 3.58 | 7.12 | 695 | 100 | 82.1 | 13.2 | 108 | 45 | 288 | 150 | NA | NA | NA | 0.11 | NA | 0.66 | 0.29 | 288 | < 1.0 | < 1.0 | 1,100 | 23.9 | 0.0029 | 345 |
| | | | 3/26/1996 | NA | NA | 1,870 | 773 | 380 | 24.0 | 125 | 95 | 427 | 154 | 0.2 | NA | 0.27 | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| | | | 6/9/1976 | NA | NA | 1,706 | 667 | 400 | 16.2 | 94 | 95 | 474 | 159 | 0.4 | NA | 0.12 | 0.5 | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| | | | 1/17/1966 | NA | NA | 1,700 | 652 | 406 | 20.0 | 95 | 83 | 440 | 175 | 1 | NA | 0.07 | 0.3 | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 32S/12E-24B02 | Screened from 120-145' - 2-inch diameter | **13.58** | | | | | | | | | | | | | | | | | | | | | | | | | |
| | Height of steel casing added to the concrete pad elevation | 2.88 | 10/29/2012 | 5.88 | 7.70 | 650 | 29 | 45 | 4.2 | 100 | 32 | 280 | 160 | <0.05 | <1 | 0.074 | 0.14 | <0.01 | 0.13 | <0.1 | 280 | <10 | <10 | 950 | 0.56 | NA | NA |
| | Pad elevation NAVD 88 | 10.70 | 7/23/2012 | 6.12 | 7.46 | 650 | 35 | 45 | 4.3 | 87 | 27 | 297 | 170 | <0.05 | <1 | <0.1 | <0.1 | <0.01 | 0.12 | <0.1 | 297 | <10 | <10 | 950 | 0.43 | NA | NA |
| | TOC elevation prior to renovation (Approximate) | 10.7 | 4/18/2012 | 5.48 | 8.1 | 630 | 37 | 39 | 3.7 | 88 | 28 | 310 | 171 | <0.1 | <1 | <0.1 | 0.16 | <0.01 | 0.099 | <0.2 | 310 | <10 | <10 | 950 | 0.26 | NA | NA |
| | | | 1/11/2012 | 5.47 | 8.11 | 650 | 33 | 46 | 4.6 | 110 | 32 | 300 | 150 | <0.1 | 1.3 | <0.1 | 0.21 | <0.02 | 0.13 | 0.03 | 300 | <10 | <10 | 950 | 1.7 | 0.0010 | 971 |
| | | | 11/21/2011 | 5.69 | 7.89 | 640 | 32 | 39 | 3.9 | 93 | 29 | 290 | 150 | <0.05 | <1 | 0.064 | <0.1 | <0.01 | 0.096 | <0.1 | 290 | <10 | <10 | 930 | 0.32 | NA | NA |
| | | | 7/26/2011 | 6.51 | 7.07 | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| | | | 7/25/2011 | NA | NA | 640 | 36 | 48 | 4.2 | 97 | 31 | 290 | 165.3 | <0.05 | <1 | <0.1 | <0.1 | <0.01 | 0.096 | <0.1 | 290 | <5 | <5 | 950 | 0.88 | NA | NA |
| | | | 4/20/2011 | 6.30 | 7.28 | 620 | 39 | 46 | 7.4 | 90 | 36 | 320 | 174 | <0.05 | <1 | 0.17 | 0.14 | 0.014 | <0.005 | <0.1 | 320 | <2.0 | <2.0 | 950 | NA | NA | NA |
| | | | 1/24/2011 | 5.69 | 7.53 | 640 | 43 | 44 | 5.9 | 87 | 28 | 270 | 170 | <0.05 | <1.0 | 0.11 | <0.1 | 0.14 | 0.085 | <0.1 | 270 | <2.0 | <2.0 | 940 | 1.3 | NA | NA |
| | | | 10/28/2010 | NA | NA | 650 | 43 | 50 | 4.5 | 110 | 35 | 270 | 160 | <0.1 | <1.0 | 0.12 | <0.1 | NA | 0.085 | <0.3 | 270 | <10 | <10 | 970 | 0.63 | NA | NA |
| | | | 10/21/2010 | 6.79 | 6.79 | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| | | | 7/27/2010 | 7.05 | 6.53 | 598 | 42 | 48.9 | 4.29 | 111 | 40.5 | 318 | 160 | < 0.10 | 1.3 | 0.0609 | < 0.10 | 0.11 | 0.106 | 0.15 | 318 | < 1.0 | < 1.0 | 980 | 2.84 | 0.0036 | 280 |
| | | | 4/27/2010 | 4.34 | 6.36 | 668 | 46 | 52.7 | 4.73 | 111 | 43.2 | 349 | 150 | < 0.10 | 1.3 | 0.0666 | < 0.10 | 0.14 | 0.101 | 0.16 | 349 | < 1.0 | < 1.0 | 980 | 6.66 | 0.0035 | 288 |
| | | | 1/27/2010 | 3.38 | 7.32 | 622 | 45 | 58.0 | 5.39 | 115 | 32.2 | 270 | 160 | 0.18 | 0.84 | 0.117 | < 0.10 | 0.14 | 0.209 | 0.16 | 270 | < 1.0 | < 1.0 | 920 | 3.49 | 0.0036 | 281 |
| | | | 10/19/2009 | 2.26 | 8.44 | 600 | 49 | 59.1 | 5.12 | 112 | 30.1 | 281 | 160 | < 0.10 | 0.98 | 0.0776 | 0.14 | < 0.10 | 0.163 | 0.19 | 281 | < 1.0 | < 1.0 | 870 | 1.14 | 0.0039 | 258 |
| | | | 8/20/2009 | 4.09 | 6.61 | 630 | 49 | 63.5 | 5.85 | 128 | 30.1 | 288 | 150 | < 0.10 | 0.98 | NA | < 0.10 | < 0.10 | 0.203 | 0.20 | 288 | < 1.0 | < 1.0 | 920 | 3.22 | 0.0041 | 245 |
| | | | 5/12/2009 | 4.74 | 5.96 | 622 | 82 | 67.5 | 6.33 | 114 | 34.5 | 282 | 150 | NA | NA | NA | 0.11 | NA | 0.252 | 0.24 | 282 | < 1.0 | < 1.0 | 990 | 6.76 | 0.0029 | 342 |
| | | | 3/26/1996 | NA | NA | 652 | 54 | 46 | 5 | 107 | 24 | 344 | 169 | 0.2 | NA | 0.1 | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| | | | 6/9/1976 | NA | NA | 565 | 34 | 52 | 4 | 104 | 27 | 337 | 153 | 0.6 | NA | 0.02 | 0.5 | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| | | | 1/17/1966 | NA | NA | 651 | 62 | 79 | 5 | 101 | 32 | 380 | 147 | 0 | NA | 0.05 | 0.3 | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 32S/12E-24B03 | Screened from 270-435' - 2-inch diameter | **13.58** | | | | | | | | | | | | | | | | | | | | | | | | | |
| | Height of steel casing added to the concrete pad elevation | 2.88 | 10/29/2012 | 3.01 | 10.57 | 680 | 45 | 49 | 4.1 | 100 | 39 | 305 | 158 | <0.05 | <1 | 0.069 | 0.1 | <0.01 | 0.0090 | <0.1 | 305 | <10 | <10 | 1,010 | 0.22 | NA | NA |
| | Pad elevation NAVD 88 | 10.70 | 7/23/2012 | 2.98 | 10.6 | 670 | 49 | 47 | 4.1 | 86 | 35 | 318 | 170 | <0.05 | <1 | <0.1 | <0.1 | <0.01 | 0.0150 | <0.1 | 318 | <10 | <10 | 1,010 | 0.24 | NA | NA |
| | TOC elevation prior to renovation (Approximate) | 10.7 | 4/18/2012 | 1.93 | 11.65 | 640 | 50 | 40 | 3.4 | 84 | 33 | 320 | 160 | <0.1 | <1 | <0.1 | <0.2 | <0.01 | 0.0070 | <0.2 | 320 | <10 | <10 | 1,010 | 0.23 | NA | NA |
| | | | 1/12/2012 | 2.15 | 11.43 | 660 | 46 | 48 | 3.2 | 92 | 36 | 300 | 150 | <0.1 | <1 | <0.1 | 0.35 | <0.02 | 0.0080 | <0.2 | 300 | <10 | <10 | 1,000 | 0.15 | NA | NA |
| | | | 11/21/2011 | 2.93 | 10.65 | 660 | 43 | 41 | 3.7 | 91 | 34 | 310 | 150 | <0.05 | 1.6 | 0.046 | <0.1 | 0.014 | 0.0090 | <0.1 | 310 | <10 | <10 | 970 | 0.12 | NA | NA |
| | | | 7/26/2011 | 3.17 | 10.41 | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| | | | 7/25/2011 | NA | NA | 650 | 46.3 | 50 | 6.0 | 98 | 38 | 310 | 159.6 | <0.05 | <1 | <0.1 | <0.1 | 0.011 | 0.0100 | <0.1 | 310 | <5 | <5 | 1,010 | 0.21 | NA | NA |
| | | | 4/20/2011 | 3.25 | 10.33 | 650 | 47 | 48 | 4.6 | 95 | 31 | 310 | 168 | <0.05 | <1 | 0.11 | 0.08 | 0.015 | 0.0080 | <0.1 | 310 | <2.0 | <2.0 | 1,020 | NA | NA | NA |
| | | | 1/24/2011 | 2.65 | 10.58 | 660 | 46 | 44 | 5.6 | 87 | 33 | 320 | 160 | <0.05 | <1.0 | NA | <0.1 | 0.15 | 0.0096 | <0.1 | 320 | <2.0 | <2.0 | 1,020 | 0.22 | NA | NA |
| | | | 10/28/2010 | NA | NA | 660 | 44 | 48 | 3.8 | 110 | 39 | 315 | 50 | <0.1 | <1.0 | 0.089 | <0.1 | NA | 0.0120 | <0.3 | 315 | <10 | <10 | 1,020 | 0.55 | NA | NA |
| | | | 10/21/2010 | 4.60 | 8.98 | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| | | | 7/27/2010 | 4.54 | 9.04 | 610 | 44 | 51.4 | 8.34 | 112 | 41.6 | 328 | 160 | < 0.10 | 1.8 | 0.0533 | < 0.10 | 0.17 | 0.0602 | 0.16 | 328 | < 1.0 | < 1.0 | 1,000 | 6.7 | 0.0036 | 275 |
| | | | 4/27/2010 | 1.43 | 9.27 | 666 | 45 | 53.2 | 4.84 | 118 | 44 | 357 | 150 | < 0.10 | 1.5 | 0.0636 | < 0.10 | 0.1 | 0.0519 | 0.17 | 357 | < 1.0 | < 1.0 | 980 | 9.71 | 0.0038 | 265 |
| | | | 1/27/2010 | 0.94 | 9.76 | 672 | 48 | 56.4 | 5.40 | 119 | 43.4 | 336 | 150 | < 0.10 | 1.4 | 0.101 | < 0.10 | 0.15 | 0.140 | 0.15 | 336 | < 1.0 | < 1.0 | 1,000 | 5.18 | 0.0031 | 320 |
| | | | 10/19/2009 | 0.81 | 9.89 | 622 | 40 | 55.1 | 3.93 | 110 | 42.6 | 342 | 160 | < 0.10 | < 0.50 | 0.0613 | < 0.10 | 0.13 | 0.0181 | 0.14 | 342 | < 1.0 | < 1.0 | 880 | 0.343 | 0.0035 | 286 |
| | | | 8/19/2009 | 4.18 | 6.52 | 680 | 47 | 54.9 | 5.21 | 128 | 43.4 | 337 | 150 | < 0.10 | 2.2 | NA | < 0.10 | 0.66 | 0.182 | 0.15 | 337 | < 1.0 | < 1.0 | 1,000 | 14.3 | 0.0032 | 313 |
| | | | 5/12/2009 | 3.18 | 7.52 | 645 | 44 | 53.2 | 4.53 | 108 | 41.8 | 332 | 140 | NA | NA | NA | < 0.10 | NA | 0.124 | 0.16 | 332 | < 1.0 | < 1.0 | 1,000 | 5.9 | 0.0036 | 275 |
| | | | 3/26/1996 | NA | NA | 646 | 41 | 52 | 4.3 | 104 | 42 | 412 | 164 | 0.2 | NA | 0.12 | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| | | | 6/9/1976 | NA | NA | 569 | 36 | 53 | 3.7 | 85 | 39 | 330 | 165 | 0 | NA | 0.06 | 0.4 | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| | | | 1/17/1966 | NA | NA | 670 | 79 | 74 | 5 | 103 | 36 | 345 | 158 | 1 | NA | 0 | 0.2 | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |

## Table 6a: Northern Cities Sentry Well Water Quality Data Summary

| Well | Construction | Top of Casing Elevation (feet NAVD) | Date | Depth to Water (feet) | Groundwater Elevation (feet NAVD) | Total Dissolved Solids (mg/L) | (-1) Chloride (mg/L) | (+1) Sodium (mg/L) | (+1) Potassium (mg/L) | (+2) Calcium (mg/L) | (+2) Magnesium (mg/L) | (-1) Bicarbonate (as CaCO3) (mg/L) | (-2) Sulfate (mg/L) | Nitrate (mg/L) | Total Kjeldahl Nitrogen (mg/L) | Boron (mg/L) | Fluoride (mg/L) | Iodide (mg/L) | (+2) Manganese (mg/L) | Bromide (mg/L) | Alkalinity, Total (as CaCO3) (mg/L) | Carbonate (as CaCO3) (mg/L) | Hydroxide (as CaCO3) (mg/L) | Specific Conductance (umhos/cm) | (+2) Iron (mg/L) | Bromide / Chloride Ratio | Chloride / Bromide Ratio |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 32S/13E-30F01 | Screened from 15- 30 and 40-55' - 1-inch diameter | **23.16** | | | | | | | | | | | | | | | | | | | | | | | | | |
| | Height of steel casing added to the concrete pad elevation | 2.80 | 10/30/2012 | 14.95 | 8.21 | 470 | 60 | 66 | 2.5 | 43 | 20 | 75 | 123 | 12 | <1 | 0.087 | <0.1 | <0.01 | <0.005 | 0.13 | 75 | <10 | <10 | 720 | <0.05 | 0.0022 | 462 |
| | Pad elevation NAVD 88 | 20.36 | 7/24/2012 | 14.00 | 9.16 | 470 | 73 | 66 | 2.70 | 36 | 18 | 86 | 120 | 13 | <1 | <0.1 | <0.1 | <0.01 | 0.019 | 0.11 | 86 | <10 | <10 | 720 | <0.05 | 0.0015 | 664 |
| | TOC elevation prior to renovation (Approximate) | 20.4 | 4/19/2012 | NA | NA | 450 | 72 | 52 | 1.90 | 32 | 15 | 81 | 130 | 13 | <1 | <0.1 | <0.2 | <0.01 | <0.005 | <0.2 | 81 | <10 | <10 | 700 | <0.1 | NA | NA |
| | | | 4/18/2012 | 13.42 | 9.74 | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| | | | 1/10/2012 | 13.80 | 9.36 | 460 | 67 | 61 | 2.00 | 35 | 17 | 81 | 120 | 11 | <1 | <0.1 | 0.12 | <0.01 | <0.005 | <0.1 | 81 | <10 | <10 | 720 | <0.1 | NA | NA |
| | | | 11/21/2011 | 13.78 | 9.38 | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| | | | 11/17/2011 | NA | NA | 470 | 70 | 82 | 2.40 | 40 | 19 | 78 | 120 | 12 | <1 | <0.1 | <0.1 | <0.01 | <0.005 | 0.16 | 78 | <10 | <10 | 720 | <0.1 | 0.0023 | 438 |
| | | | 7/26/2011 | 13.50 | 9.66 | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| | | | 7/25/2011 | NA | NA | 460 | 65.8 | 68 | 4.40 | 37 | 19 | 78 | 117.4 | 12.17 | <1 | 0.100 | 0.101 | <0.01 | 0.014 | 0.178 | 78 | <5 | <5 | 720 | 0.11 | 0.0027 | 370 |
| | | | 4/20/2011 | 12.82 | 10.34 | 460 | 71 | 69 | 2.60 | 36 | 14 | 87 | 124 | 12 | <1 | 0.180 | 0.11 | <0.01 | <0.005 | 0.17 | 87 | <2.0 | <2.0 | 730 | NA | 0.0024 | 418 |
| | | | 1/24/2011 | 13.33 | 9.97 | 510 | 75 | 64 | 4.00 | 34 | 18 | 83 | 140 | 11 | <1.0 | 0.170 | 0.11 | <0.10 | <0.005 | <0.1 | 83 | <2.0 | <2.0 | 780 | <0.1 | NA | NA |
| | | | 10/21/2010 | 16.55 | 6.61 | 540 | 100 | 73 | 2.00 | 43 | 21 | 88 | 120 | 13 | <1.0 | 0.067 | <0.1 | NA | <0.005 | <0.3 | 88 | <10 | <10 | 894 | <.1 | NA | NA |
| | | | 7/26/2010 | 15.68 | 7.48 | 464 | 74 | 82.2 | 2.16 | 47.9 | 25.1 | 88.0 | 120 | 12 | < 0.50 | 0.098 | < 0.10 | < 0.10 | 0.0817 | 0.37 | 88.0 | < 1.0 | < 1.0 | 710 | 0.79 | 0.0050 | 200 |
| | | | 4/27/2010 | 11.02 | 9.38 | 534 | 72 | 77.1 | 2.59 | 45.8 | 23.6 | 100 | 140 | 9.8 | 0.56 | 0.129 | < 0.10 | < 0.10 | 0.112 | 0.29 | 100 | < 1.0 | < 1.0 | 780 | 1.02 | 0.0040 | 248 |
| | | | 1/28/2010 | 12.73 | 7.67 | 725 | 140 | 99.9 | 2.70 | 76.4 | 35.8 | 214 | 170 | 1.6 | 0.84 | 0.120 | < 0.10 | < 0.10 | 0.112 | 0.56 | 214 | < 1.0 | < 1.0 | 1,200 | 0.640 | 0.0040 | 250 |
| | | | 10/19/2009 | 14.33 | 6.07 | 522 | 74 | 85.6 | 2.35 | 52.8 | 26.3 | 102 | 150 | 13 | 0.70 | 0.136 | 0.13 | < 0.10 | 0.123 | 0.32 | 102 | < 1.0 | < 1.0 | 770 | 1.30 | 0.0043 | 231 |
| | | | 8/19/2009 | 14.34 | 6.06 | 648 | 92 | 98.9 | 3.84 | 63.1 | 31.9 | 113 | 190 | 10 | 0.56 | NA | < 0.10 | 0.12 | 1.03 | 0.32 | 113 | < 1.0 | < 1.0 | 970 | 4.52 | 0.0035 | 288 |
| | | | 5/12/2009 | 12.38 | 8.02 | 792 | 110 | 108 | 2.89 | 80.2 | 39.9 | 136 | 280 | NA | NA | NA | < 0.10 | NA | 0.0353 | 0.39 | 136 | < 1.0 | < 1.0 | 1,200 | 0.281 | 0.0035 | 282 |
| 32S/13E-30F02 | Screened from 75-100' - 2-inch diameter | **23.16** | | | | | | | | | | | | | | | | | | | | | | | | | |
| | Height of steel casing added to the concrete pad elevation | 2.80 | 10/30/2012 | 15.27 | 7.89 | 610 | 48 | 45 | 3.0 | 79 | 34 | 188 | 135 | 13 | <1 | 0.09 | <0.1 | <0.01 | 0.06 | 0.31 | 188 | <10 | <10 | 890 | 0.011 | 0.0065 | 155 |
| | Pad elevation NAVD 88 | 20.36 | 7/24/2012 | 14.82 | 8.34 | 590 | 56 | 46 | 3.2 | 69 | 30 | 194 | 140 | 14 | <1 | <0.1 | 0.11 | <0.01 | 0.038 | 0.27 | 194 | <10 | <10 | 880 | <0.05 | 0.0048 | 207 |
| | TOC elevation prior to renovation (Approximate) | 20.4 | 4/19/2012 | NA | NA | 600 | 60 | 40 | 2.7 | 68 | 30 | 200 | 140 | 14 | <1 | <0.1 | <0.2 | <0.01 | 0.19 | 0.3 | 200 | <10 | <10 | 890 | 0.11 | 0.0050 | 200 |
| | | | 4/18/2012 | 14.38 | 8.78 | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| | | | 1/12/2012 | 14.31 | 8.85 | 610 | 52 | 45 | 3.0 | 73 | 32 | 200 | 130 | 12 | <1 | <0.1 | 0.25 | <0.02 | 0.29 | 0.33 | 200 | <10 | <10 | 890 | <0.1 | 0.0063 | 158 |
| | | | 11/21/2011 | 14.94 | 8.22 | 580 | 49 | 38 | 2.7 | 73 | 30 | 190 | 120 | 13 | <1 | 0.07 | <0.1 | <0.01 | 0.022 | 0.34 | 190 | <10 | <10 | 870 | <0.1 | 0.0069 | 144 |
| | | | 7/26/2011 | 14.46 | 8.7 | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| | | | 7/25/2011 | NA | NA | 590 | 52.1 | 46 | 5.1 | 73 | 31 | 190 | 134.3 | 13.19 | <1 | <0.1 | 0.127 | <0.1 | 0.025 | 0.387 | 190 | <5 | <5 | 900 | <0.1 | 0.0074 | 135 |
| | | | 4/20/2011 | 14.23 | 8.93 | 600 | 54 | 57 | 4.2 | 74 | 29 | 200 | 141 | 13 | <1 | 0.18 | 0.17 | <0.01 | 0.025 | 0.38 | 200 | <2.0 | <2.0 | 920 | NA | 0.0070 | 142 |
| | | | 1/24/2011 | 14.36 | 8.93 | 600 | 51 | 43 | 4.9 | 71 | 31 | 210 | 140 | 12 | <1.0 | 0.15 | 0.12 | 0.27 | 0.041 | 0.3 | 210 | <2.0 | <2.0 | 920 | <0.1 | 0.0059 | 170 |
| | | | 10/28/2010 | NA | NA | 610 | 49 | 38 | 2.3 | 70 | 30 | 210 | 130 | 11 | <1.0 | 0.10 | <0.1 | NA | 0.0094 | <0.3 | 210 | <10 | <10 | 920 | <0.1 | NA | NA |
| | | | 10/21/2010 | 7.39 | 15.77 | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| | | | 7/26/2010 | 16.21 | 6.95 | 560 | 49 | 45.8 | 2.95 | 85.4 | 36.8 | 223 | 130 | 11 | 2.5 | 0.0928 | < 0.10 | 0.13 | 0.0646 | 0.59 | 223 | < 1.0 | < 1.0 | 890 | < 0.100 | 0.0120 | 83 |
| | | | 4/27/2010 | 12.14 | 8.26 | 634 | 51 | 50.3 | 3.12 | 87.9 | 38.6 | 225 | 130 | 10 | 0.8 | 0.112 | < 0.10 | < 0.10 | 0.615 | 0.51 | 225 | < 1.0 | < 1.0 | 880 | 3.28 | 0.0100 | 100 |
| | | | 1/28/2010 | 13.09 | 7.31 | 604 | 44 | 52.2 | 4.47 | 92.1 | 38.5 | 230 | 150 | 11 | 1.4 | 0.127 | < 0.10 | < 0.10 | 0.913 | 0.48 | 230 | < 1.0 | < 1.0 | 920 | 4.55 | 0.0109 | 92 |
| | | | 10/19/2009 | 14.36 | 6.04 | 566 | 49 | 49.5 | 2.80 | 88.3 | 37.6 | 240 | 140 | 11 | 1.0 | 0.0942 | 0.17 | < 0.10 | 0.924 | 0.51 | 240 | < 1.0 | < 1.0 | 850 | 2.15 | 0.0104 | 96 |
| | | | 8/19/2009 | 14.81 | 5.59 | 614 | 49 | 51.8 | 3.19 | 87.3 | 36.8 | 225 | 130 | 11 | 2.00 | NA | 0.10 | < 0.10 | 2.24 | 0.54 | 225 | < 1.0 | < 1.0 | 920 | 19.4 | 0.0110 | 91 |
| | | | 5/12/2009 | 14.34 | 2.96 | 514 | 54 | 48.7 | 3.26 | 81.1 | 34.9 | 206 | 120 | NA | NA | NA | 0.11 | NA | 1.87 | 0.53 | 206 | < 1.0 | < 1.0 | 890 | 3.23 | 0.0098 | 102 |
| | | | 3/27/1996 | NA | NA | 678 | 49 | 52 | 3.8 | 98 | 42 | 305 | 166 | 49 | NA | 0.16 | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| | | | 6/9/1976 | NA | NA | 637 | 48 | 55 | 2.8 | 98 | 43 | 343 | 172 | 17.6 | NA | 0.1 | 0.5 | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| | | | 1/20/1966 | NA | NA | 580 | 68 | 47 | 2 | 94 | 38 | 280 | 152 | 27 | NA | 0.08 | 0.2 | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 32S/13E-30F03 | Screened from 305-372' - 2-inch diameter | **23.16** | | | | | | | | | | | | | | | | | | | | | | | | | |
| | Height of steel casing added to the concrete pad elevation | 2.80 | 10/30/2012 | 14.61 | 8.55 | 650 | 43 | 40 | 3.1 | 100 | 46 | 280 | 170 | <0.05 | <1 | 0.058 | <0.1 | 0.03 | 0.016 | <0.1 | 280 | <10 | <10 | 990 | 0.02 | NA | NA |
| | Pad elevation NAVD 88 | 20.36 | 7/24/2012 | 14.50 | 8.66 | 640 | 51 | 36 | 2.7 | 81 | 37 | 296 | 180 | <0.05 | <1 | <0.1 | 0.17 | <0.01 | 0.016 | 0.2 | 296 | <10 | <10 | 990 | <0.05 | 0.0039 | 255.0000 |
| | TOC elevation prior to renovation (Approximate) | 20.4 | 4/19/2012 | NA | NA | 640 | 54 | 32 | 2.3 | 84 | 36 | 290 | 180 | <0.1 | <1 | <0.1 | <0.2 | 0.01 | 0.014 | <0.2 | 290 | <10 | <10 | 990 | <0.1 | NA | NA |
| | | | 4/18/2012 | 10.43 | 12.73 | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| | | | 1/12/2012 | 12.37 | 10.79 | 660 | 46 | 39 | 2.1 | 94 | 42 | 280 | 160 | <0.1 | <1 | <0.1 | 0.2 | 0.025 | 0.016 | <0.2 | 280 | <10 | <10 | 990 | <0.1 | NA | NA |
| | | | 11/21/2011 | 13.24 | 9.92 | 650 | 43 | 33 | 2.6 | 93 | 39 | 290 | 160 | <0.05 | <1 | 0.04 | 0.15 | 0.028 | 0.016 | <0.1 | 290 | <10 | <10 | 960 | <0.1 | NA | NA |
| | | | 7/26/2011 | 14.22 | 8.94 | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| | | | 7/25/2011 | NA | NA | 650 | 46.5 | 46 | 5.1 | 73 | 31 | 190 | 170.5 | <0.05 | <1 | <0.1 | 0.155 | 0.02 | 0.025 | <0.1 | 190 | <5 | <5 | 900 | <0.1 | NA | NA |
| | | | 4/21/2011 | NA | NA | 650 | 48 | 40 | 3.8 | 91 | 34 | 280 | 179 | <0.05 | <1 | 0.1 | 0.2 | 0.029 | 0.015 | 0.11 | 280 | <2.0 | <2.0 | 1,000 | NA | 0.0023 | 436 |
| | | | 4/20/2011 | 12.51 | 10.65 | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| | | | 1/24/2011 | 12.67 | 10.64 | 650 | 46 | 36 | 4.7 | 87 | 38 | 300 | 170 | <0.05 | <1.0 | 0.11 | 0.17 | 0.24 | 0.016 | <0.1 | 300 | <2.0 | <2.0 | 990 | <0.1 | NA | NA |
| | | | 10/28/2010 | NA | NA | 650 | 46 | 37 | 2.7 | 100 | 43 | 280 | 160 | <0.1 | <1.0 | 0.10 | <0.1 | NA | 0.032 | <0.3 | 280 | <10 | <10 | 1,000 | 0.53 | NA | NA |
| | | | 10/21/2010 | 6.62 | 16.54 | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| | | | 7/26/2010 | 17.32 | 5.84 | 608 | 45 | 43.8 | 2.94 | 107 | 46.8 | 294 | 160 | 1.3 | 0.84 | 0.0479 | < 0.10 | 0.10 | 0.129 | 0.24 | 294 | < 1.0 | < 1.0 | 900 | 7.55 | 0.0053 | 188 |
| | | | 4/27/2010 | 11.38 | 9.02 | 668 | 48 | 40.8 | 2.91 | 101 | 44.7 | 304 | 160 | 0.21 | 0.84 | 0.0733 | 0.14 | 0.11 | 0.0694 | 0.23 | 304 | < 1.0 | < 1.0 | 940 | 2.62 | 0.0048 | 209 |
| | | | 1/28/2010 | 10.98 | 9.42 | 656 | 40 | 43.1 | 3.91 | 112 | 47.2 | 310 | 180 | < 0.20 | 2.8 | 0.0833 | 0.13 | < 0.10 | 0.287 | 0.21 | 310 | < 1.0 | < 1.0 | 980 | 4.80 | 0.0053 | 190 |
| | | | 10/19/2009 | 14.18 | 6.22 | 626 | 48 | 43.3 | 3.14 | 108 | 46.2 | 308 | 170 | < 0.10 | 1.8 | 0.0646 | 0.22 | < 0.10 | 0.255 | 0.17 | 308 | < 1.0 | < 1.0 | 910 | 2.09 | 0.0035 | 282 |
| | | | 8/19/2009 | 20.23 | 0.17 | 672 | 45 | 43.1 | 3.15 | 111 | 44.3 | 290 | 170 | < 0.10 | 2.5 | NA | 0.14 | < 0.10 | 0.468 | 0.19 | 290 | < 1.0 | < 1.0 | 980 | 18.5 | 0.0042 | 237 |
| | | | 5/12/2009 | 17.68 | 2.72 | 678 | 49 | 44.8 | 3.32 | 109 | 42.9 | 276 | 180 | NA | NA | NA | 0.17 | NA | 0.146 | 0.18 | 276 | < 1.0 | < 1.0 | 960 | 1.16 | 0.0037 | 272 |
| | | | 3/27/1996 | NA | NA | 686 | 41 | 40 | 3.4 | 109 | 48 | 379 | 197 | 0.2 | NA | 0.13 | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| | | | 6/7/1976 | NA | NA | 616 | 43 | 41 | 2.6 | 96 | 49 | 333 | 190 | 0.4 | NA | 0.05 | 0.5 | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| | | | 1/19/1966 | NA | NA | 642 | 69 | 49 | 4 | 109 | 40 | 321 | 182 | 1 | NA | 0.05 | 0.3 | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |

# Table 6a: Northern Cities Sentry Well Water Quality Data Summary

| Well | Construction | Top of Casing Elevation (feet NAVD) | Date | Depth to Water (feet) | Groundwater Elevation (feet NAVD) | Total Dissolved Solids (mg/L) | Chloride (mg/L) | Sodium (mg/L) | Potassium (mg/L) | Calcium (mg/L) | Magnesium (mg/L) | Bicarbonate (as CaCO3) (mg/L) | Sulfate (mg/L) | Nitrate (mg/L) | Total Kjeldahl Nitrogen (mg/L) | Boron (mg/L) | Fluoride (mg/L) | Iodide (mg/L) | Manganese (mg/L) | Bromide (mg/L) | Alkalinity, Total (as CaCO3) (mg/L) | Carbonate (as CaCO3) (mg/L) | Hydroxide (as CaCO3) (mg/L) | Specific Conductance (umhos/cm) | Iron (mg/L) | Bromide / Chloride Ratio | Chloride / Bromide Ratio |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | (-1) | (+1) | (+1) | (+2) | (+2) | (-1) | (-2) | | | | | | (+2) | | | | | | (+2) | | |
| 32S/13E-30N01 | Screened from 15-40' - 1-inch diameter | **16.13** | | | | | | | | | | | | | | | | | | | | | | | | | |
| | Height of steel casing added to the concrete pad elevation | 2.60 | 10/29/2012 | 8.96 | 7.17 | 900 | 180 | 120 | 34 | 77 | 60 | 300 | 190 | <0.05 | <1 | 0.21 | 0.40 | 0.011 | 0.098 | 1.2 | 300 | <10 | <10 | 1,500 | 2.8 | 0.0067 | 150 |
| | Pad elevation NAVD 88 | 13.53 | 7/23/2012 | 8.54 | 7.59 | 840 | 190 | 120 | 31 | 56 | 45 | 266 | 200 | <0.05 | <1 | 0.22 | 0.43 | <0.01 | 0.096 | 1.2 | 266 | <10 | <10 | 1,370 | 2.3 | 0.0063 | 158 |
| | TOC elevation prior to renovation (Approximate) | 13.5 | 4/18/2012 | 8.53 | 7.60 | 1,050 | 280 | 140 | 31 | 59 | 47 | 330 | 210 | <0.1 | 1.4 | 0.2 | 0.50 | <0.01 | 0.078 | 1.3 | 330 | <10 | <10 | 1,680 | 2.4 | 0.0046 | 215 |
| | | | 1/9/2012 | 8.74 | 7.39 | 1,050 | 260 | 170 | 34 | 68 | 52 | 307 | 200 | <0.05 | 2.7 | 0.21 | 0.41 | <0.01 | 0.088 | 1.9 | 307 | <10 | <10 | 1,760 | 2.9 | 0.0073 | 137 |
| | | | 11/21/2011 | 8.78 | 7.35 | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| | | | 11/17/2011 | NA | NA | 1,300 | 360 | 320 | 40 | 90 | 69 | 390 | 220 | <0.1 | <1 | 0.23 | 0.38 | 0.017 | 0.11 | 2.5 | 390 | <10 | <10 | 2,210 | 3.4 | 0.0069 | 144 |
| | | | 7/26/2011 | 9.01 | 7.12 | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| | | | 7/25/2011 | NA | NA | 1,680 | 445.3 | 230 | 42 | 99 | 81 | 380 | 255.5 | <0.05 | 1.2 | 0.21 | <0.1 | <0.01 | 0.12 | 3.016 | 380 | <5 | <5 | 2,480 | 4.2 | 0.0068 | 148 |
| | | | 4/20/2011 | 8.59 | 7.54 | 890 | 210 | 130 | 26 | 68 | 46 | 180 | 215 | <0.05 | <1 | 0.24 | 0.39 | 0.013 | 0.086 | 4.57 | 180 | <2.0 | <2.0 | 1,550 | NA | 0.0218 | 46 |
| | | | 1/24/2011 | 8.18 | 7.35 | 870 | 180 | 100 | 28 | 84 | 46 | 240 | 210 | <0.05 | <1.0 | <0.1 | 0.34 | 0.12 | 0.24 | 3.63 | 240 | <2.0 | <2.0 | 1,430 | 18 | 0.0202 | 50 |
| | | | 10/21/2010 | 9.99 | 6.14 | 890 | 190 | 120 | 26 | 58 | 45 | 246 | 200 | <0.1 | <1.0 | <0.1 | 0.37 | NA | 0.078 | 2.3 | 246 | <10 | <10 | 1,498 | <0.1 | 0.0121 | 83 |
| | | | 7/27/2010 | 8.97 | 7.16 | 917 | 200 | 130 | 30.0 | 75.0 | 56.2 | 241 | 220 | < 0.10 | < 0.50 | 0.165 | 0.29 | 0.23 | 0.101 | 2.8 | 241 | < 1.0 | < 1.0 | 1,400 | 2.61 | 0.0140 | 71 |
| | | | 4/27/2010 | 6.14 | 7.36 | 808 | 150 | 130 | 29 | 136 | 55.6 | 286 | 210 | 0.76 | 1.7 | 0.171 | 0.37 | 0.19 | 0.276 | 2.6 | 286 | < 1.0 | < 1.0 | 1,300 | 20.4 | 0.0173 | 58 |
| | | | 1/26/2010 | 4.90 | 8.60 | 902 | 210 | 155 | 33.5 | 156 | 66.4 | 307 | 230 | < 0.10 | 1.7 | 0.317 | 0.30 | 0.12 | 0.333 | 3.2 | 307 | < 1.0 | < 1.0 | 1,500 | 27.3 | 0.0152 | 66 |
| | | | 10/20/2009 | 6.53 | 7.00 | 828 | 200 | 159 | 34.3 | 118 | 59.8 | 238 | 230 | < 0.10 | 1.3 | 0.241 | 0.38 | < 0.10 | 0.157 | 3.2 | 238 | < 1.0 | < 1.0 | 1,300 | 5.33 | 0.0160 | 63 |
| | | | 8/20/2009 | 6.71 | 6.82 | 835 | 160 | 150 | 27.8 | 121 | 49.4 | 235 | 220 | < 0.10 | 1.3 | NA | 0.37 | 0.12 | 0.228 | 2.9 | 235 | < 1.0 | < 1.0 | 1,400 | 15.9 | 0.0181 | 55 |
| | | | 5/11/2009 | 6.03 | 7.50 | 960 | 180 | 175 | 33.5 | 86.7 | 46.2 | 274 | 220 | NA | NA | NA | 0.36 | NA | 0.113 | 3.2 | 274 | < 1.0 | < 1.0 | 1,500 | 2.26 | 0.0178 | 56 |
| 32S/13E-30N03 | Screened from 60-135' - 2-inch diameter | **16.13** | | | | | | | | | | | | | | | | | | | | | | | | | |
| | Height of steel casing added to the concrete pad elevation | 2.60 | 10/29/2012 | 8.01 | 8.12 | 610 | 60 | 56 | 3.7 | 74 | 33 | 155 | 148 | 14 | <1 | 0.081 | 0.20 | <0.01 | 0.027 | 0.3 | 155 | <10 | <10 | 900 | 0.04 | 0.0050 | 200 |
| | Pad elevation NAVD 88 | 13.53 | 7/23/2012 | 9.15 | 6.98 | 600 | 71 | 56 | 3.5 | 61 | 28 | 152 | 200 | <0.05 | <1 | 0.1 | <0.1 | <.002 | 0.120 | 0.3 | 152 | <10 | <10 | 890 | 0.44 | 0.0042 | 237 |
| | TOC elevation prior to renovation (Approximate) | 13.5 | 4/18/2012 | 6.72 | 9.41 | 570 | 80 | 47 | 3.0 | 57 | 25 | 150 | 150 | 16 | <1 | 0.1 | 0.3 | <0.01 | <0.005 | 0.28 | 150 | <10 | <10 | 880 | <0.1 | 0.0035 | 286 |
| | | | 1/11/2012 | 7.17 | 8.96 | 570 | 67 | 55 | 3.9 | 68 | 30 | 140 | 130 | 14 | <1 | 0.1 | 0.2 | <0.02 | 0.0510 | 0.39 | 140 | <10 | <10 | 870 | 0.17 | 0.0058 | 172 |
| | | | 11/21/2011 | 6.45 | 9.68 | 600 | 67 | 47 | 3.2 | 64 | 28 | 140 | 130 | 15 | 1.2 | 0.088 | 0.2 | <0.01 | <0.005 | 0.62 | 140 | <10 | <10 | 850 | <0.1 | 0.0093 | 108 |
| | | | 7/26/2011 | 7.59 | 8.54 | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| | | | 7/25/2011 | NA | NA | 590 | 67 | 47 | 5.0 | 54 | 24 | 290 | 139.8 | 15 | <1 | <0.1 | 0.2 | <0.01 | 0.0520 | 0.79 | 290 | <5 | <5 | 890 | 0.14 | 0.0118 | 85 |
| | | | 4/20/2011 | 6.65 | 9.48 | 580 | 76 | 58 | 4.2 | 62 | 23 | 140 | 142 | 16 | <1 | 0.12 | 0.2 | <0.1 | 0.0510 | 0.92 | 140 | <2.0 | <2.0 | 890 | NA | 0.0121 | 83 |
| | | | 1/24/2011 | 6.68 | 8.75 | 570 | 76 | 48 | 4.8 | 55 | 25 | 130 | 130 | 16 | <1.0 | 0.12 | 0.2 | <0.10 | 0.0088 | 1.7 | 130 | <2.0 | <2.0 | 900 | <0.1 | 0.0224 | 45 |
| | | | 10/21/2010 | 10.76 | 5.37 | 550 | 69 | 59 | 3.3 | 65 | 31 | 133 | 130 | 15 | <1.0 | <0.1 | 0.1 | NA | <0.005 | 1.1 | 133 | <10 | <10 | 886 | <0.1 | 0.0159 | 63 |
| | | | 7/27/2010 | 9.53 | 6.60 | 528 | 72 | 55.1 | 3.41 | 68.7 | 31.0 | 139 | 130 | 15.0 | < 0.50 | 0.0672 | 0.14 | 0.11 | < 0.00500 | 1.3 | 139 | < 1.0 | < 1.0 | 860 | < 0.100 | 0.0181 | 55 |
| | | | 4/27/2010 | 6.14 | 7.36 | 672 | 89 | 60.6 | 3.65 | 70.6 | 32.5 | 134 | 130 | 14.0 | < 0.50 | 0.0779 | 0.18 | 0.11 | < 0.00500 | 1.2 | 134 | < 1.0 | < 1.0 | 870 | < 0.100 | 0.0135 | 74 |
| | | | 1/26/2010 | 5.88 | 7.62 | 606 | 110 | 75.0 | 4.51 | 77.8 | 34.3 | 126 | 130 | 14 | 1.4 | 0.0654 | 0.15 | < 0.10 | 0.0130 | 1.3 | 126 | < 1.0 | < 1.0 | 990 | 0.653 | 0.0118 | 85 |
| | | | 10/20/2009 | 6.56 | 6.94 | 806 | 180 | 93.3 | 25.5 | 92.3 | 41.5 | 162 | 150 | 9.7 | 2.2 | 0.107 | 0.26 | < 0.10 | 0.245 | 1.4 | 162 | < 1.0 | < 1.0 | 1,200 | 0.344 | 0.0078 | 129 |
| | | | 8/20/2009 | 7.50 | 6.00 | 1,070 | 190 | 151 | 61.6 | 112 | 44.2 | 130 | 130 | 16 | 3.4 | NA | 0.20 | < 0.10 | 0.151 | 1.6 | 130 | < 1.0 | < 1.0 | 1,700 | 1.93 | 0.0084 | 119 |
| | | | 5/12/2009 | 6.33 | 7.17 | 602 | 97 | 63.4 | 3.96 | 72.9 | 32.2 | 122 | 120 | NA | NA | NA | 0.22 | NA | 24 | 1.2 | 122 | < 1.0 | < 1.0 | 900 | 2.24 | 0.0124 | 81 |
| | | | 3/27/1996 | NA | NA | 624 | 70 | 62 | 4 | 78 | 35 | 150 | 161 | 106.8 | NA | 0.13 | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| | | | 6/7/1976 | NA | NA | 705 | 90 | 54 | 2.9 | 99 | 43 | 189 | 168 | 112.5 | NA | 0.08 | 0.5 | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| | | | 1/21/1966 | NA | NA | 804 | 57 | 54 | 3 | 132 | 59 | 410 | 250 | 1 | NA | 0.08 | 0.5 | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 32S/13E-30N02 | Screened from 175-255' - 2-inch diameter | **16.13** | | | | | | | | | | | | | | | | | | | | | | | | | |
| | Height of steel casing added to the concrete pad elevation | 2.60 | 10/29/2012 | 8.52 | 7.61 | 1,030 | 40 | 68 | 5.0 | 140 | 58 | 180 | 500 | <0.25 | <1 | 0.14 | <0.5 | <0.01 | <0.005 | <0.5 | 180 | <10 | <10 | 1,360 | <0.05 | NA | NA |
| | Pad elevation NAVD 88 | 13.53 | 7/23/2012 | 8.31 | 7.82 | 1,040 | 54 | 63 | 4.5 | 110 | 48 | 188 | 510 | 0.13 | <1 | 0.15 | 0.15 | <0.01 | 0.01 | <0.1 | 188 | <10 | <10 | 1,360 | <0.05 | NA | NA |
| | TOC elevation prior to renovation (Approximate) | 13.5 | 4/18/2012 | 3.45 | 12.68 | 990 | 60 | 56 | 4.2 | 110 | 47 | 190 | 560 | 0.14 | <1 | 0.12 | 0.21 | <0.01 | <0.005 | 0.28 | 190 | <10 | <10 | 1,360 | <0.1 | 0.0047 | 214 |
| | | | 1/11/2012 | 4.88 | 11.25 | 1,040 | 49 | 64 | 4.9 | 130 | 54 | 180 | 460 | 1.30 | <1 | 0.17 | 0.16 | <0.02 | <0.005 | <0.2 | 180 | <10 | <10 | 1,360 | <0.1 | NA | NA |
| | | | 11/21/2011 | 5.35 | 10.78 | 1,020 | 46 | 57 | 4.5 | 130 | 54 | 180 | 450 | 0.15 | <1 | 0.15 | <0.2 | <0.01 | <0.005 | <0.2 | 180 | <10 | <10 | 1,360 | <0.1 | NA | NA |
| | | | 7/26/2011 | 7.25 | 8.88 | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| | | | 7/25/2011 | NA | NA | 1,050 | 50.4 | 81 | 7.7 | 150 | 62 | 180 | 479.1 | 0.15 | <1 | 0.16 | 0.144 | <0.01 | 0.006 | <0.1 | 180 | <5 | <5 | 1,370 | 0.49 | NA | NA |
| | | | 4/20/2011 | 3.53 | 12.60 | 1,030 | 52 | 63 | 5.4 | 130 | 44 | 180 | 508 | 0.17 | <1 | 0.19 | 0.2 | <0.01 | <0.005 | <0.1 | 180 | <2.0 | <2.0 | 1,380 | NA | NA | NA |
| | | | 1/24/2011 | 3.67 | 11.76 | 1,050 | 50 | 60 | 6.4 | 120 | 49 | 190 | 490 | 0.24 | <1.0 | 0.17 | 0.17 | <0.10 | 0.064 | <0.1 | 190 | <2.0 | <2.0 | 1,380 | 0.12 | NA | NA |
| | | | 10/21/2010 | 10.42 | 5.71 | 1,040 | 48 | 52 | 3.5 | 100 | 45 | 181 | 460 | 0.15 | <1.0 | <0.1 | <0.1 | NA | <0.005 | <0.3 | 181 | <10 | <10 | 1,377 | <0.1 | NA | NA |
| | | | 7/27/2010 | 10.02 | 6.11 | 777 | 57 | 67.6 | 7.31 | 141 | 58.5 | 190 | 470 | 0.3 | 3.5 | 0.138 | < 0.10 | 0.11 | 0.102 | 0.28 | 190 | < 1.0 | < 1.0 | 1,300 | 3.43 | 0.0049 | 204 |
| | | | 4/27/2010 | 5.26 | 8.27 | 800 | 93 | 71.9 | 12.50 | 108 | 46.3 | 159 | 300 | 7.0 | 3.2 | 0.123 | 0.13 | 0.11 | 0.0776 | 0.7 | 159 | < 1.0 | < 1.0 | 1,100 | 3.27 | 0.0075 | 133 |
| | | | 2/25/2010 | 1.72 | 11.78 | 1,000 | 48 | 71.4 | 4.70 | 141 | 58.1 | 195 | 490 | 0.16 | < 0.50 | 0.15 | 0.15 | < 0.10 | 0.0393 | 0.16 | 195 | < 1.0 | < 1.0 | 1,300 | 3.30 | 0.0033 | 300 |
| | *Confirmation Sample Collected from Pump Discharge at End of Purge:* | | 2/25/2010 | 1.72 | 11.78 | 1,010 | 74 | 76.9 | 10.2 | 138 | 55.8 | 195 | 440 | 0.13 | 2.4 | 0.142 | 0.16 | < 0.10 | 0.0579 | 0.24 | 195 | < 1.0 | < 1.0 | 1,400 | 1.69 | 0.0032 | 308 |
| | *Confirmation Sample Collected by Standard Method (Bailer):* | | 1/26/2010 | 3.72 | 9.78 | 970 | 50 | 74.2 | 4.77 | 152 | 62.2 | 195 | 510 | 0.14 | < 0.50 | 0.129 | 0.11 | < 0.10 | < 0.00500 | 0.16 | 195 | < 1.0 | < 1.0 | 1,300 | < 0.100 | 0.0032 | 313 |
| | | | 10/20/2009 | 7.38 | 6.12 | 2,080 | 690 | 274 | 151 | 239 | 101.0 | 220 | 400 | < 0.10 | 7.0 | 0.201 | 0.16 | 0.87 | 0.398 | 2.0 | 220 | < 1.0 | < 1.0 | 2,800 | 5.50 | 0.0029 | 345 |
| | | | 8/20/2009 | 11.94 | 1.56 | 1,350 | 500 | 199 | 82.2 | 123 | 49.0 | 199 | 220 | 6.4 | 6.3 | NA | 0.23 | 0.14 | 0.339 | 2.8 | 199 | < 1.0 | < 1.0 | 2,100 | 4.91 | 0.0056 | 179 |
| | | | 5/11/2009 | 6.98 | 6.52 | 1,290 | 170 | 129 | 52 | 137 | 66.9 | 176 | 470 | NA | NA | NA | 0.18 | NA | 0.128 | 0.56 | 176 | < 1.0 | < 1.0 | 1,800 | 5.24 | 0.0033 | 304 |
| | | | 3/27/1996 | NA | NA | 1,050 | 50 | 71 | 5.5 | 145 | 60 | 243 | 516 | 0.9 | NA | 0.23 | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| | | | 6/7/1976 | NA | NA | 1,093 | 48 | 62 | 4.7 | 150 | 60 | 248 | 484 | 0 | NA | 0.13 | 0.7 | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| | | | 1/21/1966 | NA | NA | 1,069 | 54 | 71 | 5 | 148 | 63 | 232 | 483 | 0 | NA | 0.12 | 0.5 | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |

# Table 6a: Northern Cities Sentry Well Water Quality Data Summary

| Well | Construction | Top of Casing Elevation (feet NAVD) | Date | Depth to Water (feet) | Groundwater Elevation (feet NAVD) | Total Dissolved Solids (mg/L) | (-1) Chloride (mg/L) | (+1) Sodium (mg/L) | (+1) Potassium (mg/L) | (+2) Calcium (mg/L) | (+2) Magnesium (mg/L) | (-1) Bicarbonate (as CaCO3) (mg/L) | (-2) Sulfate (mg/L) | Nitrate (mg/L) | Total Kjeldahl Nitrogen (mg/L) | Boron (mg/L) | Fluoride (mg/L) | Iodide (mg/L) | (+2) Manganese (mg/L) | Bromide (mg/L) | Alkalinity, Total (as CaCO3) (mg/L) | Carbonate (as CaCO3) (mg/L) | Hydroxide (as CaCO3) (mg/L) | Specific Conductance (umhos/cm) | (+2) Iron (mg/L) | Bromide / Chloride Ratio | Chloride / Bromide Ratio |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 12N/36W-36L01 | Screened from 227-237' - 2-inch diameter | **26.77** | | | | | | | | | | | | | | | | | | | | | | | | | |
| | Height of steel casing added to the concrete pad elevation | 2.79 | 10/31/2012 | 20.11 | 6.66 | 910 | 35 | 66 | 4.0 | 130 | 46 | 165 | 400 | 1.60 | <1 | 0.16 | 0.2 | <0.01 | <0.005 | <0.5 | 165 | <10 | <10 | 1,200 | <0.05 | NA | NA |
| | Pad elevation NAVD 88 | 23.98 | 7/24/2012 | 19.42 | 7.35 | 880 | 43 | 65 | 4 | 110 | 41 | 168 | 420 | <0.05 | <1 | 0.16 | <0.1 | <0.01 | 0.02 | <0.1 | 168 | <10 | <10 | 1,190 | 0.19 | NA | NA |
| | TOC elevation prior to renovation (Approximate) | 24.0 | 4/20/2012 | 18.26 | 8.03 | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| | | | 4/18/2012 | 23.83 | 2.94 | 880 | 47 | 52 | 3.2 | 95 | 36 | 180 | 450 | 0.42 | <1 | 0.12 | <0.2 | <0.01 | <0.005 | <0.2 | 180 | <10 | <10 | 1,190 | <0.1 | NA | NA |
| | | | 1/11/2012 | 17.68 | 9.09 | 790 | 41 | 64 | 4.1 | 120 | 44 | 170 | 380 | 1.30 | <1 | 0.19 | 0.18 | <0.02 | <0.005 | <0.2 | 170 | <10 | <10 | 1,190 | <0.1 | NA | NA |
| | | | 11/21/2011 | 18.08 | 8.69 | 910 | 39 | 55 | 3.5 | 110 | 40 | 180 | 380 | 0.37 | <1 | 0.16 | <0.2 | <0.01 | <0.005 | <0.2 | 180 | <10 | <10 | 1,200 | <0.1 | NA | NA |
| | | | 7/26/2011 | 19.63 | 7.14 | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| | | | 7/25/2011 | NA | NA | 890 | 40.5 | 65 | 5.7 | 110 | 43 | 170 | 408.9 | 0.39 | <1 | 0.15 | <0.1 | <0.01 | <0.005 | <0.1 | 170 | <5 | <5 | 1,200 | 0.024 | NA | NA |
| | | | 4/21/2011 | NA | NA | 890 | 42 | 61 | 4.2 | 100 | 30 | 170 | 415 | 0.60 | <1 | 0.19 | 0.07 | <0.01 | <0.005 | <0.1 | 170 | <2.0 | <2.0 | 1,200 | NA | NA | NA |
| | | | 4/20/2011 | 18.26 | 8.51 | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| | | | 1/24/2011 | 17.61 | 8.68 | 890 | 41 | 55 | 5.1 | 98 | 36 | 180 | 400 | 0.50 | <1.0 | 0.20 | 0.15 | <0.10 | <0.005 | <0.1 | 180 | <2.0 | <2.0 | 1,200 | <0.1 | NA | NA |
| | | | 10/21/2010 | 20.75 | 5.54 | 910 | 38 | 76 | 3.6 | 130 | 47 | 169 | 400 | 0.39 | <1.0 | 0.10 | <0.1 | NA | <0.005 | <0.3 | 169 | <10 | <10 | 1,213 | <0.1 | NA | NA |
| | | | 7/27/2010 | 21.18 | 5.11 | 707 | 36 | 64.2 | 3.70 | 127 | 47.4 | 182 | 420 | 0.40 | < 0.50 | 0.158 | < 0.10 | < 0.10 | < 0.00500 | 0.11 | 182 | < 1.0 | < 1.0 | 1,100 | < 0.100 | 0.0031 | 327 |
| | | | 4/26/2010 | 15.94 | 8.06 | 860 | 42 | 70.3 | 4.13 | 129 | 48.9 | 191 | 400 | 0.45 | 0.77 | 0.223 | < 0.1 | 0.15 | 0.057 | 0.14 | 191 | < 1.0 | < 1.0 | 1,100 | 4.53 | 0.0033 | 300 |
| | | | 10/21/2009 | 17.72 | 6.28 | 856 | 38 | 72.0 | 4.64 | 131 | 48.2 | 192 | 420 | 0.49 | 0.84 | 0.150 | 0.12 | < 0.10 | 0.0994 | 0.13 | 192 | < 1.0 | < 1.0 | 1,100 | 1.68 | 0.0034 | 292 |
| | | | 8/20/2009 | 19.16 | 4.84 | 890 | 39 | 78.0 | 4.21 | 138 | 48.1 | 184 | 390 | 0.49 | 0.56 | NA | < 0.10 | < 0.10 | 0.185 | 0.14 | 184 | < 1.0 | < 1.0 | 1,200 | 2.03 | 0.0036 | 279 |
| | | | 5/11/2009 | 17.68 | 6.32 | 832 | 63 | 83.8 | 4.88 | 111 | 45.4 | 204 | 330 | NA | NA | NA | 0.12 | NA | 0.551 | 0.22 | 204 | < 1.0 | < 1.0 | 1,200 | 4.02 | 0.0035 | 286 |
| | | | 3/26/1996 | NA | NA | 882 | 35 | 66 | 4.8 | 124 | 47 | 233 | 408 | 2 | NA | 0.24 | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| | | | 6/8/1976 | NA | NA | 936 | 38 | 72 | 3.5 | 130 | 48 | 223 | 423 | 0.6 | NA | 0.15 | 0.7 | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 12N/36W-36L02 | Screened from 535-545' - 2-inch diameter | **26.77** | | | | | | | | | | | | | | | | | | | | | | | | | |
| | Height of steel casing added to the concrete pad elevation | 2.79 | 10/31/2012 | 18.81 | 7.96 | 800 | 100 | 120 | 7.3 | 90 | 39 | 265 | 200 | <0.1 | 2.4 | 0.4 | 0.34 | 0.12 | 0.140 | 0.34 | 265 | <10 | <10 | 1,250 | 0.30 | 0.0034 | 294 |
| | Pad elevation NAVD 88 | 23.98 | 7/24/2012 | 19.05 | 7.72 | 800 | 134 | 125 | 7.4 | 83 | 35 | 277 | 200 | <0.05 | 2.3 | 0.42 | 0.13 | 0.12 | 0.140 | 0.31 | 277 | <10 | <10 | 1,250 | 0.52 | 0.0023 | 432 |
| | TOC elevation prior to renovation (Approximate) | 24.0 | 4/18/2012 | 10.81 | 15.96 | 770 | 130 | 95 | 6.2 | 75 | 33 | 270 | 210 | 0.42 | 4 | 0.35 | 0.36 | 0.12 | 0.130 | <0.2 | 270 | <10 | <10 | 1,250 | 0.77 | NA | NA |
| | | | 1/11/2012 | 11.18 | 15.59 | 900 | 122 | 110 | 7.2 | 95 | 37 | 290 | 170 | <0.1 | 4.8 | 0.48 | 0.28 | <0.02 | 0.170 | 0.45 | 290 | <10 | <10 | 1,250 | 1.80 | 0.0037 | 271 |
| | | | 11/21/2011 | 13.99 | 12.78 | 780 | 130 | 95 | 6.1 | 77 | 33 | 270 | 160 | <0.1 | <1 | 0.4 | <0.2 | <0.01 | 0.130 | 0.45 | 270 | <10 | <10 | 1,240 | 0.40 | 0.0035 | 289 |
| | | | 7/26/2011 | 18.03 | 8.74 | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| | | | 7/25/2011 | NA | NA | 790 | 128.8 | 110 | 9.1 | 74 | 33 | 280 | 177 | <0.05 | 2.3 | 0.36 | 0.12 | 0.14 | 0.130 | 0.51 | 280 | <5 | <5 | 1,280 | 2.30 | 0.0040 | 252 |
| | | | 4/21/2011 | NA | NA | 770 | 120 | 90 | 5.3 | 86 | 26 | 280 | 206 | <0.05 | 2.3 | 0.24 | 0.26 | 0.14 | 0.004 | 0.57 | 280 | <2.0 | <2.0 | 1,270 | NA | 0.0048 | 211 |
| | | | 4/20/2011 | 10.33 | 16.44 | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| | | | 1/24/2011 | 9.37 | 16.92 | 800 | 120 | 95 | 7.6 | 75 | 30 | 300 | 190 | <0.05 | 2.3 | 0.39 | 0.16 | 1.31 | 0.13 | 0.53 | 300 | <2.0 | <2.0 | 1,270 | 1.40 | 0.0044 | 226 |
| | | | 10/21/2010 | 19.77 | 6.52 | 770 | 120 | 130 | 7.6 | 89 | 44 | 275 | 160 | <0.1 | 3.4 | 0.48 | <0.1 | NA | 0.15 | 0.54 | 275 | <10 | <10 | 1,293 | 0.12 | 0.0045 | 222 |
| | | | 7/27/2010 | 20.53 | 5.76 | 737 | 110 | 121 | 7.81 | 91.1 | 38.9 | 268 | 190 | < 0.10 | < 0.50 | 0.427 | 0.10 | 0.77 | 0.180 | 0.80 | 268 | < 1.0 | < 1.0 | 1,200 | 0.845 | 0.0073 | 138 |
| | | | 4/26/2010 | 9.24 | 14.76 | 720 | 100 | 116 | 6.88 | 85.4 | 32.4 | 215 | 210 | 1.5 | 0.77 | 0.382 | 0.2 | 0.28 | 0.167 | 0.7 | 215 | < 1.0 | < 1.0 | 1,100 | 3.870 | 0.0070 | 143 |
| | | | 10/21/2009 | 17.65 | 6.35 | 638 | 99 | 113 | 6.15 | 81.6 | 23.0 | 172 | 200 | < 0.10 | 3.2 | 0.268 | 0.33 | 57 | 0.128 | 0.61 | 172 | < 1.0 | < 1.0 | 940 | 0.255 | 0.0062 | 162 |
| | | | 8/20/2009 | 19.15 | 4.85 | 785 | 100 | 131 | 6.66 | 89.8 | 36.6 | 290 | 190 | < 0.10 | 3.8 | NA | 0.15 | 0.27 | 0.307 | 0.75 | 290 | < 1.0 | < 1.0 | 1,200 | 0.830 | 0.0075 | 133 |
| | | | 5/11/2009 | 14.38 | 9.62 | 775 | 120 | 132 | 7.24 | 84 | 39.7 | 294 | 180 | NA | NA | NA | 0.18 | NA | 0.426 | 0.78 | 294 | < 1.0 | < 1.0 | 1,300 | 0.958 | 0.0065 | 154 |
| | | | 3/26/1996 | NA | NA | 772 | 127 | 130 | 8.7 | 86 | 36 | 390 | 148 | 0.2 | NA | 0.5 | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| | | | 6/8/1976 | NA | NA | 820 | 126 | 118 | 6.6 | 94 | 44 | 393 | 184 | 0 | NA | NA | 0.5 | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| County MW-3 12N/35W-32C03 | Screened from 90-170' - 5-inch diameter | 48.44 | | | | | | | | | | | | | | | | | | | | | | | | | |
| | Casing relative to concrete pad | | 10/30/2012 | 40.05 | 8.39 | 330 | 57 | 60 | 3.3 | 19 | 7.5 | 60 | 36 | 7.8 | <1 | 0.09 | <0.1 | <0.01 | 0.033 | <0.1 | 60 | <10 | <10 | 470 | 1.9 | NA | NA |
| | Pad elevation above MSL, approximate | 48.44 | 7/25/2012 | 38.62 | 9.82 | 330 | 67 | 61 | 3.3 | 17 | 6.4 | 59 | 35 | 8.2 | <1 | <0.1 | <0.1 | <0.01 | 0.068 | <0.1 | 59 | <10 | <10 | 460 | 0.49 | NA | NA |
| | All elevations relative to MSL | | 4/19/2012 | 23.02 | 25.42 | 370 | 74 | 52 | 2.9 | 30 | 12 | 120 | 58 | 5 | <1 | 0.17 | 0.2 | <0.01 | 0.056 | <0.2 | 120 | <10 | <10 | 580 | 1.3 | NA | NA |

## Table 6a: Northern Cities Sentry Well Water Quality Data Summary

| Well | Construction | Top of Casing Elevation (feet NAVD) | Date | Depth to Water (feet) | Groundwater Elevation (feet NAVD) | Total Dissolved Solids (mg/L) | (-1) Chloride (mg/L) | (+1) Sodium (mg/L) | (+1) Potassium (mg/L) | (+2) Calcium (mg/L) | (+2) Magnesium (mg/L) | (-1) Bicarbonate (as CaCO3) (mg/L) | (-2) Sulfate (mg/L) | Nitrate (mg/L) | Total Kjeldahl Nitrogen (mg/L) | Boron (mg/L) | Fluoride (mg/L) | Iodide (mg/L) | (+2) Manganese (mg/L) | Bromide (mg/L) | Alkalinity, Total (as CaCO3) (mg/L) | Carbonate (as CaCO3) (mg/L) | Hydroxide (as CaCO3) (mg/L) | Specific Conductance (umhos/cm) | (+2) Iron (mg/L) | Bromide / Chloride Ratio | Chloride / Bromide Ratio |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Oceano MW-Green | Screened from 110-130' - 3-inch diameter | 30.86 | | | | | | | | | | | | | | | | | | | | | | | | | |
| | Casing relative to concrete pad | -4.14 | 10/30/2012 | 27.31 | 7.32 | 780 | 65 | 75 | 4.70 | 100 | 46 | 255 | 280 | <0.05 | <1 | 0.19 | 0.14 | 0.04 | 0.23 | <0.1 | 255 | <10 | <10 | 1,190 | 4.0 | NA | NA |
| | Pad elevation above MSL, approximate | 35.0 | 7/25/2012 | 27.15 | 7.48 | 830 | 76 | 80 | 5.30 | 96 | 45 | 250 | 310 | <0.05 | <1 | 0.22 | 0.15 | 0.04 | 0.24 | <0.1 | 250 | <10 | <10 | 1,220 | 6.7 | NA | NA |
| | All elevations relative to MSL | | 4/19/2012 | NA | NA | 790 | 87 | 69 | 4.50 | 52 | 37 | 250 | 270 | <0.1 | <1 | 0.19 | 0.21 | 0.05 | 0.17 | <0.2 | 250 | <10 | <10 | 1,180 | 4 | NA | NA |
| | | | 4/18/2012 | 21.65 | 12.98 | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| | | | 1/12/2012 | 23.29 | 11.34 | 760 | 76 | 85 | 4.00 | 79 | 40 | 270 | 190 | <0.1 | <1 | 0.23 | 0.21 | 0.069 | 0.23 | <0.2 | 270 | <10 | <10 | 1,150 | 4.8 | NA | NA |
| | | | 11/21/2011 | 22.46 | 12.17 | 720 | 39 | 38 | 3.40 | 96 | 43 | 320 | 180 | <0.05 | 3.5 | 0.079 | 0.19 | 0.013 | 0.17 | <0.1 | 320 | <10 | <10 | 1,050 | 4.8 | NA | NA |
| | | | 7/26/2011 | 25.51 | 9.12 | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| | | | 7/25/2011 | NA | NA | 760 | 69.3 | 66 | 6.40 | 80 | 35 | 310 | 208.8 | <0.05 | <1 | 0.16 | 0.17 | 0.041 | 0.23 | 0.199 | 310 | <5 | <5 | 1,170 | 5.3 | 0.0029 | 348 |
| | | | 4/20/2011 | 114.79 | -80.16 | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| | | | 1/24/2011 | 106.59 | -71.96 | 310 | 98 | 22 | 8.1 | 34 | 9.2 | 19.0 | 53 | <0.05 | <1.0 | <0.1 | 0.2 | 4.42 | 0.4 | 0.63 | 19.0 | <2.0 | <2.0 | 480 | 10 | 0.0064 | 156 |
| | | | 10/28/2010 | NA | NA | 290 | 81 | 26 | 9.3 | 64 | 11 | 160.0 | 68 | <0.1 | <1.0 | <0.1 | 0.2 | NA | 0.85 | 0.36 | 160.0 | <10 | <10 | 520 | 38 | 0.0044 | 225 |
| | | | 10/21/2010 | 112.71 | -81.85 | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| | | | 7/26/2010 | 95.61 | -64.75 | 438 | 85 | 34.3 | 1.93 | 61.7 | 30.4 | 30.0 | 210 | < 0.10 | < 0.50 | 0.0435 | 0.58 | 0.22 | 1.46 | 0.32 | 30.0 | < 1.0 | < 1.0 | 690 | 36 | 0.0038 | 266 |
| | | | 4/26/2010 | 63.90 | -33.04 | 560 | 83 | 47.7 | 5.7 | 86.1 | 48.3 | 62 | 310 | < 0.10 | 0.84 | < 0.02 | < 0.1 | 0.56 | 2.54 | 0.31 | 62.0 | < 1.0 | < 1.0 | 880 | 233 | 0.0037 | 268 |
| | | | 1/27/2010 | 43.71 | -12.85 | 460 | 130 | 45.0 | 25.4 | 682 | 124 | 112 | 100 | 0.56 | NA | < 0.0200 | 0.21 | 0.25 | 32.4 | 0.49 | 112.0 | < 1.0 | < 1.0 | 760 | 4,360 | 0.0038 | 265 |
| | | | 10/20/2009 | 29.20 | 1.66 | 362 | 92 | 39.6 | 2.92 | 19.2 | 45.1 | 76.8 | 110 | < 0.10 | < 0.50 | 0.0697 | < 0.10 | < 0.10 | 0.242 | 0.39 | 80.0 | 3.2 | < 1.0 | 590 | 11.4 | 0.0042 | 236 |
| | | | 8/19/2009 | 24.55 | 6.31 | 420 | 160 | 48.4 | 3.37 | 49.9 | 20.4 | 17.6 | 54 | < 0.10 | 1.1 | NA | < 0.10 | 0.25 | 1.76 | 0.68 | 17.6 | < 1.0 | < 1.0 | 690 | 242 | 0.0043 | 235 |
| | | | 5/16/1983 | 15.80 | 15.06 | 665 | 35 | 40 | NA | 85 | 65 | 360 | 90 | < 4 | NA | NA | 0.2 | NA | 0.01 | NA | 360 | ND | ND | 950 | 0.10 | NA | NA |
| Oceano MW-Blue | Screened from 190-210' and 245-265' - 3-inch diameter | 30.91 | | | | | | | | | | | | | | | | | | | | | | | | | |
| | Casing relative to concrete pad | -4.09 | 10/30/2012 | 27.68 | 6.95 | 380 | 97 | 100 | 6.4 | 4.5 | 24 | 130 | 38 | <0.05 | <1 | 0.28 | <0.1 | 0.1 | 0.09 | 0.2 | 168 | 38 | <10 | 720 | 6.10 | 0.0021 | 485 |
| | Pad elevation above MSL, approximate | 35.0 | 7/25/2012 | 27.18 | 7.45 | 240 | 49 | 56 | 11 | 5.4 | 22 | 99 | 43 | <0.05 | <1 | 0.16 | 0.19 | 0.023 | 0.11 | <0.1 | 132 | 33 | <10 | 470 | 6.6 | NA | NA |
| | All elevations relative to MSL | | 4/19/2012 | NA | NA | 380 | 100 | 87 | 5.5 | 3.5 | 26 | 150 | 79 | <0.1 | <1 | 0.27 | 0.26 | 0.09 | 0.033 | 0.68 | 180 | 30 | <10 | 750 | 1.6 | 0.0068 | 147 |
| | | | 4/18/2012 | 20.10 | 14.53 | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| | | | 1/12/2012 | 22.26 | 12.37 | 480 | 96 | 110 | 4.9 | 5.6 | 33 | 154 | 95 | <0.1 | <1 | 0.28 | <0.2 | 0.11 | 0.01 | 0.306 | 180 | 26 | <10 | 850 | 0.2 | 0.0032 | 314 |
| | | | 11/21/2011 | 22.73 | 11.90 | 390 | 90 | 78 | 4.6 | 5.2 | 24 | 111 | 86 | <0.05 | <1 | 0.19 | 0.13 | 0.092 | 0.014 | 0.28 | 128 | 17 | <10 | 720 | 0.5 | 0.0031 | 321 |
| | | | 7/26/2011 | 25.29 | 9.34 | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| | | | 7/25/2011 | NA | NA | 260 | 29.3 | 23 | 5.3 | 8.7 | 20 | 84 | 80 | <0.05 | <1 | <0.1 | 0.199 | 0.072 | 0.041 | <0.1 | 89 | <5 | <5 | 440 | 2.7 | NA | NA |
| | | | 4/21/2011 | NA | NA | 580 | 118 | 70 | 19 | 49 | 17 | 8.8 | 274 | <0.05 | <1 | <0.1 | 0.29 | 0.109 | 0.091 | 0.4 | 11.3 | 2.5 | <2.0 | 950 | NA | 0.0034 | 295 |
| | | | 4/20/2011 | 22.59 | 12.04 | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| | | | 1/24/2011 | 24.87 | 9.76 | 680 | 110 | 60 | 17 | 64 | 22 | 5.0 | 330 | <0.05 | <1.0 | <0.1 | 0.22 | 0.96 | 0.16 | 0.31 | 11.2 | 6.2 | <2.0 | 1,040 | 10.0 | 0.0028 | 355 |
| | | | 10/21/2010 | 30.11 | 0.80 | 770 | 100 | 68 | 12 | 88 | 31 | 14.0 | 380 | <0.1 | <1.0 | <0.1 | 0.28 | NA | 0.054 | <0.3 | 14.0 | <10 | <10 | 1,163 | 2.2 | NA | NA |
| | | | 7/26/2010 | 24.74 | 6.17 | 783 | 130 | 80.1 | 8.58 | 142 | 42.0 | 2.8 | 450 | < 0.10 | < 0.50 | < 0.0200 | 0.26 | 0.31 | 3.97 | 0.8 | 2.8 | < 1.0 | < 1.0 | 1,200 | 593 | 0.0059 | 169 |
| | | | 4/26/2010 | 18.52 | 12.39 | 1,130 | 160 | 70.2 | 6.48 | 208 | 50.7 | 8.4 | 530 | < 0.10 | 0.56 | < 0.02 | 0.23 | 0.54 | 3.10 | 1.0 | 8.4 | < 1.0 | < 1.0 | 1,600 | 383 | 0.0061 | 165 |
| | | | 1/27/2010 | 22.06 | 8.85 | 1,740 | 430 | 55.6 | 4.98 | 282 | 43.0 | < 1.0 | 680 | < 0.10 | < 0.50 | 0.0819 | 0.14 | 0.41 | 9.41 | 2.0 | < 1.0 | < 1.0 | < 1.0 | 2,300 | 170 | 0.0047 | 215 |
| | | | 10/20/2009 | 27.50 | 3.41 | 2,250 | 1,000 | 19.5 | 2.40 | 487 | 22.5 | 5.0 | 410 | < 0.10 | 0.98 | 0.0532 | 0.13 | < 0.10 | 13.1 | 4.5 | 5.0 | < 1.0 | < 1.0 | 3,100 | 236 | 0.0045 | 222 |
| | | | 8/19/2009 | 24.65 | 6.26 | 322 | 150 | 93.2 | 16.7 | 23.9 | 12.1 | 3.0 | 4.0 | < 0.10 | 1.3 | NA | 0.19 | 0.5 | 0.7 | 0.74 | 23.0 | 20.0 | < 1.0 | 640 | 153 | 0.0049 | 203 |
| | | | 5/16/1983 | 13.30 | 17.61 | 840 | 80 | 90 | NA | 100 | 50 | 250 | 160.0 | < 4 | NA | ND | 0.2 | NA | 0.14 | NA | 250.0 | ND | ND | 1,200 | 0.10 | NA | NA |
| Oceano MW-Silver | Screened from 395-435' and 470-510' - 3-inch diameter | 30.85 | | | | | | | | | | | | | | | | | | | | | | | | | |
| | Casing relative to concrete pad | -4.15 | 10/30/2012 | 27.14 | 7.49 | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| | Pad elevation above MSL, approximate | 35.0 | 7/25/2012 | 27.68 | 6.95 | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| | All elevations relative to MSL | | 4/18/2012 | 20.13 | 14.5 | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| | | | 11/21/2011 | 23.00 | 11.63 | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| | | | 7/26/2011 | 25.23 | 9.4 | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| | | | 4/21/2011 | NA | NA | 410 | 97 | 100 | 7.2 | 3.5 | 21 | 80 | 134 | <0.05 | <1 | 0.23 | 0.18 | 0.097 | 0.065 | 0.42 | 100 | 20 | <2.0 | 770 | NA | 0.0043 | 231 |
| | | | 4/20/2011 | 21.27 | 13.36 | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| | | | 1/24/2011 | 22.02 | 12.61 | 440 | 92 | 90 | 9.2 | 3.4 | 27 | 90 | 140 | <0.05 | <1.0 | 0.25 | 0.11 | 0.94 | 0.041 | 0.35 | 110 | 20 | <2.0 | 810 | 2.2 | 0.0038 | 263 |
| | | | 10/21/2010 | 29.11 | 1.74 | 460 | 90 | 110 | 15 | 6.8 | 32 | 94 | 140 | <0.1 | <1.0 | 0.2 | 0.1 | NA | 0.1 | 0.38 | 124 | 30 | <10 | 868 | 3.5 | 0.0042 | 237 |
| | | | 7/26/2010 | 24.24 | 6.61 | 478 | 83 | 109 | 5.94 | 52.9 | 30.4 | 122.0 | 94 | < 0.10 | <0.50 | 0.255 | < 0.10 | 0.41 | 0.477 | 0.56 | 130.0 | 8.0 | < 1.0 | 730 | 61.0 | 0.0067 | 148 |
| | | | 4/26/2010 | 19.04 | 11.81 | 452 | 83 | 83 | 7.42 | 29.3 | 34.5 | 72.0 | 190 | < 0.1 | 0.56 | 0.134 | < 0.10 | 0.65 | 0.702 | 0.4 | 86.0 | 14.0 | < 1.0 | 810 | 71.0 | 0.0048 | 208 |
| | | | 1/27/2010 | 21.05 | 9.8 | 496 | 71 | 92.2 | 10.6 | 22.9 | 39.1 | 13.0 | 230 | <0.10 | < 0.50 | 0.323 | < 0.10 | 0.20 | 0.604 | 0.29 | 51.0 | 38.0 | < 1.0 | 780 | 54.4 | 0.0041 | 245 |
| | | | 10/20/2009 | 27.52 | 3.33 | 564 | 71 | 80.8 | 8.63 | 33.2 | 49.8 | 49.6 | 310 | <0.10 | < 0.50 | 0.148 | < 0.10 | < 0.10 | 0.337 | 0.32 | 64.0 | 14.4 | < 1.0 | 850 | 20.0 | 0.0045 | 222 |
| | | | 8/19/2009 | 29.34 | 1.51 | 522 | 180 | 148 | 71.6 | 95.2 | 8.42 | 30.0 | 3.5 | <0.10 | 1.7 | NA | 0.24 | 0.52 | 2.36 | 0.76 | 170 | 140 | < 1.0 | 1,000 | 278 | 0.0042 | 237 |
| | | | 5/16/1983 | 13.50 | 17.35 | 630 | 40 | 40 | NA | 90 | 50 | 330 | 80 | < 4 | NA | NA | 0.1 | NA | 0.02 | NA | 330 | ND | ND | 900 | 0.05 | NA | NA |
| Oceano # 8 | | 0.00 | | | | | | | | | | | | | | | | | | | | | | | | | |
| | Casing relative to concrete pad | | 10/30/2012 | NA | NA | 660 | 40 | 44 | 2.9 | 110 | 49 | 345 | 170 | <0.05 | <1 | 0.071 | 0.14 | <0.01 | 0.03 | <0.1 | 345 | <10 | <10 | 1,070 | 0.09 | NA | NA |
| | Pad elevation above MSL, approximate | | 7/24/2012 | NA | NA | 700 | 47 | 44 | 2.8 | 93 | 45 | 356 | 180 | <0.05 | <1 | <0.1 | 0.17 | <0.01 | 0.029 | <0.1 | 356 | <10 | <10 | 1,070 | 0.66 | NA | NA |
| | All elevations relative to MSL | | 4/25/2012 | NA | NA | 680 | 48 | 44 | 2.7 | 95 | 43 | 350 | 200 | <0.1 | <1 | <0.1 | 0.26 | <0.01 | 0.032 | <0.2 | 350 | <10 | <10 | 1,070 | 0.200 | NA | NA |
| | | | 1/10/2012 | NA | NA | 690 | 45 | 44 | 2.6 | 100 | 44 | 340 | 160 | <0.05 | <1 | <0.1 | 0.2 | <0.01 | 0.024 | <0.1 | 340 | <10 | <10 | 1,070 | 0.100 | NA | NA |
| | | | 11/22/2011 | NA | NA | 690 | 41 | 39 | 2.7 | 100 | 46 | 350 | 160 | <0.1 | <1 | 0.046 | <0.2 | 0.013 | 0.03 | <0.2 | 350 | <10 | <10 | 1,010 | 0.0 | NA | NA |
| | | | 7/25/2011 | NA | NA | 690 | 44 | 39 | 4.5 | 86 | 40 | 340 | 166.9 | <0.05 | <1 | <0.1 | 0.145 | <0.01 | 0.026 | <0.1 | 340 | <5 | <5 | 1,070 | <0.1 | NA | NA |
| Oceano MW-Yellow | Screened from 625-645' - 3-inch diameter | 30.89 | | | | | | | | | | | | | | | | | | | | | | | | | |
| | Casing relative to concrete pad | -4.11 | 10/30/2012 | 27.23 | 7.40 | 380 | 88 | 99 | 5.7 | 3.3 | 30 | 160 | 63 | <0.05 | <1 | 0.25 | <0.1 | 0.08 | 0.035 | 0.3 | 168 | 7.5 | <10 | 740 | 0.33 | 0.0034 | 293 |
| | Pad elevation above MSL, approximate | 35.0 | 7/25/2012 | 27.69 | 6.94 | 390 | 108 | 107 | 5.5 | 2.7 | 29 | 13 | 66 | <0.05 | <1 | 0.28 | <0.1 | 0.079 | 0.0037 | 0.23 | 168 | 155 | <10 | 750 | 0.84 | 0.0021 | 470 |
| | All elevations relative to MSL | | 4/19/2012 | NA | NA | 390 | 110 | 83 | 4.3 | 2.5 | 26 | 400 | 68 | <0.1 | <1 | 0.22 | 0.23 | 0.09 | 0.032 | 0.39 | 420 | 20 | <10 | 790 | 0.24 | 0.0035 | 282 |
| | | | 4/18/2012 | 20.05 | 14.58 | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| | | | 1/12/2012 | 23.08 | 11.55 | 410 | 94 | 95 | 4.5 | 3.0 | 28 | 300 | 68 | <0.1 | <1 | 0.24 | <0.2 | 0.1 | 0.032 | 0.31 | 320 | 20 | <10 | 760 | 0.89 | 0.0033 | 303 |
| | | | 11/21/2011 | 22.98 | 11.65 | 410 | 94 | 83 | 4.6 | 3.4 | 30 | 152 | 72 | <0.05 | <1 | 0.21 | <0.1 | 0.09 | 0.035 | 0.3 | 160 | 8 | <10 | 730 | 0.65 | 0.0032 | 313 |
| | | | 7/26/2011 | 26.73 | 7.90 | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| | | | 7/25/2011 | NA | NA | 420 | 89.7 | 84 | 7.1 | 4.4 | 31 | 148 | 91.8 | <0.05 | <1 | 0.20 | <0.1 | 0.071 | 0.046 | 0.297 | 150 | 2.5 | <5 | 760 | 1.90 | 0.0033 | 302 |
| | | | 4/21/2011 | NA | NA | 380 | 88 | 110 | 6.3 | 4.0 | 27 | 140 | 101 | <0.05 | <1 | 0.41 | 0.14 | 0.07 | 0.13 | 0.33 | 140 | <2.0 | <2.0 | 750 | N/A | 0.0038 | 267 |
| | | | 4/20/2011 | 21.30 | 13.33 | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| | | | 1/24/2011 | 22.01 | 12.62 | 430 | 83 | 73 | 6 | 6.3 | 31 | 160 | 100 | <0.05 | <1.0 | 0.22 | 0.11 | 0.66 | 0.078 | 0.28 | 160 | <2.0 | <2.0 | 780 | 0.49 | 0.0034 | 296 |
| | | | 10/21/2010 | 28.22 | 2.67 | 410 | 87 | 100 | 3.9 | 6.0 | 33 | 148 | 100 | <0.1 | <1.0 | 0.14 | <0.1 | NA | 0.087 | <0.3 | 148 | <10 | <10 | 796 | 0.66 | NA | NA |
| | | | 7/26/2010 | 25.50 | 5.39 | 446 | 94 | 93.0 | 8.81 | 10.2 | 32.0 | 38.4 | 120 | < 0.10 | < 0.50 | 0.142 | < 0.10 | 0.32 | 0.196 | 0.48 | 56.0 | 17.6 | < 1.0 | 700 | 22.4 | 0.0051 | 196 |
| | | | 4/26/2010 | 19.17 | 11.72 | 416 | 96 | 87.6 | 9.86 | 14.8 | 37.1 | 46.0 | 150 | < 0.1 | 0.63 | 0.132 | < 0.10 | 0.39 | 0.579 | 0.44 | 58.0 | 12.0 | < 1.0 | 780 | 56.2 | 0.0046 | 218 |
| | | | 1/27/2010 | 20.58 | 10.31 | 498 | 89 | 79.6 | 10.2 | 15.6 | 38.0 | 31.0 | 180 | < 0.10 | 0.56 | 0.132 | < 0.10 | 0.19 | 0.283 | 0.38 | 51.0 | 20.0 | < 1.0 | 810 | 23.6 | 0.0043 | 234 |
| | | | 10/20/2009 | 25.80 | 5.09 | 446 | 100 | 97.1 | 12.8 | 16.4 | 37.9 | 26.6 | 180 | < 0.10 | 0.56 | 0.168 | 0.15 | < 0.10 | 0.18 | 0.42 | 42.6 | 16.0 | < 1.0 | 760 | 18.9 | 0.0042 | 238 |
| | | | 8/19/2009 | 31.04 | -0.15 | 426 | 160 | 101 | 18.9 | 93.2 | 29.1 | 64.4 | 36 | < 0.10 | 0.98 | NA | 0.16 | 0.31 | 5.49 | 0.60 | 84.4 | 20 | < 1.0 | 790 | 682 | 0.0038 | 267 |
| | | | 5/16/1983 | 14.30 | 16.59 | 770 | 60 | 70 | NA | 90 | 70 | 330 | 120 | 9 | NA | NA | 0.1 | NA | 0.02 | NA | 330 | ND | ND | 1,100 | 0.24 | NA | NA |

## Table 6b: Summary of Key Data from Northern Cities Sentry Wells

| Well | Production Interval | Date | Depth to Water (feet) | Groundwater Elevation (feet NAVD) | Total Dissolved Solids (mg/L) | Chloride (mg/L) | Sodium (mg/L) |
|---|---|---|---|---|---|---|---|
| 32S/12E-24B01 | Screened from 48-65' | 10/29/2012 | 5.92 | 7.66 | 2,950 | 1,200.0 | 590.0 |
| | | 7/23/2012 | 5.79 | 7.79 | 3,010 | 1,400.0 | 530.0 |
| | | 4/18/2012 | 5.58 | 8 | 3,000 | 1,500.0 | 450.0 |
| | | 1/11/2012 | 5.72 | 7.86 | 2,750 | 1,200.0 | 520.0 |
| | | 11/21/2011 | 5.80 | 7.78 | 2,740 | 1,200.0 | 410.0 |
| | | 7/26/2011 | 6.38 | 7.2 | NA | NA | NA |
| | | 7/25/2011 | NA | NA | 3,690 | 1,199.9 | 530.0 |
| | | 4/20/2011 | 6.40 | 7.18 | 2,810 | 1,214.0 | 500.0 |
| | | 1/24/2011 | 5.78 | 7.42 | 2,380 | 1,100.0 | 370.0 |
| | | 10/28/2010 | NA | NA | 2,330 | 960.0 | 390.0 |
| | | 10/21/2010 | 6.37 | 7.21 | NA | NA | NA |
| | | 7/27/2010 | 6.48 | 7.1 | 616 | 43.0 | 52.5 |
| | | 4/27/2010 | 3.84 | 6.86 | 676 | 47.0 | 54.7 |
| | | 1/27/2010 | 3.13 | 7.57 | 694 | 55.0 | 56.2 |
| | | 10/19/2009 | 2.28 | 8.42 | 766 | 140.0 | 121.0 |
| | | 8/20/2009 | 3.25 | 7.45 | 705 | 94.0 | 86.8 |
| | | 5/12/2009 | 3.58 | 7.12 | 695 | 100.0 | 82.1 |
| | | 3/26/1996 | NA | NA | 1,870 | 773.0 | 380.0 |
| | | 6/9/1976 | NA | NA | 1,706 | 667.0 | 400.0 |
| | | 1/17/1966 | NA | NA | 1,700 | 652.0 | 406.0 |
| 32S/12E-24B02 | Screened from 120-145' | 10/29/2012 | 5.88 | 7.7 | 650 | 29.0 | 45.0 |
| | | 7/23/2012 | 6.12 | 7.46 | 650 | 35.0 | 45.0 |
| | | 4/18/2012 | 5.48 | 8.1 | 630 | 37.0 | 39.0 |
| | | 1/11/2012 | 5.47 | 8.11 | 650 | 33.0 | 46.0 |
| | | 11/21/2011 | 5.69 | 7.89 | 640 | 32.0 | 39.0 |
| | | 7/26/2011 | 6.51 | 7.07 | NA | NA | NA |
| | | 7/25/2011 | NA | NA | 640 | 36.0 | 48.0 |
| | | 4/20/2011 | 6.30 | 7.28 | 620 | 39.0 | 46.0 |
| | | 1/24/2011 | 5.69 | 7.53 | 640 | 43.0 | 44.0 |
| | | 10/28/2010 | NA | NA | 650 | 43.0 | 50.0 |
| | | 10/21/2010 | 6.79 | 6.79 | NA | NA | NA |
| | | 7/27/2010 | 7.05 | 6.53 | 598 | 42.0 | 48.9 |
| | | 4/27/2010 | 4.34 | 6.36 | 668 | 46.0 | 52.7 |
| | | 1/27/2010 | 3.38 | 7.32 | 622 | 45.0 | 58.0 |
| | | 10/19/2009 | 2.26 | 8.44 | 600 | 49.0 | 59.1 |
| | | 8/20/2009 | 4.09 | 6.61 | 630 | 49.0 | 63.5 |
| | | 5/12/2009 | 4.74 | 5.96 | 622 | 82.0 | 67.5 |
| | | 3/26/1996 | NA | NA | 652 | 54.0 | 46.0 |
| | | 6/9/1976 | NA | NA | 565 | 34.0 | 52.0 |
| | | 1/17/1966 | NA | NA | 651 | 62.0 | 79.0 |
| 32S/12E-24B03 | Screened from 270-435' | 10/29/2012 | 3.01 | 10.57 | 680 | 45.0 | 49.0 |
| | | 7/23/2012 | 2.98 | 10.6 | 670 | 49.0 | 47.0 |
| | | 4/18/2012 | 1.93 | 11.65 | 640 | 50.0 | 40.0 |
| | | 1/12/2012 | 2.15 | 11.43 | 660 | 46.0 | 48.0 |
| | | 11/21/2011 | 2.93 | 10.65 | 660 | 43.0 | 41.0 |
| | | 7/26/2011 | 3.17 | 10.41 | NA | NA | NA |
| | | 7/25/2011 | NA | NA | 650 | 46.3 | 50.0 |
| | | 4/20/2011 | 3.25 | 10.33 | 650 | 47.0 | 48.0 |
| | | 1/24/2011 | 2.65 | 10.58 | 660 | 46.0 | 44.0 |
| | | 10/28/2010 | NA | NA | 660 | 44.0 | 48.0 |
| | | 10/21/2010 | 4.60 | 8.98 | NA | NA | NA |
| | | 7/27/2010 | 4.54 | 9.04 | 610 | 44.0 | 51.4 |
| | | 4/27/2010 | 1.43 | 9.27 | 666 | 45.0 | 53.2 |
| | | 1/27/2010 | 0.94 | 9.76 | 672 | 48.0 | 56.4 |
| | | 10/19/2009 | 0.81 | 9.89 | 622 | 40.0 | 55.1 |
| | | 8/19/2009 | 4.18 | 6.52 | 680 | 47.0 | 54.9 |
| | | 5/12/2009 | 3.18 | 7.52 | 645 | 44.0 | 53.2 |
| | | 3/26/1996 | NA | NA | 646 | 41.0 | 52.0 |
| | | 6/9/1976 | NA | NA | 569 | 36.0 | 53.0 |
| | | 1/17/1966 | NA | NA | 670 | 79.0 | 74.0 |

## Table 6b: Summary of Key Data from Northern Cities Sentry Wells

| Well | Production Interval | Date | Depth to Water (feet) | Groundwater Elevation (feet NAVD) | Total Dissolved Solids (mg/L) | Chloride (mg/L) | Sodium (mg/L) |
|---|---|---|---|---|---|---|---|
| 32S/13E-30F01 | Screened from 15- 30 and 40-55' | 10/30/2012 | 14.95 | 8.21 | 470 | 60.0 | 66.0 |
| | | 7/24/2012 | 14.00 | 9.16 | 470 | 73.0 | 66.0 |
| | | 4/19/2012 | NA | NA | 450 | 72.0 | 52.0 |
| | | 4/18/2012 | 13.42 | 9.74 | NA | NA | NA |
| | | 1/10/2012 | 13.80 | 9.36 | 460 | 67.0 | 61.0 |
| | | 11/21/2011 | 13.78 | 9.38 | NA | NA | NA |
| | | 11/17/2011 | NA | NA | 470 | 70.0 | 82.0 |
| | | 7/26/2011 | 13.50 | 9.66 | NA | NA | NA |
| | | 7/25/2011 | NA | NA | 460 | 65.8 | 68.0 |
| | | 4/20/2011 | 12.82 | 10.34 | 460 | 71.0 | 69.0 |
| | | 1/24/2011 | 13.33 | 9.97 | 510 | 75.0 | 64.0 |
| | | 10/21/2010 | 16.55 | 6.61 | 540 | 100.0 | 73.0 |
| | | 7/26/2010 | 15.68 | 7.48 | 464 | 74.0 | 82.2 |
| | | 4/27/2010 | 11.02 | 9.38 | 534 | 72.0 | 77.1 |
| | | 1/28/2010 | 12.73 | 7.67 | 725 | 140.0 | 99.9 |
| | | 10/19/2009 | 14.33 | 6.07 | 522 | 74.0 | 85.6 |
| | | 8/19/2009 | 14.34 | 6.06 | 648 | 92.0 | 98.9 |
| | | 5/12/2009 | 12.38 | 8.02 | 792 | 110.0 | 108.0 |
| 32S/13E-30F02 | Screened from 75-100' | 10/30/2012 | 15.27 | 7.89 | 610 | 48.0 | 45.0 |
| | | 7/24/2012 | 14.82 | 8.34 | 590 | 56.0 | 46.0 |
| | | 4/19/2012 | NA | NA | 600 | 60.0 | 40.0 |
| | | 4/18/2012 | 14.38 | 8.78 | NA | NA | NA |
| | | 1/12/2012 | 14.31 | 8.85 | 610 | 52.0 | 45.0 |
| | | 11/21/2011 | 14.94 | 8.22 | 580 | 49.0 | 38.0 |
| | | 7/26/2011 | 14.46 | 8.7 | NA | NA | NA |
| | | 7/25/2011 | NA | NA | 590 | 52.1 | 46.0 |
| | | 4/20/2011 | 14.23 | 8.93 | 600 | 54.0 | 57.0 |
| | | 1/24/2011 | 14.36 | 8.93 | 600 | 51.0 | 43.0 |
| | | 10/28/2010 | NA | NA | 610 | 49.0 | 38.0 |
| | | 10/21/2010 | 7.39 | 15.77 | NA | NA | NA |
| | | 7/26/2010 | 16.21 | 6.95 | 560 | 49.0 | 45.8 |
| | | 4/27/2010 | 12.14 | 8.26 | 634 | 51.0 | 50.3 |
| | | 1/28/2010 | 13.09 | 7.31 | 604 | 44.0 | 52.2 |
| | | 10/19/2009 | 14.36 | 6.04 | 566 | 49.0 | 49.5 |
| | | 8/19/2009 | 14.81 | 5.59 | 614 | 49.0 | 51.8 |
| | | 5/12/2009 | 14.34 | 2.96 | 514 | 54.0 | 48.7 |
| | | 3/27/1996 | NA | NA | 678 | 49.0 | 52.0 |
| | | 6/9/1976 | NA | NA | 637 | 48.0 | 55.0 |
| | | 1/20/1966 | NA | NA | 580 | 68.0 | 47.0 |
| 32S/13E-30F03 | Screened from 305-372' | 10/30/2012 | 14.61 | 8.55 | 650 | 43.0 | 40.0 |
| | | 7/24/2012 | 14.50 | 8.66 | 640 | 51.0 | 36.0 |
| | | 4/19/2012 | NA | NA | 640 | 54.0 | 32.0 |
| | | 4/18/2012 | 10.43 | 12.73 | NA | NA | NA |
| | | 1/12/2012 | 12.37 | 10.79 | 660 | 46.0 | 39.0 |
| | | 11/21/2011 | 13.24 | 9.92 | 650 | 43.0 | 33.0 |
| | | 7/26/2011 | 14.22 | 8.94 | NA | NA | NA |
| | | 7/25/2011 | NA | NA | 650 | 46.5 | 46.0 |
| | | 4/21/2011 | NA | NA | 650 | 48.0 | 40.0 |
| | | 4/20/2011 | 12.51 | 10.65 | NA | NA | NA |
| | | 1/24/2011 | 12.67 | 10.64 | 650 | 46.0 | 36.0 |
| | | 10/28/2010 | NA | NA | 650 | 46.0 | 37.0 |
| | | 10/21/2010 | 6.62 | 16.54 | NA | NA | NA |
| | | 7/26/2010 | 17.32 | 5.84 | 608 | 45.0 | 43.8 |
| | | 4/27/2010 | 11.38 | 9.02 | 668 | 48.0 | 40.8 |
| | | 1/28/2010 | 10.98 | 9.42 | 656 | 40.0 | 43.1 |
| | | 10/19/2009 | 14.18 | 6.22 | 626 | 48.0 | 43.3 |
| | | 8/19/2009 | 20.23 | 0.17 | 672 | 45.0 | 43.1 |
| | | 5/12/2009 | 17.68 | 2.72 | 678 | 49.0 | 44.8 |
| | | 3/27/1996 | NA | NA | 686 | 41.0 | 40.0 |
| | | 6/7/1976 | NA | NA | 616 | 43.0 | 41.0 |
| | | 1/19/1966 | NA | NA | 642 | 69.0 | 49.0 |

## Table 6b: Summary of Key Data from Northern Cities Sentry Wells

| Well | Production Interval | Date | Depth to Water (feet) | Groundwater Elevation (feet NAVD) | Total Dissolved Solids (mg/L) | Chloride (mg/L) | Sodium (mg/L) |
|---|---|---|---|---|---|---|---|
| 32S/13E-30N01 | Screened from 15-40' | 10/29/2012 | 8.96 | 7.17 | 900 | 180.0 | 120.0 |
| | | 7/23/2012 | 8.54 | 7.59 | 840 | 190.0 | 120.0 |
| | | 4/18/2012 | 8.53 | 7.60 | 1,050 | 280.0 | 140.0 |
| | | 1/9/2012 | 8.74 | 7.39 | 1,050 | 260.0 | 170.0 |
| | | 11/21/2011 | 8.78 | 7.35 | NA | NA | NA |
| | | 11/17/2011 | NA | NA | 1,300 | 360.0 | 320.0 |
| | | 7/26/2011 | 9.01 | 7.12 | NA | NA | NA |
| | | 7/25/2011 | NA | NA | 1,680 | 445.3 | 230.0 |
| | | 4/20/2011 | 8.59 | 7.54 | 890 | 210.0 | 130.0 |
| | | 1/24/2011 | 8.18 | 7.35 | 870 | 180.0 | 100.0 |
| | | 10/21/2010 | 9.99 | 6.14 | 890 | 190.0 | 120.0 |
| | | 7/27/2010 | 8.97 | 7.16 | 917 | 200.0 | 130.0 |
| | | 4/27/2010 | 6.14 | 7.36 | 808 | 150.0 | 130.0 |
| | | 1/26/2010 | 4.90 | 8.60 | 902 | 210.0 | 155.0 |
| | | 10/20/2009 | 6.53 | 7.00 | 828 | 200.0 | 159.0 |
| | | 8/20/2009 | 6.71 | 6.82 | 835 | 160.0 | 150.0 |
| | | 5/11/2009 | 6.03 | 7.50 | 960 | 180.0 | 175.0 |
| 32S/13E-30N03 | Screened from 60-135' | 10/29/2012 | 8.01 | 8.12 | 610 | 60.0 | 56.0 |
| | | 7/23/2012 | 9.15 | 6.98 | 600 | 71.0 | 56.0 |
| | | 4/18/2012 | 6.72 | 9.41 | 570 | 80.0 | 47.0 |
| | | 1/11/2012 | 7.17 | 8.96 | 570 | 67.0 | 55.0 |
| | | 11/21/2011 | 6.45 | 9.68 | 600 | 67.0 | 47.0 |
| | | 7/26/2011 | 7.59 | 8.54 | NA | NA | NA |
| | | 7/25/2011 | NA | NA | 590 | 67.0 | 47.0 |
| | | 4/20/2011 | 6.65 | 9.48 | 580 | 76.0 | 58.0 |
| | | 1/24/2011 | 6.68 | 8.75 | 570 | 76.0 | 48.0 |
| | | 10/21/2010 | 10.76 | 5.37 | 550 | 69.0 | 59.0 |
| | | 7/27/2010 | 9.53 | 6.60 | 528 | 72.0 | 55.1 |
| | | 4/27/2010 | 6.14 | 7.36 | 672 | 89.0 | 60.6 |
| | | 1/26/2010 | 5.88 | 7.62 | 606 | 110.0 | 75.0 |
| | | 10/20/2009 | 6.56 | 6.94 | 806 | 180.0 | 93.3 |
| | | 8/20/2009 | 7.50 | 6.00 | 1,070 | 190.0 | 151.0 |
| | | 5/12/2009 | 6.33 | 7.17 | 602 | 97.0 | 63.4 |
| | | 3/27/1996 | NA | NA | 624 | 70.0 | 62.0 |
| | | 6/7/1976 | NA | NA | 705 | 90.0 | 54.0 |
| | | 1/21/1966 | NA | NA | 804 | 57.0 | 54.0 |
| 32S/13E-30N02 | Screened from 175-255' | 10/29/2012 | 8.52 | 7.61 | 1,030 | 40.0 | 68.0 |
| | | 7/23/2012 | 8.31 | 7.82 | 1,040 | 54.0 | 63.0 |
| | | 4/18/2012 | 3.45 | 12.68 | 990 | 60.0 | 56.0 |
| | | 1/11/2012 | 4.88 | 11.25 | 1,040 | 49.0 | 64.0 |
| | | 11/21/2011 | 5.35 | 10.78 | 1,020 | 46.0 | 57.0 |
| | | 7/26/2011 | 7.25 | 8.88 | NA | NA | NA |
| | | 7/25/2011 | NA | NA | 1,050 | 50.4 | 81.0 |
| | | 4/20/2011 | 3.53 | 12.60 | 1,030 | 52.0 | 63.0 |
| | | 1/24/2011 | 3.67 | 11.76 | 1,050 | 50.0 | 60.0 |
| | | 10/21/2010 | 10.42 | 5.71 | 1,040 | 48.0 | 52.0 |
| | | 7/27/2010 | 10.02 | 6.11 | 777 | 57.0 | 67.6 |
| | | 4/27/2010 | 5.26 | 8.27 | 800 | 93.0 | 71.9 |
| | | 2/25/2010 | 1.72 | 11.78 | 1,000 | 48.0 | 71.4 |
| | ***Confirmation Sample Collected from Pump Discharge at End of Purge:*** | 2/25/2010 | 1.72 | 11.78 | 1,010 | 74.0 | 76.9 |
| | ***Confirmation Sample Collected by Standard Method (Bailer):*** | 1/26/2010 | 3.72 | 9.78 | 970 | 50.0 | 74.2 |
| | | 10/20/2009 | 7.38 | 6.12 | 2,080 | 690.0 | 274.0 |
| | | 8/20/2009 | 11.94 | 1.56 | 1,350 | 500.0 | 199.0 |
| | | 5/11/2009 | 6.98 | 6.52 | 1,290 | 170.0 | 129.0 |
| | | 3/27/1996 | NA | NA | 1,050 | 50.0 | 71.0 |
| | | 6/7/1976 | NA | NA | 1,093 | 48.0 | 62.0 |
| | | 1/21/1966 | NA | NA | 1,069 | 54.0 | 71.0 |

## Table 6b: Summary of Key Data from Northern Cities Sentry Wells

| Well | Production Interval | Date | Depth to Water (feet) | Groundwater Elevation (feet NAVD) | Total Dissolved Solids (mg/L) | Chloride (mg/L) | Sodium (mg/L) |
|---|---|---|---|---|---|---|---|
| 12N/36W-36L01 | Screened from 227-237' | 10/31/2012 | 20.11 | 6.66 | 910 | 35.0 | 66.0 |
| | | 7/24/2012 | 19.42 | 7.35 | 880 | 43.0 | 65.0 |
| | | 4/20/2012 | 18.26 | 8.03 | NA | NA | NA |
| | | 4/18/2012 | 23.83 | 2.94 | 880 | 47.0 | 52.0 |
| | | 1/11/2012 | 17.68 | 9.09 | 790 | 41.0 | 64.0 |
| | | 11/21/2011 | 18.08 | 8.69 | 910 | 39.0 | 55.0 |
| | | 7/26/2011 | 19.63 | 7.14 | NA | NA | NA |
| | | 7/25/2011 | NA | NA | 890 | 40.5 | 65.0 |
| | | 4/21/2011 | NA | NA | 890 | 42.0 | 61.0 |
| | | 4/20/2011 | 18.26 | 8.51 | NA | NA | NA |
| | | 1/24/2011 | 17.61 | 8.68 | 890 | 41.0 | 55.0 |
| | | 10/21/2010 | 20.75 | 5.54 | 910 | 38.0 | 76.0 |
| | | 7/27/2010 | 21.18 | 5.11 | 707 | 36.0 | 64.2 |
| | | 4/26/2010 | 15.94 | 8.06 | 860 | 42.0 | 70.3 |
| | | 10/21/2009 | 17.72 | 6.28 | 856 | 38.0 | 72.0 |
| | | 8/20/2009 | 19.16 | 4.84 | 890 | 39.0 | 78.0 |
| | | 5/11/2009 | 17.68 | 6.32 | 832 | 63.0 | 83.8 |
| | | 3/26/1996 | NA | NA | 882 | 35.0 | 66.0 |
| | | 6/8/1976 | NA | NA | 936 | 38.0 | 72.0 |
| 12N/36W-36L02 | Screened from 535-545' | 10/31/2012 | 18.81 | 7.96 | 800 | 100.0 | 120.0 |
| | | 7/24/2012 | 19.05 | 7.72 | 800 | 134.0 | 125.0 |
| | | 4/18/2012 | 10.81 | 15.96 | 770 | 130.0 | 95.0 |
| | | 1/11/2012 | 11.18 | 15.59 | 900 | 122.0 | 110.0 |
| | | 11/21/2011 | 13.99 | 12.78 | 780 | 130.0 | 95.0 |
| | | 7/26/2011 | 18.03 | 8.74 | NA | NA | NA |
| | | 7/25/2011 | NA | NA | 790 | 128.8 | 110.0 |
| | | 4/21/2011 | NA | NA | 770 | 120.0 | 90.0 |
| | | 4/20/2011 | 10.33 | 16.44 | NA | NA | NA |
| | | 1/24/2011 | 9.37 | 16.92 | 800 | 120.0 | 95.0 |
| | | 10/21/2010 | 19.77 | 6.52 | 770 | 120.0 | 130.0 |
| | | 7/27/2010 | 20.53 | 5.76 | 737 | 110.0 | 121.0 |
| | | 4/26/2010 | 9.24 | 14.76 | 720 | 100.0 | 116.0 |
| | | 10/21/2009 | 17.65 | 6.35 | 638 | 99.0 | 113.0 |
| | | 8/20/2009 | 19.15 | 4.85 | 785 | 100.0 | 131.0 |
| | | 5/11/2009 | 14.38 | 9.62 | 775 | 120.0 | 132.0 |
| | | 3/26/1996 | NA | NA | 772 | 127.0 | 130.0 |
| | | 6/8/1976 | NA | NA | 820 | 126.0 | 118.0 |
| County MW-3 12N/35W-32C03 | Screened from 90-170' | 10/30/2012 | 40.05 | 8.39 | 330 | 57.0 | 60.0 |
| | | 7/25/2012 | 38.62 | 9.82 | 330 | 67.0 | 61.0 |
| | | 4/19/2012 | 23.02 | 25.42 | 370 | 74.0 | 52.0 |

## Table 6b: Summary of Key Data from Northern Cities Sentry Wells

| Well | Production Interval | Date | Depth to Water (feet) | Groundwater Elevation (feet NAVD) | Total Dissolved Solids (mg/L) | Chloride (mg/L) | Sodium (mg/L) |
|---|---|---|---|---|---|---|---|
| Oceano MW-Green | Screened from 110-130' | 10/30/2012 | 27.31 | 7.32 | 780 | 65.0 | 75.0 |
| | All elevations relative to MSL | 7/25/2012 | 27.15 | 7.48 | 830 | 76.0 | 80.0 |
| | | 4/19/2012 | NA | NA | 790 | 87.0 | 69.0 |
| | | 4/18/2012 | 21.65 | 12.98 | NA | NA | NA |
| | | 1/12/2012 | 23.29 | 11.34 | 760 | 76.0 | 85.0 |
| | | 11/21/2011 | 22.46 | 12.17 | 720 | 39.0 | 38.0 |
| | | 7/26/2011 | 25.51 | 9.12 | NA | NA | NA |
| | | 7/25/2011 | NA | NA | 760 | 69.3 | 66.0 |
| | | 4/20/2011 | 114.79 | -80.16 | NA | NA | NA |
| | | 1/24/2011 | 106.59 | -71.96 | 310 | 98.0 | 22.0 |
| | | 10/28/2010 | NA | NA | 290 | 81.0 | 26.0 |
| | | 10/21/2010 | 112.71 | -81.85 | NA | NA | NA |
| | | 7/26/2010 | 95.61 | -64.75 | 438 | 85.0 | 34.3 |
| | | 4/26/2010 | 63.90 | -33.04 | 560 | 83.0 | 47.7 |
| | | 1/27/2010 | 43.71 | -12.85 | 460 | 130.0 | 45.0 |
| | | 10/20/2009 | 29.20 | 1.66 | 362 | 92.0 | 39.6 |
| | | 8/19/2009 | 24.55 | 6.31 | 420 | 160.0 | 48.4 |
| | | 5/16/1983 | 15.80 | 15.06 | 665 | 35.0 | 40.0 |
| Oceano MW-Blue | Screened from 190-210' and 245-265' | 10/30/2012 | 27.68 | 6.95 | 380 | 97.0 | 100.0 |
| | All elevations relative to MSL | 7/25/2012 | 27.18 | 7.45 | 240 | 49.0 | 56.0 |
| | | 4/19/2012 | NA | NA | 380 | 100.0 | 87.0 |
| | | 4/18/2012 | 20.10 | 14.53 | NA | NA | NA |
| | | 1/12/2012 | 22.26 | 12.37 | 480 | 96.0 | 110.0 |
| | | 11/21/2011 | 22.73 | 11.90 | 390 | 90.0 | 78.0 |
| | | 7/26/2011 | 25.29 | 9.34 | NA | NA | NA |
| | | 7/25/2011 | NA | NA | 260 | 29.3 | 23.0 |
| | | 4/21/2011 | NA | NA | 580 | 118.0 | 70.0 |
| | | 4/20/2011 | 22.59 | 12.04 | NA | NA | NA |
| | | 1/24/2011 | 24.87 | 9.76 | 680 | 110.0 | 60.0 |
| | | 10/21/2010 | 30.11 | 0.80 | 770 | 100.0 | 68.0 |
| | | 7/26/2010 | 24.74 | 6.17 | 783 | 130.0 | 80.1 |
| | | 4/26/2010 | 18.52 | 12.39 | 1,130 | 160.0 | 70.2 |
| | | 1/27/2010 | 22.06 | 8.85 | 1,740 | 430.0 | 55.6 |
| | | 10/20/2009 | 27.50 | 3.41 | 2,250 | 1,000.0 | 19.5 |
| | | 8/19/2009 | 24.65 | 6.26 | 322 | 150.0 | 93.2 |
| | | 5/16/1983 | 13.30 | 17.61 | 840 | 80.0 | 90.0 |

## Table 6b: Summary of Key Data from Northern Cities Sentry Wells

| Well | Production Interval | Date | Depth to Water (feet) | Groundwater Elevation (feet NAVD) | Total Dissolved Solids (mg/L) | Chloride (mg/L) | Sodium (mg/L) |
|---|---|---|---|---|---|---|---|
| Oceano MW-Silver | Screened from 395-435' and 470-510' | 10/30/2012 | 27.14 | 7.49 | NA | NA | NA |
| | | 7/25/2012 | 27.68 | 6.95 | NA | NA | NA |
| | | 4/18/2012 | 20.13 | 14.5 | NA | NA | NA |
| | | 11/21/2011 | 23.00 | 11.63 | NA | NA | NA |
| | | 7/26/2011 | 25.23 | 9.4 | NA | NA | NA |
| | | 4/21/2011 | NA | NA | 410 | 97.0 | 100.0 |
| | | 4/20/2011 | 21.27 | 13.36 | NA | NA | NA |
| | | 1/24/2011 | 22.02 | 12.61 | 440 | 92.0 | 90.0 |
| | | 10/21/2010 | 29.11 | 1.74 | 460 | 90.0 | 110.0 |
| | All elevations relative to MSL | 7/26/2010 | 24.24 | 6.61 | 478 | 83.0 | 109.0 |
| | | 4/26/2010 | 19.04 | 11.81 | 452 | 83.0 | 83.0 |
| | | 1/27/2010 | 21.05 | 9.8 | 496 | 71.0 | 92.2 |
| | | 10/20/2009 | 27.52 | 3.33 | 564 | 71.0 | 80.8 |
| | | 8/19/2009 | 29.34 | 1.51 | 522 | 180.0 | 148.0 |
| | | 5/16/1983 | 13.50 | 17.35 | 630 | 40.0 | 40.0 |
| Oceano #8 | | 10/30/2012 | NA | NA | 660 | 40.0 | 44.0 |
| | | 7/24/2012 | NA | NA | 700 | 47.0 | 44.0 |
| | | 4/25/2012 | NA | NA | 680 | 48.0 | 44.0 |
| | | 1/10/2012 | NA | NA | 690 | 45.0 | 44.0 |
| | | 11/22/2011 | NA | NA | 690 | 41.0 | 39.0 |
| | | 7/25/2011 | NA | NA | 690 | 44.0 | 39.0 |
| Oceano MW-Yellow | Screened from 625-645' | 10/30/2012 | 27.23 | 7.40 | 380 | 88.0 | 99.0 |
| | | 7/25/2012 | 27.69 | 6.94 | 390 | 108.0 | 107.0 |
| | | 4/19/2012 | NA | NA | 390 | 110.0 | 83.0 |
| | | 4/18/2012 | 20.05 | 14.58 | NA | NA | NA |
| | | 1/12/2012 | 23.08 | 11.55 | 410 | 94.0 | 95.0 |
| | | 11/21/2011 | 22.98 | 11.65 | 410 | 94.0 | 83.0 |
| | | 7/26/2011 | 26.73 | 7.90 | NA | NA | NA |
| | | 7/25/2011 | NA | NA | 420 | 89.7 | 84.0 |
| | | 4/21/2011 | NA | NA | 380 | 88.0 | 110.0 |
| | | 4/20/2011 | 21.30 | 13.33 | NA | NA | NA |
| | | 1/24/2011 | 22.01 | 12.62 | 430 | 83.0 | 73.0 |
| | | 10/21/2010 | 28.22 | 2.67 | 410 | 87.0 | 100.0 |
| | | 7/26/2010 | 25.50 | 5.39 | 446 | 94.0 | 93.0 |
| | All elevations relative to MSL | 4/26/2010 | 19.17 | 11.72 | 416 | 96.0 | 87.6 |
| | | 1/27/2010 | 20.58 | 10.31 | 498 | 89.0 | 79.6 |
| | | 10/20/2009 | 25.80 | 5.09 | 446 | 100.0 | 97.1 |
| | | 8/19/2009 | 31.04 | -0.15 | 426 | 160.0 | 101.0 |
| | | 5/16/1983 | 14.30 | 16.59 | 770 | 60.0 | 70.0 |

piezometer (24B01) showed elevated Cl and Na in October 2010 and all quarterly samples taken in 2011 and 2012 while samples from the two deeper piezometers TDS, Cl, and Na levels that indicate no such effect. Occasional downward percolation of seawater or brackish lagoon water may influence the quality of sample from the shallow piezometer (24B01). A sensor has been installed to measure short term fluctuations in water level and TDS to provide additional insight as to the source of Cl and Na fluctuations. However, no correlation has been established between exceptionally high tides or storm surges and increases in electrical conductivity.

Schoeller diagrams are geochemical representations that show the relative portions of major water quality constituents based on ionic charge (in milliequivalents per liter or meq/L). This approach allows graphical, or visual, means to evaluate measured water quality against potential water sources. Figure 15 is a Schoeller diagram illustrating the water quality in the DWR sentry wells for all of the 2012 quarterly monitoring events. Each line of connected points illustrates the water quality signature from a specific well (e.g., 30N02) for a given sample period. For comparison, Figure 15 (the Schoeller diagram) also shows the typical geochemical signature for seawater (in black) and the typical signature for a groundwater basin water supply well (Grover Beach Well#1, labeled as “GW Base”, in blue). Most of the water quality samples plotted on the lower portion of the diagram are similar in shape to the groundwater basin sample and are combined within the shaded area. It is important to note that shallow well 24B01 has a different profile exhibiting high Cl and Na compared to the other wells. This may be the profile expected if seawater intrusion occurs in any of the deeper wells.

The Oceano CSD Observation well cluster has four wells; from shallow to deep, they are identified as green, blue, silver, and yellow (see Figures 7 and 8). As documented in Table 6, the Oceano CSD observation wells have been sampled in each quarterly monitoring event since August 2009, but have not shown consistent water quality chemistry. In general, the two deeper Oceano CSD Observation wells show similar water quality to the rest of the groundwater basin with the exception of low sulfate values reported in August 2008. Chloride concentrations have been slightly elevated and peaked in August 2009; however, the overall water quality character does not appear to indicate seawater intrusion.

The two shallow Oceano CSD Observation wells were serviced in 2011 to restore functionality. Jetting to clear obstructions in the Oceano CSD “Green” and“ Blue” wells were successful and water levels were found to recover quickly after purging during sampling. Rehabilitation of Oceano CSD Silver well found the casing blocked above the screened interval suggesting a portion of the casing had failed. The screened interval in the Yellow well was not jetted since the available equipment was not able to reach to the screened depth of 625 ft. Because the Silver well appears to be damaged, water level measurements and water quality samples were obtained from Oceano CSD production well #8 which has a similar screened interval.

As documented in Table 6a, chloride concentrations from the blue well were elevated in October 2009 but have fallen since January 2010 and are now in a range similar to other sentry wells and shows a signature close to groundwater (labeled “GW” in Figure 15) not seawater.

Well 32C03 (County monitoring well #3) is located south and east of the main NCMA groundwater development area. It has exhibited little change compared to the initial sample taken in April 2012. Water in well 32C03 exhibits lower Ca, Mg and Carbonate than all other wells and has a higher ratio of Na+Cl to CA+Mg+Carbonate. Public water supply systems are required to provide water quality information to the DPH. Data submitted from the NCMA area was reviewed and most recent data added to the NCMA data base. Although the data supplied by DPH does not include specific well locations, individual public supply wells are identified and their location determined.

Although there is variation among wells, data from 2012 suggest that water quality in individual wells has remained generally consistent from year to year. High levels of Nitrate, Selenium and Manganese have been present historically in some wells, however all NCMA public supplies now meet the MCL for these constituents. These wells are subject to more frequent sampling and water produced is subject to treatment or blending. Treatment to remove selenium and manganese and blending result in the water delivered through the municipal systems meeting State and Federal water quality standards.

## 4.3 Threats to Water Supply

Both state-wide and local impacts to the NCMA water supply exist. Because the water supply contains sources imported from other areas of the state, threats include State-wide drought, effects of climate change in the SWP source area, management and environmental protection issues in the Sacramento-San Joaquin Delta that affect the amount and reliability of SWP deliveries and seismic risk to the SWP delivery system. Local potential impacts to NCMA water supply similarly include extended drought and climate change that may affect the yield from Lopez Lake as well as reduced recharge to the NCMA. In addition, the NCMA is not hydrologically isolated from the rest of the SMGB; and increased growth and excessive pumping on the Nipomo Mesa have contributed to a deepening groundwater depression underlying the Nipomo Mess Management Area (NMMA).[2] There is a potential impact from seawater intrusion if the groundwater system as a whole is not adequately monitored (as discussed in the above section) and managed. In particular the management of the basin may need to account for sea level rise and the relative change in groundwater gradient along the shore line as well as an ongoing imbalance between pumping and recharge in the NMMA (NMMA Technical Group. 2011).

[2] To address the pumping in excess of local recharge and the growing groundwater depression in the NMMA, the Settlement Stipulation and Judgment require the NCSD to purchase and deliver a minimum of 2,500 acre-feet per year (AFY) of supplemental water to the Nipomo Mesa.

### 4.3.1 Threats to State Water Project Supply

Both extended drought and long term reduction in snowpack due to climate change can affect deliveries from the State Water Project. California experienced a relatively short (2 year) drought that resulted in below-average precipitation and runoff in the SWP source area; runoff in 2007 and 2008 amounted to only 53 and 60 percent of average, respectively, and runoff in 2009 was only slightly better at 85 percent. As a result, storage in SWP reservoirs was reduced. In addition to drought conditions, SWP pumping capacity was reduced as the result of a May 2007 federal court ruling to protect Delta smelt.

However, the threat of reduced delivery to local SWP users—Oceano CSD and Pismo Beach—has not materialized to date, as San Luis Obispo County's allocation continues to be approved in full because the FC&WCD is able to use some of its unallocated Table A amount to augment deliveries. The FC&WCD hold SWP allocation in addition to the amount needed to meet contracts with local agencies. In addition, the City of Pismo Beach acquired additional allocation form FC&WCD in 2012. Both sources of extra allocation may be used as a drought buffer to provide additional deliveries during years when full deliveries are not available. Nonetheless, in the future, the Delta's fragile ecosystem, uncertain precipitation patterns and reduced snowmelt may further reduce California's water supply reliability with potential ramifications for Oceano CSD and Pismo Beach.

### 4.3.2 Seawater Intrusion

The NCMA is underlain by an accumulation of alluvial materials that slope gently offshore and extend for many miles under the ocean (DWR 1985). Coarser materials within the alluvial materials comprise aquifer zones that receive freshwater recharge in areas above sea level. The elevation difference causes fresh water in the aquifers to flow toward the ocean and form an interface between freshwater and seawater. Under natural and historical conditions the differential pressure between the aquifer and seawater induces net outflow of freshwater and establishes a dynamic interface between fresh water and salt water at depth. Sufficient outflow prevents the dynamic interface from moving onshore. Sufficient differential pressure to maintain a net outflow is indicated by onshore groundwater elevations that are above mean sea level.

The Annual Report for CY 2008 documented that a portion of the NCMA groundwater basin exhibited water surface elevations below sea level (Todd Engineers 2009). Hydrographs for NCMA sentry wells (Figures 10 and 11) show coastal groundwater elevations that were at relatively low levels for as long as two years. Such sustained low levels had not occurred previously in the historical record and reflected the impact of drought on groundwater levels. The low coastal groundwater levels indicated a potential for seawater intrusion. Increased

TDS, Na and Cl concentrations were found in sentry well 32S/13E N03 in August 2009 and in 32S/13E N02 in August and October 2009[3].

As documented in Section 4.2.2 of this report, groundwater elevations in October 2012 were significantly above groundwater elevations relative to October 2008 and October 2009. In addition, groundwater quality in the sentry wells N02 and N03 remained consistent in 2011 and 2012 since the improvement which began in January 2010, in particular low levels of seawater indicators. Water elevation and quality measurements in 2009 through October 2012 indicate the following:

- Sentry wells in the cluster 32S/13E 30N may be relatively sensitive to seawater intrusion because of their location near Arroyo Grande Creek and the more permeable sediments deposited by the ancestral creek (Todd Engineers 2010) as well as the lower groundwater elevations typical to the east (Figures 9a and 9b).
- The initial portions of the seawater/groundwater interface were detected onshore at one site beginning with elevated Chloride levels in May 2009; by October 2009 the interface had manifested in the middle and deep aquifer zones monitored by sentry wells 30-N02 and 30-N03. The extent to which seawater may have intruded other localized aquifer zones along the coast without being detected in the NCMA sentry wells is unknown due to heterogeneity of the aquifer and spacing of sentry wells.
- Above average precipitation and decreased groundwater withdrawal in 2010 resulted in increased water levels in the sentry wells on a comparative seasonal basis and an apparent decrease in water table depression immediately south of lower Arroyo Grande Creek. Lower volumes of groundwater development in 2012 have maintained this condition. (Figures 9a and 9b).
- Water quality in most wells remains similar to historic measurements thus indicating no effects of seawater intrusion.

### *4.3.3 Measures to Avoid Seawater Intrusion*

In response to the early warning of seawater intrusion, the Northern Cities have developed and implemented a water quality monitoring program for the sentry wells and Oceano CSD Observation wells, as described above in Section 4.2.3. The Northern Cities, County FC&WCD, and State of California have also worked cooperatively toward the protection of the sentry wells as long-term monitoring sites. To address the impacts of potential seawater intrusion, the Northern Cities have voluntarily reduced coastal groundwater pumping, decreased overall water use via conservation, and initiated plans, studies and institutional arrangements to secure additional surface water supplies. As a result, each of the 4 major

[3] In addition to increased water levels beginning in 2010, well head modifications were made to all sentry wells in July 2011. Specifically, all well heads were raised above ground level. Prior to the modifications, the sentry wells including 30N piezometers were completed below land surface. The location and condition of the well heads raised concerns about the potential for contamination of samples.

municipal water users reduced groundwater use between 25 and 90 percent between 2007 and 2010. In 2012, groundwater use ranged between 3 and 68 percent compared to 2007, similar to 2011. Pismo Beach and Oceano CSD reduced their groundwater demand between in part by importing SWP supplies. A summary of the Northern Cities Management Area objectives and activities is presented below in Section 6.

### *4.3.4 Change in Groundwater Recharge along the NMMA Boundary*

Groundwater recharge includes subsurface flow from adjacent areas into aquifers serving as water sources in the NCMA. Historically an important source of subsurface recharge has been in-flow to the NCMA from the NMMA along the southeast boundary of the NCMA, estimated to be 1,300 AFY (DWR 2002). However, it appears that this inflow from the NMMA has been reduced to "something approaching no subsurface flow" due to lower groundwater levels in the NMMA (NMMA 2010, page 43). Contour maps prepared by DWR for spring 1975, 1985, 1995 and 2000 as well as Figures 6-5 and 6-6 from NMMA 2011 and NMMA 2012, indicate a growing depression in water level elevation beneath the NMMA. This depression has been associated with increased pumping during the same time period (DWR 2002 and NMMA 2012).

Despite above average rainfall in 2010, the subsequent NMMA Annual Reports, (NMMA 2011 and NMMA 2012, as shown in Figures 6-5 and 6-6), confirm the persistence of a NW/SE trending depression in water level contours in the northern portion of the NMMA. Finding 4 states; "there are a number of direct measurements that indicate that demand exceeds the ability of the supply to replace water pumped from the aquifers" (NMMA 2012).

In their management area the NMMA projects increasing water demand, thus extraction from groundwater (NMMA 2012, page 34). Due to the ongoing imbalance between extraction and replenishment of aquifers in the NMMA, increasing amounts of groundwater extraction may lower groundwater along the NMMA and NCMA boundary below current levels. Lower groundwater levels in the boundary area will further reduce gradients and may allow "groundwater to flow from coastal areas into the depression" (NMMA 2012, page 52). Either circumstance would reduce groundwater available to urban and agricultural users in the NCMA and "create conditions for seawater intrusion" (NMMA 2012, page 53). In response to ongoing concerns about risk to their water supplies, the NCMA has requested that groundwater users in the NMMA cure their overdraft and restore the historical inflow to the NCMA by developing supplemental supplies pursuant to the Settlement Agreement and Judgment, by reducing pumping, or both.

# 5 Supply/Demand Comparison

This section presents a comparison of the 2012 water supplies and demands of the Northern Cities Management Area including applied irrigation, and rural water systems.

Table 5 in Section 4 outlines the Available Urban Water Supplies for each of the Northern Cities. The total available urban water supply is 10,769 AFY. As discussed in Section 4, the 2002 Management Agreement estimated that the historical safe yield from the groundwater basin was 9,500 AFY. Since all of the irrigation applied water demand is supplied by groundwater, the total available applied irrigation supply is based on a portion of the estimated groundwater safe yield, which was allocated as 5,300 AFY for agricultural and rural use. The agricultural conversion of 330 AFY reduces this allocation to 4,970 AFY. Of this estimated safe yield of 9,500 AFY, other than what is allocated for applied irrigation and rural use, the remaining 4,000 AFY is allocated for urban water use and 200 AFY allocated to subsurface outflow to the ocean.

In 2012, the total urban water demand, based on production, was 7,646 AF. Based on 2012 precipitation and ET data, 2012 applied irrigation water use was estimated at 2,742 AF, while rural water use was estimated at 41 AF. The total combined demand for the NCMA in 2012 was 10,429 AF. Total groundwater use by urban and rural users in 2012 was 1.7% greater than in 2011. The following Table 7 displays the water demand, by source, of each city and agency in 2012.

**Table 7. 2012 Water Demand by Source (AF)**

| Urban Area | Lopez Lake | State Water Project | Groundwater | Transfers | Other Supplies | Total |
|---|---|---|---|---|---|---|
| Arroyo Grande | *2,492.1* | *0.0* | *180.0* | *200.0* | *149.6* | 3,021.7 |
| Grover Beach | *880.5* | *0.0* | *877.0* | *0.0* | *0.0* | 1,757.5 |
| Pismo Beach | *1,109.6* | *896.6* | *22.5* | *0.0* | *0.0* | 2,028.6 |
| Oceano CSD | *241.1* | *738.4* | *58.9* | *-200.0* | *0.0* | 838.4 |
| **Urban Water Use Total** | **4,723.3** | **1,635.0** | **1,138.4** | **0.0** | **149.6** | **7,646.3** |
| Applied Irrigation | *0.0* | *0.0* | *2,742.0* | *0.0* | *0.0* | 2,742.0 |
| Rural Water Users | *0.0* | *0.0* | *41.0* | *0.0* | *0.0* | 41.0 |
| **Total** | **4,723.3** | **1,635.0** | **3,921.4** | **0.0** | **149.6** | **10,429.3** |

Urban water demand in 2012 to the NCMA totaled 4,723 AF of Lopez Lake water, 1,635 AF of State Water Project water, and 1,138 AF of groundwater. Neither Arroyo Grande, nor Grover Beach, has a State Water Project allocation. Arroyo Grande has a temporary agreement to purchase 100 AFY per water year of water from Oceano CSD through 2013.

Arroyo Grande purchased 200 AY in the 2012 calendar year. The 150 AF of “Other Supplies” delivered to Arroyo Grande consists of groundwater pumped from the Pismo Formation, which is located outside of the shared groundwater basin.

Based on the estimated groundwater safe yield, the total available supply for all uses is 15,739 AFY, which is the sum of 10,769 AFY for urban plus the allocation for applied irrigation and rural area of 4,970 AFY. Total applied water demand by source was estimated at 10,429 AFY for 2012.

# 6 Management Activities

Section 6 presents the primary NCMA groundwater management objectives and summarizes major historical management activities relevant to the objectives. Each subsection section includes a discussion of management activities in 2012.

The group of NCMA groundwater users involved in the stipulation, the Northern Parties, comprises the Northern Cities, the overlying owners, San Luis Obispo County and San Luis Obispo County FC&WCD have actively managed surface water and groundwater resources for more than 30 years. Management objectives and responsibilities were first established in the 1983 *Gentlemen's Agreement* and updated in the 2002 Management Agreement. The responsibility and authority of the Northern Parties for NCMA groundwater management was formally established through the 2002 Settlement Agreement, 2005 Stipulation, and 2008 Judgment. The overall management goal for the Northern Cities is to preserve the long-term integrity of water supplies in the NCMA portion of the Santa Maria Groundwater Basin (SMGB).

## 6.1 Management Objectives

Seven basic objectives have been established for ongoing NCMA groundwater management. Under each objective, the NCMA technical group has identified a number of strategies to meet the objectives. These strategies are shown under each of the seven objectives listed below:

1. **Share Groundwater Resources and Manage Pumping**

   - Continued reduction of groundwater pumping, maintain below safe yield.
   - Coordinated delivery of Lopez Lake surplus water to maximize surface water supplies.
     - Temporary purchase of 100 AFY of water by Arroyo Grande from Oceano CSD, which expires after water year 2013.
   - Continue to import State Water Project supplies to Oceano CSD and Pismo Beach.
   - Performed capacity assessments on the Lopez Lake and Coastal Branch pipelines to allow maximum current and future surface water imports.
   - Maintain surface water delivery infrastructure to maximize capacity.
     - 18" Lopez Lake Pipeline Pigging Project (complete)
     - 33" Lopez Lake Pipeline Pigging Project

**2. Monitor Supply and Demand and Share Information**

- Share monthly groundwater pumping data at NCMA TG meetings.
- Evaluate future water demands through comparison to UWMP projections.
  - Arroyo Grande 2010 UWMP
  - Pismo Beach 2010 UWMP
  - Grover Beach 2010 UWMP
  - Due to size, OCSD has no UWMP

**3. Manage Groundwater Levels and Prevent Seawater Intrusion**

- Utilize storm-water ponds to capture storm-water run-off and recharge the groundwater basin.
- Install transducers in key monitoring wells to provide continuous groundwater elevation data; the following wells have transducers:
  - 24B01
  - 24B03
  - 30F03
  - 30N02
  - County Monitoring Well #3
- Collect and evaluate daily municipal pumping data to determine impact on local groundwater elevation levels.
- Received IRWM Planning grant funding to characterize the SMGB as basis for developing a groundwater flow model.

**4. Protect Groundwater Quality**

- Perform water quality monitoring at all sentry wells and County Well #.3
- Gather temperature and electrical conductivity data from 5 monitoring wells to continuously track water quality indicators for seawater intrusion.
- Use IRWM Planning grant to characterize groundwater basin as basis for the development of a Salt and Nutrient Management Plan pursuant to State policy.
- Pursue Local Groundwater Assistance Grant to develop a Salt and Nutrient Management Plan for the NCMA and NMMA.
- Utilize IRWM Planning grant funding to investigate alternatives for utilizing recycled water from the Pismo Beach and the South San Luis Obispo County wastewater treatment plants, including:

- Development of a seawater intrusion barrier.
- Recharge groundwater basin for indirect potable re-use
- Offset potable water pumping through agriculture/landscape irrigation
- Augment stream flow in Arroyo Grande creek

**5. Manage Cooperatively**

- Include the Santa Maria Valley Management Area (SMVMA) in the Santa Maria Groundwater Basin Management Areas (SMGB MA) Technical Subcommittee.
- Coordinate groundwater monitoring data sharing and annual report preparation with the NCMA, NMMA and the SMVMA.

**6. Encourage Water Conservation**

- Share updated water conservation information
- Implement UWMPs

**7. Evaluate alternative sources of new developed water (Stipulation Section IV)**

- Addressed through investigation into increasing SWP supplies and expanded use of recycled water
- Analyze capacity of the Lopez Lake and Coastal Branch pipelines to maximize deliveries of surface water. The following analyses have been completed:
  - Lopez Pipeline Capacity Evaluation
  - Lopez Pipeline Capacity Re-Evaluation
  - Coastal Branch Capacity Assessment

The history and rationale are discussed in the sections below. Other potential objectives are outlined in the final section.

The Northern Cities, both individually and jointly, are engaged in water resource management projects, programs, and planning efforts that address water supply and demand issues, particularly efforts to assure a long-term sustainable supply. Each section discusses major management activities during 2012. These management activities, taken as a whole, address all of the Management Objectives described in Section 5.0

### *6.1.1 Share Groundwater Resources and Manage Pumping*

A longstanding objective of water users in the NCMA has been to cooperatively share and manage groundwater resources. In 1983 the Northern Parties mutually agreed on an initial safe yield estimate (defined by DWR) and an allotment of pumping between the urban users and applied irrigation users of 57 percent and 43 percent respectively. In this agreement the Northern Cities also established pumping allotments among themselves. Subsequently the 2002 Management Agreement included provisions to account for changes such as land conversion. The agreements provide that any increase or decrease in the safe yield based on ongoing assessments would be shared on a pro rata basis. Pursuant to the stipulation the Northern Cities conducted a water balance study to update the safe yield estimate (Todd Engineers 2007). Among other results, the parties agreed to maintain the existing pumping allotment among the urban users and established a consistent methodology to address agricultural land use conversion.

In addition to cooperatively sharing and managing groundwater resources, the Northern Cities have coordinated delivery of water from Lopez Lake, and have continued to import SWP water to maximize use of available surface water supplies. A total of 100 AFY of Lopez Lake entitlement, or groundwater allotment, is made available each water year (through 2013) for Arroyo Grande to purchase from Oceano CSD via a temporary purchase agreement. In 2012 Oceano CSD and Pismo Beach continued to import their full or nearly their full allotment of SWP water. These activities allowed the Northern Cities, as a whole, to reduce the amount of groundwater that is pumped from the shared basin in 2012.

Along with coordination activities to maximize surface water supplies, the Northern Cities have performed capacity assessments on the Lopez Lake and Coastal Branch pipelines to maximize current and future surface water imports. A portion of the Lopez Lake pipeline has been “pigged” (a cleaning and maintenance procedure) to increase delivery capacity as well.

The water balance study also highlighted the threat of seawater intrusion as the most important potential adverse impact to consider in managing the basin. Seawater intrusion, a concern since the 1960s, would degrade the quality of water in aquifer and potentially render portions of the basin unsuitable for groundwater production (DWR 1970). The Northern Cities management of groundwater levels maintained the sentry well index above the 7.5 ft. (NAVD 88) level throughout 2012.

Another potential adverse impact of localized pumping includes reduction of flow in local streams, notably Arroyo Grande (Todd Engineers 2007). The Northern Cities (as Zone 3 contractors) have participated with San Luis Obispo County FC&WCD in preparation of the Arroyo Grande Creek Habitat Conservation Plan (HCP) that addresses reservoir releases to maintain both groundwater levels and habitat diversity in the creek.

### *6.1.2 Monitor Supply and Demand and Share Information*

Regular monitoring of activities that affect the groundwater basin, and sharing that information, has occurred for many years. Monitoring includes gathering data on hydrologic conditions, water supply and demand, and groundwater pumping, levels, and quality. This was first established in 1983 and then formalized in 2002 to include quarterly meetings. The current monitoring program is managed by the Northern Cities in accordance with the 2005 Stipulation and 2008 Judgment, guided by the July 2008 Monitoring Program for the NCMA. The data and its implication to groundwater management are summarized in the Annual Reports. Arroyo Grande, Grover Beach, and Pismo Beach have each evaluated their future water demands as part of their respective 2010 UWMP updates. The NCMA has engaged the two other management areas (NMMA and SMVMA) and now shares information through data exchange and regular meetings throughout the annual report preparation cycle. The sharing of information has expanded as the management areas continue to work together.

Pismo Beach and Oceano have allocations of the State Water Project in 2011 and 2012 Pismo Beach and Oceano received nearly all of their allocation, reducing groundwater demand. Continuing importation of State Water project supplies will allow the users in NCMA to reduce groundwater demand. Under stipulated conditions, surplus water (above the Lopez Lake's safe yield) is declared surplus and is used by NCMA members to increase use of surface supplies. In addition, each of the Northern Cities was able to reduce its groundwater use below its safe yield allotment in 2012, continuing this level of use for the 4$^{th}$ consecutive year.

### *6.1.3 Manage Groundwater Levels and Prevent Seawater Intrusion*

Prevention of seawater intrusion through the management of groundwater levels is essential to protecting the shared resource. While closely related to the objectives to manage pumping, monitor supply and demand, and share information, this objective specifically recognizes the proximity of production wells to the coast and the threat of seawater intrusion. The Northern Cities, County and San Luis Obispo FC&WCD have long cooperated in the monitoring of groundwater levels, including quarterly measurement of groundwater levels in the sentry wells at the coast. Upon assuming responsibility for the coastal monitoring wells, the NCMA became aware of the need to upgrade their condition. In July 2010 the well-heads (surface completions) at four sentry monitoring well clusters within the Northern Cities Management Area were renovated (Todd Engineers 2010). The modifications occurred at well clusters:

- 32S/12E-24B01, B02, B03
- 32S/13E-30F01, F02, F03;
- 32S/13E-30N01, N02, N03
- 12N/36W-36L01, L02

The renovations included raising the elevations of the top of each individual well casing by two to three feet in order to reduce the risk of surface water entering the wells. Because the top of the well casing is used as the reference point for all depth to water measurements, the new surface completions were surveyed relative to the NAVD 88 standard in late September 2010 (Wallace Group 2010). (Changes in the wellhead elevations are indicated in Table 1.) The individual well casings have been raised above ground surface and protective locking steel risers now enclose each cluster. As a result of this work, the sentry wells within the NCMA are now protected from surface contamination and tampering.

While quarterly measurement of groundwater levels aids in assessing the risk of seawater intrusion along the coast, the NCMA has installed transducers in 5 monitoring wells to provide continuous groundwater levels at key locations. By combining this with the collection and evaluation of daily municipal pumping data, the NCMA hopes to be able to determine the response of local groundwater levels to extractions and therefore better manage the basin.

In order to gain insight into water level fluctuation and water quality variation in the area between the NCMA and NMMA, a continuous monitor was installed in Well 32C03. Well 32C03 was constructed and is owned by the County of San Luis Obispo and is part of their county-wide groundwater monitoring network. Well 32C03 is completed to 170 feet with a screened interval from 90 to 170 below ground surface and is constructed of 5-inch diameter polyvinyl chloride (PVC) casing. To provide more detail regarding seasonal and other groundwater level changes in the area between the NCMA and NMMA, detailed water level monitoring was initiated in April 2012. Sensors were installed to document long- and short-term changes in water level, temperature and specific conductance. The results from detailed monitoring of Well 32C03 are provided in Figure 12f.

As a result of lowering of water levels during 2007 and 2008, the Northern Cities reduced pumping from the basin and requested increased SWP deliveries. This response has allowed groundwater levels to rise to a level apparently sufficient to prevent seawater intrusion (see Section 4.2 of this report).

### *6.1.4 Protect Groundwater Quality*

The objective to protect groundwater quality is closely linked with the objective for monitoring and data sharing. To meet this objective all sources of water quality degradation, including the threat of seawater intrusion, need to be recognized. Water quality problems could affect the integrity of groundwater supplies, resulting in loss of use or expensive water treatment processes. Sentry wells are monitored quarterly and data from other NCMA production wells are assessed annually. The monitoring program includes evaluation of potential contaminants in addition to those that might indicate seawater intrusion. Temperature and electrical conductivity probes have been installed in 5 monitoring wells to provide continuous water quality tracking for early indication of seawater intrusion. For example, local nitrate and selenium concentrations in excess of primary drinking water standards have been addressed through actions such as provision of municipal water to private domestic users and through nitrate removal or blending to ensure that delivered water meets all drinking water standards. Additionally, the groundwater basin is being characterized in preparation for the possible development of a Salt and Nutrient Management Plan.

As discussed in Section 6.1, the NCMA has sought funding for several projects to further protect and enhance groundwater quality. These funding sources include:

- Local Groundwater Assistance Grant to develop a salt and nutrient management plan for the NCMA and NMMA.
- IRWM Planning grant funding to investigate alternatives for utilizing recycled water from the Pismo Beach and the South San Luis Obispo County wastewater treatment plants

The NCMA, through the County of San Luis, has received IRWM funding and will initiate the study in 2013. The NCMA continues to pursue the LGA grant.

### 6.1.5 Manage Cooperatively

Since 1983, NCMA management has been based on cooperative efforts of the affected parties themselves including the four Northern Cities with ongoing collaboration with San Luis Obispo County, the San Luis Obispo County FC&WCD, and other local and state agencies. Specifically the NCMA agencies have limited their pumping and, in cooperation with SLOFC&WCD, invested in surface water supplies so as to not exceed the safe yield of the NCMA of the SMGB. Other organizations participate as appropriate to the issues of the time. In addition to the efforts discussed in the report, cooperative management occurs through many means including communication by the Northern Cities in their respective public meetings and participation in the Water Resources Advisory Council (the County-wide advisory panel on water issues).

The NCMA agencies participated in preparation and adoption of the 2007 San Luis Obispo County Integrated Regional Water Management Plan (IRWMP). The IRWMP promotes integrated regional water management to ensure sustainable water uses, reliable water supplies, better water quality, environmental stewardship, efficient urban development, protection of agriculture, and a strong economy. The IRWMP integrates all of the programs, plans, and projects lead by entities within the region into water supply, water quality, ecosystem preservation and restoration, groundwater monitoring and management, and flood management programs. The County of San Luis received a grant from the California Department of Water Resources and the IRWM Plan is in the process of being revised and NCMA agencies are participating.

In 2012 the NCMA took the lead in managing cooperatively within its own management area but also within the Santa Maria Groundwater Basin as a whole. The NCMA Technical Group met monthly throughout the year. The group also took the lead in meeting twice with the NMMA group and brought the SMVMA group into the final meeting for 2012. The coordination among the management areas is leading to joint projects such as enhanced monitoring of groundwater levels.

The NCMA meetings also provide for collaborative development of joint budget proposals for studies and plans as well as shared water resources (as discussed in Section 6.1.1 and 6.1.4). In addition, the monthly meetings provide a forum for discussing the data collected as part of the quarterly monitoring reports (as discussed in Sections 6.1.2 and 6.1.3).

Other water supply planning and management activities in 2012 included ongoing recharge using storm water detention ponds, and implementation of additional water conservation measures, and ongoing studies to acquire new water supply sources. Pursuant to State law, three of the NCMA members prepared and are now implementing Urban Water Management Plans that document current supply and demand as well as project future supply and demand. In addition, Oceano CSD is in the process of completing its Water and Sewer Master Plan that details their water system and provides water shortage contingency plans.

**Storm Water Ponds**
Arroyo Grande and Grover Beach each maintain storm water retention ponds. The SLOFC&WCD maintains the storm water system, including retention ponds, in Oceano. These ponds collect storm water runoff, allowing it to recharge the underlying aquifers. There are approximately 140 acres and 48 acres of detention ponds in Arroyo Grande and Grover Beach, respectively. The existing storm water detention pond in Oceano CSD is approximately half an acre. Grover Beach recently modified its storm water system to direct additional flow into one of its recharge basins. San Luis Obispo County is currently evaluating creation of a 50-acre storm water detention pond near the Oceano Airport. This pond would also create an opportunity for recharge to the groundwater basin. The *Oceano Drainage and Flood Control Study* documents the need for such a pond and identifies the steps required to implement the facility.

### 6.1.6 Encourage Water Conservation

Water conservation, or water use efficiency, is linked to the monitoring of supply and demand and the management of pumping. Water conservation would reduce overall demand on all sources, including groundwater, and support management objectives to manage groundwater levels and prevent seawater intrusion. In addition water conservation is consistent with State policies seeking to achieve significant water use reductions by the year 2020. Water conservation activities in the NCMA are summarized in various documents produced by the Northern Cities, including the 2010 Urban Water Management Plans of Arroyo Grande, Grover Beach, and Pismo Beach. Due to its size, the OCSD is not required to reduce water consumption by 20% by 2020; however the OCSD encourages water conservation and the installation of low flow fixtures.

#### 6.1.6.1 Existing Water Conservation Programs

The Northern Cities implement water conservation activities to reduce water use and thus reduce groundwater demand. The Cities participate in a wide range of water conservation activities designed to educate the public on ways to reduce water use.

**City of Arroyo Grande**

The City of Arroyo Grande supports a part time water conservation coordinator staff position to manage existing conservation activities, encourage public participation, and create new conservation programs for the community. In the last eight years, Arroyo Grande spent over $1,000,000 on water conservation efforts. Arroyo Grande is implementing the following water Demand Management Measures (DMMs):

- Water Survey Programs (Equivalent program elements)
- Residential Plumbing Retrofits
- Water System Audits
- Metering with Commodity Rates
- Large Landscape Irrigation Programs
- High-efficiency washing machine rebate programs
- Public information programs.
- School education programs.
- Conservation programs for commercial and institutional accounts.
- Conservation pricing.
- Water conservation coordinator.
- Water waste prohibition.
- Residential ultra-low-flush toilet replacement programs.
- Cash for Grass

The water conservation efforts of Arroyo Grande have been very successful to date; the DMMs that have been implemented have decreased water use per residential connection from 190 gpcd to 160 gpcd. The target per capita usage for 2015 is 167 gpcd, while the target per capita usage for 2020 is 149 gpcd. Continued implementation of these DMMs will help Arroyo Grande to reach its per capita water use goals and indicates the commitment Arroyo Grande has to optimizing use of its water supply.

**City of Pismo Beach**

The City of Pismo Beach is a member of the California Urban Water Conservation Council, and as such has developed best management practices (BMPs) to reduce water consumption and ensure reliable future water supply. Included in BMPs implemented by Pismo Beach are activities and programs that promote water conservation and sustainable use of water resources. BMPs that Pismo Beach is implementing or has equivalent coverage for are:

- Water Survey Programs
- Residential Plumbing Retrofit
- Water System Audits
- Metering with Commodity Rates
- Landscape Irrigation Programs
- Conservation Pricing
- Water Conservation Coordinator
- Ultra Low Flush Toilet Replacement

The water conservation efforts of Pismo Beach have helped reduce residential water use from a high of 256 gpcd in 2007, to 226 gpcd in 2010. The 10-year baseline average water use is 236 gpcd. Continued implementation of these BMPs and implementation of other BMPs in the future will help Pismo Beach reach its per capita water use goals and indicates the commitment of Pismo Beach to optimizing use of its water supply. The target water use for 2015 is 214 gpcd, while the target water use for 2020 is 192 gpcd.

**City of Grover Beach**

As described in their 2010 Urban Water Plan, Grover Beach has developed and implemented Demand Management Measures to reduce water consumption and ensure reliable future water supply. Included in the DMMs implemented by the Grover Beach are activities and programs that promote water conservation and sustainable use of water resources. DMMs that Grover Beach is implementing or has equivalent coverage are:

- Water survey programs for single-family residential and multifamily residential customers
- Residential plumbing retrofit
- System water audits, leak detection, and repair
- Metering with commodity rates for all new connections and retrofit of existing connections
- Large landscape conservation programs and incentives
- High-efficiency washing machine rebate programs
- Public information programs
- School education programs
- Conservation programs for commercial, industrial, and institutional accounts
- Conservation pricing
- Water conservation coordinator
- Water waste prohibition
- Residential ultra-low-flush toilet replacement programs

Grover Beach has implemented or is planning to implement all applicable demand management measures as part of the Water Conservation Program. The ongoing water conservation activities of Grover Beach include a "Cash for Grass" rebate, a water-efficient washing machine rebate program, and smart irrigation controller and sensor rebate program. The 10-year baseline average water use for Grover Beach is 140.7 gpcd. The target water use for 2015 is 127 gpcd, while the target water use for 2020 is 113 gpcd.

### *6.1.7 Evaluate Alternative Sources of Supply*

The Northern Cities continue to evaluate alternative sources of water supply which could provide a more reliable and sustainable water supply for the NCMA. An expanded portfolio of water supply sources will support sustainable management of the groundwater resource and help to reduce the risk of water shortages. These alternative sources include:

**State Water Project**

Oceano CSD and Pismo Beach are currently SWP customers and could use additional water immediately. Pismo Beach has increased its SWP allocation by securing a "drought buffer" to increase the availability os supply during periods of SWP shortfalls. Grover Beach and Arroyo Grande are not SWP customers. While it is possible that a long term allocation to any of the 4 communities could be evaluated based on existing SLOFC&WCD allotment from the SWP, the availability of surplus water from Lopez Lake obviates the need for additional SWP water in the foreseeable future..

**Water Recycling**

In 2010, the South San Luis Obispo County Sanitation District (SSLOCSD) updated their 2001 evaluation of recycled water opportunities. The new evaluation included an evaluation of using disinfected secondary treated water to irrigate landscaping and the potential use of recycled water if the SSLOCSD Waste Water Treatment Plant were upgraded to provide tertiary treatment. By providing tertiary treatment up to 189 AFY of potential demand could be satisfied.

The City of Pismo Beach also has evaluated use of recycled water. As described in their 2010 UWMP, "*the City may begin regional planning efforts regarding recycled water within the next five years*". The City of Pismo Beach is considering plans to upgrade its waste water treatment plant to provide an anticipated recycled water supply of up to an estimated 1,558 AFY in 2015. This estimate provides an idea of the amount of recycled water that could be available. The City of Pismo Beach UWMP anticipates that the recycled water not used for irrigation near the WWTP and in the Price Canyon development area *"may be applied towards groundwater recharge operations*."

New funding through the county IRWM Plan update will allow additional progress in water recycling in the NCMA.

**Lopez Lake Expansion**

In 2008, San Luis Obispo County sponsored a preliminary assessment of the concept of installing an inflatable rubber dam at the Lopez Dam spillway. Subsequently, the San Luis Obispo County FC&WCD Service Area 12 and the Cities of Arroyo Grande, Grover Beach and Pismo Beach funded a study to further analyze the feasibility of increasing the yield of Lopez Lake by raising the spillway height with an inflatable dam or permanent extension. The study was finalized in 2013 and identified the potential to increase the annual yield from the lake by 500 AFY with a spillway height increase by 6 ft (Stetson 2013). The NCMA agencies are continuing to evaluate other aspects of the project, including: pipeline capacity and impacts on the HCP process. (Stetson Engineers. 2013).

**Desalination**

In 2006, Arroyo Grande, Grover Beach, and Oceano CSD utilized Prop 50 funds to complete a feasibility study on desalination as an additional water supply option for the NCMA. This alternative supply is not considered to be a viable option at this time.

**Nacimiento Pipeline Extension**

In 2006, Arroyo Grande, Grover Beach, and Oceano CSD completed a Nacimiento pipeline extension evaluation to determine the feasibility of delivery water from the Nacimiento reservoir to the NCMA. This alternative supply is not considered to be a viable option at this time.

### *6.1.8 Other Potential Management Objectives*

Based on information developed in preparation of this Annual Report and other management activities (discussed in Section 6.2), it may be appropriate to develop other management objectives to address:

- Optimizing sources to best provide for prolonged droughts (Todd Engineers 2007)
- Optimizing location and rate of groundwater pumping to protect groundwater quality (Todd Engineers 2007)
- Assessing basin response to recharge and use based on drought cycles and sea level rise
- Develop a Salt and Nutrient Management Plan
- Compile data and develop a conceptual framework for a groundwater basin model

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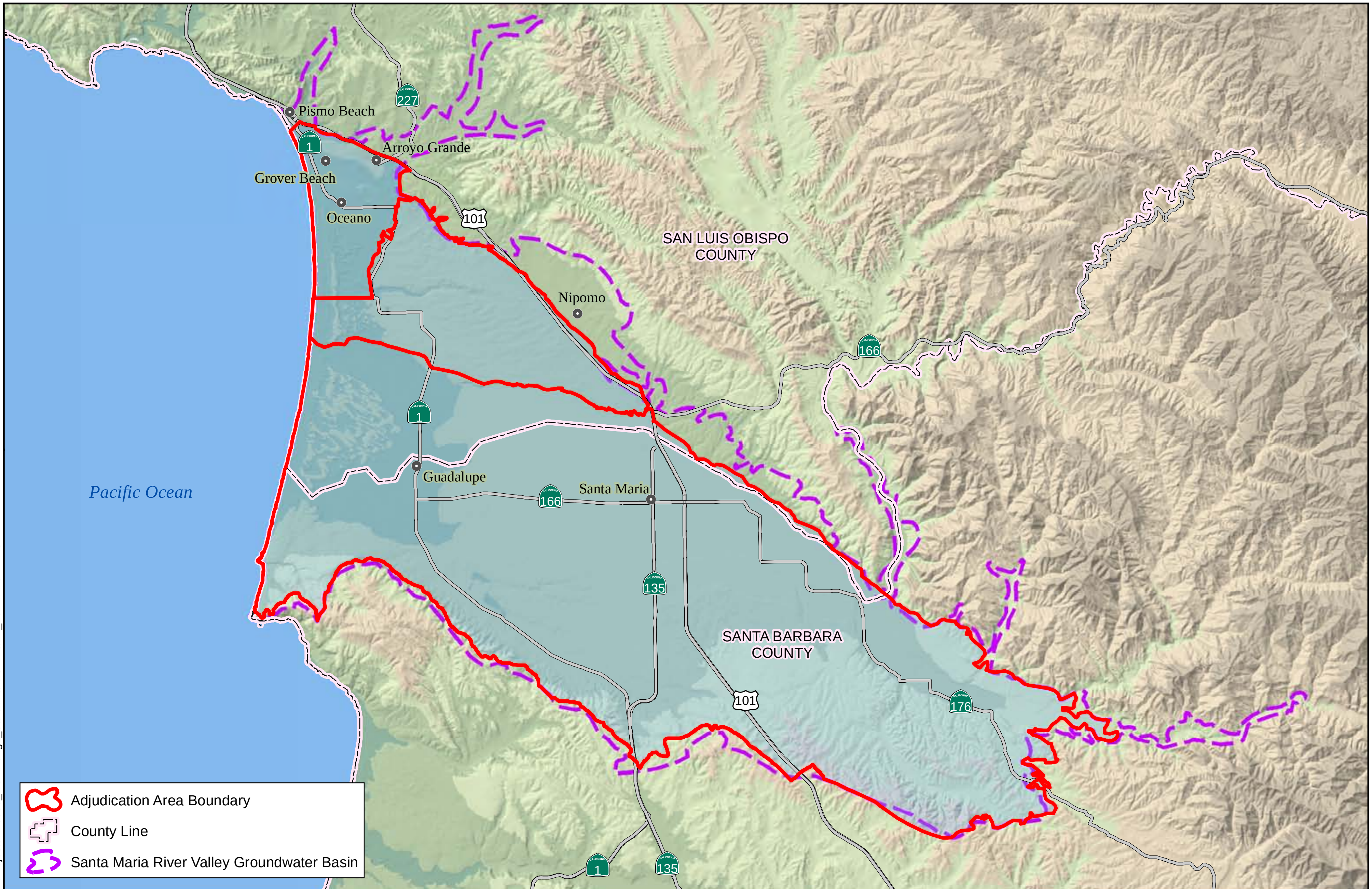
# 8 Figures

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25-Jan-2013

2012 Annual Monitoring Report
San Luis Obispo and Santa Barbara Counties

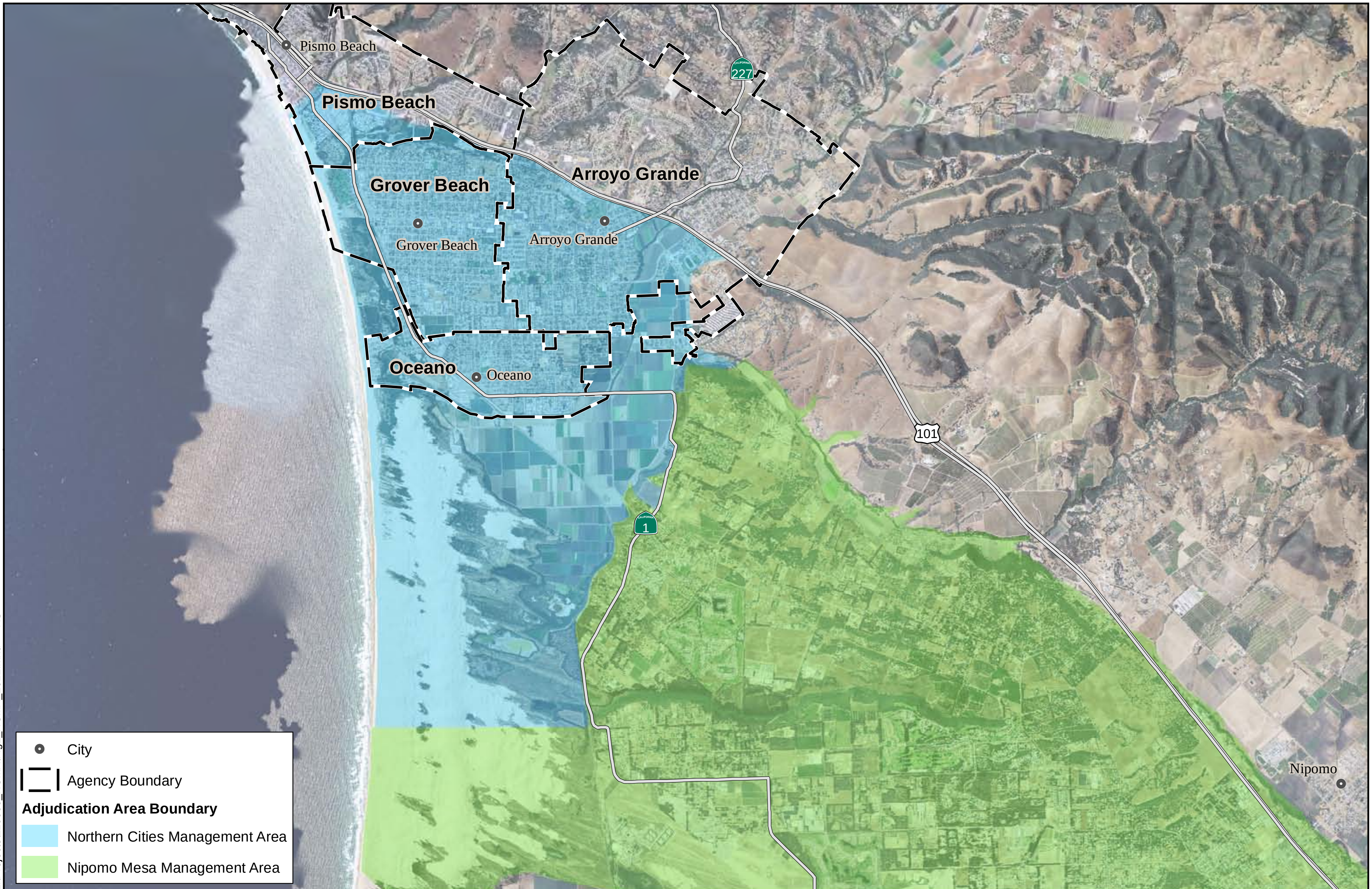
Northern Cities Management Area

GEI Consultants
Bookman-Edmonston Division

SANTA MARIA RIVER VALLEY
GROUNDWATER BASIN

APRIL 2013

FIGURE 1

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2012 Annual Monitoring Report
San Luis Obispo County

Northern Cities Management Area

GEI Consultants
Bookman-Edmonston Division

NORTHERN CITIES MANAGEMENT AREA

APRIL 2013

FIGURE 2

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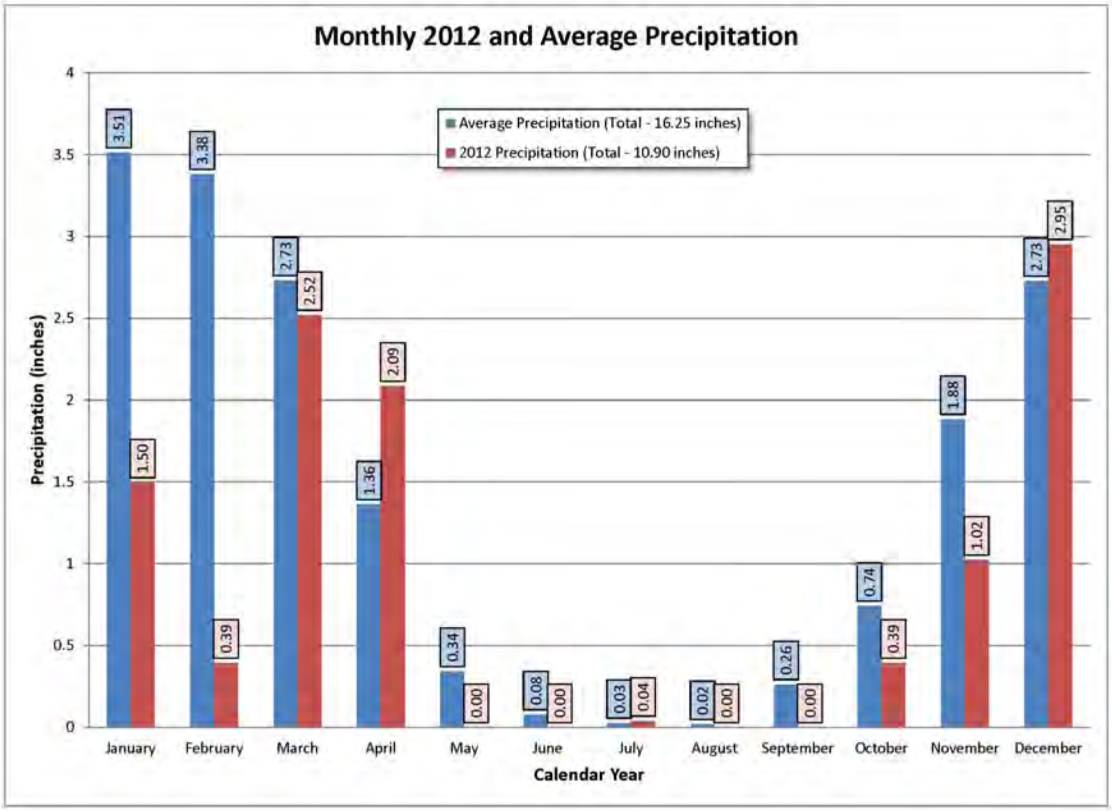
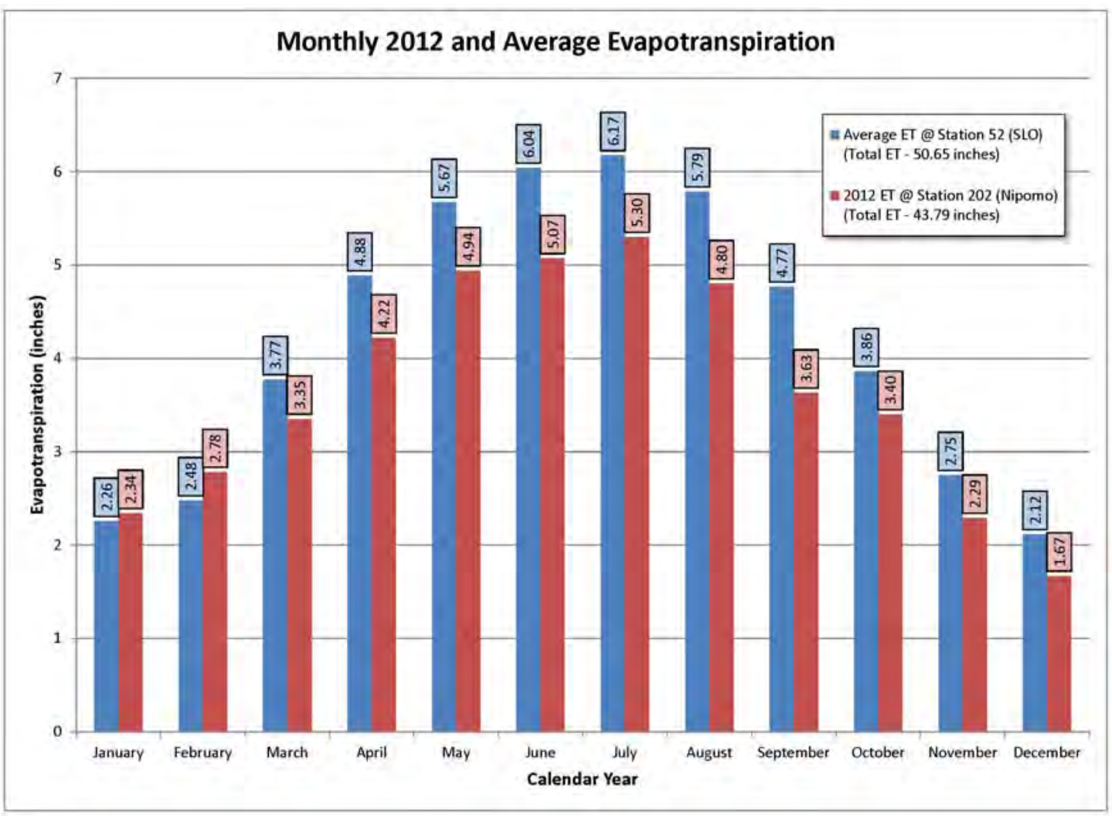
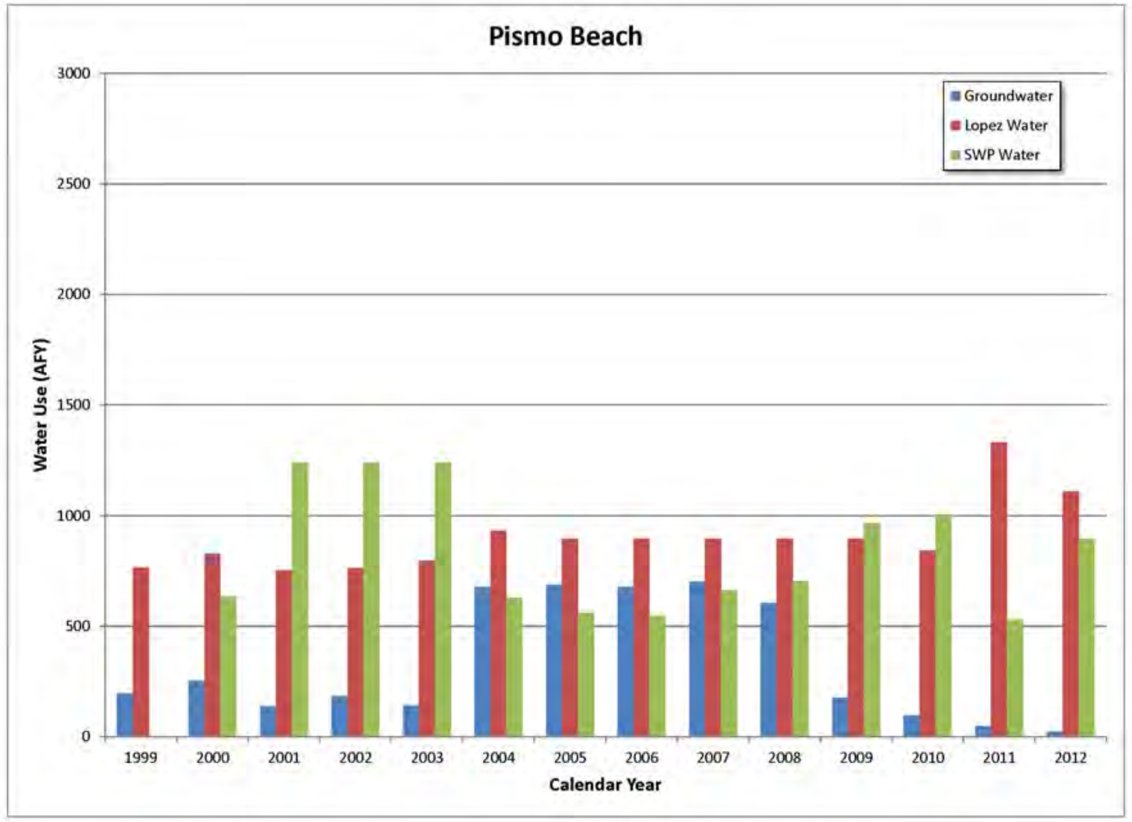
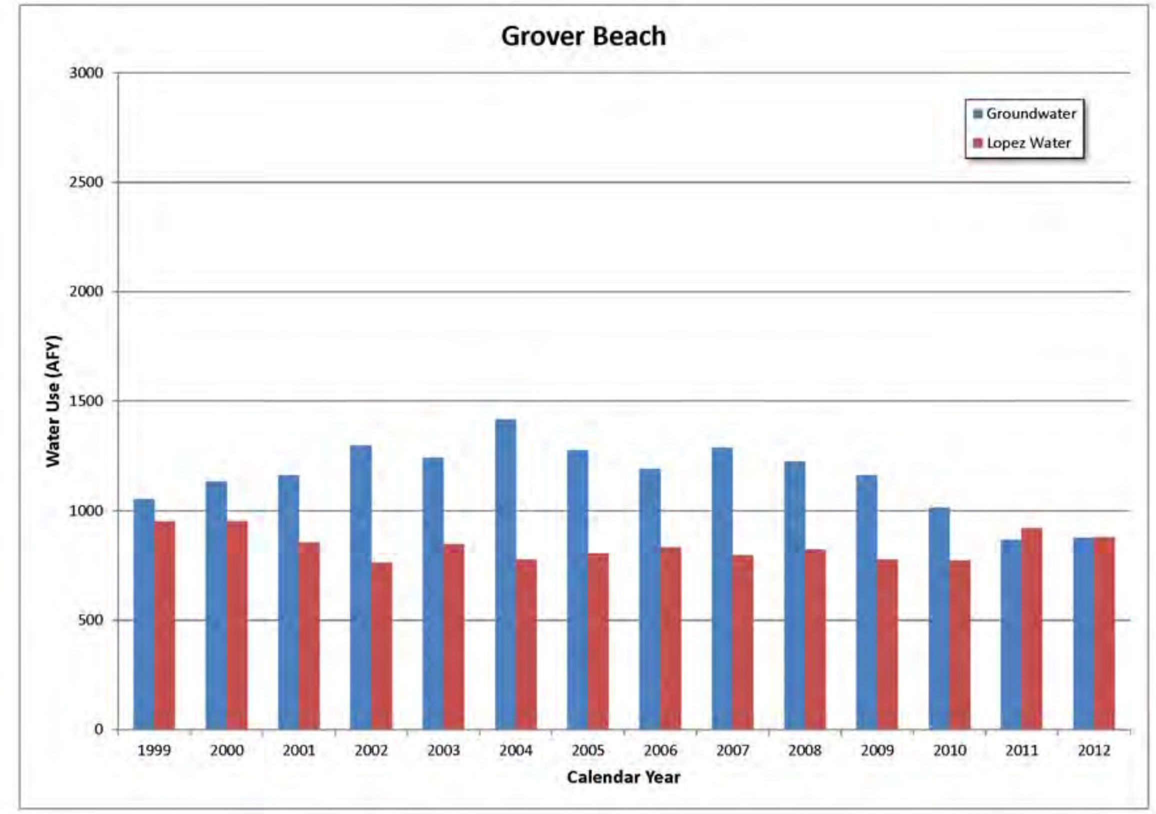
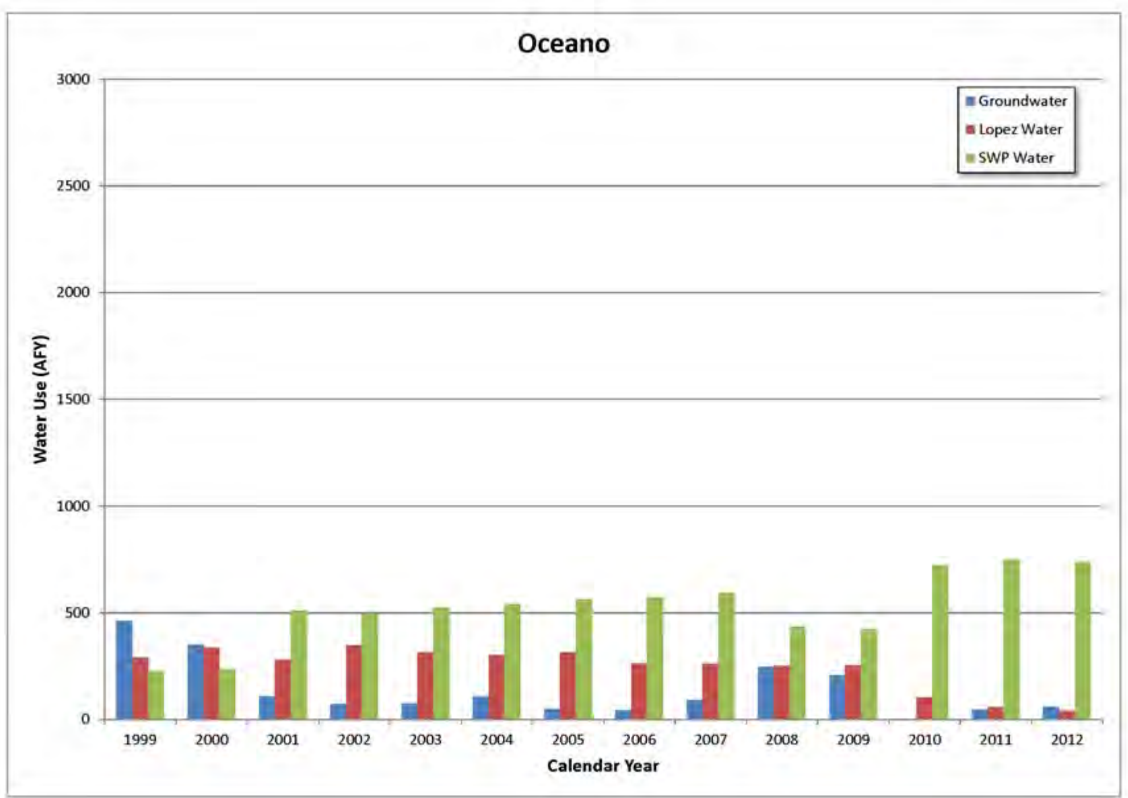
25-Jan-2013

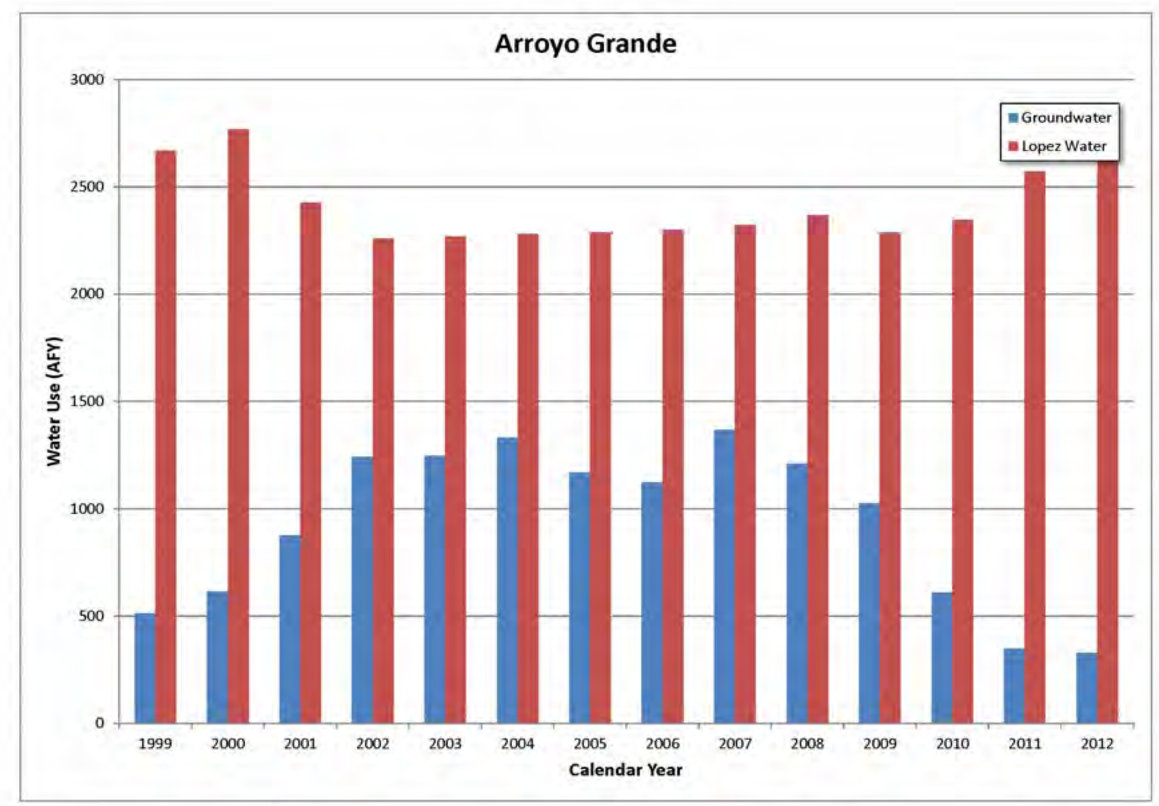

Monthly 2012 and Average Precipitation
Average Precipitation (Total - 16.25 inches)
2012 Precipitation (Total - 10.90 inches)
Precipitation (inches)
Calendar Year
January
February
March
April
May
June
July
August
September
October
November
December
3.51
1.50
3.38
0.39
2.73
2.52
1.36
2.09
0.34
0.00
0.08
0.00
0.03
0.04
0.02
0.00
0.26
0.00
0.74
0.39
1.88
1.02
2.73
2.95

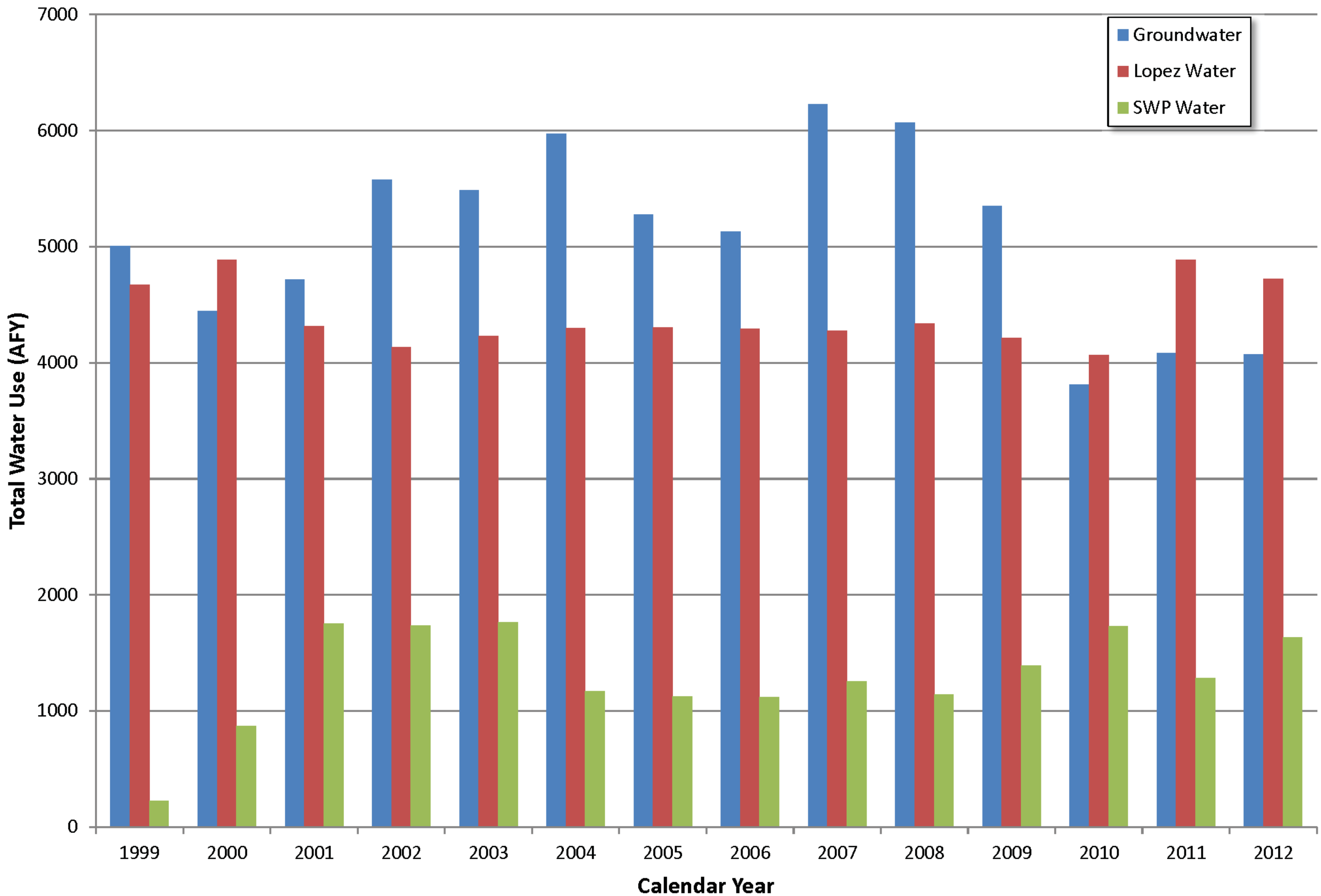

Monthly 2012 and Average Evapotranspiration
Average ET @ Station 52 (SLO) (Total ET - 50.65 inches)
2012 ET @ Station 202 (Nipomo) (Total ET - 43.79 inches)
Evapotranspiration (inches)
Calendar Year
January
February
March
April
May
June
July
August
September
October
November
December
2.26
2.34
2.48
2.78
3.77
3.35
4.88
4.22
5.67
4.94
6.04
5.07
6.17
5.30
5.79
4.80
4.77
3.63
3.86
3.40
2.75
2.29
2.12
1.67


Pismo Beach
Groundwater
Lopez Water
SWP Water
Water Use (AFY)
Calendar Year
0
500
1000
1500
2000
2500
3000
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012


Grover Beach
Groundwater
Lopez Water
Water Use (AFY)
Calendar Year
0
500
1000
1500
2000
2500
3000
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012


Oceano
Groundwater
Lopez Water
SWP Water
Water Use (AFY)
Calendar Year
0
500
1000
1500
2000
2500
3000
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012


Arroyo Grande
Groundwater
Lopez Water
Water Use (AFY)
Calendar Year
0
500
1000
1500
2000
2500
3000
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012

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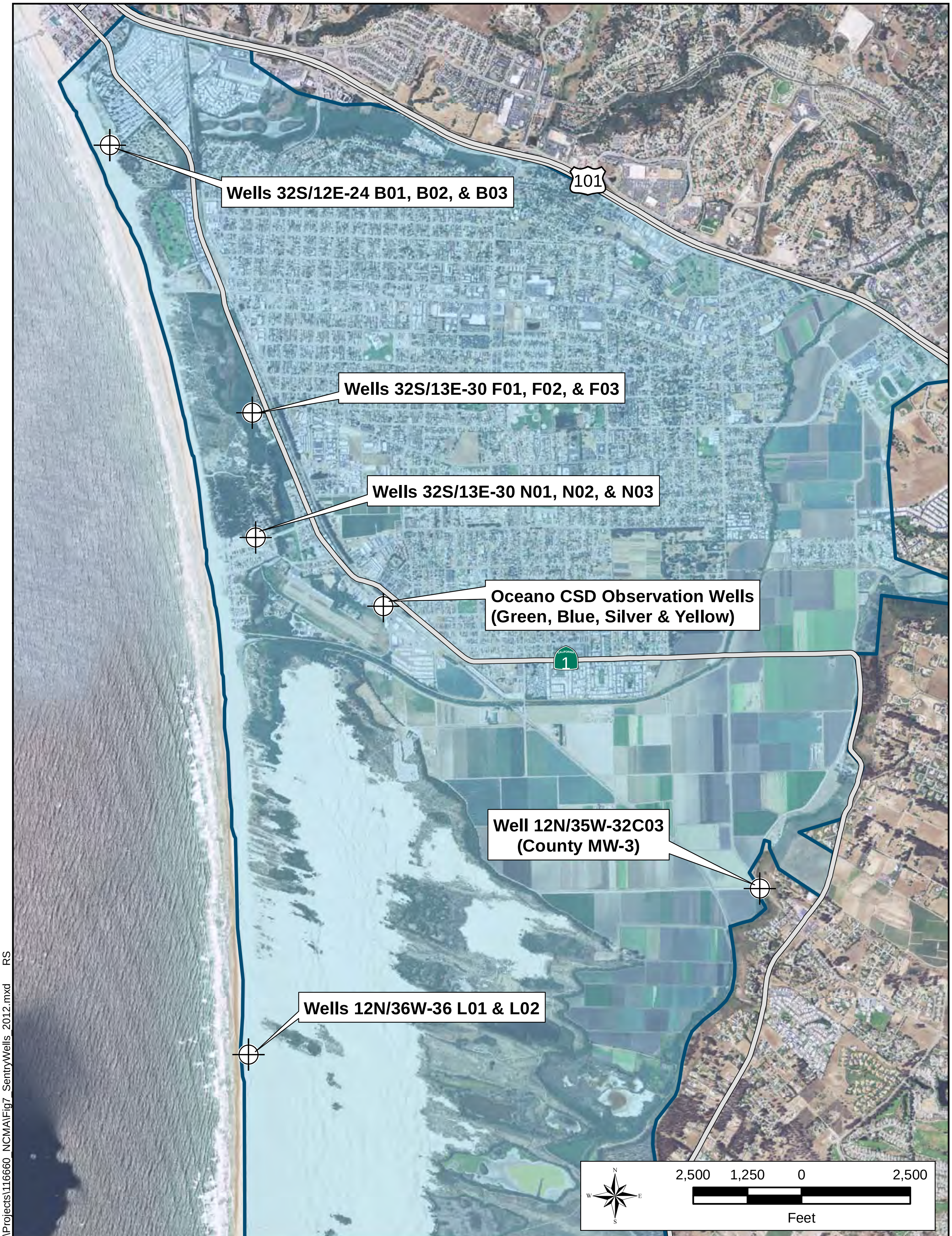
|---|---|---|
| 2012 Annual Monitoring Report | GEI Consultants | Total Water Use By Source |
| Northern Cities Management Area | | February 2013 Figure 6 |

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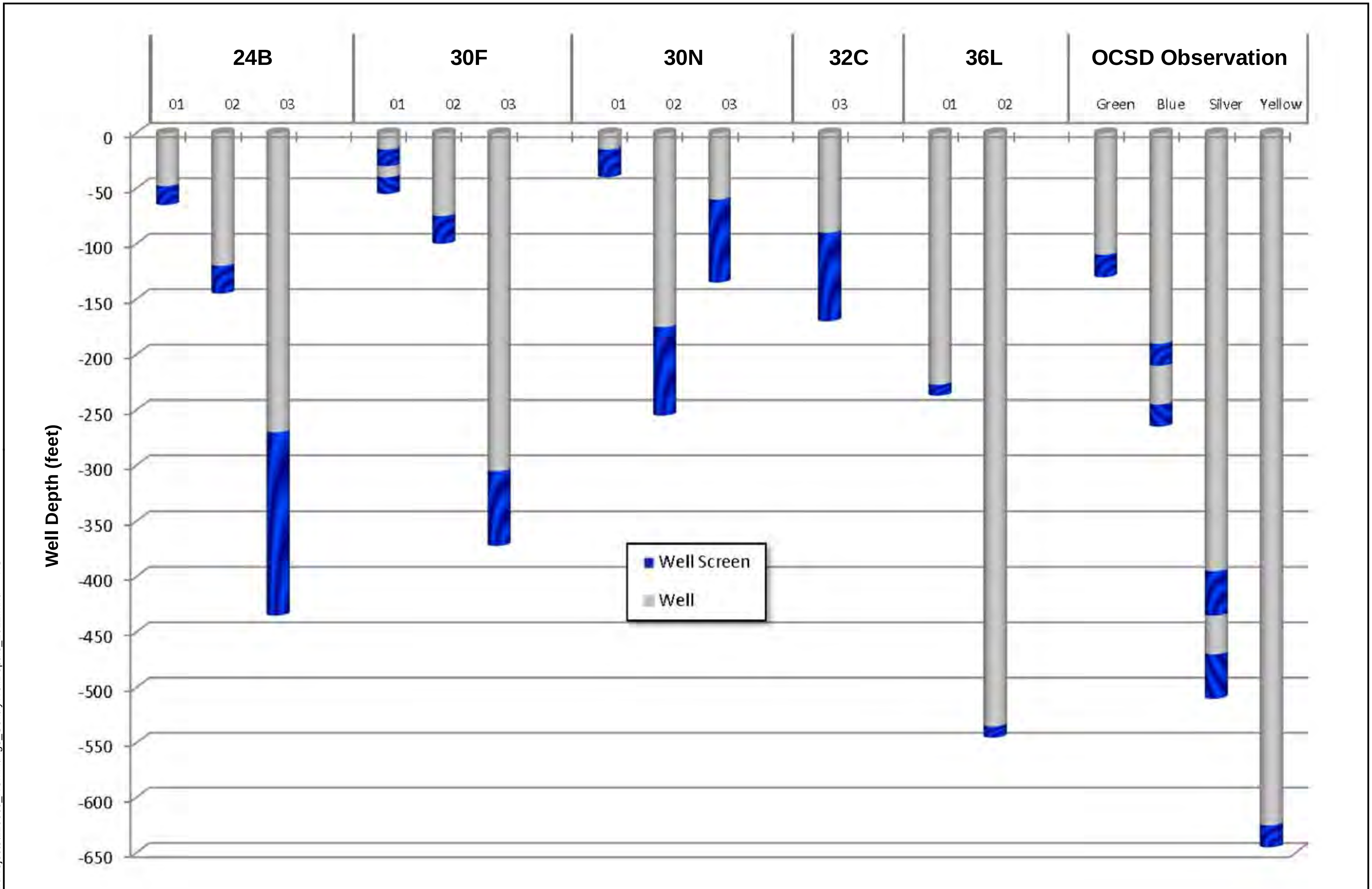
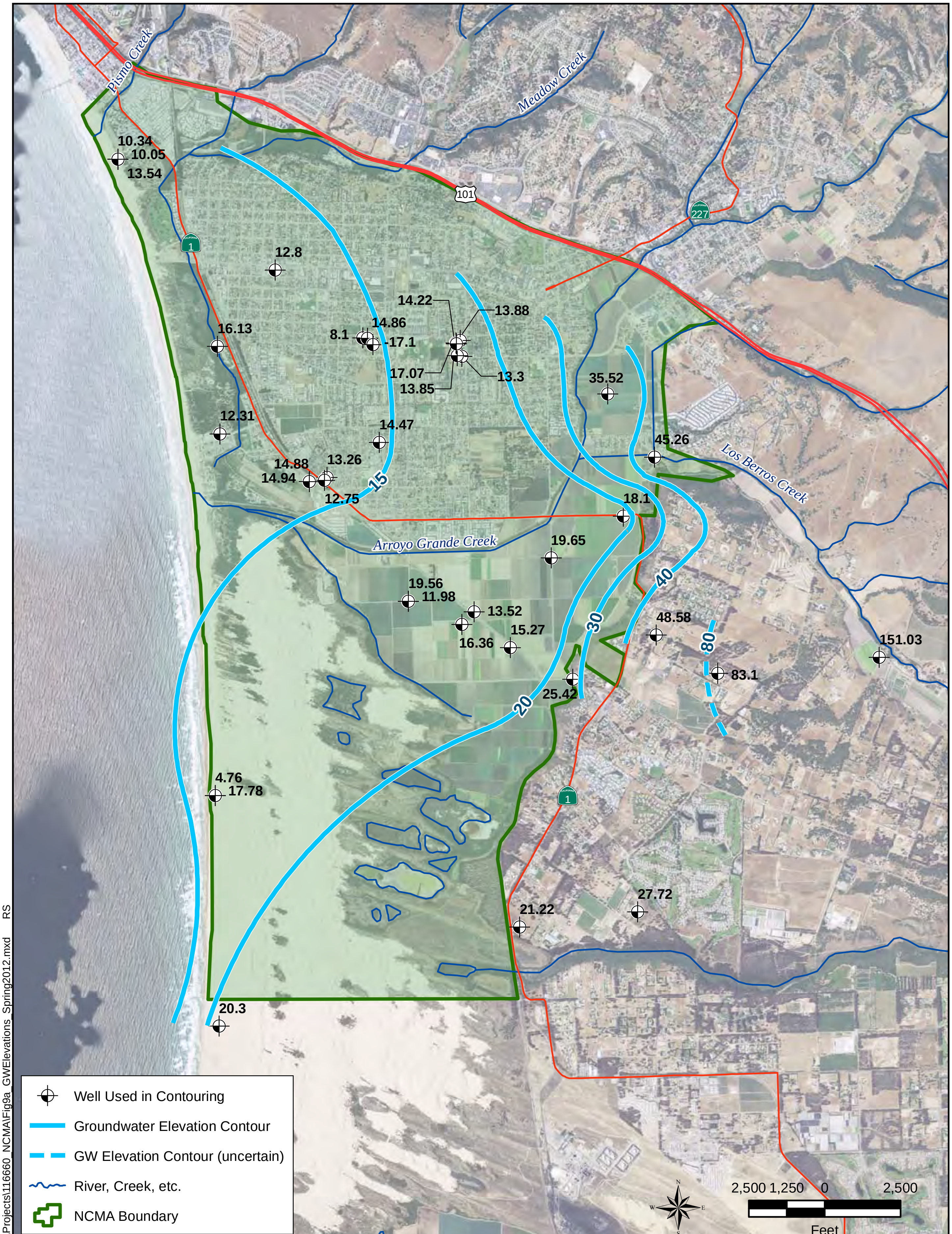
25-Jan-2013

| | | |
|---|---|---|
| 2012 Annual Monitoring Report<br>San Luis Obispo County | GEI Consultants<br>Bookman-Edmonston Division | Location of Sentry Wells |
| Northern Cities Management Area | | APRIL 2013 FIGURE 7 |




| 2012 Annual Monitoring Report<br>San Luis Obispo County | GEI Consultants | DEPTHS OF SENTRY WELLS |
|---|---|---|
| Northern Cities Management Area | | APRIL 2013 FIGURE 8 |

Z:\Projects\116660_NCMA\Fig8_SentryWellDepths_2012.mxd RS
11-Dec-2012

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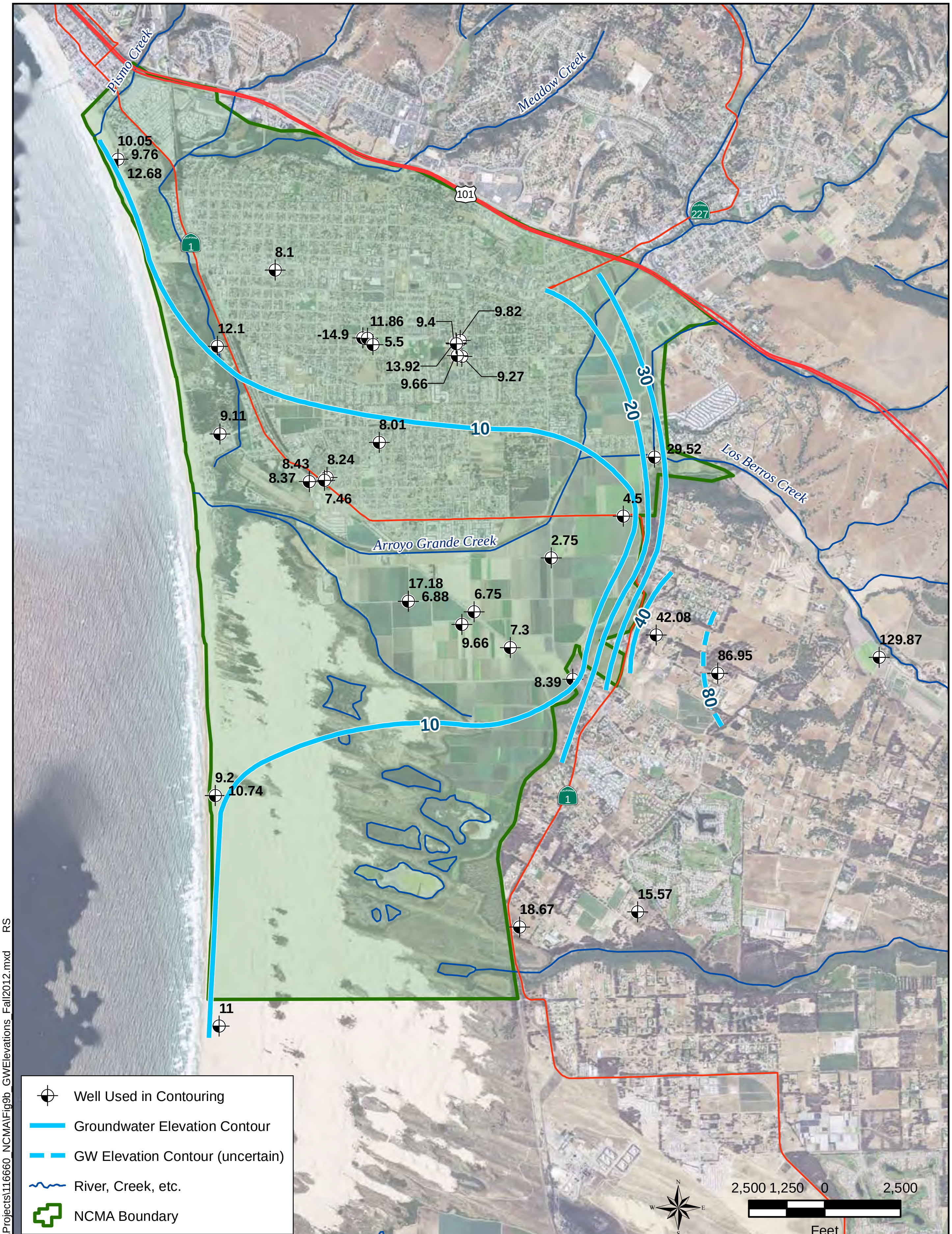
22-Apr-2013

| 2012 Annual Monitoring Report | GEI Consultants Bookman-Edmonston Division | Groundwater Elevation Contours Spring 2012 |
|---|---|---|
| Northern Cities Management Area | | APRIL 2013 FIGURE 9A |

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22-Apr-2013

2012 Annual Monitoring Report

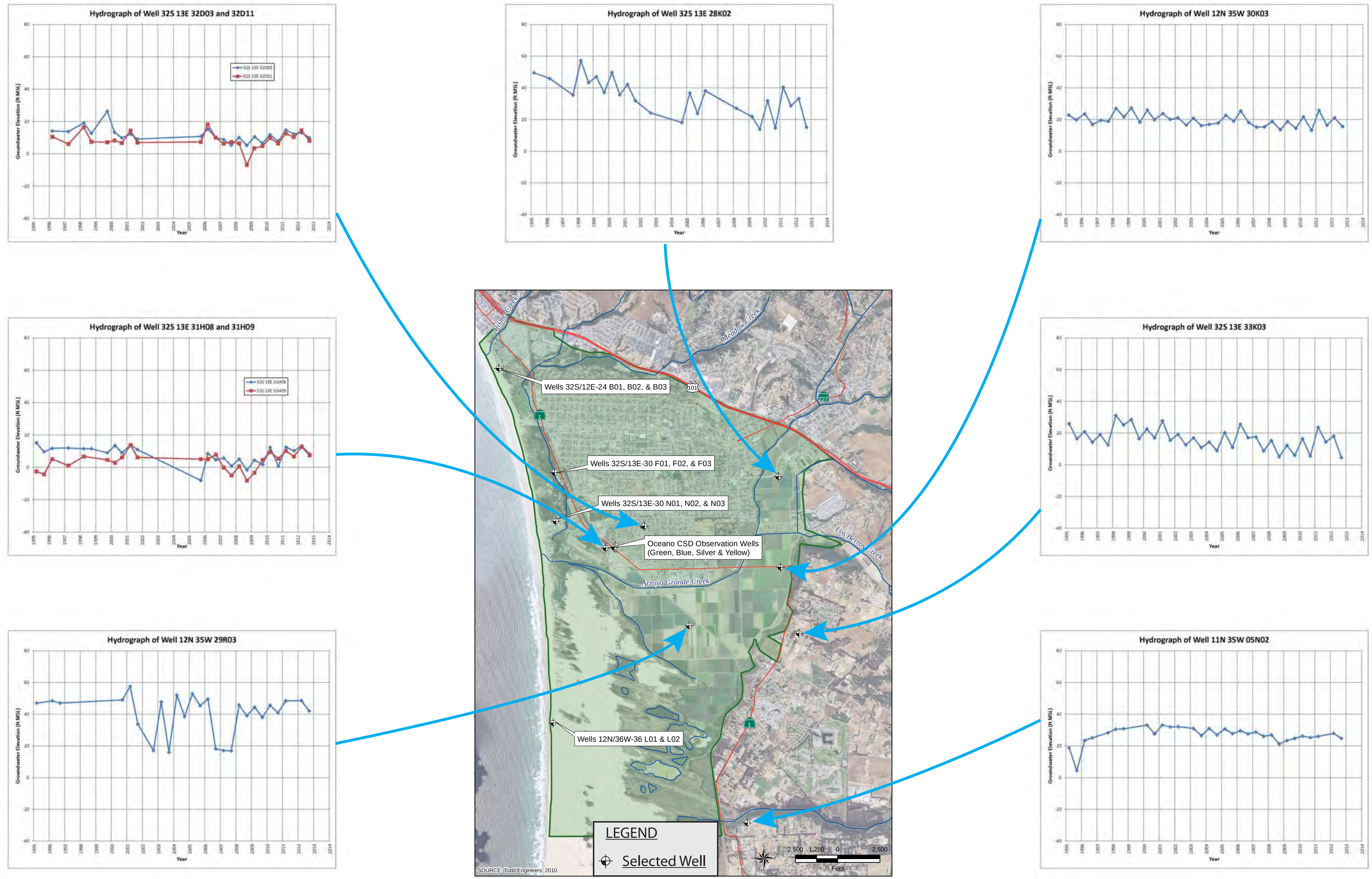
Northern Cities Management Area

GEI Consultants Bookman-Edmonston Division

Groundwater Elevation Contours
Fall 2012

APRIL 2013

FIGURE 9B

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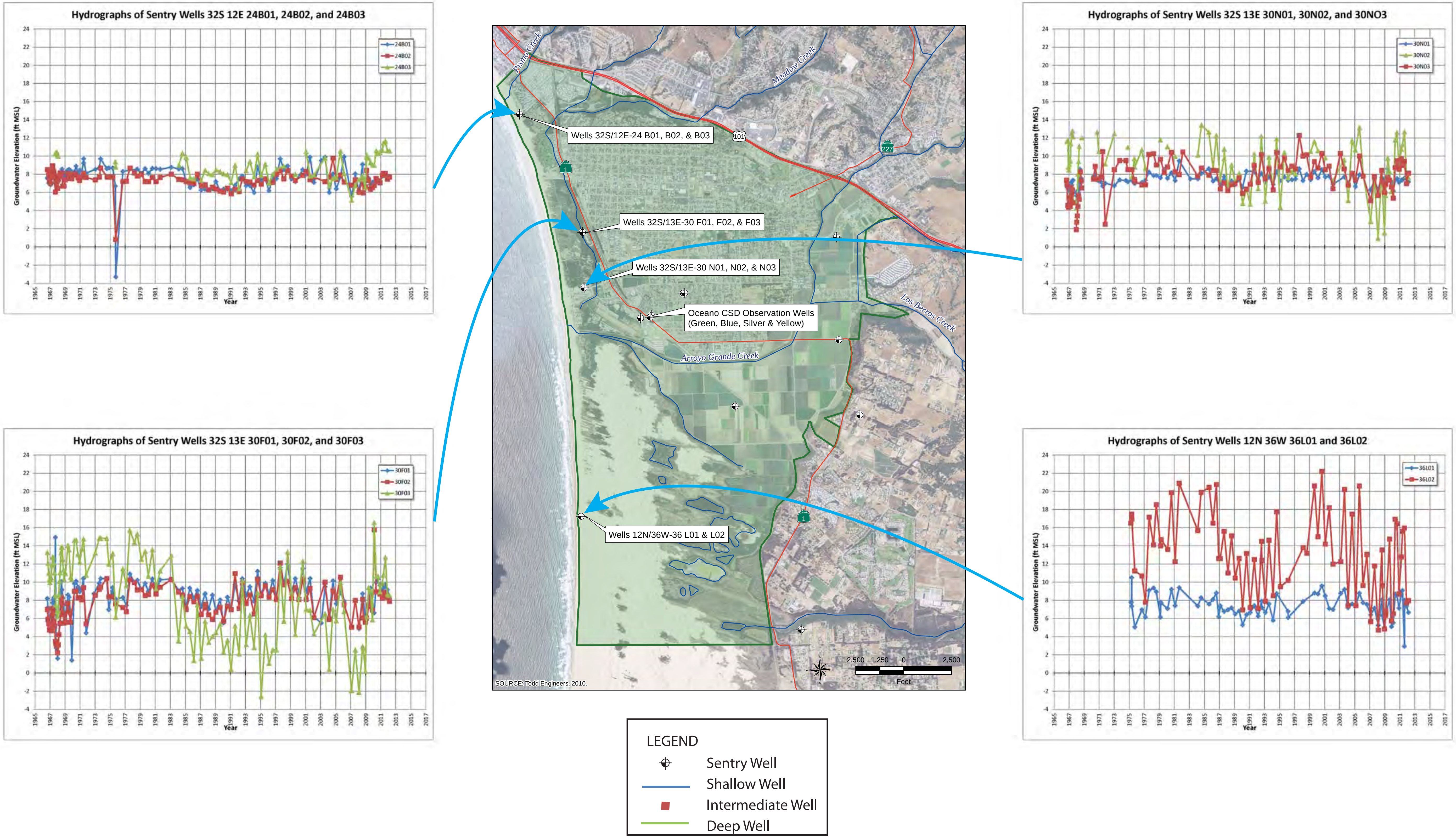
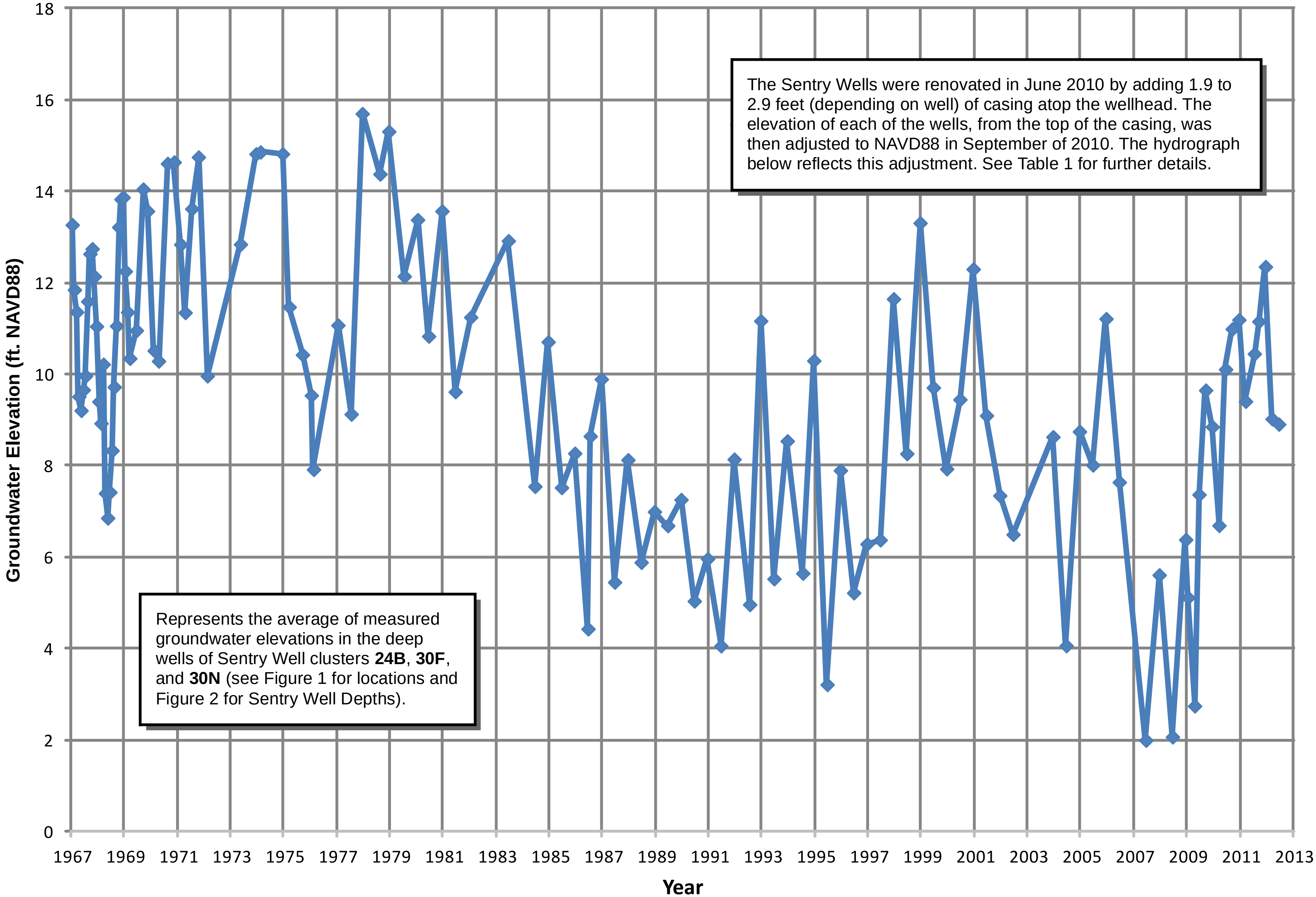
|---|---|---|
| 2012 Annual Monitoring Report | GEI Consultants | Selected Well Hydrographs |
| Northern Cities Management Area | | February 2013 — Figure 10 |



Hydrographs of Sentry Wells 32S 12E 24B01, 24B02, and 24B03
24B01
24B02
24B03
Groundwater Elevation (ft MSL)
Year
Hydrographs of Sentry Wells 32S 13E 30N01, 30N02, and 30NO3
30N01
30N02
30N03
Groundwater Elevation (ft MSL)
Year
Hydrographs of Sentry Wells 32S 13E 30F01, 30F02, and 30F03
30F01
30F02
30F03
Groundwater Elevation (ft MSL)
Year
Hydrographs of Sentry Wells 12N 36W 36L01 and 36L02
36L01
36L02
Groundwater Elevation (ft MSL)
Year
Pismo Creek
Meadow Creek
Wells 32S/12E-24 B01, B02, & B03
Wells 32S/13E-30 F01, F02, & F03
Wells 32S/13E-30 N01, N02, & N03
Oceano CSD Observation Wells
(Green, Blue, Silver & Yellow)
Los Berros Creek
Arroyo Grande Creek
Wells 12N/36W-36 L01 & L02
2,500 1,250 0 2,500
Feet
SOURCE: Todd Engineers, 2010.
LEGEND
Sentry Well
Shallow Well
Intermediate Well
Deep Well

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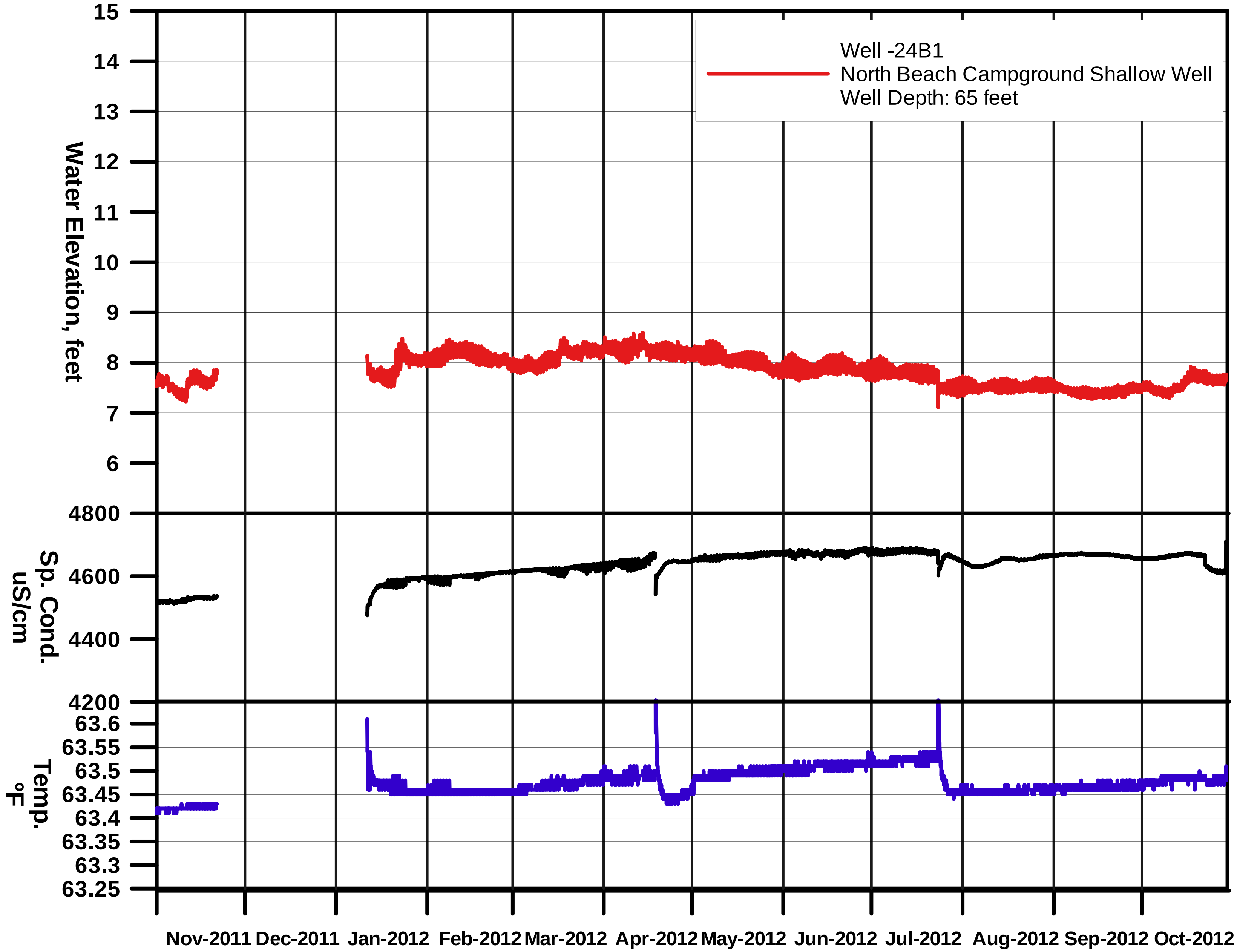
| 2012 Annual Monitoring Report<br>San Luis Obispo County | GEI Consultants | AVERAGE DEEP SENTRY WELL ELEVATIONS | |
|---|---|---|---|
| Northern Cities Management Area | | APRIL 2013 | FIGURE 12A |



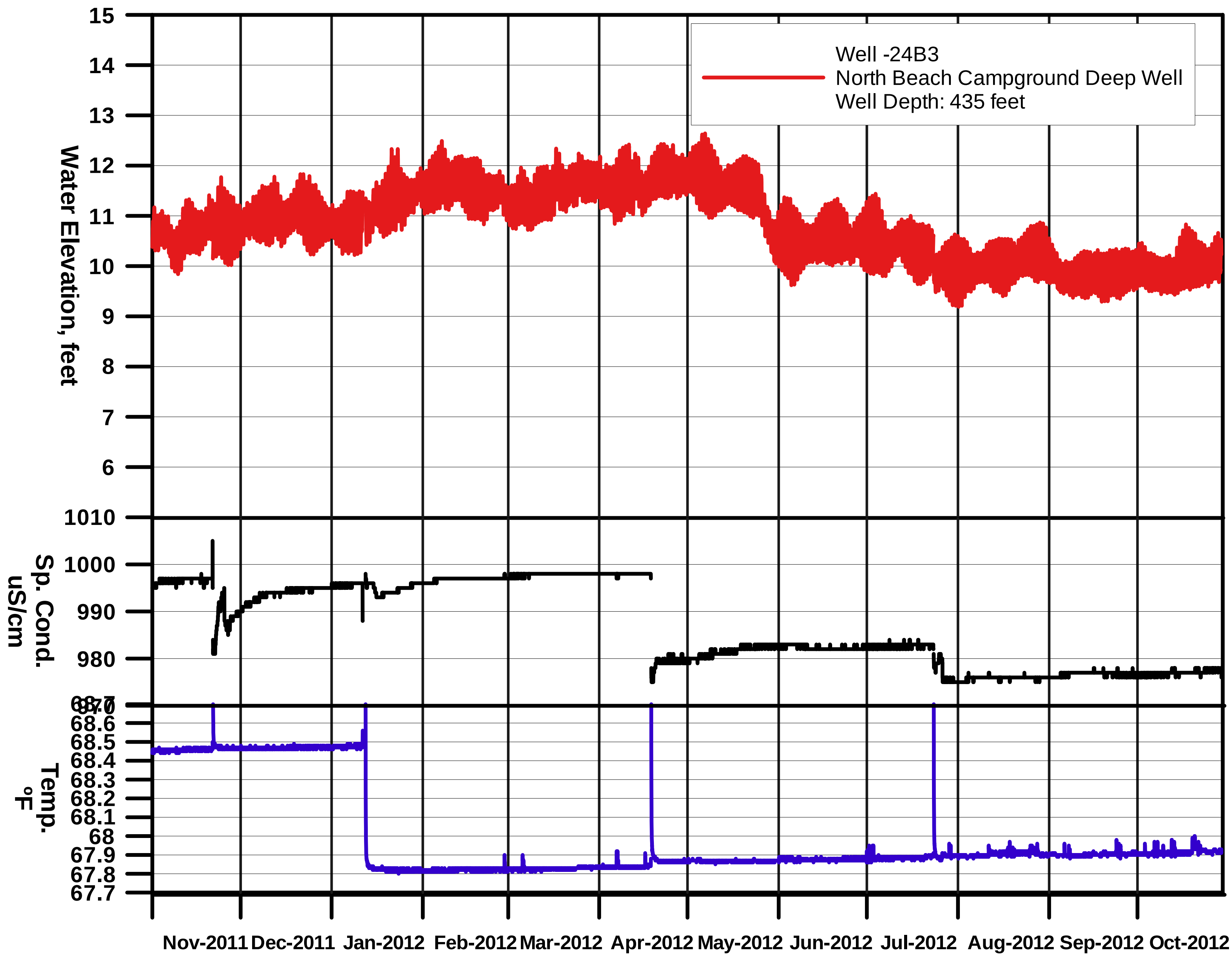

2012 Annual Monitoring Report

Northern Cities Management Area

WATER ELEVATION, CONDUCTIVITY, AND TEMPERATURE
WELL 24B01

APRIL 2013

Figure 12B

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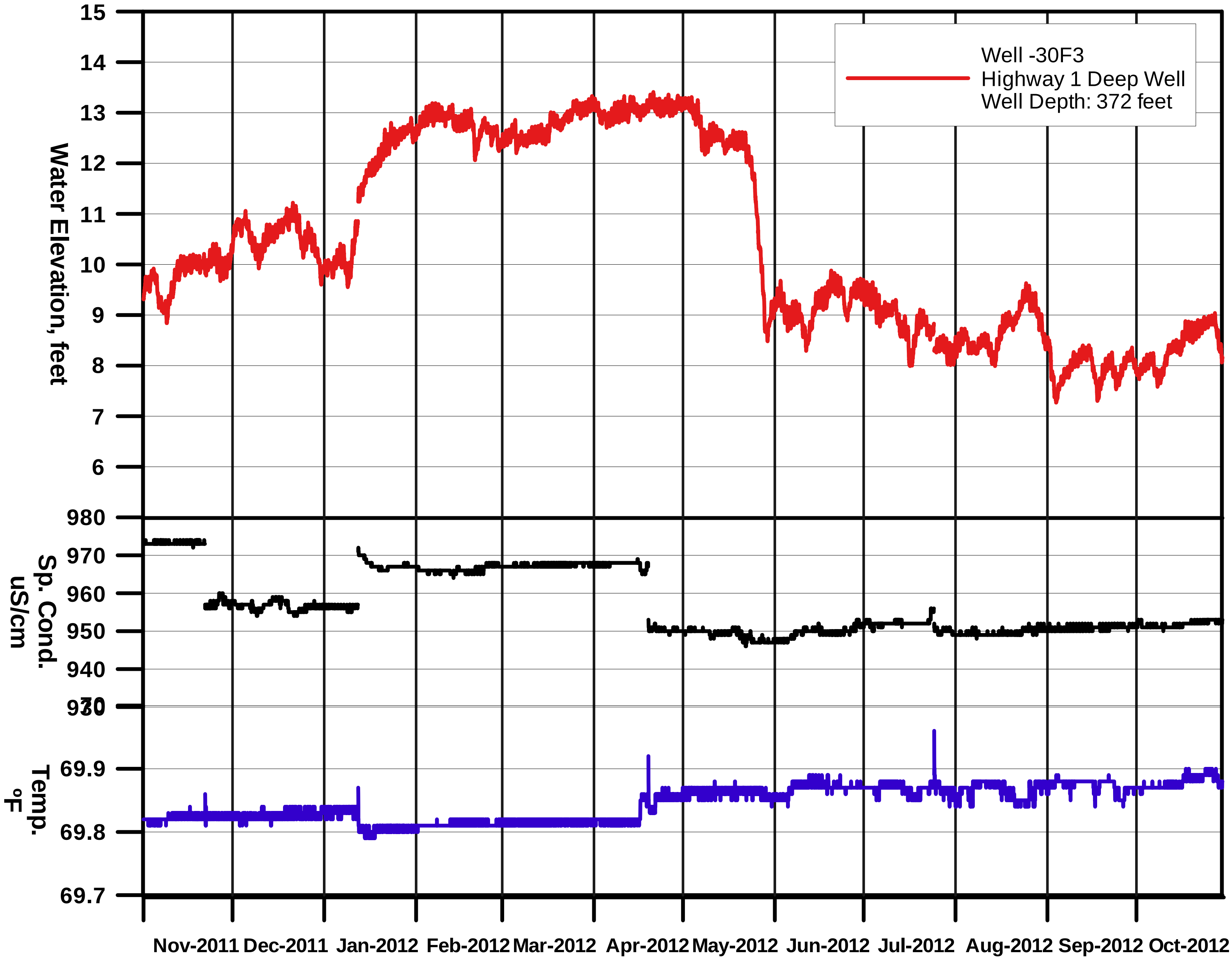
| 2012 Annual Monitoring Report | GEI Consultants | WATER ELEVATION, CONDUCTIVITY, AND TEMPERATURE WELL 24B03 | |
|---|---|---|---|
| Northern Cities Management Area | | APRIL 2013 | Figure 12C |




2012 Annual Monitoring Report

Northern Cities Management Area

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WATER ELEVATION, CONDUCTIVITY, AND TEMPERATURE
WELL 30F03

APRIL 2013

Figure 12D

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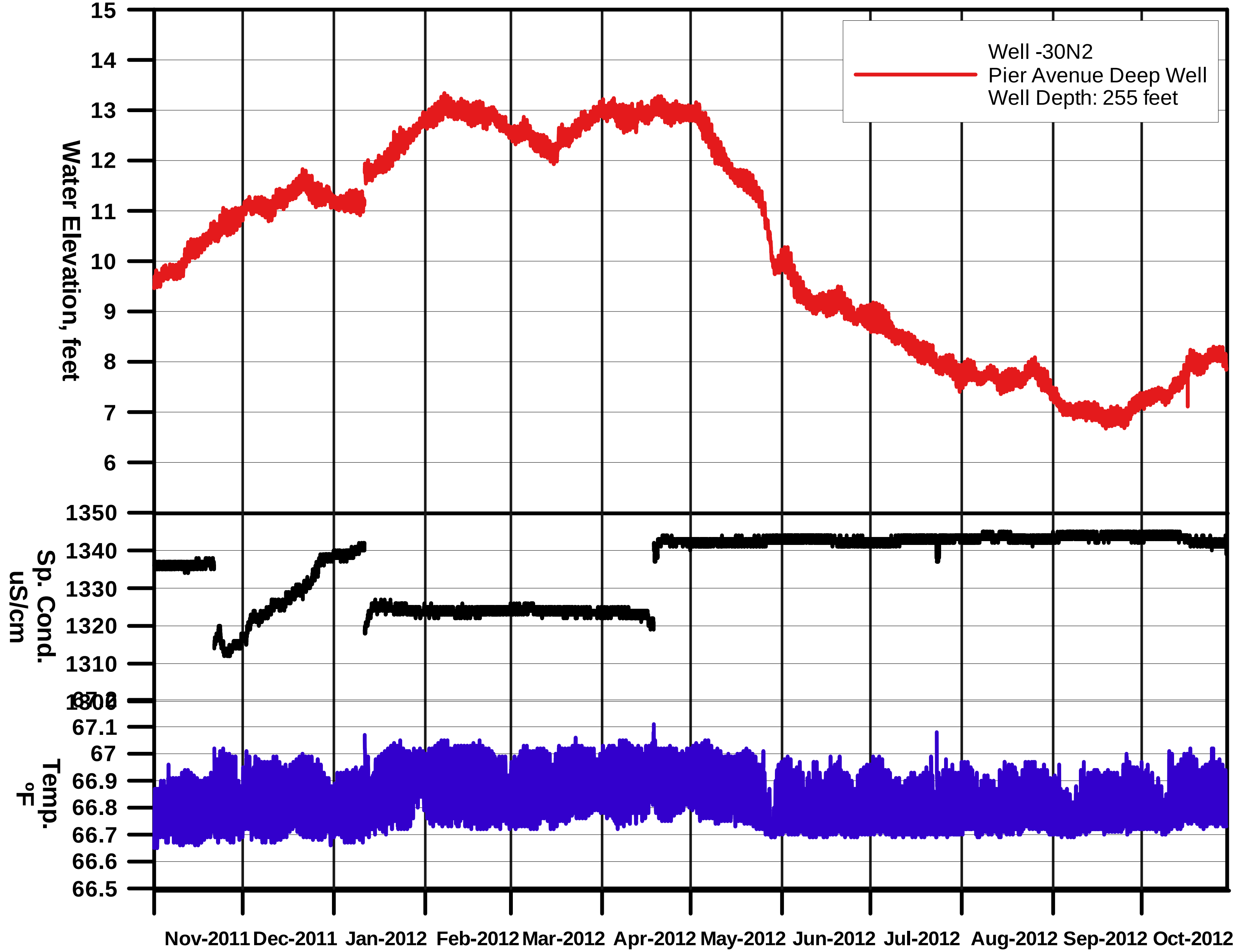


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2012 Annual Monitoring Report

Northern Cities Management Area

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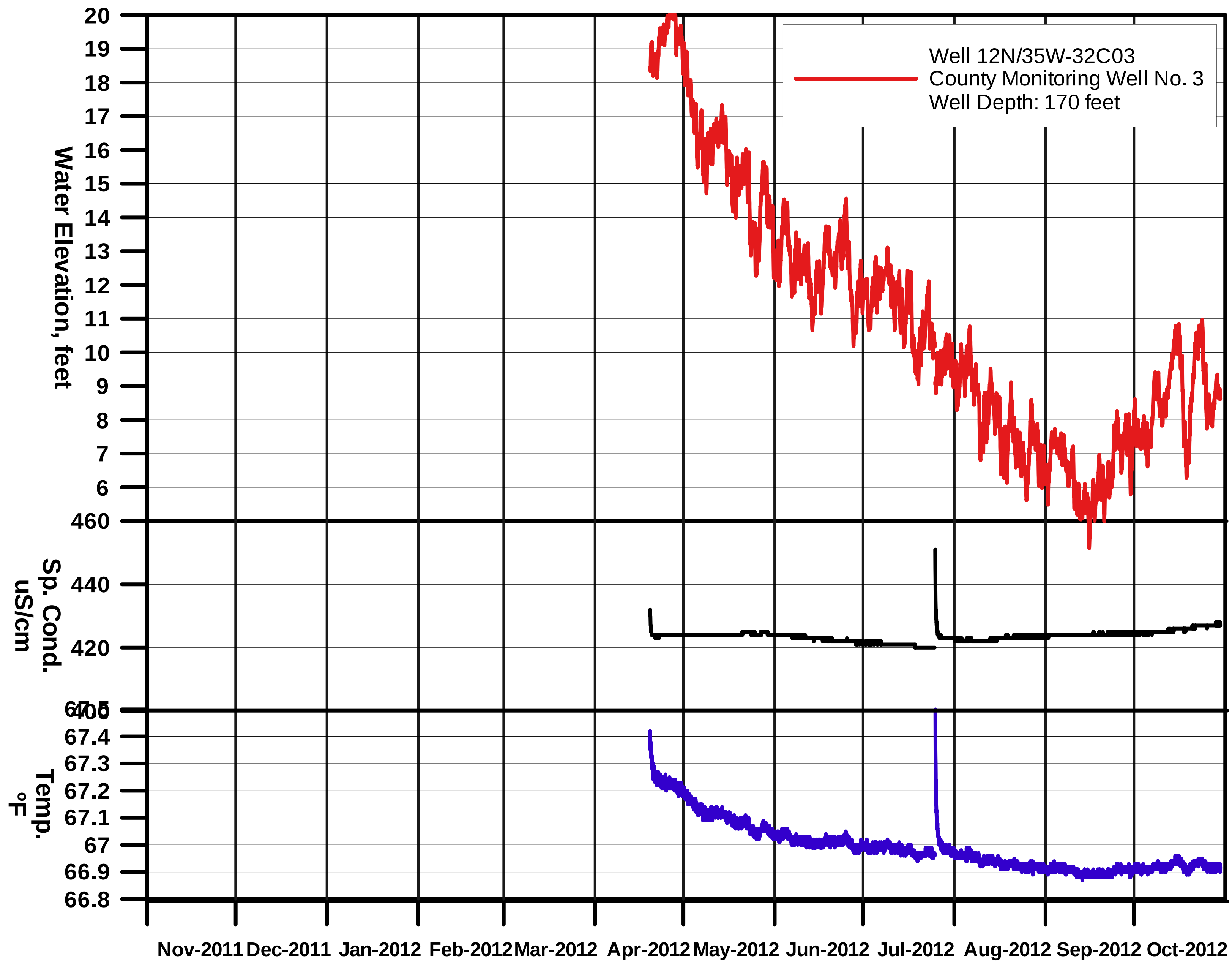
WATER ELEVATION, CONDUCTIVITY, AND TEMPERATURE
WELL 30N02

APRIL 2013

Figure 12E

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2012 Annual Monitoring Report

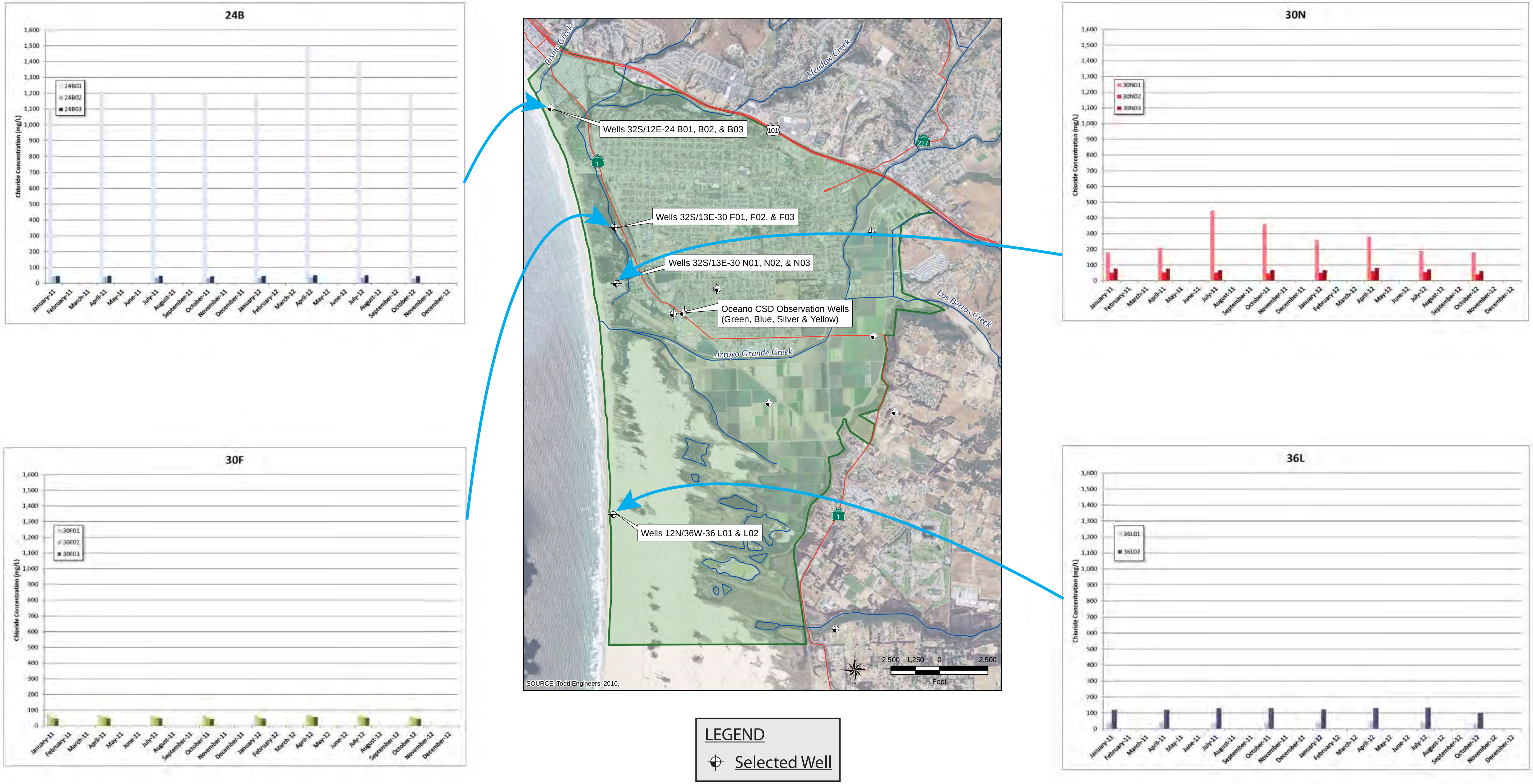
Northern Cities Management Area

GEI Consultants

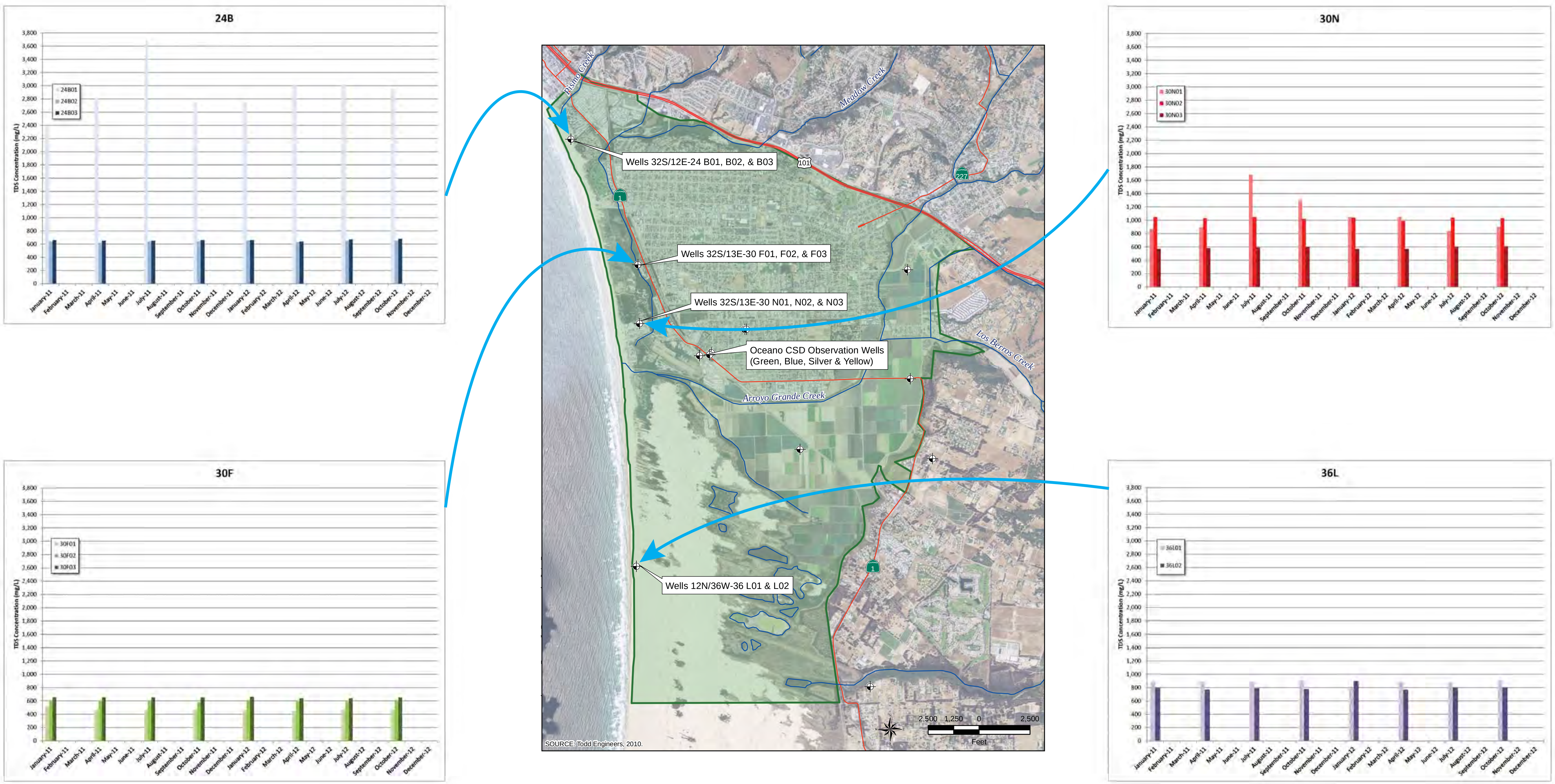
WATER ELEVATION, CONDUCTIVITY, AND TEMPERATURE
WELL 32C03

APRIL 2013

Figure 12F



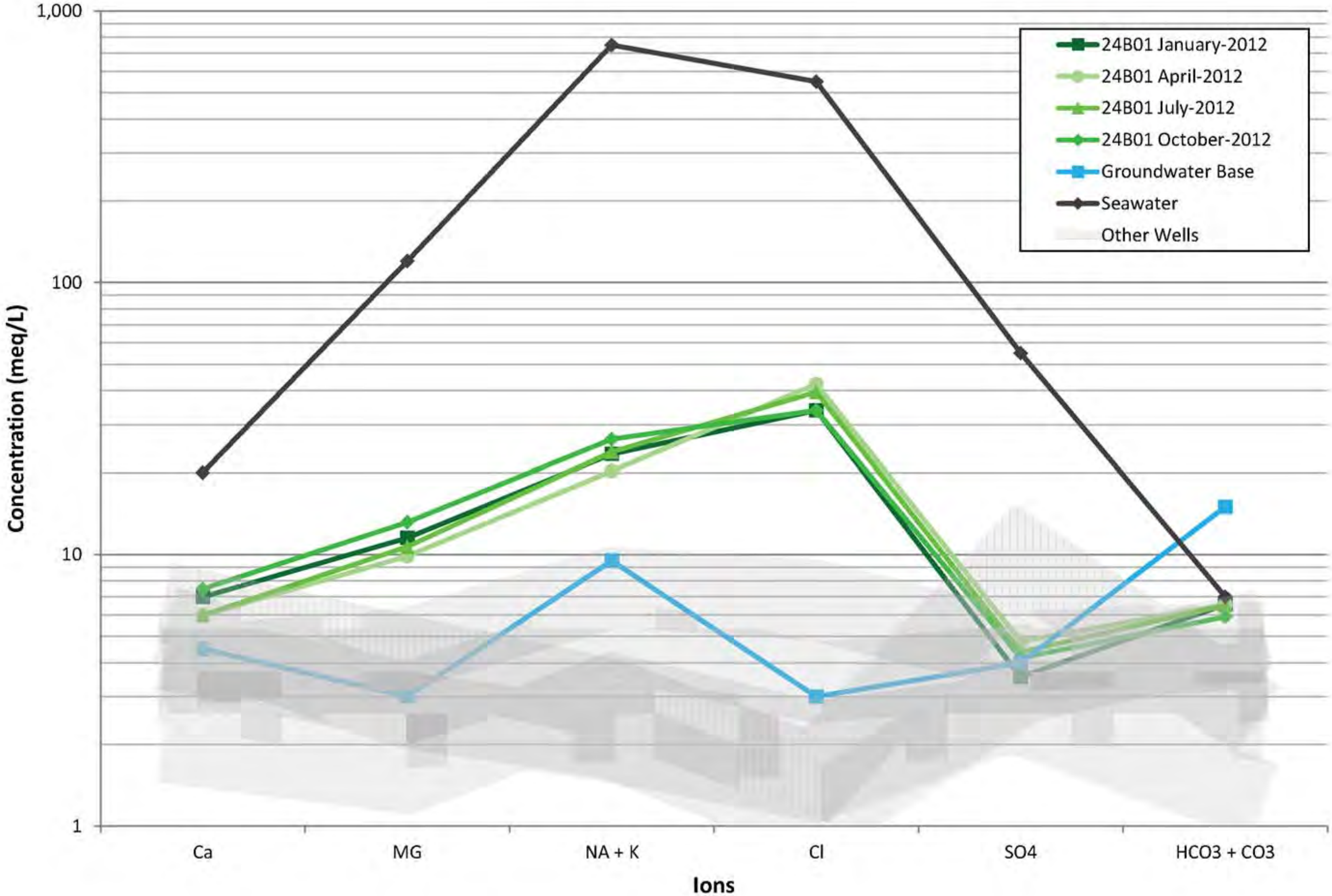

| | | |
|---|---|---|
| 2012 Annual Monitoring Report | GEI Consultants | Chloride Concentrations Over Time In Sentry Wells |
| Northern Cities Management Area | | February 2013 — Figure 13 |



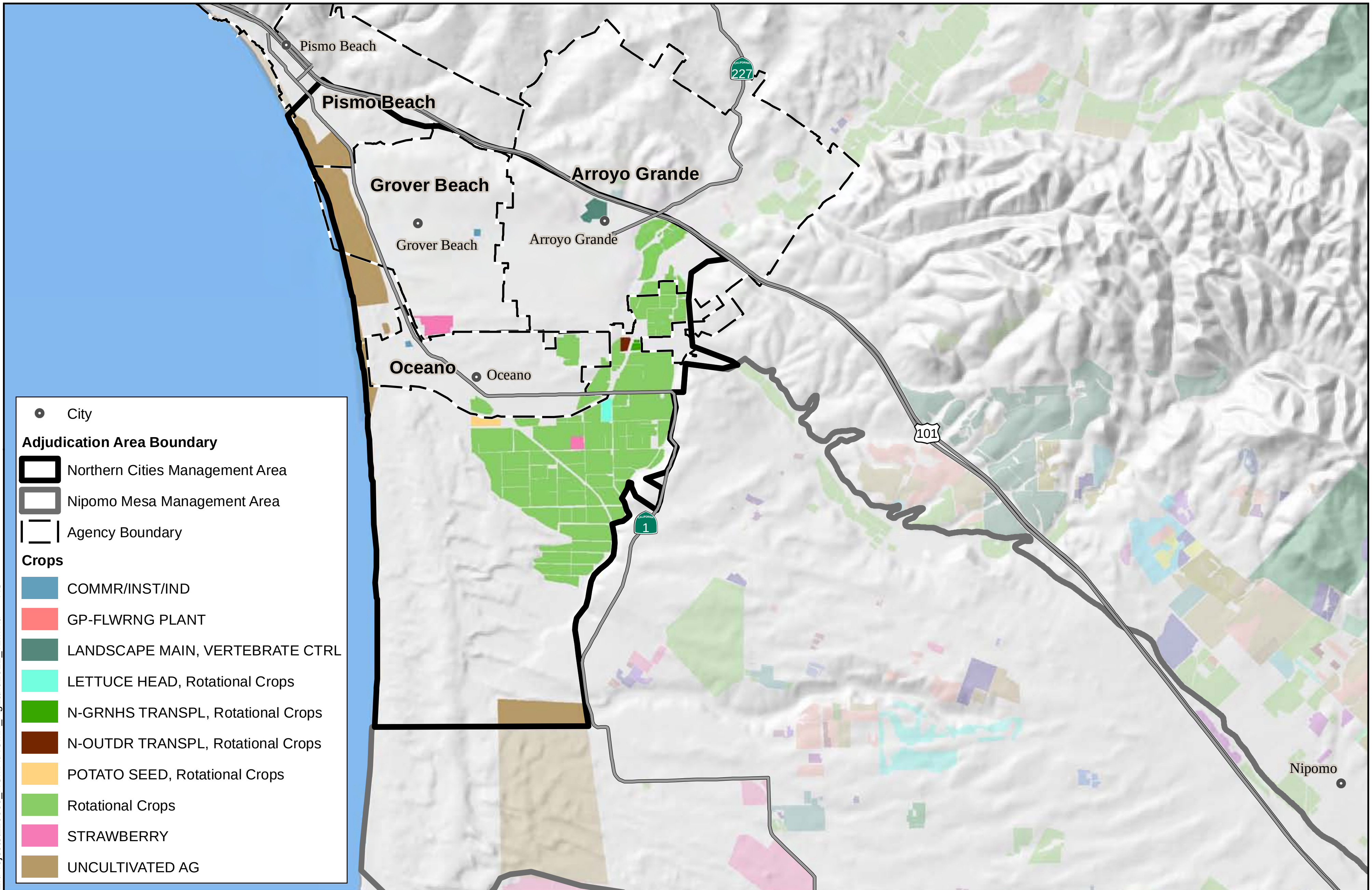

LEGEND

Selected Well

| 2012 Annual Monitoring Report | GEI Consultants | Total Dissolved Solids Concentrations Over Time In Sentry Wells | |
|---|---|---|---|
| Northern Cities Management Area | | February 2013 | Figure 14 |




| | | |
|---|---|---|
| 2012 Annual Monitoring Report | GEI Consultants | Schoeller Diagram for Sentry Well 24B01, 2012 |
| Northern Cities Management Area | | February 2013 — Figure 15 |

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San Luis Obispo County

Northern Cities Management Area

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Bookman-Edmonston Division

NORTHERN CITIES MANAGEMENT AREA
AGRICULTURAL LAND 2012

APRIL 2013

FIGURE 16

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