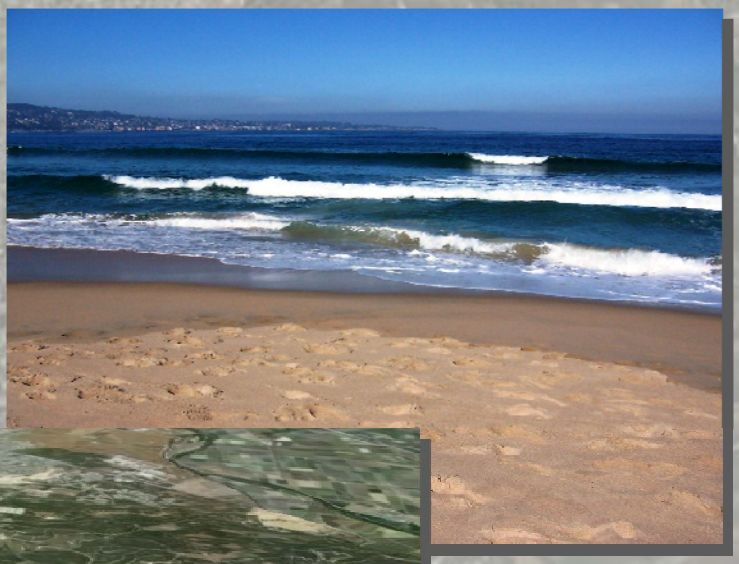
Basin Management Action Plan
Seaside Groundwater Basin
Monterey County, California

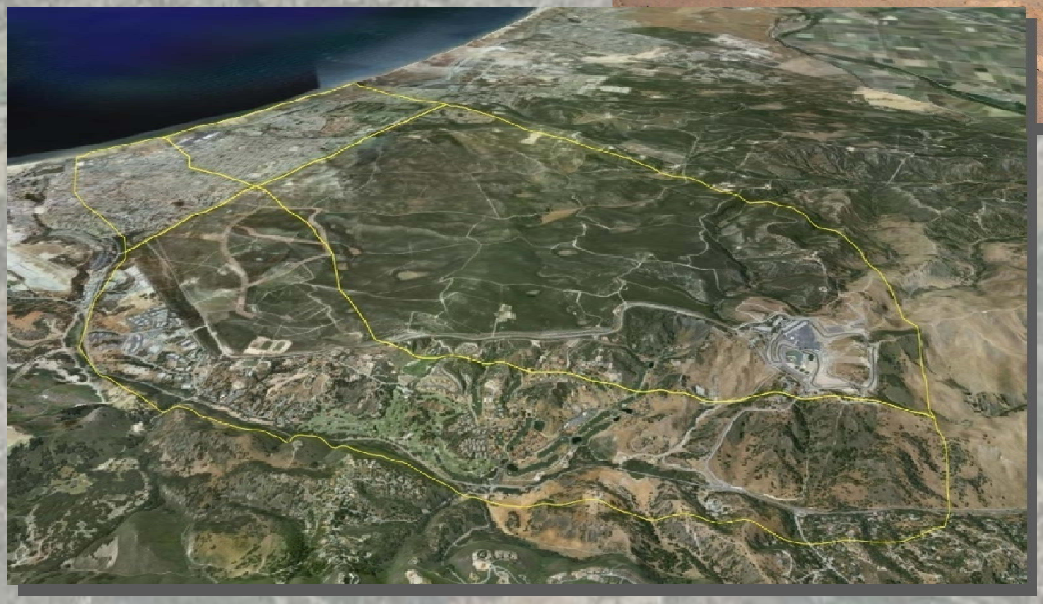
Prepared for:
Seaside Groundwater Basin Watermaster

February 2009

Prepared by:

HydroMetrics LLC





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ABBREVIATIONS

ASR.....aquifer storage and recovery
BMAP.....Basin Management Action Plan
CAW.....California American Water Company
CDPH.....California Department of Public Health
CPUC.....California Public Utilities Commission
CSIP.....Castroville Seawater Intrusion Project
CWP.....Coastal Water Project
EIR.....Environmental Impact Report
FORA.....Fort Ord Reuse Authority
HDD.....horizontal directionally drilled
MCWD.....Marina Coast Water District
MCWRA.....Monterey County Water Resources Agency
mgd.....million gallons per day
MLPP.....Moss Landing Power Plant
M&MP.....Seaside Basin Monitoring and Management Plan
MPWMD.....Monterey Peninsular Water Management District
MRWPCA.....Monterey Regional Water Pollution Control Agency
msl.....mean sea level
NAVD 88.....North American Vertical Datum of 1988
O&M.....operation and maintenance
PEA.....Proponent's Environmental Assessment
RUWAP.....Regional Urban Water Augmentation Project
RWQCB.....Regional Water Control Board
SBWM.....Seaside Basin Watermaster
SIAR.....Seawater Intrusion Analysis Report
SIRP.....Seawater Intrusion Response Plan
SOC.....synthetic organic chemicals
SVIGSM.....Salinas Valley Integrated Ground and Surface Water Model
SVRP.....Salinas Valley Reclamation Plant
SWRCB.....State Water Resources Control Board
TAC.....Technical Advisory Committee

EXECUTIVE SUMMARY

INTRODUCTION

It is the Seaside Groundwater Basin's court-appointed Watermaster's role to administer and enforce the provisions of the Amended Decision (California American Water v. City of Seaside et al., 2007). One provision of the Amended Decision was the requirement to develop a Monitoring and Management Plan (M&MP). The Seaside Basin M&MP was subsequently developed in May 2006, and included general suggestions for a Basin Management Plan. This current document constitutes the Basin Management Plan outlined in the M&MP.

STATE OF THE SEASIDE GROUNDWATER BASIN

The Seaside Groundwater Basin as delineated in Exhibit B of the original Decision (March 2006) is bound by the Pacific Ocean, faults, bedrock, and a groundwater flow divide on the northern boundary. The Basin is subdivided internally by the Laguna Seca Anticline which separates the northern and southern subbasins. This feature, including the segment of the Ord Terrace Fault that offsets the anticline, forms a subsurface hydraulic barrier to groundwater flow. The Amended Decision subdivides the subbasins into coastal and inland subareas even though groundwater flow is continuous between coastal and inland subareas.

The Seaside Groundwater Basin comprises three aquifers: a deep aquifer, a shallow aquifer, and surficial Aromas Sands. The deep aquifer generally consists of the Purisima Formation and Santa Margarita Sandstone. The shallow aquifer refers collectively to numerous discontinuous lenses of sand and gravel in the depth interval of the Paso Robles Formation overlying the Santa Margarita Sandstone and below the surficial Aromas Sand layer.

Much of the *Total Stored Groundwater* in the Seaside Groundwater Basin is not easily extracted due to the clustered location of wells in the Basin. The Basin's *Usable Stored Groundwater*, which is a subset of *Total Stored Groundwater*, is estimated to be at most 72,000 acre-feet as of fall 2007. In the unsaturated portion above the *Total Stored Groundwater* there is at most approximately 52,030 acre-feet of *Total Usable Storage Space*. Of this 52,030 acre-feet of *Total Usable Storage Space*, 31,770 acre-feet are in the Coastal and Northern Inland Subareas and 20,260 acre-feet are in the Laguna Seca Subarea. The total actual and potential groundwater

storage in the Seaside Groundwater Basin is approximately 124,000 acre-feet (*Total Stored Groundwater* plus *Total Usable Storage Space*). These initial storage estimates, as required by the Amended Decision, will be revised as improved tools for estimating storage become available.

Over the last five years since the last comprehensive study was completed, groundwater levels in much of the Seaside Groundwater Basin have continued the downward trend documented previously. This is reflected in the annual estimated loss of stored groundwater of between 1,300 and 1,430 acre-feet per year. The declines confirm that the current basinwide Operating Yield of 5,600 acre-feet per year exceeds the basinwide Natural Safe Yield of 3,000 acre-feet per year (as both set forth in the Amended Decision) plus approximately 1,000 acre-feet per year needed to prevent seawater intrusion. While no seawater intrusion or operational problems have been reported as a result of these lowering groundwater levels, this trend is not sustainable over the long-term.

SUPPLEMENTAL WATER SUPPLIES

Long-term supplemental supplies will be needed in order to be able to reduce pumping in the Seaside Groundwater Basin to the Safe Yield, and to provide water which can be used to replenish the Basin. Developing these supplemental supplies is the strategy that will have the greatest impact on the Basin and allow for its long-term management and use in the future. The initial feasibilities of a number of supplemental supplies have been evaluated by various project proponents. Most of these supplies are being evaluated as parts of other larger programs. Many of the proposed supplemental supply projects are designed to provide up to 2,000 acre-feet per year of supplemental supply to Seaside Groundwater Basin for offsetting existing pumping, with one project proposing to provide up to 6,700 acre-feet per year. A supplemental supply of 2,000 acre-feet per year is below the 2,600 acre-feet of annual over-production, calculated as the difference between the current Operating Yield of 5,600 acre-feet and the Court's initially assumed Natural Safe Yield of 3,000 acre-feet per year. Therefore it is doubtful that any single supplemental supply project, other than combined Monterey Regional Water Supply Program projects, will be adequate for long-term basin management; project capacity of the supplemental supplies should be increased or projects combined, and coupled with demand reduction, to provide adequate supply.

Providing supplemental supplies on the order of 2,600 acre-feet per year will have the effect of halting water level decline, but will still leave groundwater levels below sea level. Supplemental supplies in excess of 2,600 acre-feet will be needed for a period of years to raise groundwater levels to protective levels. It is recommended that a groundwater model be used to evaluate the effectiveness of each supplemental supply and its impacts on groundwater levels. Furthermore, the model can be used to improve and refine the estimate of the amount of supplemental water needed to increase groundwater levels to protective levels.

All of the supplemental projects, except one, are physical projects with capital costs associated with them. The exception is water conservation which does not produce additional supply but rather results in a demand reduction. Water conservation should be given high priority with respect to Seaside Groundwater Basin Watermaster's (Watermaster) support of projects that reduce the amount of groundwater pumped from the Seaside Groundwater Basin.

GROUNDWATER MANAGEMENT ACTIONS

A number of immediate actions could be implemented by various water agencies to initially meet requirements of the Amended Decision to reduce the Operating Yield by 10 percent triennially, as well as to delay the onset of seawater intrusion and maximize the use of existing groundwater. Any action that would assist in appropriate management of the Seaside Groundwater Basin should be encouraged and supported by the Watermaster.

Of the near-term management actions reviewed, the following appear to be the most cost-effective and most likely to be implemented, and provide the greatest benefit to the Seaside Groundwater Basin in the short-term:

1. Irrigate the Bayonet and Blackhorse Golf Courses with water from the Ord Community Water System,
2. Reactivate the Marina Coast Water District Desalination Plant,
3. Provide Interties Between CAW's Main, Bishop Ranch, and Ryan Ranch Water Systems,
4. Install new inland and coastal subarea wells in coordination with the Watermaster, and
5. Sand City Desalination Plant.

The recommended interim actions are not intended to provide long-term solutions for restoring groundwater levels in the Seaside Groundwater Basin, although many interim solutions will have long-term benefits.

OTHER RECOMMENDATIONS

This BMAP identifies other basin management issues that need to be addressed and pursued by the Watermaster. One such issue is the dynamic nature of the Basin's northern boundary. This boundary (flow divide), although delineated in the Amended Decision will change location over time in response to changes in pumping in the Seaside area, Marina, the Salinas Valley and the lower El Toro Creek area. Given that this boundary is controlled by hydraulic factors, it is possible that if pumping in the Seaside area ceased completely and groundwater levels recovered to a certain point, groundwater in the northern portion of the Basin might flow into the Salinas Valley. Similarly, increased pumping in the Seaside Groundwater Basin might capture groundwater from the Salinas Valley.

Whatever management strategies are ultimately recommended, their impacts need to be assessed before implementation. Issues such as the fate of water that is recharged in the Basin at different locations, pumping redistribution, and establishing protective groundwater levels need to be addressed. For example, it will be important to know if recharge water will be lost to the ocean or the Salinas Valley, and whether the extraction wells in the Basin are located in the correct places to recover stored water. In order to assess these impacts, the most efficient method would be groundwater modeling. The model would be a management tool with which informed decisions regarding the management of the Basin can be made, assist in a better understanding of basin impacts from supplemental supplies on the groundwater basin, and to develop a plan for how the supplemental water could be best used to benefit the Seaside Groundwater Basin and water purveyors. A calibrated model should be developed in order to be ready to evaluate Basin impacts of planned supplemental supply projects and other management actions in a timely manner.

Selecting, evaluating and developing supplemental supplies for the Seaside Groundwater Basin should be done as expeditiously as possible. The Watermaster can support this by facilitating between parties, providing data and information on the Basin, and ensuring that Material Injury does not result from any of the proposed projects.

Managing the Basin requires evaluating impacts associated with implemented strategies. Monitoring of groundwater levels, quality and production are the means by which this can be done. The Watermaster should continue to install monitoring wells and continue with its monitoring program. In locations where the Watermaster determines additional data are needed, the monitoring network should be expanded.

SECTION 1
BACKGROUND AND PURPOSE

In 2006, an adjudication process was conducted by the State Water Resources Control Board (SWRCB) to determine water rights and establish management procedures for the Seaside Groundwater Basin. This process led to the issuance of the Court Decision (amended in 2007) that created the Seaside Groundwater Basin Watermaster (Watermaster). The Watermaster's role is to administer and enforce the provisions of the Amended Decision (California American Water v. City of Seaside et al., 2007). One provision of the Amended Decision was the requirement to develop a Monitoring and Management Plan (M&MP). The Seaside Basin M&MP was developed in May 2006, and included general suggestions for a developing a Basin Management Plan.

This current document, called the Basin Management Action Plan (BMAP), constitutes the Basin Management Plan outlined in Phase 2 of the M&MP Implementation Plan. This BMAP summarizes both short-term and long-term strategies to manage the Basin in accordance with the court's orders. Specifically, included in the BMAP are:

- A description of the state of the Seaside Groundwater Basin with emphasis on those basin properties that are called out in the Amended Decision, e.g. groundwater storage, and which have an impact on basin management;
- Potential supplemental supplies that are being considered for long-term augmentation of production from the Seaside Groundwater Basin,
- Potential management actions and interim water supplies that could be implemented in the short-term prior to developing supplemental supplies, and
- Recommended management actions and strategies that the Watermaster should support and/or encourage, which will help meet the groundwater pumping reductions required by the Amended Decision, and help prevent seawater intrusion.

Also discussed in the BMAP are issues from the Amended Decision that the Watermaster is required to address. The relevant Amended Decision sections are shown in parenthesis, and include:

- Determining *Total Useable Storage Space* and allocated storage for each producer in the Basin (III.H.4);
- Addressing efficiencies of storage (III.H.5); and
- Monitoring and studying the Seaside Groundwater Basin and all Seaside Groundwater Basin activities (III.L.3.j.xxi).

This BMAP is one of a number of documents and actions necessary for managing the Seaside Groundwater Basin. It is in effect a seawater intrusion prevention plan that focuses on providing groundwater management options to control groundwater levels, that if allowed to decline would lead to seawater intrusion. This document is intended to be used in coordination with the Watermaster's ongoing activities and the Seawater Intrusion Response Plan (HydroMetrics LLC, 2008). Implementing the recommendations included in this plan will result in a number of actions and strategies that will be necessary for effective groundwater management in the Seaside Groundwater Basin.

SECTION 2
STATE OF THE SEASIDE GROUNDWATER BASIN

This section details pertinent geologic and hydrogeologic aspects of the Seaside Groundwater Basin. These hydrogeologic details are presented as background for the ensuing discussions of supplemental supplies and potential groundwater management actions. Furthermore, paragraph III.H.4 of the Amended Decision requires that the Watermaster make a determination of the *Total Usable Storage Space*, which in turn can be used to establish the Storage Allocation for each producer. This section develops the initial estimate of *Total Usable Storage Space*, and compares recent yield numbers with the Natural Safe Yield of the Seaside Groundwater Basin prescribed in the Amended Decision. As this is the Watermaster's first effort to define *Total Usable Storage Space*, it includes a broad discussion of groundwater storage mechanisms and creates a conceptual framework for implementing the provisions of the Decision that address storage.

2.1 GEOLOGIC FRAMEWORK

The Seaside Groundwater Basin is commonly divided into three hydrostratigraphic units: a deep aquifer, a shallow aquifer, and surficial Aromas Sands. A complete geologic description of these aquifers can be found in Yates et al. (2005). The surficial Aromas Sands are unsaturated in many parts of the Seaside Groundwater Basin, and are not extensively pumped for municipal use. The main aquifers that are therefore the subject of this report are the shallow and deep aquifers.

The shallow aquifer consists of a mixture of continentally-derived sand, silt and clay sedimentary deposits, commonly known as the Paso Robles Formation. This is an unconfined aquifer that is overlain by surficial Aromas Sand.

The deep aquifer consists primarily of marine-derived, sedimentary sandstone, commonly known as the Santa Margarita Sandstone. Recent exploratory drilling associated with the Sentinel Wells suggests that parts of the deep aquifer in and near the Northern Coastal and Northern Inland Subareas consist of generally finer-grained sediments assigned to the Purisima Formation. Due to overlying low conductivity sediments, the deep aquifer is confined. Based on observed groundwater level behavior in the deep aquifer, there appears to be little leakage into the deep aquifer from the shallow aquifer.

Geologic data from the recently installed sentinel wells, shown as SBWM-1 through SBWM-4 on the well location map (Figure 1), were incorporated into a north-south geologic cross section by Feeney (2007) (see Figure 2 and Figure 3). Based on data from the four sentinel wells, two new geologic conclusions were reported that revise the most recent investigation of deep stratigraphy (WRIME, Inc. 2003). First, the Santa Margarita Sandstone does not extend north to the basin boundary as previously assumed. It was encountered only in the southernmost of the four sentinel wells (SBWM-4). Second, the lower two-thirds of the Tertiary continental deposits have been reclassified as Purisima Formation.

Exhibit B of the original Decision (California American Water v. City of Seaside et al., March 2006) demarcates the legal boundaries of the Seaside Groundwater Basin. Figure 4 shows this boundary. The southern boundary is defined by the Chupines fault. The northern boundary runs roughly parallel to a groundwater flow divide that acts as a groundwater ridge, separating groundwater flowing north toward the Salinas Valley from groundwater flowing south toward the Seaside Groundwater Basin.

The Laguna Seca Anticline separates the northern and southern subbasins of the Seaside Groundwater Basin. This feature—including the segment of the Ord Terrace Fault that offsets the anticline—forms a subsurface hydraulic partial barrier to groundwater flow. The northern and southern subbasins are further subdivided into coastal and inland subareas. It should be noted that this subdivision is based on land use and has no hydrogeologic justification. As such, groundwater flow is continuous between inland and coastal subareas.

The northern basin boundary, although delineated in the Amended Decision, will change position over time in response to changes in recharge and pumping. Pumping centers in the Seaside area, City of Marina, Salinas Valley and lower El Toro Creek area, control the local movement of groundwater, and thus the resultant groundwater flow divide locations. The flow divide in the deep aquifer is farther north than the flow divide in the shallow aquifer due to differing groundwater levels and hydraulic gradients in each of the aquifers (see Figure 5 and Figure 6). Given that the northern boundary of the groundwater basin is controlled by hydraulic factors, it is possible that if pumping in the Seaside area ceased completely and groundwater levels recovered to a certain point, groundwater in the northern part of the Seaside Groundwater Basin might flow into the Salinas Valley. However, it is also possible to influence the location of the northern boundary through the use of management strategies such as

deliberate placement of extraction wells to form a barrier that would prevent groundwater from flowing out of the Seaside Groundwater Basin.

Figure 1: Location of Production and Monitoring Wells in and near the Seaside Groundwater Basin

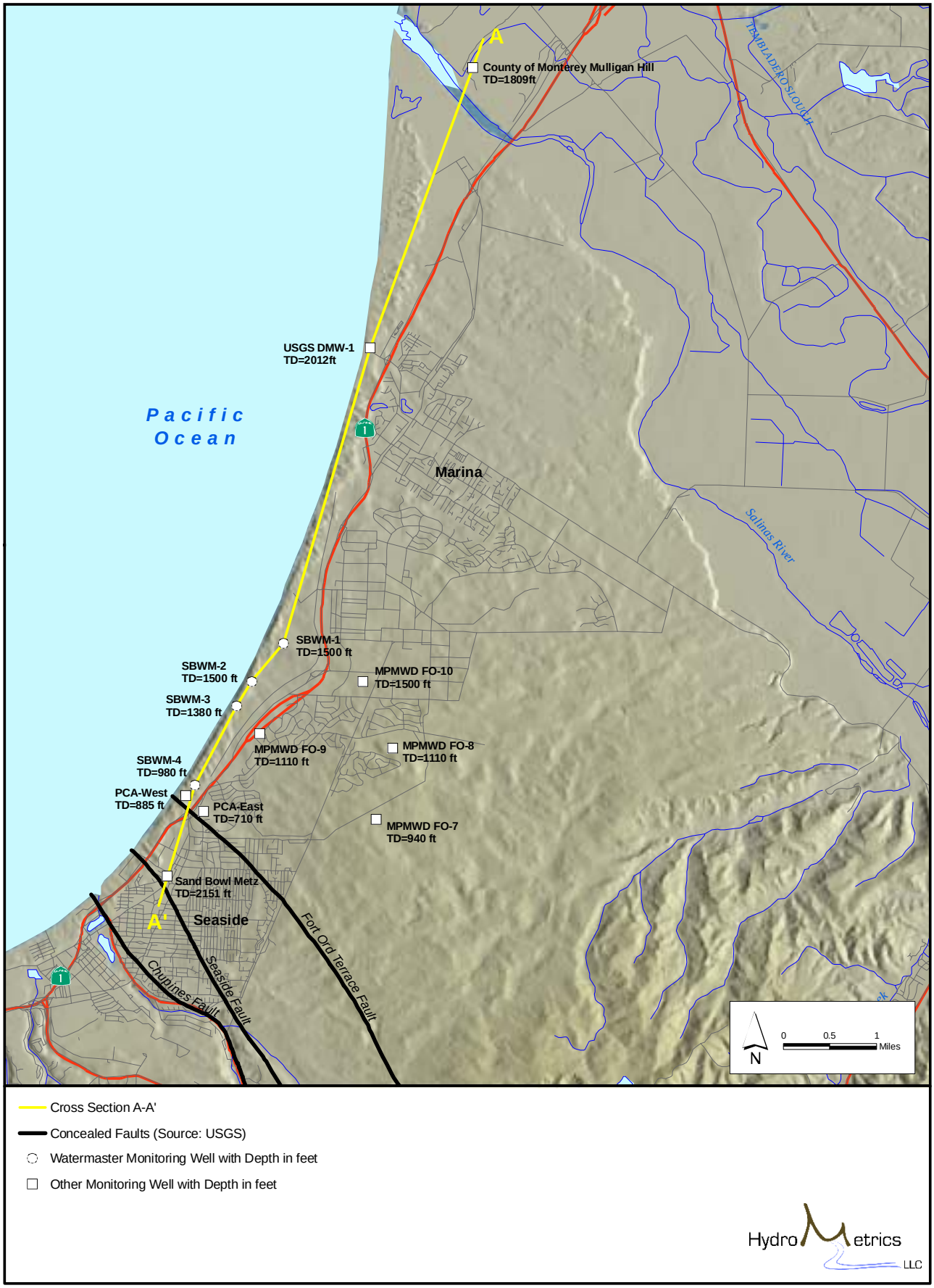


Figure 2: Location of Cross Section A-A'

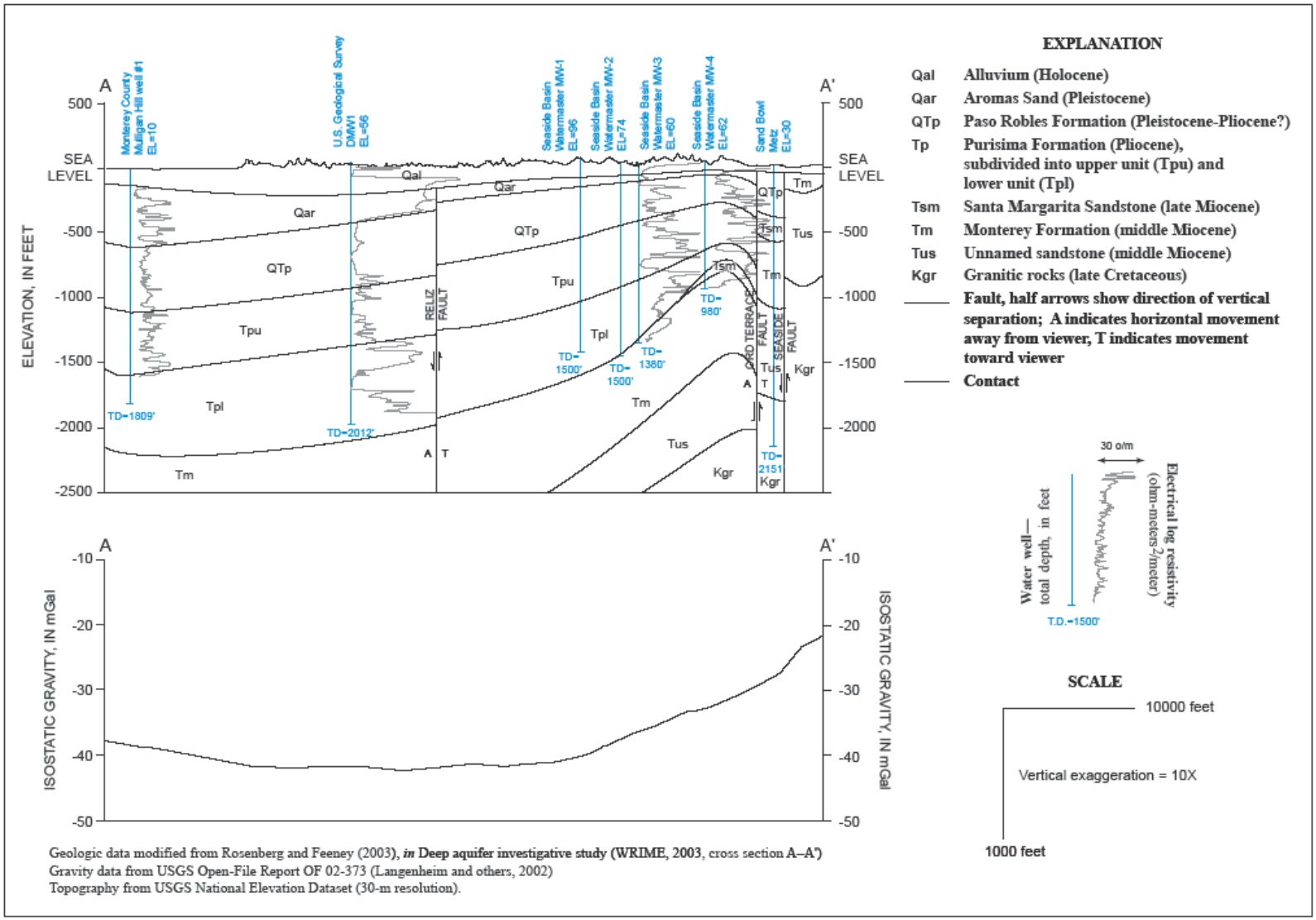


Figure 3: Geologic Cross Section A-A′ (from Feeny, 2007)

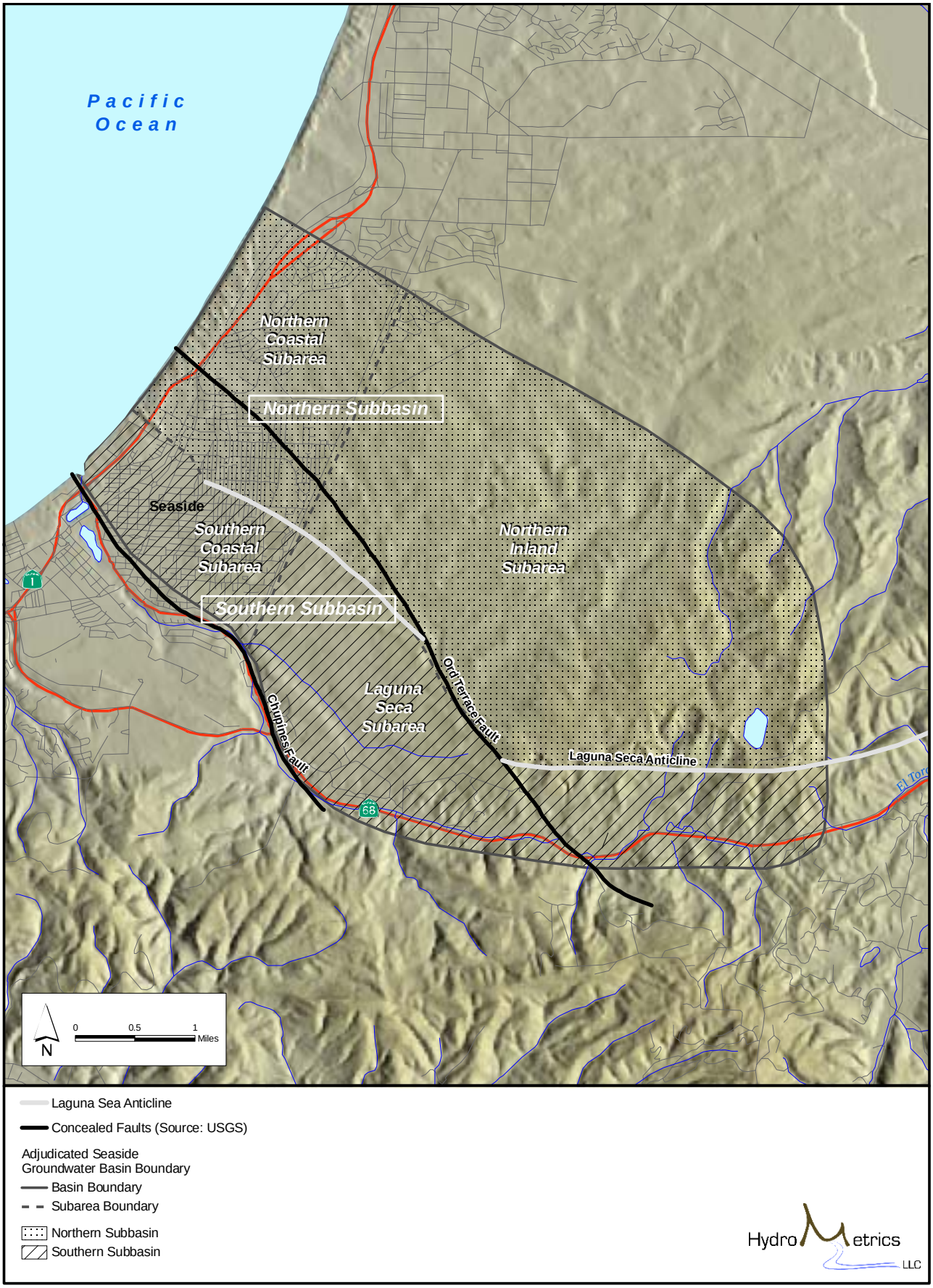
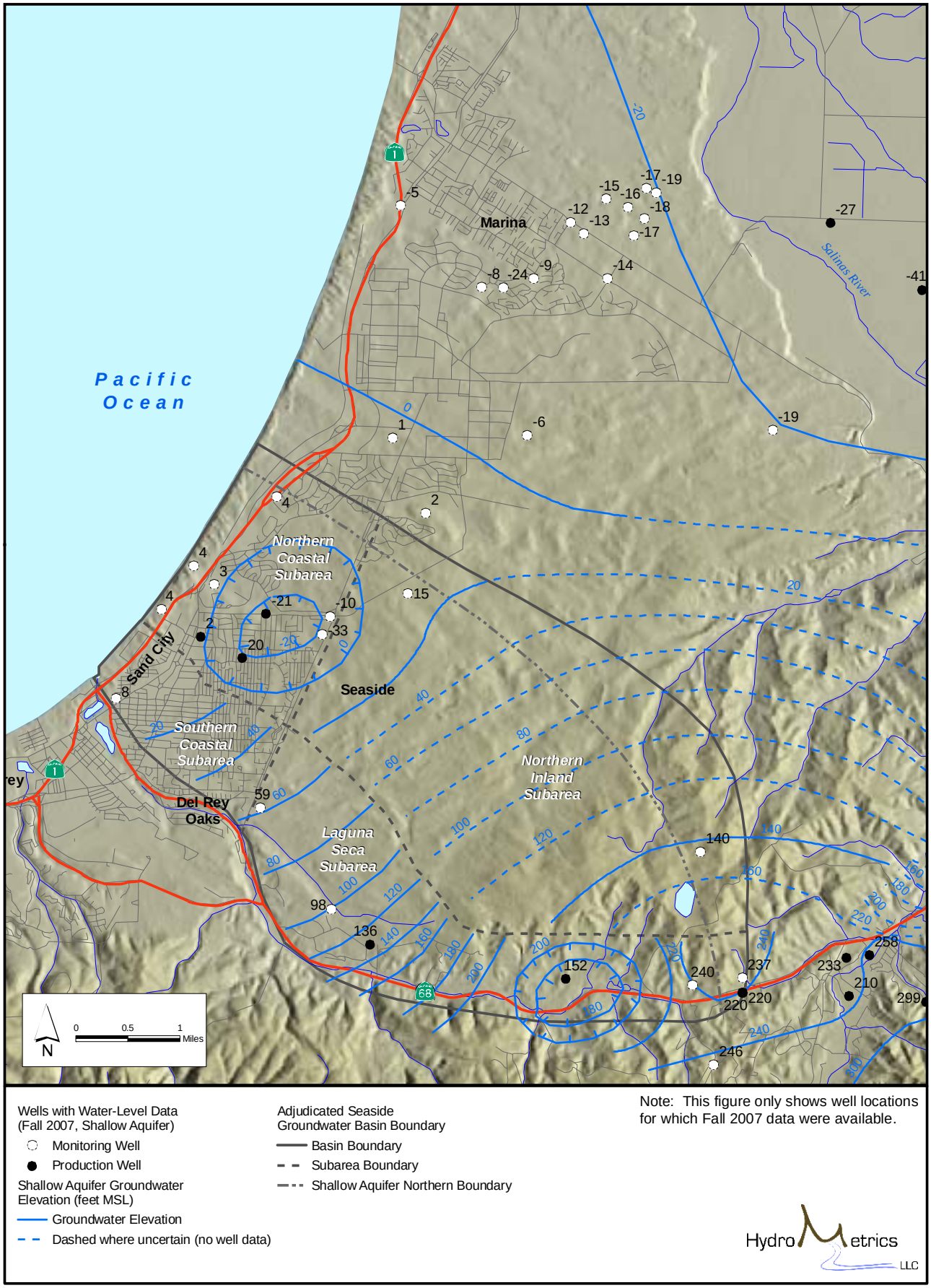


Figure 4: Amended Decision Boundary of the Seaside Groundwater Basin with Subareas



Wells with Water-Level Data (Fall 2007, Shallow Aquifer)

- Monitoring Well
- Production Well

Shallow Aquifer Groundwater Elevation (feet MSL)

- Groundwater Elevation
- Dashed where uncertain (no well data)

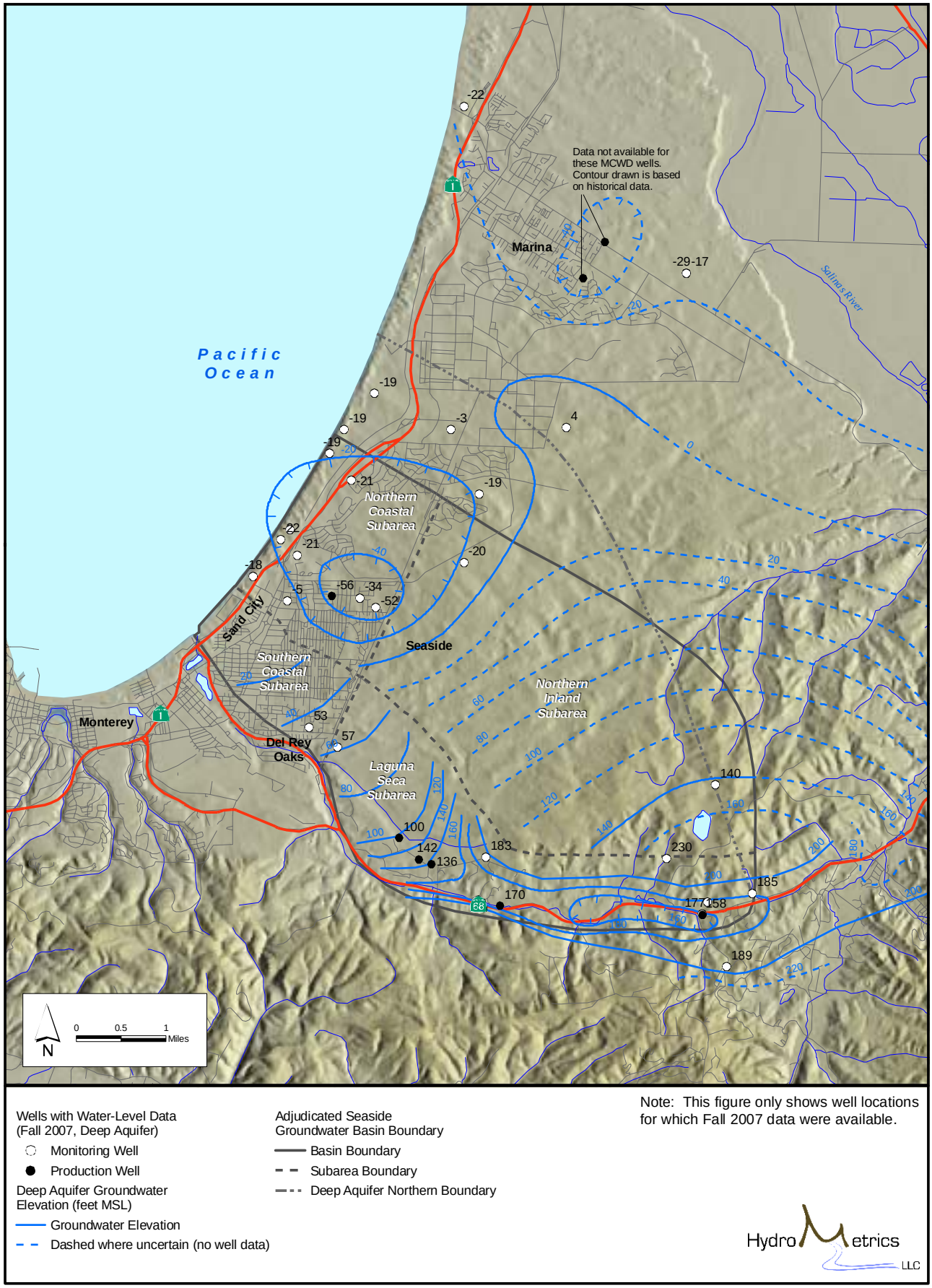
Adjudicated Seaside Groundwater Basin Boundary

- Basin Boundary
- Subarea Boundary
- Shallow Aquifer Northern Boundary

Note: This figure only shows well locations for which Fall 2007 data were available.

HydroMetrics LLC

Figure 5: Groundwater Elevation Contours in the Shallow Aquifer (Correlated to the 400-Foot Aquifer in Salinas Valley) – Fall 2007



Wells with Water-Level Data (Fall 2007, Deep Aquifer)

- Monitoring Well
- Production Well

Deep Aquifer Groundwater Elevation (feet MSL)

- Groundwater Elevation
- Dashed where uncertain (no well data)

Adjudicated Seaside Groundwater Basin Boundary

- Basin Boundary
- Subarea Boundary
- Deep Aquifer Northern Boundary

Note: This figure only shows well locations for which Fall 2007 data were available.

Figure 6: Groundwater Elevation Contours in the Deep Aquifer (Correlated to the Deeper Aquifer in the Salinas Valley) – Fall 2007

2.2 JURISDICTIONAL FRAMEWORK

In addition to the water management framework established by the court in *California American Water v. City of Seaside et al.*, Monterey County Superior Court, Case No. M66343, two public agencies--the Monterey County Water Resources Agency (MCWRA) and the Monterey Peninsula Water Management District (MPWMD)--have statutory powers over water resources in the Seaside Groundwater Basin. MCWRA is organized and existing under the Monterey County Water Resources Agency Act, Water Code Appendix, Chapter 52 (Agency Act), and its territory consists of "all of the territory of the county lying within the exterior boundaries of the county." (Agency Act, Section 52-4) Under the Act, MCWRA has broad powers to plan, design and implement flood control and water supply projects within its territory, including the power to "[a]ppropriate and acquire water and water rights, and import water into the agency and conserve within or outside the agency, water for any purpose useful to the agency." (Agency Act Section 52-9(d)(3)). While MCWRA retains its statutory powers in the Seaside Groundwater Basin, MCWRA is actively participating in Watermaster-directed efforts to address water supply issues in the Basin.

MPWMD is organized and existing under the Monterey Peninsula Water Management District Law, Water Code Appendix Chapter 118 (District Law) and its territory covers an area within the Monterey Peninsula as more particularly described in Section 118-102 of the District Law. MPWMD has the "power as limited in this law to do any and every lawful act necessary in order that sufficient water may be available for any present or future beneficial use or uses of the lands or inhabitants within the district, including, but not limited to, irrigation, domestic, fire protection, municipal, commercial, industrial, recreational, and all other beneficial uses and purposes." (District Law, Section 118-325). While MPWMD retains its statutory powers in the Seaside Groundwater Basin, MPWMD is actively participating in Watermaster-directed efforts to address water supply issues in the Basin. Historically, MPWMD and MCWRA have undertaken water monitoring and management activities within the Seaside Groundwater Basin pursuant to a Memorandum of Understanding between the two agencies.

Figure 7 includes a map depicting MCWRA's Zone 2C and the overlapping territories of MCWRA and MPWMD in the Seaside Groundwater Basin. The lands within Zone 2C are subject to certain restrictions, including but not limited

to restrictions on water exportation, which may limit the nature and scope of supplemental water supply projects or recommended groundwater management actions.

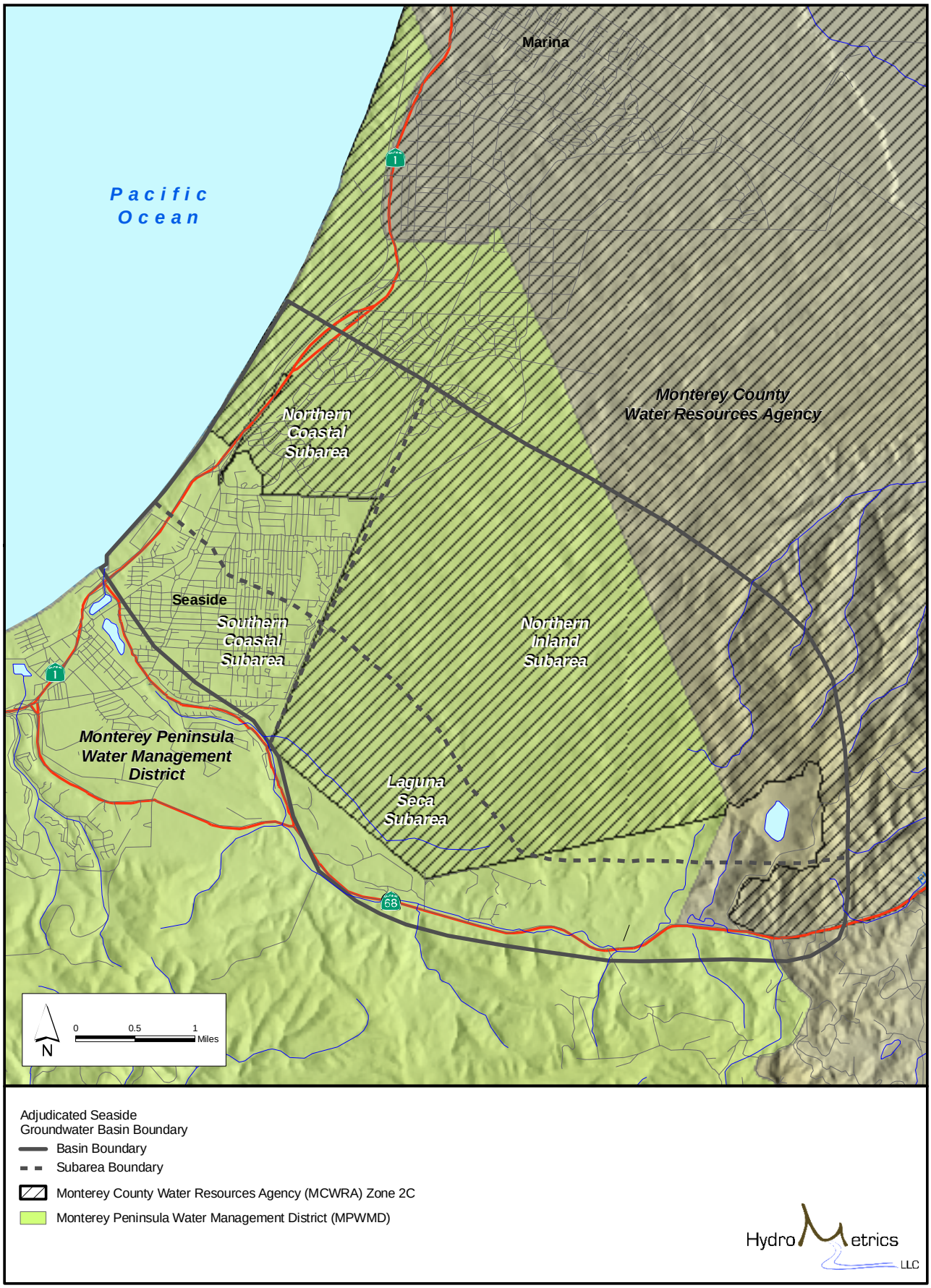


Figure 7: Administrative Jurisdictions in the Seaside Groundwater Basin

2.3 GROUNDWATER LEVELS

2.3.1 GROUNDWATER LEVEL MAPS

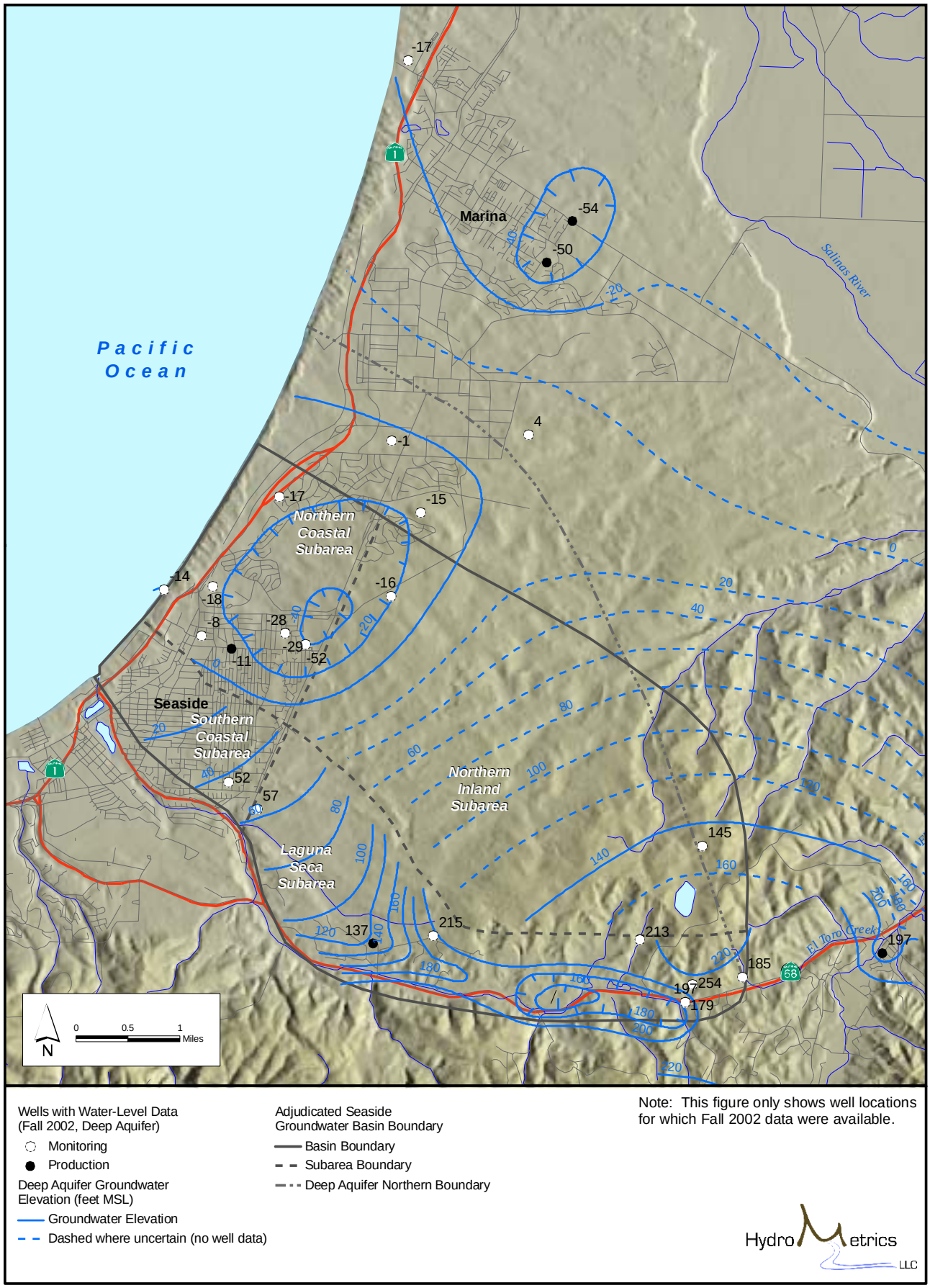
Basinwide contours of groundwater levels were prepared by Yates et al. (2005) using data from 2002. These contours were updated with data collected on or around October 2006 by HydroMetrics LLC (2007). The contours were again updated for the 2007 *Seawater Intrusion Analysis Report* (HydroMetrics LLC, 2008) using fall 2007 data. Consistent with previous studies, water levels were grouped by well depth and contoured by hand.

Groundwater levels from the Seaside Groundwater Basin shallow aquifer were combined with groundwater levels from the lower Pressure 180-foot and Pressure 400-foot aquifers in the former Fort Ord and Salinas Valley. Groundwater levels from the Seaside Groundwater Basin deep aquifer were grouped with the groundwater levels from the new sentinel wells and the deep aquifer zone in the Marina area. Figure 5 and Figure 6 show the resulting water-level contour maps for fall 2007. For reference, Figure 8 and Figure 9 show the corresponding contour maps for fall 2002 water levels.

The groundwater level maps show that water levels in the deep aquifer are generally below water levels in the shallow aquifer. This is because the shallow aquifer is unconfined, meaning it receives recharge from rainfall, and pumping results in relatively less drawdown. The deeper aquifer is confined, meaning little water leaks into it from above, and pumping results in relatively greater drawdown. The recharge mechanism for the deeper aquifer is poorly understood at this time.

In general, the contour maps show that the fall 2007 groundwater contours for the shallow and deep aquifers have retained the general shape as in previous years. The contour shape reflects the movement of groundwater, which flows from high to low elevations at right angles to the contours.

Figure 8: Groundwater Elevation Contours in the Shallow Aquifer (Correlated to the 400-Foot Aquifer in Salinas Valley) – Fall 2002



Wells with Water-Level Data (Fall 2002, Deep Aquifer)

- Monitoring
- Production

Deep Aquifer Groundwater Elevation (feet MSL)

- Groundwater Elevation
- Dashed where uncertain (no well data)

Adjudicated Seaside Groundwater Basin Boundary

- Basin Boundary
- Subarea Boundary
- Deep Aquifer Northern Boundary

Note: This figure only shows well locations for which Fall 2002 data were available.

HydroMetrics LLC

Figure 9: Groundwater Elevation Contours in the Deep Aquifer (Correlated to the Deeper Aquifer in the Salinas Valley) – Fall 2002

2.3.2 NORTHERN SUBBASIN HYDROGRAPHS

2.3.2.1 NORTHERN COASTAL SUBAREA - SHALLOW AQUIFER

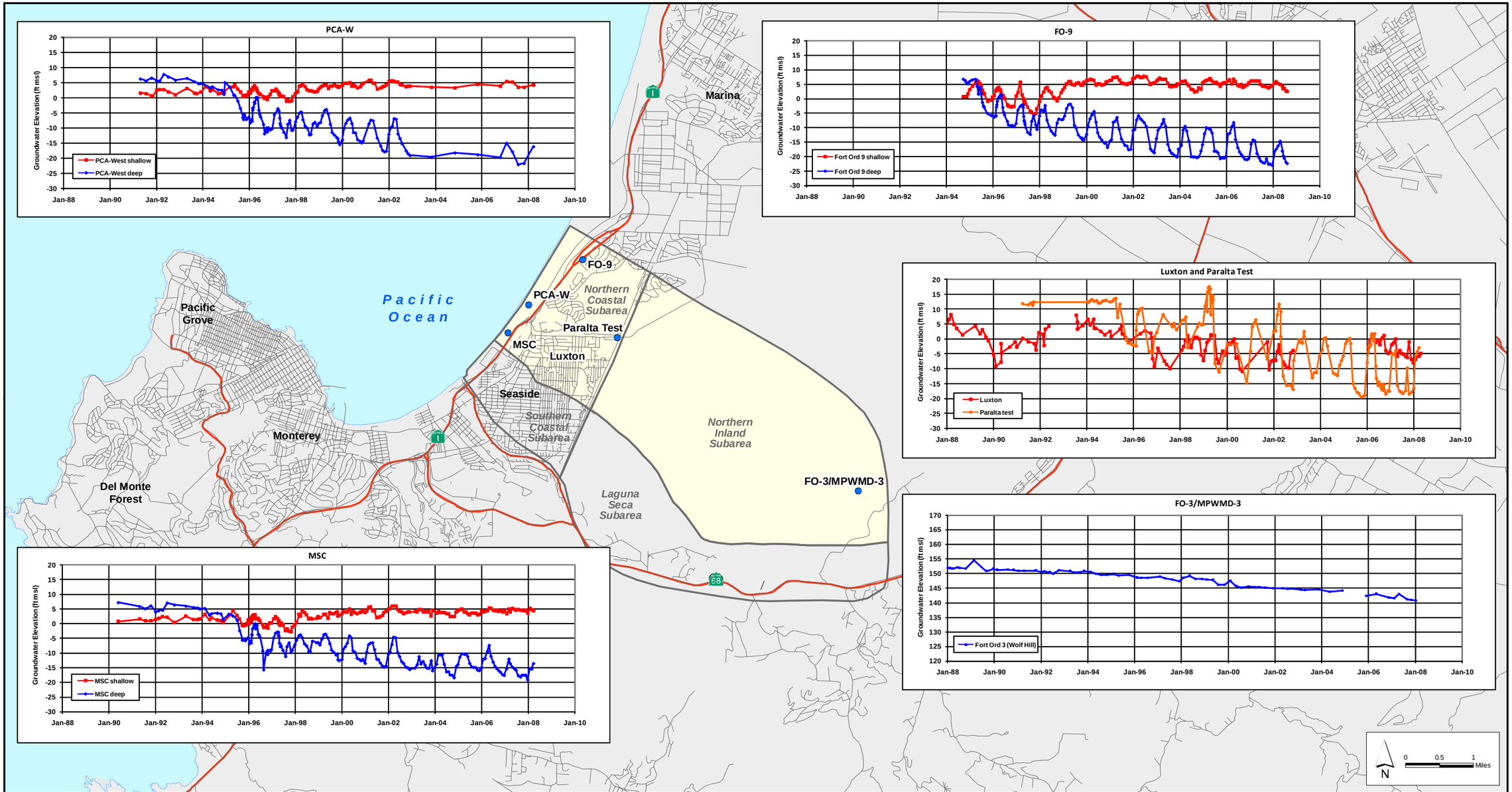
Shallow aquifer groundwater level trends in the Northern Coastal subarea can be seen on the red and orange lines in the hydrographs depicted on Figure 10. Groundwater levels in the shallow aquifer nearest the coast showed a slight rise over this period, while levels farther inland showed a slight lowering.

2.3.2.2 NORTHERN COASTAL SUBAREA - DEEP AQUIFER

Deep aquifer groundwater level trends in the Northern Coastal Subarea can be seen on the blue lines in the hydrographs depicted on Figure 10. Groundwater levels in the deep aquifer continued their ongoing decline, with an average net decline of 5 feet between 2002 and 2007.

Figure 11 shows groundwater levels in all four of the Watermaster's Sentinel Wells having similar seasonal water level trends. Groundwater in each well recovered from approximately -22 feet mean sea level (msl) in November-December 2007 to approximately -16 feet msl in late March 2008. Superimposed on the seasonal trend are daily fluctuations driven by ocean tides and variations in response to groundwater pumping at major production wells. The response to ocean tides observed in these hydrographs is a response to pressure loading from tidal changes, and does not imply a direct hydraulic flow path between the ocean and these sentinel wells.

The larger variations seen in the sentinel well hydrographs correlate to production at CAW's Paralta and Ord Grove wells (locations shown on Figure 1). The magnitude of the water-level response at the sentinel wells decreases with increasing distance from the CAW wells, further confirming that the water levels are responding to CAW pumping. This is particularly evident during the February 2008 pumping event where the decline in groundwater level decreases northwards away from the CAW wells. In general, the water-level responses were nearly simultaneous among the four wells, suggesting that the pressure drop propagated rapidly from the pumping wells. Review of pumping data from Marina Coast Water District's (MCWD) Wells 10 and 11 showed a lack of correlation with groundwater levels in the sentinel wells, thereby supporting the finding that the sentinel wells are influenced by wells in the Seaside Groundwater Basin.



Hydrograph Location

Note: Red and orange colors on hydrogrpahs indictae shallow aquifer wells, and blue indicates deep aquifer wells.

Figure 10: Northern Subbasin Hydrographs

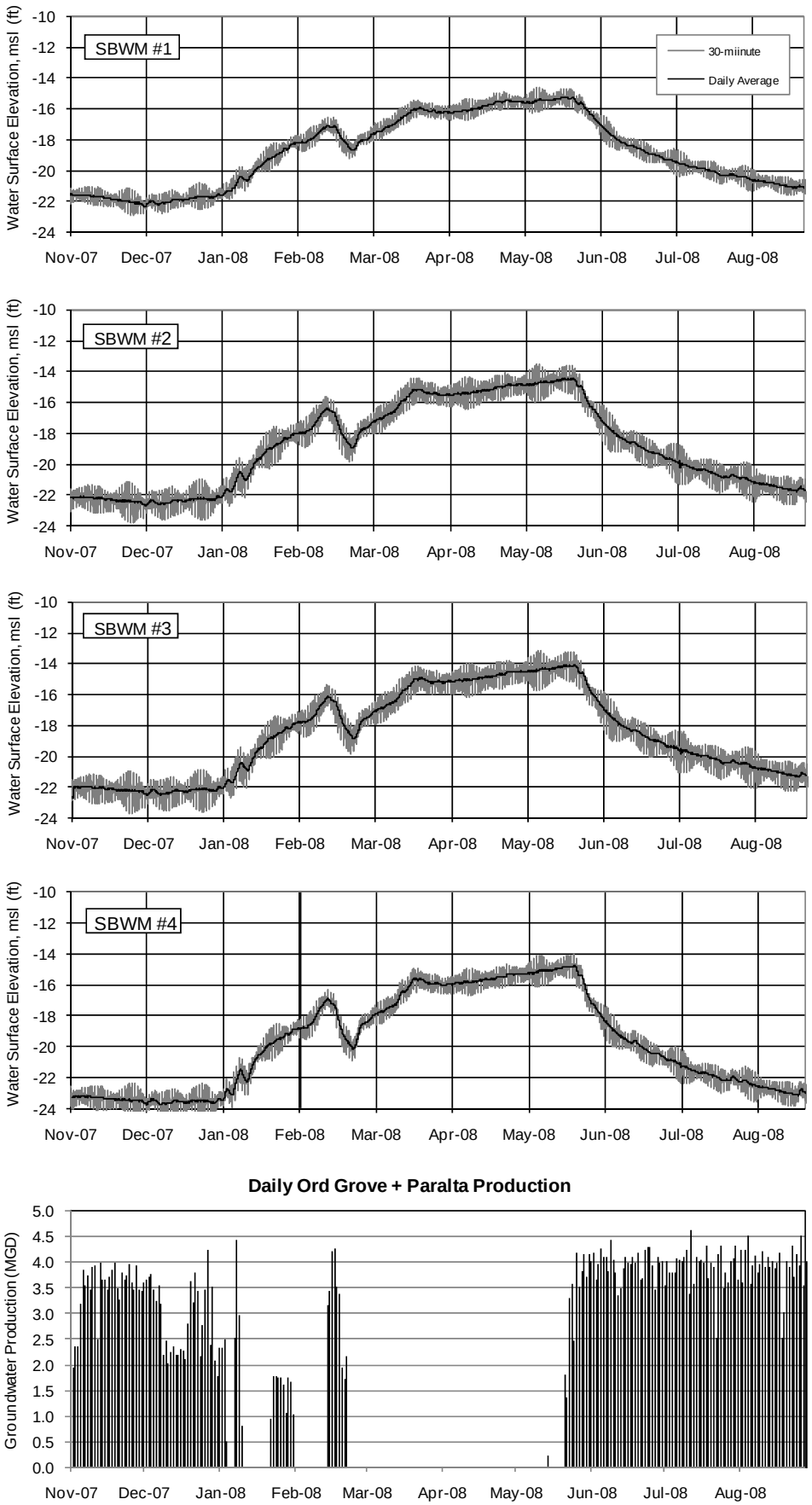


Figure 11: Deep Sentinel Well Hydrographs and Nearby Pumping

2.3.2.3 Northern Inland Subarea

As shown in Figure 10, groundwater levels in monitoring well Fort Ord 3 (Wolf Hill) near the most inland corner of the northern subbasin continues to decline at a rate of approximately 0.5 - 1 feet per year. Groundwater level data for this subarea is extremely limited due to a lack of wells.

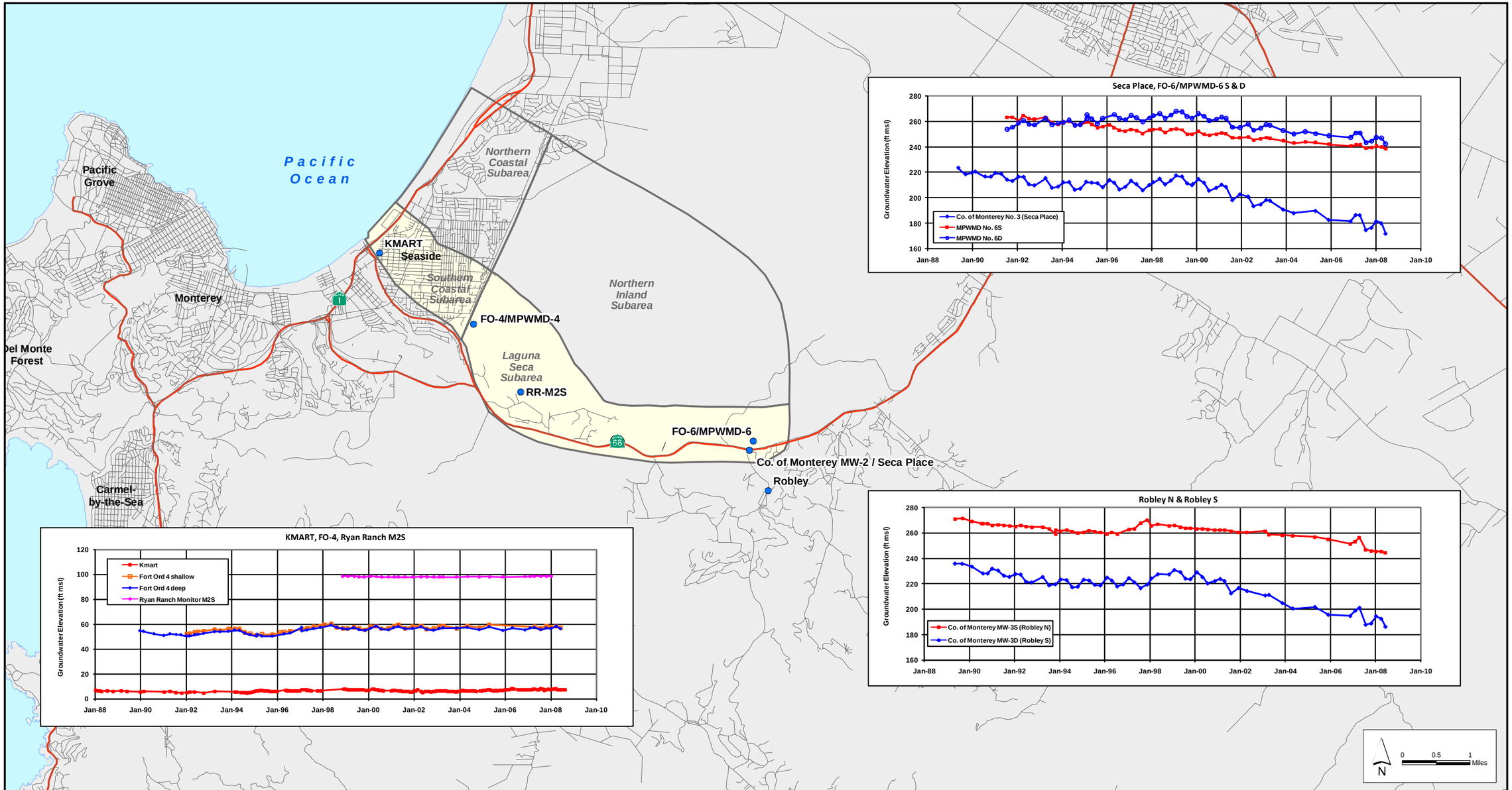
2.3.3 Southern Subbasin Hydrographs

2.3.3.1 Southern Coastal Subarea

Hydrographs for selected wells in both shallow and deep aquifer in the Southern Coastal subarea are shown in Figure 12. Groundwater levels in the Southern Coastal subarea have been stable in recent years, with essentially flat hydrographs.

2.3.3.2 Laguna Seca Subarea

Hydrographs for selected wells in the Laguna Seca subarea are shown in Figure 12. Groundwater levels in both the shallow and deep aquifers in this subarea are declining rapidly, at rates averaging as high as 4 feet per year (Figure 12).



Hydrograph Location

Note: Red and orange colors on hydrogrpahs indictae shallow aquifer wells, and blue indicates deep aquifer wells.

Figure 12: Southern Subbasin Hydrographs

2.3.4 GROUNDWATER LEVEL CONCLUSIONS

A number of observations and conclusions relevant to the storage analysis can be drawn from these water-level data:

- Although the sentinel wells are not screened completely in the Santa Margarita Sandstone, groundwater levels in these wells generally reflect conditions in the deep aquifer.

- The deep aquifer is highly confined. High confinement means there is very little leakage into the aquifer from above. It is apparent that vertical leakage within the aquifer system is low near the coast, which retards the downward movement of seawater. Supporting this statement are:

  - Drawdown of groundwater levels in the sentinel wells correlates closely with pumping cycles in the Ord Grove and Paralta production wells, despite being relatively distant from these wells. For responses to pumping at such a distance to be seen in the sentinel wells, confined conditions that are sensitive to such changes must be occurring.

  - The prominent tidal fluctuations observed in sentinel well groundwater levels is a common occurrence in confined aquifers.

- Including groundwater levels from the sentinel wells in the groundwater contours reveals a relatively flat groundwater surface extending north along the coast, at an elevation of about 20 feet below sea level. There is still a flow divide between the Seaside Groundwater Basin and the Salinas Valley, but the flow divide is below sea level.

- The presence of groundwater levels well below sea level along the coastline implies that seawater will likely eventually intrude into that area. Although intrusion may take many years or decades to occur, groundwater levels need to be increased to above sea level to ensure protection of the aquifers.

- The continued steady long-term decline of groundwater levels over the last 20 years at Well FO-3/MPWMD-3 indicates that coastal pumping

influences groundwater levels in the Northern Inland Subarea, (Figure 10).

- Water levels declined from fall 2002 to fall 2007 in all parts of the Seaside Groundwater Basin except the in Southern Coastal Subarea and in shallow wells near the coast in the Northern Coastal Subarea. In those locations, water levels remained stable or increased slightly. The overall water-level declines in the rest of the Seaside Groundwater Basin confirm that the current basinwide Operating Yield exceeds the basinwide Natural Safe Yield.

- The continued lowering of water levels in the Laguna Seca Subarea is creating a new flow divide in the vicinity of York Road Well. East of the new divide, groundwater will either be captured internally by the growing cone of depression, or could potentially begin flowing northeast in the direction of the El Toro Creek drainage, depending on the rate of decline in water levels in the adjacent El Toro area.

2.4 GROUNDWATER STORAGE

As this report is the first attempt to determine groundwater storage in the Seaside Groundwater Basin, it includes a broad discussion of storage concepts and creates a conceptual framework for implementing the provisions of the Amended Decision that deal with storage. The concepts are applied to obtain quantitative estimates of groundwater storage under current and historical conditions. Estimates of storage changes between 2002 and 2007 are used to refine the groundwater budget and review the Natural Safe Yield of the Seaside Groundwater Basin.

2.4.1 STORAGE CONCEPTS

Three key storage terms used in this section are *Total Stored Groundwater*, *Usable Stored Groundwater*, and *Total Usable Storage Space*.

- *Total Stored Groundwater* in a basin is the total volume of groundwater below the water table and above the impermeable geologic materials that form the bottom of the basin.

- *Usable Stored Groundwater* is a subset of total stored groundwater and reflects limitations imposed by well depths, well locations, seawater intrusion threats, aquifer layering, etc. Some of these limitations are fixed characteristics of the natural system that are difficult to change. Others are man-made characteristics such as well locations and land use that could be changed to optimize the amount of usable storage space.

- *Total Usable Storage Space* refers to the usable portion of the aquifer above the water table that is currently unsaturated and could be used for artificial recharge and storage. It can be thought of as the volume of storage that is currently unused, and therefore available for storage of replenishment water. It is defined in the Amended Decision (Section III.A.41) as:

  "Total Useable Storage Space means the maximum amount of space available in the Seaside Groundwater Basin that can prudently be used for Storage as shall be determined and modified by Watermaster… less Storage space which may be reserved by the Watermaster for its use in recharging the Basin.".

In practice, most of the *Total Useable Storage Space* and most of the *Usable Stored Groundwater* is in the shallowest portion of most basins because unconfined aquifers have more storage capacity. Water deep within a basin cannot be withdrawn without risking seawater intrusion, lowering groundwater levels at nearby wells, subsidence, or other undesirable outcomes. The simplest approach is to consider all groundwater and all storage space below sea level as unusable regardless of distance from the coast. A more realistic approach considers the difference in density between seawater and freshwater. For simplicity we have adopted the Ghyben-Herzberg assumption that the water table must be above sea level by a height equal to one-fortieth of the depth to which intrusion is to be prevented. In the Seaside Groundwater Basin, some active production wells extend to a depth of nearly 500 feet below mean sea level. In order to repel seawater down to that depth, a groundwater elevation about 13 feet above mean sea level would need to be maintained in the well.

The ability to use storage space is further limited by the locations of wells. The distribution of wells in the Seaside Groundwater Basin is extremely uneven. Moving production wells inland would smooth out and redistribute the coastal area cone of depression, resulting in less associated risk of seawater intrusion

and allow more efficient access to *Usable Stored Groundwater* in the Northern Inland subarea.

2.4.2 QUANTITATIVE ESTIMATES OF GROUNDWATER STORAGE

2.4.2.1 TOTAL STORED GROUNDWATER

The *Total Stored Groundwater* in the Seaside Groundwater Basin has been estimated in several previous technical studies and by MPWMD as part of their basin monitoring program. These estimates relied on various different assumptions, and areas, so the values may not be strictly comparable to each other. However, the method employed by all storage estimates is similar: it is calculated as the product of a geographic area, a vertical distance between two water-level surfaces, and a storage coefficient.

Table 1 summarizes previous estimates of *Total Stored Groundwater*. Those estimates that included the whole Seaside Groundwater Basin resulted in a range of groundwater in storage of between 439,000 and 730,200 acre-feet. The table also provides some of the key assumptions and parameter values used to develop the estimates. Of the different assumptions used, the greatest source of discrepancy among the estimates on Table 1 stems from the use of different geographic areas for the analysis.

Table 1: Previous Estimates of Seaside Groundwater Basin Groundwater in Storage

Investigation	Geographic Area: Name	Geographic Area: Size (ac)	Aquifer	Total Groundwater in Storage: Water-Level Range Defining Storage Volume: Upper	Total Groundwater in Storage: Water-Level Range Defining Storage Volume: Lower	Average Saturated Thickness (ft)	Gross Aquifer Volume (ac-ft)	Storage Coefficient	Storage Capacity (ac-ft)	Usable Groundwater in Storage: Lower Water-Level Range	Usable Groundwater in Storage: Storage Capacity (ac-ft)
K. S. Muir (1982)	Storage unit 1[1]	6,200	All	Fall 1979	Top of Monterey Fm.?	550	3,410,000	0.12	409,200	Sea level	170,000
	Storage unit 2[1]	5,700	All	Fall 1979	Top of Monterey Fm.?	350	1,995,000	0.12	239,400	Sea level	60,000
	Storage unit 3a[1]	2,000	All	Fall 1979	Top of Monterey Fm.?	200	400,000	0.12	48,000	Sea level	5,000
	Storage unit 3b[1]	1,400	All	Fall 1979	Top of Monterey Fm.?	200	280,000	0.12	33,600	Sea level	4,000
	Total	15,300					6,085,000		730,200		239,000
Converse Consultants (1985)	Southeast part of Northern Inland Subarea	3,840	SM	Top of Santa Margarita	Bottom of Santa Margarita	200	768,000	0.12	92,000	Bottom of Santa Margarita	92,000
Staal, Gardner & Dunne, Inc. (May 1987)	East[2]	4,400	All	Spring 1987	Top of Monterey Fm.	450	1,980,000	0.12	237,600		
	Central[2]	3,900	All	Spring 1987	Top of Monterey Fm.	250	975,000	0.12	117,000		
	Southern Subbasin[3]	940	All	Spring 1987	Top of Monterey Fm.	300	282,000	0.12	33,800	Sea level	2,900
	Northern Coastal										
	North Central[4]	1,400	All	Spring 1987	Top of Monterey Fm.	300	420,000	0.12	50,400		
	Northern Subbasin[5]	970	All	Spring 1987	Top of Monterey Fm.	300	291,000	0.12	34,900	Sea level	1,800
	Offshore	3,400	PR	Spring 1987	Top of Monterey Fm.(?)	200	680,000	0.12	81,600		
	Total	11,610					4,628,000		555,300		4,700
Staal, Gardner & Dunne, Inc. (August 1990)	East[6]	3,400	All	Spring 1984	Top of Monterey Fm.	450	1,530,000	0.12	183,600		
	Central[7]	3,790	All	Spring 1984	Top of Monterey Fm.	250	948,000	0.12	113,800		
	Southern Subbasin[8]	1,290	All	Spring 1984	Top of Monterey Fm.	300	387,000	0.12	46,400	Sea level	3,000
	Northern Coastal[9]	790	All	Spring 1984	Top of Monterey Fm.	400	316,000	0.12	37,900		
	Fort Ord[10]	1,300	All	Spring 1984	Top of Monterey Fm.	500	650,000	0.12	78,000	Sea level	3,250
	Offshore Southern	680	PR	Spring 1984	Top of Monterey Fm.	100	68,000	0.12	8,200		
	Offshore Northern and Ft. Ord	1,640	All	Spring 1984	Top of Monterey Fm.(?)	500	820,000	0.12	98,400		
	Total	11,250					4,719,000		566,300		6,250
CH2M-HILL (2004)	Coastal subareas	?	All	1963	Top of Monterey Fm.	Varies (contoured surfaces)	1,633,000	0.09	147,000		
	Entire onshore basin	14,000	All	1963	Top of Monterey Fm.	Varies (contoured surfaces)	5,378,000	0.09	484,000		
	Coastal subareas	?	All	2002	Top of Monterey Fm.	Varies (contoured surfaces)	1,633,000	0.09	147,000		
	Entire onshore basin	14,000	All	2002	Top of Monterey Fm.	Varies (contoured surfaces)	4,878,000	0.09	439,000		

Notes:

1 Muir's storage units 1 and 2 cover the eastern and central halves of the combined "Northern Inland" and "Laguna Seca" subareas of Fugro (1997), with minor external boundary differences. Storage units 3a and 3b together cover the coastal subareas of Fugro (1997), but the dividing line is very different from the boundary between the "Southern Coastal" and "Northern Coastal" subareas.

[2] SGD (1987) "East" and "Central" Subbasins are together approximately equivalent to the "Northern Inland Subarea" of subsequent studies.

[3] SGD (1987) "Southern Subbasin" corresponds to the "Southern Coastal Subarea" of subsequent studies.

[4] SGD (1987) "North Central Subbasin" corresponds to the "Fort Ord Subarea" of Fugro (1997) and is included in the "Northern Coastal" subarea of Yates et al (2005).

[5] SGD (1987) "Northern Subbasin" corresponds to the "Northern Coastal Subarea" of Fugro (1997) and is included in the "Northern Coastal" subarea of Yates et al (2005)

[6] Decreased from 1987 area based on updated hydrogeologic information.

[7] Decreased from 1987 area based on updated hydrogeologic information.

[8] Boundary between Southern Coastal and Laguna Seca subareas farther inland than in 1987 study.

[9] Corresponds to the "Northern Coastal Subarea" of Fugro (1997).

[10] Corresponds to the "Fort Ord Subarea" of Fugro (1997).

2.4.2.2 USABLE STORED GROUNDWATER

Current estimates of *Usable Stored Groundwater* were developed for this report using an approach similar to those used in previous investigations. As mentioned previously, storage was calculated as the product of a geographic area, a vertical distance between two water-level surfaces, and a storage coefficient. Two types of storage coefficients were used: specific yields and storativities. Specific yield (or drainable porosity) is the volume of water an unconfined aquifer will yield when all the water is allowed to drain out of it under the forces of gravity. Storativity is a measure of the volume of water a confined aquifer releases per unit surface area of the aquifer per unit change in head. Both specific yields and storativities are measured as percentages of the total aquifer volume. Storativities are orders of magnitude smaller than specific yields.

Different geographic areas were used for the shallow and deep aquifers in the northern subbasin, reflecting the different locations of the flow divides in those aquifers that define the northeast boundary of the Seaside Groundwater Basin (Figure 5 and Figure 6). The southern boundary is the same for both aquifers.

A specific yield of 0.0805 and a storativity of 0.0005 were used in the storage calculations. The specific yield value was obtained by calibrating a groundwater model to long-term water-level changes (Yates et al., 2002) and is similar to the value obtained by CH2M HILL (2004) using a different method. The storativity value was used to calculate *Useable Stored Groundwater* for the confined deep aquifer; and a storativity-plus-specific-yield storage coefficient was used to calculate *Useable Stored Groundwater* for the shallow aquifer.

Several elevation surfaces were used to calculate components of storage, as follows:

- **Ghyben-Herzberg level.** This water-level surface reflects the head needed in onshore aquifers to compensate for the greater density of seawater. A map was prepared showing the elevations of the bottom of the screened intervals in all production wells near the coast. These elevations were contoured to create a smooth envelope extending downward from sea level at the coastline, passing below all of the production wells, and rising symmetrically back to sea level east of the

coastal wells. This envelope defined the depth to which seawater needs to be repelled to prevent impacts to these wells. These elevation contours were converted to a minimum Ghyben-Herzberg water-level surface by dividing the elevations by 40. The result is shown in Figure 13. The Paralta Well is the deepest well (477 feet below mean sea level) and is the reason for the observed mound in elevations on Figure 13. Although there are few coastal production wells near the northern edge of the Seaside Groundwater Basin, a minimum elevation of +2 feet msl was included in that area to provide a small amount of protection against density-driven inflow around the edge of the main pumping center. Note that because this map was based on the depths of production wells, the elevations on this map are only protective of these production wells, and do not protect against seawater intrusion throughout the Seaside Groundwater Basin. The purpose of the map was to produce an initial water surface that could be used only to estimate *Useable Stored Groundwater*. In order to protect the entire Seaside Groundwater Basin, this map must be extended to reflect the depths of all aquifers that should be protected against seawater intrusion. Using the protective elevations for all aquifers will result in a surface that would be generally higher near the coast than the one depicted on Figure 13.

Pre-development water table. This water surface is intended to represent the highest water levels that would occur under conditions of natural recharge and no groundwater pumping. This surface was estimated by constructing a simple groundwater model. Contours of the resulting simulated groundwater surface are shown in Figure 14.

- **Fall 2007 groundwater elevations.** These are contours of the groundwater elevations described in Section 2.2 - Groundwater Levels. The fall 2007 contours approximate current conditions.

A graphical representation of the relationship between the various surfaces is shown in Figure 15 . The amount of *Total Stored Groundwater* was calculated by subtracting two surfaces (i.e., predevelopment and Ghyben-Herzberg level; and fall 2007 and Ghyben-Herzberg level) and multiplying the resulting gross volumes by the storage coefficient. Table 2 lists the amount of *Usable Stored Groundwater* under pre-development and fall 2007 conditions, subtotaled by aquifer and grouped subareas.

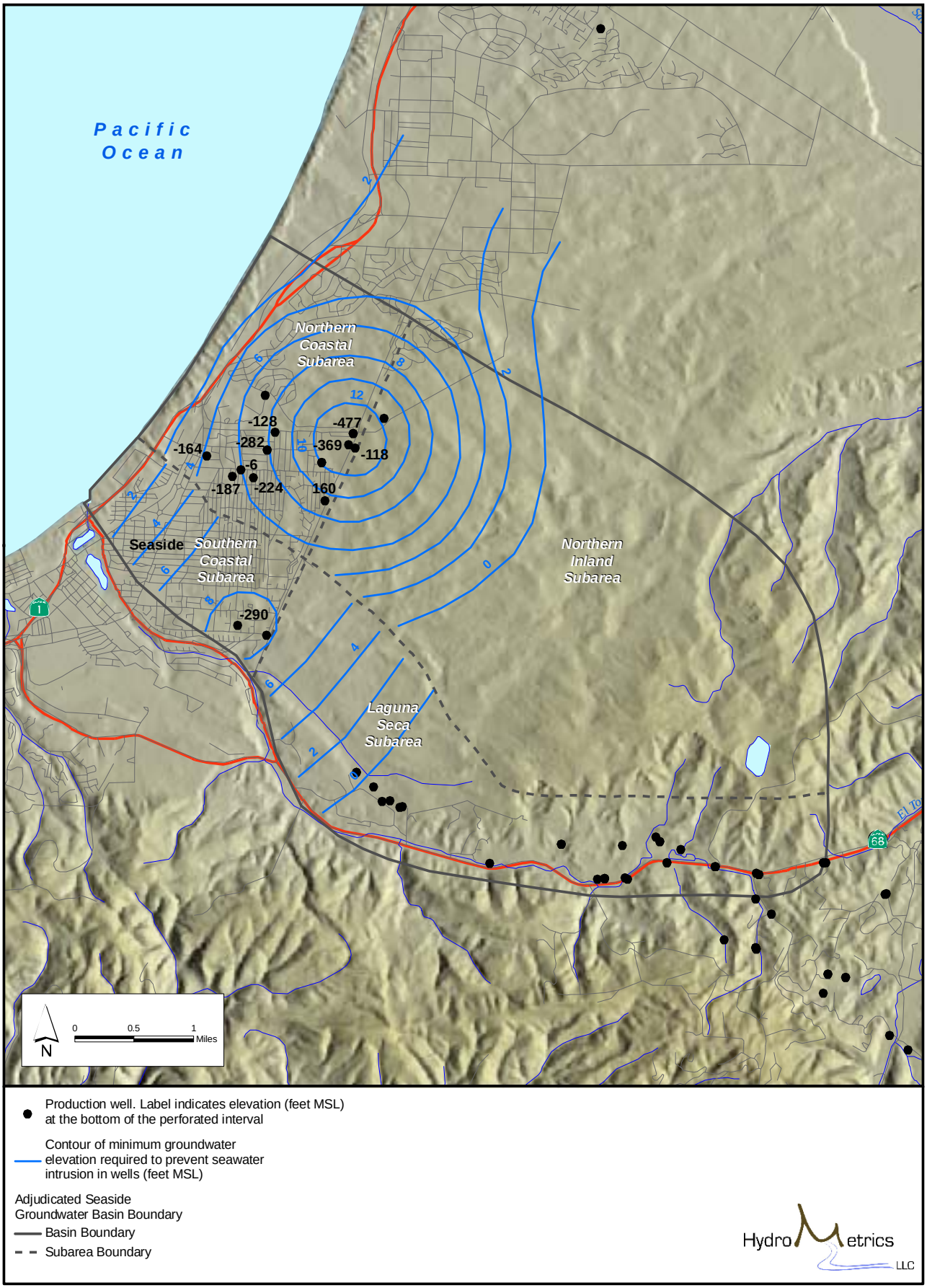


Figure 13: Ghyben-Herzberg Protective Groundwater Levels Based on Well Depths

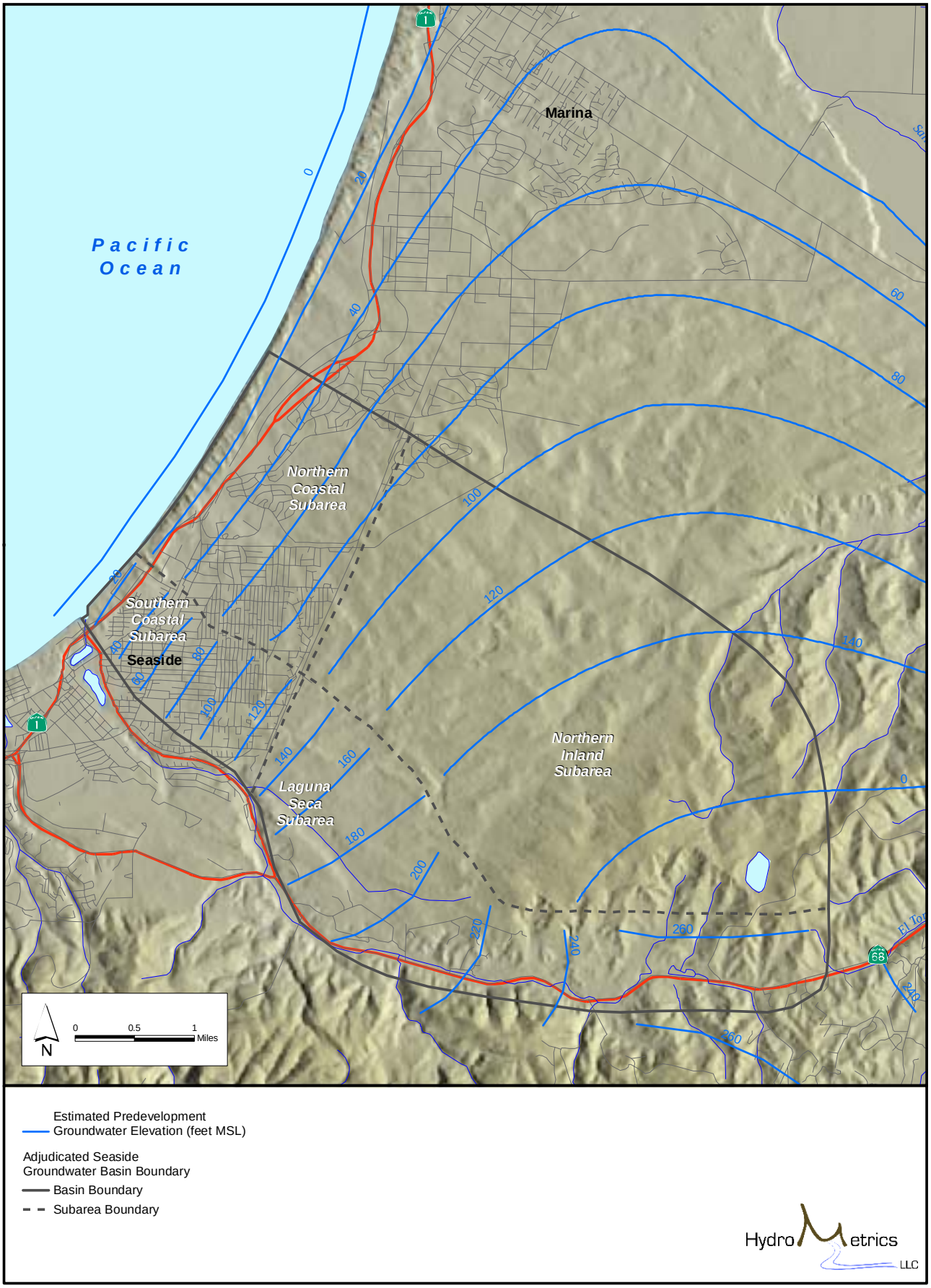


Figure 14: Estimated Pre-Development Groundwater Levels

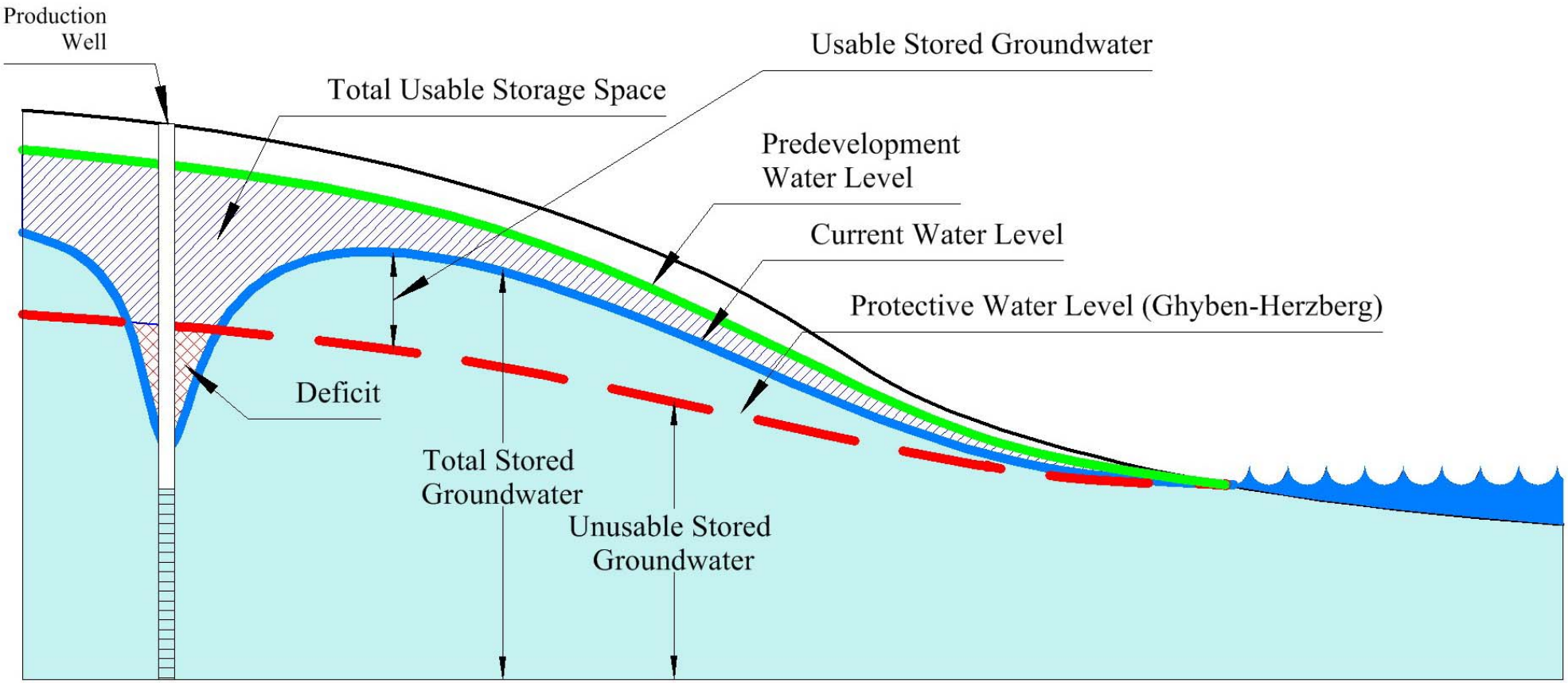


Figure 15: Definition of Total Usable Storage Space

Table 2: Useable Stored Groundwater under Predevelopment and Fall 2007 Conditions Based on the Ghyben-Herzberg Level (GHL)

Groundwater Surface	Coastal and Northern Inland Subareas		Laguna Seca Subarea		Total	
	Storage above GHL	Deficit below GHL	Storage above GHL	Deficit below GHL	Storage above GHL	Deficit below GHL
	(acre-feet)					
Shallow Aquifer						
Predevelopment	60,919	0	64,526	0	125,445	0
Fall 2007	27,332	2,102	44,409	0	71,741	2,102
Deep Aquifer						
Predevelopment	549	0	401	0	950	0
Fall 2007	198	65	260	0	458	65
Total						
Predevelopment	61,468	0	64,926	0	126,394	0
Fall 2007	27,530	2,167	44,669	0	72,199	2,167

Two significant conclusions can be drawn from these data:

- Over 99% of *Usable Stored Groundwater* is in the shallow aquifer because the specific yield value is 160 times larger than the confined storativity estimated for the deep aquifer.
- The amount of *Usable Stored Groundwater* in fall 2007 is slightly more than half of the pre-development amount.

2.4.2.3 TOTAL USABLE STORAGE SPACE

Similar to *Usable Stored Groundwater* calculated above, the *Total Usable Storage Space* was calculated as the product of a geographic area, a vertical distance between two water-level surfaces, and a storage coefficient. The lower surface for calculating the *Total Usable Storage Space* is the current groundwater level above the Ghyben-Herzberg protective level. The upper surface for calculating the *Total Usable Storage Space* is the estimated pre-development surface. It is possible to inject groundwater above this pre-development surface, but a more accurate

groundwater model would be required to estimate how much of the injected water could be recovered. Figure 15 shows the *Total Usable Storage Space* in blue diagonal lines. Unusable storage space, below the protective water levels, is shown with a red hatch and is referred to as deficit.

Based on the concepts presented above and illustrated in Figure 15, the *Total Usable Storage Space* can be estimated from data in Table 2. The *Total Usable Storage Space* is arrived at by calculating the difference between the total groundwater in storage under pre-development conditions with the *Total Stored Groundwater* in 2007. The resultant volumes are presented in Table 3.

Table 3: Total Usable Storage Space Using Ghyben-Herzberg Surface (acre-feet)

		Pre-development	**Fall 2007**	**Difference**
Coastal and Northern Inland Subareas	Storage	61,470	27,530	33,940
	Deficit	0	2,170	-2,170
Laguna Seca Subarea	Storage	64,930	44,670	20,260
	Deficit	0	0	0
Total Basin	Storage	126,400	72,200	54,200
	Deficit	0	2,170	-2,170

Values obtained from Table 2 are rounded to the nearest 10

Combining the storage and deficit numbers in Table 3 results in the following:

Total Usable Storage Space in the
Coastal and Northern Inland Subareas ..... 31,770 acre-feet
Total Usable Storage Space in the Laguna Seca Subarea ..... 20,260 acre-feet
Total Usable Storage Space
in the entire Seaside Groundwater Basin ..... 52,030 acre-feet

For the purpose of allocating *Total Usable Storage Space*, the Watermaster has combined the *Total Usable Storage Space* of the Northern Inland Subarea with the *Total Usable Storage Space* of the Coastal Subareas, and allocated all of this space to the Coastal Subarea producers. This approach mirrors the way safe yield is allocated in the Amended Decision, which implicitly combines the Natural Safe Yield of the Northern Inland Subarea with the Natural Safe Yield estimate of the Northern and Southern Coastal Subareas.

Each producer's storage allocation is based on the amount of *Total Usable Storage Space* available in the Seaside Groundwater Basin. An initial estimate of storage allocation is provided in Table 4. Groundwater production is currently allocated in accordance with Sections III.B.2 and III.B.3 of the Amended Decision. This means that the producers listed in Table 2 of the Amended Decision have elected to participate in an Alternative Production Allocation at this time, and therefore do not currently have storage rights in the Basin as per the Amended Decision (Section III.B.3.b). Those producers are removed from the current allocation of storage space, and the remaining producers' allocation percentages are increased from the Standard Production Allocations (Table 1 of the Amended Decision) on a pro-rata basis to equal 100%. Alternative Producers may, however, subject to the provisions of the Amended Decision, convert to Standard Producers and thereby acquire storage rights. This is illustrated in the right-hand column of Table 4.

Total Usable Storage Space is a dynamic volume that changes with changing groundwater levels in the Seaside Groundwater Basin. The Watermaster is required under the Amended Decision to recalculate *Total Usable Storage Space* and adjust the allocation as needed. In particular, the estimates should be revised as improved tools for estimating storage space become available.

Table 4: Initial Allocation of Usable Storage Space

Producer	Current Allocation (Using Table 1 of Amended Decision)		Allocation if all Alternative Production Allocations are Converted to Standard Production Allocations (Using Table 1 of Amended Decision)	
	Allocation Percentage	Useable Storage Allocation (acre-feet)	Allocation Percentage	Useable Storage Allocation (acre-feet)
Coastal and Northern Inland Subareas				
California American Water	90.60%	28,784	77.55%	24,638
City of Seaside (Municipal)	7.43%	2,361	6.36%	2,021
City of Seaside (Golf Courses)*	0%	0	10.47%	3,326
City of Sand City*	0%	0	0.17%	54
Granite Rock Company	0.70%	222	0.60%	191
SNG*	0%	0	2.89%	918
DBO Development No. 27	1.27%	403	1.09%	346
Calabrese*	0%	0	0.27%	86
Mission Memorial Park*	0%	0	0.60%	191
TOTAL	**100%**	**31,770**	**100%**	**31,770**
Laguna Seca Subarea				
California American Water	100.00%	20,260	45.13%	9,143
Pasadera Country Club*	0%	0	22.65%	4,589
Bishop*	0%	0	28.88%	5,851
York School*	0%	0	2.89%	586
Laguna Seca County Park*	0%	0	0.45%	91
TOTAL	**100%**	**20,260**	**100%**	**20,260**

* Designates producer that is currently an Alternative Producer and therefore has no current storage allocation.

2.4.3 Recent Changes in Storage

The change in *Total Stored Groundwater* from fall 2002 to fall 2007 was estimated in order to compare it with the groundwater budget presented in the next subsection. For the northern subbasin, storage change was estimated by subtracting the 2002 water-level surface (Yates et al., 2005) from the 2007 water-level surface for the shallow and deep aquifers and multiplying the resulting volumes by their respective storage coefficients. This procedure resulted in an estimated net decrease in storage over the 5-year period of 3,650 acre-feet for the Northern Inland Subarea, or an average annual *Total Stored Groundwater* change of -730 acre-feet per year. The Northern Coastal Subarea portion of this subbasin had a decline in storage of -850 acre-feet over the 5-year period, or an average annual *Total Stored Groundwater* change of -170 acre-feet per year.

The storage change in the Southern Coastal subarea was calculated by multiplying the average water-level change at the Kmart and Fort Ord 4-shallow wells (+1.75 ft), the land surface area (1,052 acres) and storage factor (0.0805) to obtain a net storage increase during 2002-2007 of 148 acre-feet, or an average annual storage change of +30 acre-feet per year. The cause of this rise is unknown.

The method used to estimate the change in *Total Stored Groundwater* in the Northern Subbasin proved to be unsuitable for the Laguna Seca Subarea because of a large degree of local spatial variability in water levels at clusters of wells, and uncertainty in extrapolating contours to the edges of the basin. An alternative method was developed that takes advantage of the results of a previous groundwater modeling study of the Laguna Seca Subarea (Yates et al., 2002). The simulated annual changes in *Total Stored Groundwater* between 1995 and 2001 were compared with annual changes in measured water levels at five wells (Figure 16`). The resulting linear regression equation was used to estimate net *Total Stored Groundwater* change between fall 2002 and fall 2007 in the Laguna Seca Subarea. The average water-level change in the Laguna Seca wells between 2002 and 2007 was -13.42 feet, corresponding to an estimated *Total Stored Groundwater* change of -2,190 acre-feet, or an average annual *Total Stored Groundwater* change of -440 acre-feet per year.

To summarize, for the period between fall 2002 and fall 2007, the annual change in *Total Stored Groundwater* for each of the subareas was:

Coastal and Northern Inland Subareas ..... -870 acre-feet per year
Laguna Seca Subarea ..... -440 acre-feet per year
Entire Seaside Groundwater Basin..... -1,310 acre-feet per year

Note that the estimate presented above is preliminary only and is based on best available data, which is limited in some areas.

The decline in *Total Stored Groundwater* of 1,310 acre-feet per year since 2002 does not represent the amount of over-production in the Seaside Groundwater Basin. Over-production has been estimated as 2,600 acre-feet per year. The overproduction accounts for all basin recharge and discharge, and is approximately equal to the 1,310 acre-feet per year of storage loss plus the approximately 1,000 acre-feet per year needed to prevent seawater intrusion.

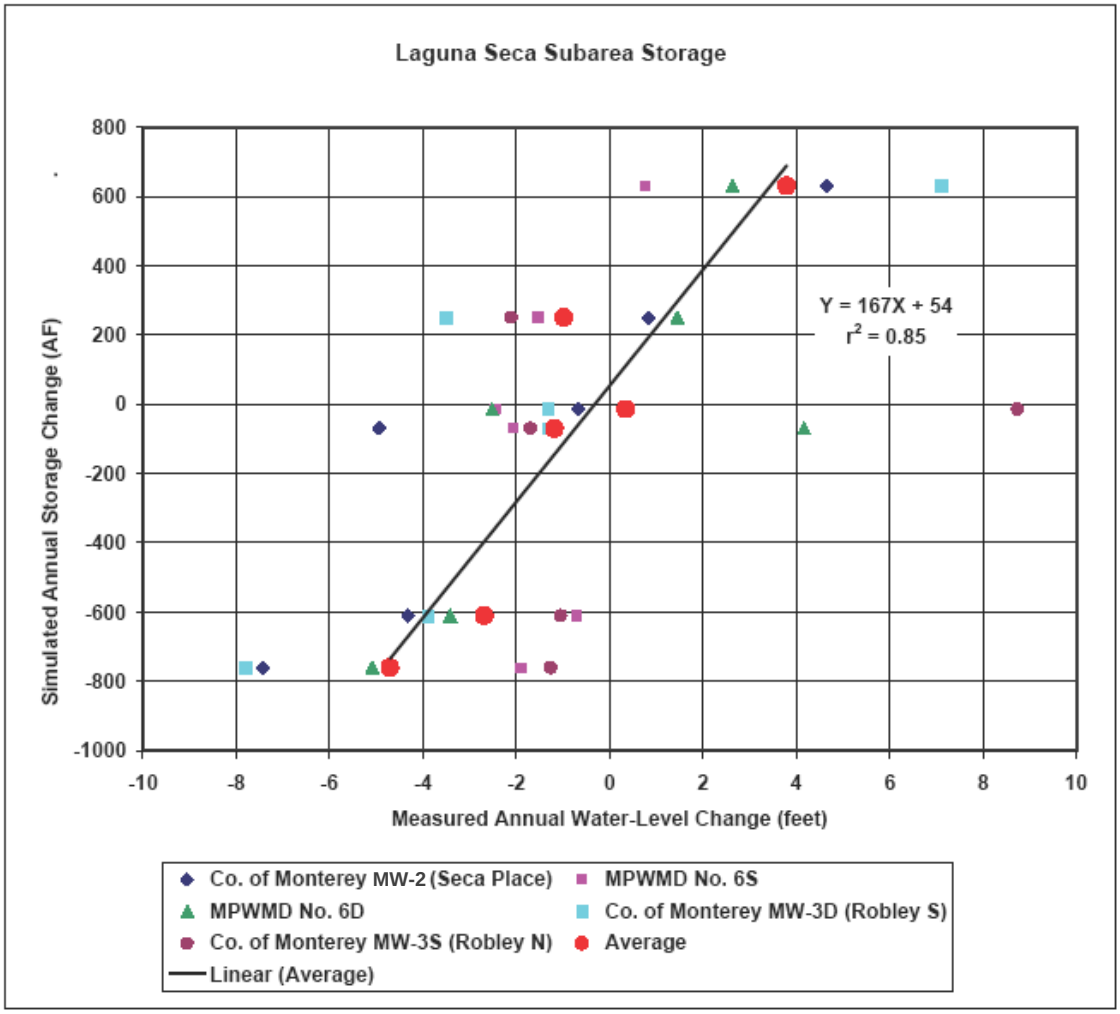


Figure 16: Relationship between Measured Water Levels and Simulated Change in Storage in the Laguna Seca Subarea

2.4.4 Storage Efficiency

Storage efficiency refers to the percentage of *Usable Stored Groundwater* in the Seaside Groundwater Basin that can be recovered at a later date; often a number of years after the water was stored. The Amended Decision notes that storage may result from recharge of non-native water, a producer's carryover (i.e., allocated production that is not extracted during a particular water year), and in-lieu storage from non-native water purchased by the Watermaster and used to reduce over-production. Inefficiency arises when stored groundwater flows out of the Basin to adjacent basins, creeks or the ocean, or when groundwater is consumed by vegetation.

Presently, the only outflows are along the ocean boundary and are considered, based on our current hydrogeologic understanding, to be relatively small. Outflow from the Southern Coastal Subarea is through alluvial deposits that are relatively thin at the coastline. Outflow from the Northern Coastal Subarea is only from a narrow coastal strip of the shallow aquifer

The storage efficiency of *Usable Stored Groundwater* in the Seaside Groundwater Basin depends on location, method of storage, groundwater levels and flow direction, nearby pumping, and the amount of time before extraction of the stored water. For example, water injected into the northern subbasin inland of Highway 1 under current hydraulic conditions could be stored and extracted in the short-term with a high percentage of efficiency. However, if hydraulic conditions change (i.e., pumping in Seaside is reduced), the stored water may flow towards the Salinas Valley thereby reducing storage efficiency. Another example of storage efficiency is when recharge is carried out by surface percolation. Some of the recharged water may remain unavailable to wells for several years as it lingers in transit through the unsaturated zone, and some may leave the Basin as outflow through the shallow Aromas Sands. A reliable tool such as a groundwater flow model is necessary to estimate storage efficiency numbers, and to develop storage efficiencies for individual supplemental water projects based on storage location and method.

2.5 GROUNDWATER BUDGET

A groundwater budget is an accounting of all the inflows and outflows to a groundwater basin. The groundwater budget developed by Yates et al., (2005) was updated to reflect conditions observed between 2003 and 2007. The revised water budget is shown in Table 5. Several minor budget entries had originally been developed as average annual values, and those values were retained in the updated budget. This includes percolation from streams, recharge from rainfall and irrigation, recharge from pipe leaks and recharge from septic systems. The average climatic conditions between 2003 and 2007 were close to the long-term average annual values.

Differences between Table 5's water budget and the water budget originally developed by Yates, et al. (2005) are:

- Amounts pumped and injected,
- Flow from inland subareas to coastal subareas,

- Inflows from beneath the ocean to the Northern Coastal Subarea, and
- Outflows from the coastal subareas to beneath the ocean.

Table 5: Estimated Average Annual Groundwater Budget Water Years 2003 through 2007, units in acre-feet per year

Recharge Source	Northern Coastal Subarea	Northern Inland Subarea	Southern Coastal Subarea	Laguna Seca Subarea	Total
Inflows					
Percolation from streams	0	0	0	0	0
Rainfall and irrigation deep percolation					
Runoff from impervious areas	190	10	140	40	380
Irrigated areas	470	20	150	130	770
Nonirrigated areas	250	1,050	100	530	1,930
Pipe leaks					
Water pipes	160	10	120	80	370
Sewer pipes	50	0	40	10	100
Septic systems	0	0	0	20	20
Injection wells	230	0	0	0	230
Groundwater inflow					
From onshore subareas	2,850	0	450	180	3,480
From offshore area	100	0	0	0	100
Total inflows	*4,300*	*1,090*	*1,000*	*990*	*7,380*
Outflows					
Wells	4,250	0	160	1,000	5,410
Groundwater outflow					
To onshore subareas	0	2,060	790	450	3,300
To offshore area	70	0	30	0	100
Total outflows	*4,320*	*2,060*	*980*	*1,450*	*8,810*
Storage Change					
Based on Inflows-Outflows	-20	-970	20	-460	-1,430
Based on Water-Level Change*	-170	-730	30	-440	-1,310

* Storage change based on measured groundwater levels is included in this table as a common-sense check on the inflow-outflows approach. The results from the two approaches compare thereby providing greater confidence in the values.

See Yates, et al., (2005) for descriptions of each water budget component.

2.5.1 GROUNDWATER RECHARGE

Based on climate data, groundwater recharge estimates were developed for the period between 2003 and 2007. The recharge estimates include both primary recharge and secondary recharge components. The primary recharge components include percolation from rainfall and infiltration below stream beds. The secondary recharge components include irrigation return flows, leaks from water pipes and sewer pipes, and septic system flows. These secondary recharge components were based on estimates included in Yates et al. (2005). Groundwater recharge from all of these components averaged 3,570 acre-feet per year.

Groundwater injection data were obtained from MPWMD, and represent the annual averages for water years 2003-2007. The average groundwater injection was 230 acre-feet per year.

2.5.2 BOUNDARY FLOWS

Flows across the ocean boundary for the coastal subareas were calculated using Darcy's Law. Gradients perpendicular to the coastline are relatively flat, so the boundary flows were small for any reasonable estimate of horizontal hydraulic conductivity. Hydraulic conductivity values of 4 feet per day for the shallow aquifer, and 8 feet per day for the deep aquifer were used in the calculations, reflecting values that best matched observed changes in storage, and the shallow/ deep aquifer hydraulic conductivity ratio from the calibrated Laguna Seca groundwater flow model (Yates et al., 2002). The use of lower hydraulic conductivity values decreased the estimated ocean boundary flows relative to values presented by Yates et al. in 2005.

In the Northern Coastal Subarea, the Darcy calculations estimated an annual inflow from beneath the ocean of approximately 100 acre-feet per year, and an annual outflow to beneath the ocean of approximately 70 acre-feet per year. The inflow from beneath the ocean occurs in the deep aquifer, and the outflow to the ocean occurs in the shallow aquifer. The net ocean boundary flow in the Northern Coastal Subarea is 30 acre-feet per year flowing onshore from beneath the ocean.

Water levels in the Southern Coastal Subarea and western half of the Laguna Seca Subarea remained nearly unchanged from 2002 to 2007. Inflow from the

Laguna Seca Subarea to the Southern Coastal Subarea was assumed to equal the simulated outflow from the calibrated groundwater model, i.e., 450 acre-feet per year. Of the 820 acre-feet per year that flows out of the Southern Coastal Subarea, 30 acre-feet per year (calculated using Darcy's Law) flows out to the ocean and the remainder is assumed to flow northwards across the subbasin boundary into the pumping trough in the Northern Coastal Subarea.

2.5.3 GROUNDWATER PUMPING AND OPERATING YIELD

Groundwater pumping data between 2003 and 2008 were compiled by the Watermaster and MPWMD. Between Water Year 2003 and Water Year 2008, an average of 5,400 acre-feet per year were extracted from the Seaside Groundwater Basin. The annual pumping volumes for 2006 through 2008 are shown on Figure 17. This figure also compares the recent annual pumping with the court mandated Operating Yield, and the estimated Natural Safe Yield values included in the Amended Decision

The current court mandated Operating Yield is 5,600 acre-feet per year. The Amended Decision calls for the Operating Yield to be reduced to 5,180 acre-feet per year on January 1 2009, to 5,040 acre-feet per year on October 1 2009 and by 10 percent every October 1 triennially until the Operating Yield is the equivalent of the Natural Safe Yield (Figure 17). The following four actions provided in the Amended Decision would be cause for the triennial reduction in pumping to cease for the duration of the described action:

- The Watermaster has secured and is adding an equivalent amount of non-native water to the Seaside Groundwater Basin on an annual basis; or

- The Watermaster has secured reclaimed water in an equivalent amount and has contracted with one or more of the Producers to utilize said water in lieu of their Production Allocation, with the Producer agreeing to forego their right to claim a Stored Water Credit for such forbearance; or

- Any combination of these which results in the decrease in production of Native Water required by this decision; or

- The Watermaster has determined that groundwater levels within the Santa Margarita [deep] and Paso Robles [shallow] aquifers are at sufficient levels to ensure a positive offshore gradient to prevent seawater intrusion.

Note that Figure 17 assumes the triennial 10 percent pumping reduction takes place provided none of the actions described above occur.

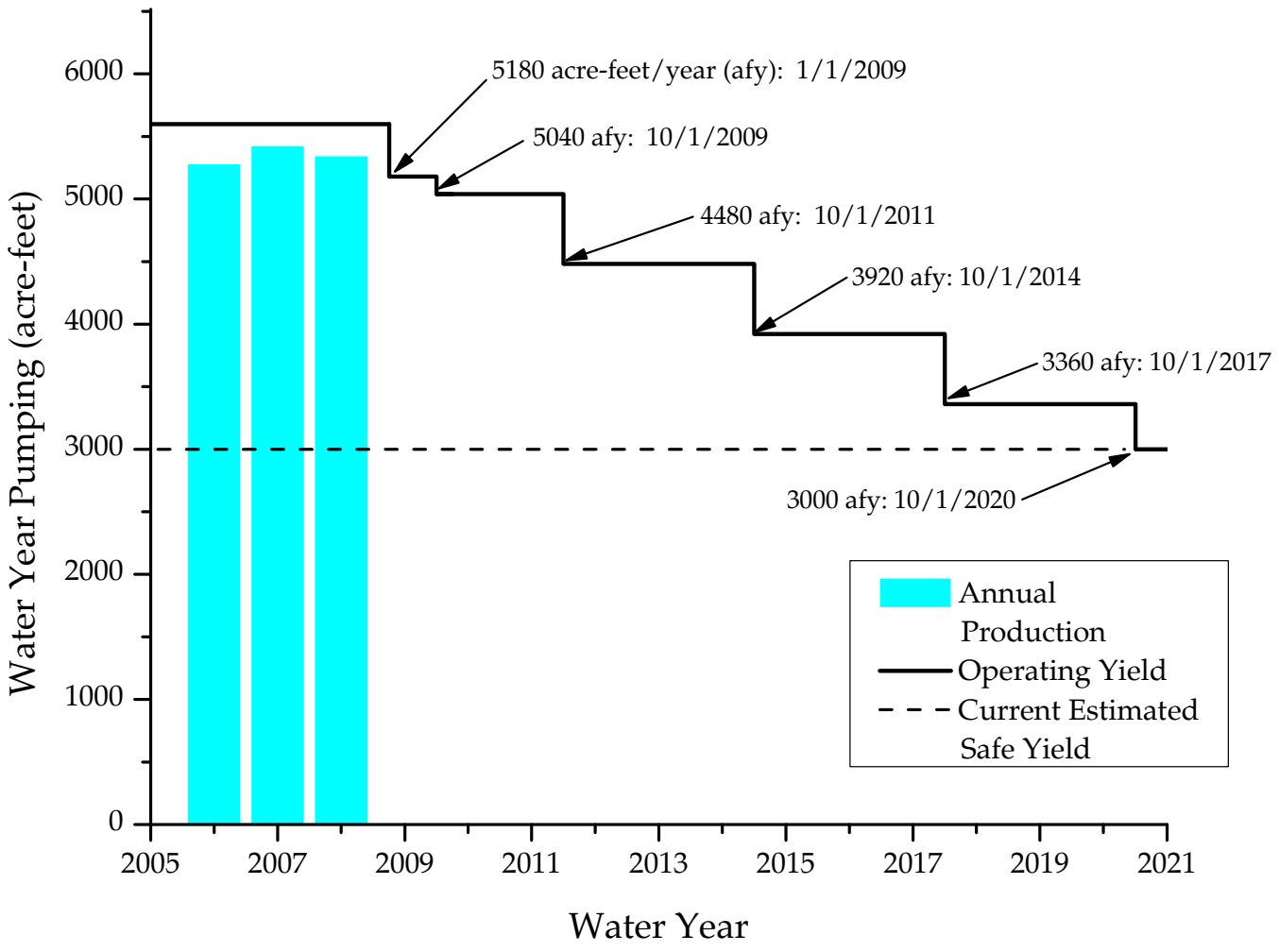


Figure 17: Annual Groundwater Extractions and Operating Yield

2.5.4 CHANGE IN STORAGE

As shown in Table 5 the estimated annual groundwater inflows into the Seaside Groundwater Basin between 2002 and 2007 averaged 7,380 acre-feet per year; and total outflows averaged 8,810 acre-feet per year. The net change in *Total Stored Groundwater* basinwide calculated by adding all inflows and outflows was an annual net loss of 1,430 acre-feet per year, calculated as:

$$7{,}380 - 8{,}810 = -1{,}430 \text{ acre-feet per year.}$$

This estimate compares well with the net *Total Stored Groundwater* change of -1,310 acre-feet per year estimated from water levels and storage coefficients, as discussed in Section 2.3.3. As noted earlier, this change in storage is not equal to the over-production in the Seaside Groundwater Basin.

2.6 REVIEW OF NATURAL SAFE YIELD

The Amended Decision stated that the Natural Safe Yield of the Basin is between 2,581 and 2,913 acre-feet per year, and was rounded up to 3,000 acre-feet per year. This range includes the estimate presented by Yates et al. (2005), which was developed using methods similar to those used here.

The recent Natural Safe Yield of the Seaside Groundwater Basin, for the last five years, is shown in Table 6. The estimated safe yield using recent data is 2,310 acre-feet per year for the Coastal and Northern Inland Subareas, and 540 acre-feet for the Laguna Seca Subarea, with an estimate of 2,850 acre-feet per year for the entire Seaside Groundwater Basin. This estimate of recent safe yield is within the estimate range specified in the Amended Decision. Therefore, until modeling enables more refined analyses to be made, the 3,000 acre-feet per year initial Natural Safe Yield value in the Amended Decision should continue to be used.

Table 6: Estimated Recent Natural Safe Yield of the Seaside Groundwater Basin, 2002-2007, units in acre-feet per year

Yield Components and Adjustments[1]	**Coastal and Inland Subareas**	**Laguna Seca Subarea**	**Total**
Current pumping	4,410	1,000	5,410
Storage change[2]	-970	-460	-1,430
Current ocean boundary inflow	100	0	100
Injected water	-230	0	-230
Yield (assuming no outflow to the ocean)	3,310	540	3,850
Ocean boundary outflow needed to prevent seawater intrusion[3]	1,000	0	1,000
Natural Safe Yield	2,310	540	2,850

Note: values are rounded to nearest 10.

[1] The values for pumping, storage change and ocean boundary flows are from the subarea groundwater budgets in Table 5.
[2] The estimate of storage change equals the difference between inflows and outflows.
[3] Yates et al. (2005).

2.7 STATE OF THE BASIN AND MATERIAL INJURY

Over the last five years, groundwater levels in the Seaside Groundwater Basin continued the downward trends documented in previous studies. This is reflected in the annual estimated loss of *Total Stored Groundwater* of between 1,310 and 1,430 acre-feet per year. While no operational problems have been reported as a result of these lowering groundwater levels, this trend is not sustainable.

Lower groundwater levels do not by themselves define material injury. Section III.A.15 of the Amended Decision states:

> *"Material Injury means a substantial adverse physical impact to the Seaside Groundwater Basin or any particular Producer(s), including but not limited to: seawater intrusion, land subsidence, excessive pump lifts, and water quality degradation. Pursuant to a request by any Producer, or on its own initiative, Watermaster shall determine whether a Material Injury has occurred, subject to a review by the Court as provided for in Section III.N."*

No seawater intrusion has been detected in any monitoring or production wells completed in the shallow or deep aquifers in the Seaside Groundwater Basin. Furthermore, land subsidence has not been observed. Therefore, it could be concluded that the Seaside Groundwater Basin has not suffered Material Injury.

Individual producers may suffer Material Injury based on impacts to individual wells. The following conditions are examples of Material Injury to an individual well, but each claim should be considered on a case-by-case basis by the Watermaster:

- Seawater intrusion.
- Pumping groundwater levels falling below the top of a well screen that was previously submerged during pumping. Note, this must be shown to result from a general lowering of the piezometric head, not loss of well efficiency.
- Pumping groundwater levels falling below the pump intake. Note, this must be shown to result from a general lowering of the piezometric head, not loss of well efficiency. Furthermore, it must be shown that the pump intake is at a reasonable depth, and lowering the pump intake is infeasible.

There are no reports that any of the above situations have occurred in the Seaside Groundwater Basin. Therefore, it can be concluded that Material Injury has not occurred.

SECTION 3
SUPPLEMENTAL WATER SUPPLIES

This section summarizes water supply projects currently being considered to meet long-term water needs in the Seaside Groundwater Basin. These supplemental supply projects could achieve the goals of the Amended Decision by reducing pumping in the Basin to below the Natural Safe Yield, and providing additional water that can be used to replenish the Basin.

The supplemental supplies listed below have utility beyond offsetting pumping in the Seaside Groundwater Basin. Many of the supplemental supplies provide water to satisfy SWRCB Order No. 95-10, which requires California American Water Company (CAW) to reduce its withdrawal from the Carmel Valley Aquifer and diversions from the Carmel River by approximately 8,500 acre-feet per year (MPWMD, 2006). These supplemental supplies are the same projects that were used to calculate the Watermaster's 2009 Replenishment Assessments.

3.1 REGIONAL CONTEXT

A number of supplemental supply projects are described below. These projects are presented to inform the Watermaster of the range and type of projects that may provide supplemental supply. The feasibility of these projects is being reviewed and considered in several public input processes, most notably, in the Coastal Water Project (CWP) Draft Environmental Impact Report (EIR). The EIR process along with other associated public processes provides opportunities for the Watermaster to have input into which projects may be implemented in the Seaside Groundwater Basin. It is imperative that the Watermaster actively review and comment on the CWP EIR, as well as other documents such as cost opinions for the various projects.

This BMAP was originally designed to provide estimated costs, volumes of water available to the Seaside Groundwater Basin, implementation schedules, and organizational implementation descriptions for each project. However, these details are no longer included because many of these issues will be refined by the CWP EIR, which is due to be released in January 2009.

Although the projects are presented in the following sections individually, some of the individual projects will be included in larger programs and may not be

implemented unless the entire program is implemented. Therefore, the individual projects are grouped below into the associated larger programs to provide context for each project.

3.2 SUMMARY OF AVAILABLE ALTERNATIVES

Various long-term water supply alternatives, and the programs in which they are included, are presented below. A description of each alternative is presented, followed by estimates of the amount of water each alternative would supply.

3.2.1 COASTAL WATER PROJECT ENVIRONMENTAL IMPACT REPORT PROJECTS

CAW proposed the CWP which includes a desalination facility and aquifer storage and recovery within the Seaside Groundwater Basin. The Proponent's Environmental Assessment (PEA) describes the CWP and includes alternative locations and sizes for the desalination facility, including sites at Moss Landing and North Marina, in both local and regional sizes. The individual components that comprise the CWP are described below. The CWP projects described in this section can be implemented individually. The CWP would both provide sufficient water to offset the over-pumping in the Seaside Groundwater Basin and satisfy Order No. 95-10.

3.2.1.1 MOSS LANDING DESALINATION – LOCAL ALTERNATIVE

The Moss Landing Desalination Plant would be located near the Dynegy Moss Landing Power Plant (MLPP). The feedwater supply for the desalination plant would be MLPP's existing seawater intake. Brine would be disposed through the MLPP's existing outfall. This desalination plant will likely be owned and operated by CAW.

This project would provide approximately 10,430 acre-feet per year, and when combined with the Seaside ASR project (described below), would both provide sufficient water to offset the over-pumping in the Seaside Groundwater Basin and satisfy Order No. 95-10. Desalination using seawater as feedwater would ensure a constant water supply with limited water quality variability.

3.2.1.2 Moss Landing Desalination – Regional Alternative

A larger version of the Moss Landing Desalination Plant – Local Alternative is included in the CWP PEA and is referred to as the Regional Alternative. This larger desalination plant is intended to serve many communities in Monterey County including Moss Landing, North Monterey County, and Castroville. This alternative would produce approximately 19,000 acre-feet of water per year. The desalination plant will likely be owned and operated by CAW.

The project would both provide sufficient water to offset the over-pumping in the Seaside Groundwater Basin, and satisfy Order No. 95-10. This project would additionally provide supplemental supply throughout CAW's service area. Desalination using seawater as feedwater would ensure a constant water supply with limited water quality variability.

3.2.1.3 North Marina Desalination – Local Alternative

A North Marina seawater desalination facility is proposed in the PEA as an alternative to the plant located at the MLPP. As described in the PEA, this plant would be owned and operated by CAW in the City of Marina's sphere of influence on Armstrong Ranch. This plant would either include a pipeline to the MLPP to discharge the brine, or use the Monterey Regional Water Pollution Control Agency's (MRWPCA) existing outfall. The plant is closer to end users, potentially resulting in less piping if the MRWPCA outfall option is chosen for brine disposal. The feedwater intake for this plant is a proposed set of coastal slant wells extending under the sea floor.

Currently, the plant is designed to produce up to 10,580 acre-feet per year (RBF, personal communication), and when combined with the Seaside ASR project (described below), would both provide sufficient water to offset the over-pumping in the Seaside Groundwater Basin and satisfy Order No. 95-10. Desalination using mostly seawater as feedwater would ensure a relatively constant water supply with limited water quality variability.

3.2.1.4 Seaside Aquifer Storage and Recovery Project – Phase 1

Aquifer storage and recovery (ASR) is the storage of water in an aquifer during times when water is available, and recovery of the stored water from the same aquifer when it is needed. This project entails MPWMD diverting excess winter

flows from the Carmel River Basin during high flow periods using existing CAW wells. The diverted water is treated to potable drinking water standards and pumped through the CAW distribution system to the Seaside Groundwater Basin, where the water would be injected into MPWMD's ASR wells for recovery during dry periods. Existing infrastructure allows the diversion and transport of river water to the existing ASR sites for injection.

There would be variable supply available for this project, depending on the availability of excess winter flows in the Carmel River. However, it is expected that Phase 1 of the Seaside ASR project can potentially divert up to 2,426 acre-feet per year from December 1st to May 31st, with a maximum extraction of 1,500 acre-feet during peak summer months. There is also potential for expansion in the future which could provide additional water.

3.2.2 MONTEREY REGIONAL WATER SUPPLY PROGRAM PROJECTS

The Monterey Regional Water Supply Program will be included in the CWP EIR as an alternative to the CWP. Together, a group of proposed local projects, which make up the Program, will be considered. This Regional Program would provide water to users in the CAW service area, as well as water users in the Marina Coast Water District (MCWD), Castroville, Moss Landing and North Monterey County. Many of the projects described in this section can only be implemented as part of the larger program. This program has been designed to respond to and satisfy Order No. 95-10 and the Amended Decision.

3.2.2.1 REGIONAL DESALINATION PROJECT

The Regional Desalination Project is the primary component of the Monterey Regional Water Supply Program. The plant would be located on Armstrong Ranch. The plant would use a blend of ocean water and brackish groundwater for the desalination water supply and would be constructed in two phases. The present proposal includes desalination wells located on the inland side of the coastal dunes (Phase 1). Future opportunities for a second line of brackish wells inland of the initial Phase 1 wells will be considered as a part of future phases of the project. The brine from the desalination facility would be discharged to the ocean through the existing MRWPCA outfall with a salinity level approximately 10% above ambient seawater. At present, the MCWD is the proponent for this project. The Regional Desalination Project would share distribution

infrastructure with the Salinas River Surface Water Treatment Plant (SWTP) (described below).

The current Regional Water Supply Program includes an initial desalination plant capacity of approximately 10,000 acre-feet per year. When combined with the other projects such as the Seaside ASR Project, the Regional Urban Water Augmentation Project (described below), or the Seaside Groundwater Replenishment Project (described below), the program would both provide sufficient water to offset the over-pumping in the Seaside Groundwater Basin and satisfy the requirements of Order No. 95-10. Desalination using seawater as feedwater would ensure a constant water supply with limited water quality variability.

3.2.2.2 Salinas River Surface Water Treatment Plant

The Salinas River Surface Water Treatment Plant (SWTP) is part of the Monterey Regional Water Supply Program, and would work conjunctively with the Regional Desalination project described above. The SWTP would use a surface water diversion from the Salinas River to provide potable water to urban users overlying the Seaside Groundwater Basin. Diversions would occur during the winter and spring months when flows exceed the instream requirements (ENTRIX, Inc., 2007). Water diverted for urban use would be treated at a surface water treatment plant located south of the existing MRWPCA regional treatment plant on Armstrong Ranch.

The surface water facility could ultimately treat up to 10,000 acre-feet per year. Current planning has in initial treatment plant capacity of 13 mgd, treating an average of 3,000 acre-feet per year. When combined with the other elements of the Monterey Regional Water Supply Program, the project would both provide sufficient water to offset the over-pumping in the Seaside Groundwater Basin and satisfy Order No. 95-10.

3.2.2.3 Sand City Water Supply Project

The Sand City Water Supply Project is owned by the City of Sand City, and will be operated by CAW through a contractual agreement. It comprises a desalination facility and a potable water system that serves City of Sand City customers. Brackish source water for the desalination plant will be obtained from the shallow groundwater aquifer near Monterey Bay. Byproduct water will

be disposed of through a Horizontal Directionally Drilled well beneath the beach in Sand City.

The Sand City Desalination Plant is expected to provide approximately 300 acre-feet per year. The water produced by this project is not required to offset Order No. 95-10. It can therefore be used to offset production in the Seaside Groundwater Basin, subject to the best management practices of CAW, and only on an interim basis until Sand City customers use the water for their own purposes. The facilities are currently under construction.

3.2.2.4 Regional Urban Water Augmentation Project

The Regional Urban Water Augmentation Project (RUWAP) includes a recycled water distribution system that provides recycled water from the existing MRWPCA Salinas Valley Reclamation Plant to urban users within the Cities of Marina, Seaside, Monterey, Del Rey Oaks, and the County of Monterey. Additional recycled water may be provided to the Monterey Peninsula under a joint cooperative effort with MCWD, MRWPCA, and CAW.

A project-level EIR was certified for the RUWAP to provide up to 1,727 acre-feet per year of recycled water to the identified urban areas: 1,427 acre-feet per year within the former Fort Ord and 300 acre-feet per year to the Monterey Peninsula. Of the 1,427 acre-feet per year available to former Fort Ord, approximately 450 acre-feet would be available to two City of Seaside golf courses and approximately 250 acre-feet would be available to a proposed golf course at Del Rey Oaks. Therefore, the amount of water benefiting the Seaside Groundwater Basin may be on the order of 700 acre-feet per year. When combined with the other Monterey Regional Water Supply Program projects, the project would both help provide sufficient water to offset the over-pumping in the Seaside Groundwater Basin and satisfy Order No. 95-10.

As recycled wastewater is the source for this project, supply variability is not seen to be a problem based on historical wastewater production. Quality of the water is also expected to remain fairly consistent from the reclamation plant.

3.2.2.5 Seaside Groundwater Replenishment Project

The Seaside Groundwater Replenishment Project (GWR) is part of the Monterey Regional Water Supply Program, and would inject advanced treated recycled

water into the Seaside Groundwater Basin. The source water would be recycled water and dilution water. Three potential dilution water sources have been identified: the Salinas Industrial Wastewater Facility, the Blanco Drain System, and the Salinas Reclamation Ditch.

The treated water would be conveyed to the Seaside Groundwater Basin and recharged through a combination of vadose zone wells and groundwater injection wells (GEI Consultants et al., 2008). Existing potable water wells would capture the injected water, thus augmenting the overall groundwater basin yield for local potable water supply (RBF, 2007). The GWR project includes a large part of the Backbone Pipeline that was envisioned as part of the Regional Urban Water Augmentation project.

The Seaside Groundwater Replenishment Project could provide up to 6,700 acre-feet of water per year to the Seaside Groundwater Basin. This includes 700 acre-feet per year that would provide advanced treated water to that portion of Phase 1A of the Regional Urban Water Augmentation Project (RUWAP) designated for golf course irrigation. The GWR project would be sufficient to offset the over-pumping in the Seaside Groundwater Basin. The recharged water would have a high degree of reliability given historical wastewater production and availability.

3.2.2.6 Pacific Grove Stormwater Project

Although this project is outside the Seaside Groundwater Basin, it reduces demand on the CAW system, thus potentially satisfying part of the Seaside Groundwater Basin Adjudication. This expansion of Pacific Grove's existing stormwater collection system would deliver stormwater to the David Avenue Reservoir for storage. A treatment plant would be constructed, and the water would be treated and delivered to users for irrigation. The tentative plan is for the City of Pacific Grove to own the facilities, and for CAW to operate the treatment plant. The plan is preliminary and would require inter-agency agreements.

The amount of stormwater generated each year would be dependent on storm runoff, and as such, the supply would be variable from year to year. Recent data suggest the average annual supply would be approximately 200 acre-feet, stored in a 46 acre-foot tank (Everest, 2008).

3.2.2.7 CONSERVATION

CAW and MPWMD proposed a conservation program to the CPUC which could be implemented immediately upon approval. Although water savings are not a new supply source, they could reduce overall demand and the need for potable water, thus contributing to satisfying SWRCB Order No. 95-10 and the Seaside Groundwater Basin Adjudication. The overall conservation measures would be administered by CAW and MPWMD within the MPWMD service area (including the Laguna Seca Subarea).

The conservation measures would include, but not be limited to:

- Water audits for residential, large landscape and commercial/industrial customers.
- Residential rebates for heavy use appliances including toilets and washers as well as irrigation system equipment to target outdoor water usage.
- Residential plumbing retrofits including low flow showerheads and faucet aerators, leak detection kits, evapotranspiration-based (ETo) irrigation equipment and timers. The ETo controllers would automatically control an outdoor sprinkler system using real-time or historical weather data, using data such as humidity, temperature, solar radiation, soil moisture, and rain gauge sensors.
- Commercial rebates for devices such as high efficiency or dual flush toilets, waterless urinals, dishwashers, and other devices.
- School Education Programs targeting grades K through 12.
- Implementing the Expanded Water Conservation and Standby Rationing Plan allowing for mandatory water rationing and conservation during either legal or actual supply shortages, including reductions ranging from 15% to 50% reduction goals (*California American Water Company's Application for a Special Conservation Program and Modification to Its Rate Design CPUC Application A.07-12-010*, 2007).

The capacity and reliability of this project is linked to the success of the local authority and public's participation in conservation measures. The capacity is difficult to quantify.

3.2.3 NON-PROGRAMMATIC PROJECTS

Two additional projects are described below. These two projects are not part of larger programs. These two projects could be implemented individually.

3.2.3.1 MPWMD 95-10 DESALINATION PROJECT

A desalination plant was proposed by Monterey Peninsula Water Management District (MPWMD) in 1995 in response to SWRCB Order No. 95-10. The proposal was not implemented at the time. Recently, the MPWMD Board has directed staff to update the desalination engineering analysis and the follow-up EIR analysis. The project would be owned and operated by the MPWMD.

The plant would collect seawater through either horizontal directionally drilled (HDD) wells or radial collector wells located along beaches in either the City of Sand City or the former Fort Ord. Based on the latest available analysis, the brine would be disposed of through either HDD wells along the coastline in the former Fort Ord, or through the existing MRWPCA outfall. Additional technical studies and analysis would be required to determine the feasibility of using the HDD wells for brine disposal (GEI Consultants et al., 2008).

The MPWMD 95-10 Desalination Project would provide up to 8,400 acre-feet of water per year. The water would offset the requirements of SWRCB Order No. 95-10, and therefore would not offset over-pumping in the Seaside Groundwater Basin. Desalination using mostly seawater as feedwater would ensure a relatively constant water supply with limited water quality variability.

3.2.3.2 SEAWATER CONVERSION VESSEL

Water Standard Company has proposed the Seawater Conversion Vessel project, consisting of a seawater desalination vessel anchored in Monterey Bay. The seawater is treated on the vessel and delivered to CAW and other customers. It would most likely be located less than five miles from the shore, which allows for feasible delivery. This would be a completely self-contained seawater desalination treatment plant installed on a ship, with electrical energy and propulsion provided by gas turbine engines fueled with bunker fuel or biodiesel. Water intake would be below the photic zone, or the level that light penetrates, in order to decrease impact to organisms. The brine would be mixed with seawater on the vessel to cool it, and then the mixture would be discharged

through diffusers into the open ocean, near the water surface. A seabed pipeline could be constructed to deliver water to the shore, or the water could be shuttled to shore by barges (GEI Consultants et al., 2008). Currently, there is no project proponent for this alternative.

The seawater conversion vessel could provide approximately 20,200 acre-feet per year of potable water. It could be outfitted to provide up to 85,000 acre-feet per year in the future. Although this alternative has not been fully defined, it is assumed that, if developed, it would both provide sufficient water to offset the over-pumping in the Seaside Groundwater Basin and satisfy Order No. 95-10. Although the water quality of the supply is reliable, the ability of this project to reliably deliver water is somewhat unknown since this option has not been proven in any other applications.

SECTION 4
GROUNDWATER MANAGEMENT ACTIONS

Supplemental water supplies from the long-term solutions identified in Section 3 will not be immediately available. Furthermore, after implementing the long-term water supply solutions, an additional amount of time will pass before the desired rise in groundwater levels is observed in the Seaside Groundwater Basin. To address these issues, this section presents local groundwater management actions and interim water supplies that could be implemented before the supplemental supplies begin to restore groundwater levels. Although many of the actions discussed in this section are not under Watermaster's direct control, the Watermaster should consider providing support where needed.

The purpose of these interim management actions is threefold:

1. Extending the life of the Seaside Groundwater Basin before supplemental supplies become available.
2. Optimizing the existing natural recharge and basin storage capacity.
3. Managing and reducing the near-term threat of seawater intrusion.

These actions are not intended to provide long-term solutions to restoring groundwater levels in the Basin. Rather, these actions assist with groundwater management and are intended to reduce the risk of seawater intrusion before the long-term solutions restore groundwater levels.

Two types of actions are presented: interim water supplies and local groundwater management actions.

4.1 INTERIM WATER SUPPLIES

Interim water supplies are those that can be developed rapidly, but might not be reliable as a long-term supply. These interim supplies provide a benefit by offsetting a portion of the current groundwater pumping. Reducing groundwater pumping will help raise groundwater levels, reducing the threat or slowing the rate of seawater intrusion.

4.1.1 TEMPORARILY TRANSFER GROUNDWATER FROM ORD COMMUNITY WATER SYSTEM TO THE SEASIDE GROUNDWATER BASIN

Marina Coast Water District (MCWD) is authorized to pump up to 6,600 acre-feet per year from the Salinas Valley Groundwater Basin for the Ord Community Water System which serves the former Fort Ord military base. Historical withdrawals by MCWD have ranged between 2,000 and 6,600 acre-feet per year. Current withdrawals by MCWD for the Ord Community Water System are approximately 2,300 acre-feet per year (Denise Duffy & Associates Inc., 2007).

Water could be transferred from the Ord Community Water System to the Seaside Groundwater Basin with relatively little new infrastructure. Assuming that up to 4,000 acre-feet are available and could be transferred annually, this transfer could significantly reduce the amount of water pumped from the Seaside Groundwater Basin.

This interim supply would require an inter-basin transfer of water, and therefore an agreement would be necessary between the Monterey County Water Resources Agency (MCWRA), the project proponent, and any other entities if necessary, as per the Adjudicated Decision requirements.

ADVANTAGES

- Provides a significant supply of water that could be used to offset groundwater pumping in the Seaside Groundwater Basin.
- Requires little change to the existing infrastructure.
- This action is easily reversible.

DISADVANTAGES

- The groundwater is extracted from the Salinas Valley Groundwater Basin. Transferring this water to the Seaside Groundwater Basin will require an inter-basin transfer agreement that addresses restrictions in the MCWRA's enabling legislation regarding such transfers.
- The Salinas Valley Groundwater Basin is seawater intruded. Increased pumping from the Salinas Valley Groundwater Basin could exacerbate this problem.

4.1.2 IRRIGATE THE BAYONET AND BLACKHORSE GOLF COURSES WITH WATER FROM THE ORD COMMUNITY WATER SYSTEM

Irrigation water for the Bayonet and Blackhorse golf courses is currently provided by on-site wells extracting from the Seaside Groundwater Basin. Both of these courses are on former Fort Ord land. Irrigation water for these golf courses could be provided by MCWD's existing wells in the Salinas Valley, and distributed through the Ord Community Water System, with no inter-basin transfer agreement. The golf courses have an Alternative Production Allocation of 540 acre-feet per year in the Amended Decision. The golf courses pumped 593 acre-feet during Water Year 2008.

ADVANTAGES

- Groundwater pumping could be reduced by approximately 500 acre-feet per year immediately.
- This plan requires little change to the existing infrastructure.
- This action is easily reversible.

DISADVANTAGES

- The Salinas Valley Groundwater Basin is seawater intruded. Increased pumping from the Salinas Groundwater Basin could exacerbate this problem.
- Water quality from MCWD wells in the Salinas Groundwater Basin may have sodium and chloride concentrations, which may be unsuitable for turf irrigation.
- Implementing this option may be complicated by the inability to transfer Alternative Production Allocation. This will need to be investigated further.

4.1.3 SEASIDE AQUIFER STORAGE AND RECOVERY PROJECT - PHASE 1

This project is covered in Section 3.2.1.4 discussing supplemental supplies. The Phase 1 Aquifer Storage and Recovery (ASR) project purpose is to offset the extraction deficit under SWRCB Order No. 95-10, therefore this project has only incidental storage benefits.

ADVANTAGES

- Minimal new infrastructure is needed for distribution or injection.
- The MPWMD and CAW have an existing water right to provide up to 2,426 acre-feet of recharge per year by diverting high flows from the Carmel River.

DISADVANTAGES

- The water supply is unpredictable. It will only be available in certain years, depending on flows in the Carmel River.
- New wells may be needed in Carmel Valley to capture the stream flows. CAW has recently completed construction of three replacement wells which may provide the needed winter capacity.
- The Phase 1 ASR project includes conditions that require extraction of injected water to meet CAW system demands resulting in only incidental (i.e., seasonal) storage benefits to the Seaside Groundwater Basin.

4.1.4 SEASIDE GROUNDWATER BASIN EXPANDED AQUIFER STORAGE AND RECOVERY PROJECT

The MPWMD Phase 1 ASR project could be expanded by installing new ASR wells and obtaining additional water rights, or another ASR project could be undertaken by a new project proponent.

ADVANTAGES

- Infrastructure for obtaining ASR water and distributing it close to new ASR wells is already in place.
- An expanded or new ASR system could include a long-term groundwater storage component by leaving injected ASR water in the ground at the end of every water year.
- A new or expanded ASR program will likely not be abandoned as other supplemental supplies are developed, so there is little risk of stranding assets by installing wells.

DISADVANTAGES

- The water supply is unpredictable. It will only be available in certain years, depending on flows in the Carmel River.
- If the Carmel River is used as the ASR water supply, a new or expanded water right from the State Water Resources Control Board for the Carmel River will be required. This may difficult and time consuming to obtain in the near future.

4.1.5 REACTIVATE THE MARINA COAST WATER DISTRICT DESALINATION PLANT

The MCWD owns a permitted and constructed municipal desalination plant on the Monterey Bay coast. The plant is currently not operating. The plant is capable of producing approximately 300 acre-feet per year of potable water. The plant uses beach well intakes, and does not reduce the amount of potable water in the Seaside Groundwater Basin. It will take approximately $1.5 million and support from CAW to reactivate the plant.

ADVANTAGES

- The water produced by the desalination plant could offset some of the existing groundwater pumping if it is piped to the Seaside Groundwater Basin, marginally raising water levels in the Seaside Groundwater Basin.
- The desalination plant already exists. A simple interconnect is needed to deliver water to CAW's delivery system.
- This action is easily reversible.

DISADVANTAGES

- The cost of desalinated water is relatively high.
- The plant is currently idle. It would require an approximately $1.5 million investment prior to restarting.
- Restarting the plant may require renewal of the RWQCB Waste Discharge Permit allowing brine discharge.
- Interagency agreements will be required to transfer water to the Seaside Groundwater Basin.

4.1.6 ENHANCED STORM WATER RECHARGE

Although there are some existing storm water percolation facilities, most of the stormwater from the City of Seaside is currently collected and discharged to the ocean through outfalls to Monterey Bay. A portion of this stormwater could be captured and recharged into the Seaside Groundwater Basin. This would potentially supplement the natural groundwater recharge, allowing for additional groundwater pumping.

ADVANTAGES

- No water right is needed
- A storm water recharge system will likely not be abandoned as other supplemental supplies are developed, so the up-front investment would not become obsolete if other supplemental supplies come on-line.
- Seaside has existing stormwater disposal capacity problems that this project might help remedy.

DISADVANTAGES

- There is an unknown capital cost involved in designing, constructing, and managing stormwater recharge facilities.
- The recharge facilities should be sited in a place where the recharge water can be captured by existing wells. This may require a pump station(s) to move the stormwater to the recharge location(s).
- Depending on recharge location and method, recharged water may not be available in the immediate future. The benefits of this project might not be immediate.
- Depending on recharge location and method, recharged water may flow out to ocean.
- Urban runoff includes street runoff that contains contaminants. Water proposed for recharge will need to be treated before it can be recharged.
- Land is needed for recharge facilities.
- It may be difficult to quantify the volume of recharge enhancement due to the project.

4.1.7 SAND CITY DESALINATION

The City of Sand City is currently constructing a 300 acre-foot per year capacity desalination plant. The source water for the desalination plant is shallow brackish water from the Southern Coastal Subarea. The City of Sand City was granted rights to pumping this brackish water in the Amended Decision. Byproduct water from the plant is disposed through a horizontal well beneath the beach in Sand City. The plant is scheduled to begin operating in early 2009. Water produced by this plant will be supplied to the CAW system on an interim basis until Sand City customers use the water for their own purposes. The water is not dedicated to offsetting the extraction deficit under SWRCB Order No. 95-10.

ADVANTAGES

- The water produced by the desalination plant can be temporarily used to offset up to 300 acre-feet per year of existing groundwater pumping subject to the best management practices of CAW. This offset would diminish over time as Sand City uses the water for its redevelopment purposes. This would marginally raise water levels in the Seaside Groundwater Basin.
- The desalination plant is already being constructed. Water will be available in early 2009.
- All of the necessary agreements are in place to deliver this water to the CAW distribution system.

DISADVANTAGES

- The cost of desalinated water is relatively high.

4.2 LOCAL GROUNDWATER MANAGEMENT ACTIONS

Local groundwater management actions are activities that may reduce or delay the threat of seawater intrusion without any new water sources. These actions provide a benefit by either reducing the amount of groundwater pumping in the Seaside Groundwater Basin, or moving pumping centers to reduce drawdown near the coast.

4.2.1 CONSERVATION

Conservation reduces demand, effectively reducing the requirement for pumping groundwater from the Seaside Groundwater Basin. This plan is covered in Section 3.2.2.7. The concept is repeated here because it could be implemented before many of the other supplemental supplies are implemented.

Examples of conservation efforts may include:

- Installing climate based irrigation systems that measure evapotranspiration and precipitation in order to automatically control irrigation.
- Encouraging water use audits.
- Requiring separate outdoor irrigation water metering.
- Implementing an enhanced tiered pricing that focuses on differences between summer and winter use, to discourage excessive landscape irrigation.
- Promoting residential graywater irrigation systems.
- Promoting use of more water efficient fixtures.

ADVANTAGES

- No infrastructure needed for many efforts.
- Although some conservation measures require capital investments, they will be of continuing value even after a long-term water supply comes on-line.

DISADVANTAGES

- The Watermaster does not have authority to regulate water use, but could support conservation plans of others.
- Conservation may require implementing agencies to adopt new regulations. The Watermaster would not be an implementing agency.
- Conservation may require willing residents and businesses to implement the plans. This reduces the reliability of water savings from conservation because it relies on ongoing individual actions.

4.2.2 REDISTRIBUTE PUMPING AMONG EXISTING WELLS

Extractions from the Northern Coastal Subarea during Water Year 2007 were concentrated at two wells: CAW's Ord Grove and Paralta wells. Of the 4,283 acre-feet pumped from the Northern Subbasin during Water Year 2007, 2,898 acre-feet were derived from these two wells. These two wells constitute 68% of the total pumping from this subbasin. Spreading the pumping among multiple wells in the subbasin could result in a broader, shallower cone of depression. The shallower cone of depression would slow the rate of seawater intrusion.

ADVANTAGES

- This action potentially reduces the rate of potential seawater intrusion
- This action is easily reversible.

DISADVANTAGES

- Most of the underused wells are in the shallower Paso Robles Formation Additional pumping in the Paso Robles Formation may be more likely to induce intrusion because it appears to have a better connection to the ocean than the Santa Margarita Sandstone.
- CAW has few wells in the Paso Robles Formation, and the wells they do have, have limited production capacity.
- This action would require funding approval from California Public Utilities Commission (CPUC).
- Additional distribution piping will likely be required to get water to existing infrastructure.

4.2.3 INSTALL NEW COASTAL SUBAREA WELLS

As noted in Section 4.2.2, extraction from the Northern Coastal Subarea is concentrated at two existing wells. Pumping could be distributed more evenly across the Coastal Subareas by installing new production wells in the Northern or Southern Coastal Subareas. The Southern Coastal Subarea would be particularly advantageous, because it appears to have more water stored above sea level than the Northern Coastal Subarea. Installing these new wells could result in a broader, shallower cone of depression across the coastal portion of the

Seaside Groundwater Basin. The shallower cone of depression would slow the rate of seawater intrusion.

ADVANTAGES

- This action potentially reduces the rate of potential seawater intrusion.
- There is an opportunity to transfer pumping to the Paso Robles aquifer if it does not result in an increase in the overall drawdown near the coast.
- CAW may already own land for the new wells, resulting in no land acquisition issues.

DISADVANTAGES

- Potential well sites are likely located in urban areas with limited available land, leading to possibly difficult well installations.
- The new wells would be located relatively close to the coast, resulting in marginal improvements in reducing seawater intrusion in the Northern Coastal Subarea.
- Increasing pumping in the Southern Coastal Subarea increases the risk of seawater intrusion in this subarea.
- These actions would require funding approval from the CPUC.
- Additional distribution piping will likely be required to get water to existing infrastructure.

4.2.4 INSTALL NEW INLAND WELLS

All pumping in the Northern Subbasin occurs in the Northern Coastal Subarea. Installing wells in the Northern Inland Subarea would spread out the cones of depression more effectively than simply redistributing pumping among existing wells. The shallow and disperse cones of depression would slow the rate of seawater intrusion.

ADVANTAGES

- This action potentially reduces the rate of potential seawater intrusion.
- The new wells more effectively take advantage of groundwater stored in the Northern Inland Subarea.

- The wells would have lasting value even after a long-term water supply becomes available because inland wells will always be more effective at capturing basin yield with less intrusion risk than the existing coastal wells.
- The wells would have lasting value after a long-term water supply becomes available because they will provide future pumping flexibility.

DISADVANTAGES

- Obtaining access and permits to install wells on former Fort Ord land may be difficult.
- There may be significant costs to obtain right of way, install new distribution piping, install new wells, and obtain new power drops.
- Water level data from the Sentinel Wells suggest that significant cones of depression from CAW's existing pumping extend miles from the extraction locations. If the inland portion of the Santa Margarita Sandstone is as confined as the coastal portion, the cone of depression around the new wells could extend a long distance (miles) out from the wells.
- Water quality is untested, and may require additional treatment costs.
- Overlapping jurisdictions in this area may require interagency agreements for wells located within MCWRA's Zone 2C.
- These actions would require funding approval from the CPUC.

4.2.5 PROVIDE INTERTIES BETWEEN WATER SYSTEMS

Pumping in the Laguna Seca Subarea could be better managed by installing interties between individual systems. CAW's Main system is already tied to the Ryan Ranch system with an emergency intertie. This could be enhanced to serve as an intertie that would transfer water whenever excess water is available in the Main system. For example, excess water available during the winter could be transferred to the Ryan Ranch area, reducing winter pumping in the Laguna Seca Subarea. Additionally, an intertie between the Bishop Ranch system and Ryan Ranch water system would allow some flexibility for limited costs.

ADVANTAGES

- Interties allow pumping flexibility, effectively moving pumping troughs.
- Upgrading the intertie between the Main system and Ryan Ranch/Bishop systems, such that water could be transferred in average or wet years, would allow for in-lieu recharge in the Laguna Seca Subarea.
- Upgrading the intertie between the Main system and Ryan Ranch/Bishop systems, such that water could be transferred in average or wet years, would allow water to be transferred in excess of the needs of these two systems when it is available. The excess water would provide enhanced recharge or ASR opportunities in the Laguna Seca Subarea.

DISADVANTAGES

- A full intertie with CAW's Main system will require some infrastructure costs.
- The advantages are relatively small on a basinwide scale, although they may be significant for the Laguna Seca Subarea.
- System interties would require CPUC and MPWMD permission and approval.
- Local residents or homeowner associations may be resistant to a full intertie with the main CAW's Peninsula system.
- A water accounting system would be necessary to reassure compliance with the requirements of the Amended Decision.

4.2.6 RAINFALL ENHANCEMENT

Rainfall enhancement uses silver iodide to nucleate water droplets over mountains. The silver iodide can be disbursed by either aircraft or ground based dispensers. Increasing rainfall will supplement the natural recharge of the Seaside Groundwater Basin, allowing additional pumping from the Basin.

ADVANTAGES

- Rainfall enhancement provides a new source of water without a water right or any significant permitting.

- Increased winter flows may result in longer durations of Carmel River flow, allowing for greater yield for the ASR program, which could have incidental benefits for the Seaside Groundwater Basin

DISADVANTAGES

- Rainfall enhancement is not a reliable source of water in the Seaside Groundwater Basin.
- Liability issues may occur in urbanized areas if there is a flood event.

The topography of the Seaside Groundwater Basin may not be conducive to rainfall enhancement. Higher hills than those in the main Seaside Groundwater Basin may be needed. Therefore, rainfall enhancement may be more effective in the Carmel Valley than in the Seaside Groundwater Basin.

SECTION 5
RECOMMENDED MANAGEMENT STRATEGIES

This section presents recommendations for managing the Seaside Groundwater Basin. Recommendations are based on the results presented in Sections 2, 3, and 4, as well as discussions with the Watermaster TAC.

This report has outlined some interim actions that could be implemented to initially meet requirements of the Amended Decision. However, to address the majority of over-pumping of the Seaside Groundwater Basin, long-term supplemental supplies are needed. These supplies will have the greatest impact on the Basin and allow for its long-term management.

Whatever management strategies are ultimately pursued, their impacts need to be assessed before implementation. Issues such as the fate of water that is recharged in the Basin at different locations need to be addressed. For example, it will be important to know if recharged water will be lost to the ocean or to the Salinas Valley, and whether the extraction wells in the Basin are located in the optimum locations to recover stored water.

RECOMMENDATION 1: ENCOURAGE IMPLEMENTATION OF SELECTED INTERIM ACTIONS

From the interim water supplies and groundwater management actions outlined in Section 4, the following six are the most likely to be implemented cost-effectively and to provide the greatest benefit to the Seaside Groundwater Basin in the short-term:

1. *Irrigate the Bayonet and Blackhorse Golf Courses with Water from the Ord Community Water System*
   This interim supply would provide an immediate reduction in pumping in the Seaside Groundwater Basin that is readily implementable. Water from the Ord Community Water System is extracted from the Salinas Valley Groundwater Basin.

2. *Reactivate the Marina Coast Water District Desalination Plant*
   This action is recommended because desalination facilities are already in place, which will facilitate implementation.

3. *Provide Interties Between Water Systems*
   This is a low-cost option that will allow for better management of CAW's water supplies if and when there is excess water in their Main system. This option also provides the Laguna Seca Subarea with the greatest benefit of all the potential interim supplies.

4. *Install New Inland Wells*
   This management strategy has both short and long-term benefits to the Seaside Groundwater Basin. In particular, inland wells can capture natural recharge while posing less of a seawater intrusion risk than coastal wells. A feasibility study of the effort needed to install new inland wells will need to be undertaken as an initial step.

5. *Install New Coastal Subarea Wells*
   This strategy further spreads pumping across the Seaside Groundwater Basin. It could be implemented more quickly than the inland wells strategy because land is available to CAW in the Coastal Subarea.

6. *Sand City Desalination*
   The facilities for the plant are currently under construction. Plant is scheduled to begin operating in early 2009.

These actions will be undertaken by various water agencies. It is recommended that the Watermaster support these actions in whatever way it can. As stated in Section 4, the recommended actions are not intended to provide long-term solutions for restoring groundwater levels in the Seaside Groundwater Basin. Rather, they will assist with groundwater management and are intended to reduce the risk of seawater intrusion prior to and during implementation of long-term solutions. Some of these strategies, however, will continue to provide groundwater management benefits after the long-term solutions are implemented.

RECOMMENDATION 2: SUPPORT DEVELOPMENT OF SUPPLEMENTAL SUPPLIES

Reducing the pumping of the Seaside Groundwater Basin aquifers to the level of the Natural Safe Yield will require developing supplemental water supplies. The Watermaster may not develop supplemental sources of water itself; however the

Watermaster should lend support to plans to develop these supplies. A number of potential supplemental supplies are presented in Section 3. The feasibility of many supplemental supply projects are currently being reviewed and considered in the CWP EIR. This EIR process, and other public processes, provides opportunities for the Watermaster to have input into which projects may be implemented in the Seaside Groundwater Basin. It is imperative that the Watermaster actively review and comment on the CWP DEIR, as well as other documents such as cost opinions for the various projects.

Many individual projects will offset less than 2,000 acre-feet per year of pumping from the Seaside Groundwater Basin. This amount is below the 2,600 acre-feet of over-production, calculated from the difference between current production of 5,600 acre-feet and the Court's initially assumed Natural Safe Yield of 3,000 acre-feet per year. However, the combination of multiple projects will supply adequate water to offset the entire 2,600 acre-feet of over production.

Providing supplemental supplies on the order of 2,600 acre-feet per year will have the effect of halting water level decline, but will still leave groundwater levels below sea level. Supplemental supplies in excess of 2,600 acre-feet will be needed for a period of years to raise groundwater levels to protective levels. It is recommended to use a groundwater model to evaluate the effectiveness of each supplemental supply and its impacts on groundwater levels. Furthermore, the model can be used to improve and refine the estimate of the amount of supplemental water needed to increase groundwater levels to protective levels.

All of the supplemental projects, except water conservation, are physical projects with capital costs associated with them. Water conservation does not produce additional supply but rather results in a demand reduction. Conservation is readily implementable and should be given high priority with respect to Watermaster's support of projects that reduce the amount of groundwater pumped from the Seaside Groundwater Basin.

Evaluating, selecting, and developing supplemental supplies for the Seaside Groundwater Basin should be done as expeditiously as possible. The Watermaster should provide support where possible to aid in facilitating between parties, provide data and information on the Basin, and ensure that Material Injury does not result from any of the proposed projects.

RECOMMENDATION 3: CONTINUE ONGOING GROUNDWATER MONITORING

Groundwater level and groundwater quality monitoring is currently being conducted in accordance with the Seaside Basin M&MP and Seawater Intrusion Response Plan (SIRP). The M&MP is a key component of basin management that is already being implemented by the Watermaster. Continued monitoring in accordance with the M&MP and SIRP will provide the data necessary for making future management decisions.

As presented in the Watermaster's 2007 and 2008 Annual Reports, the need for additional monitoring wells has been evaluated and should continue to be addressed regularly by the Watermaster. Supplementary to the monitoring well site already recommended, additional monitoring wells within the Northern Inland Subarea may need to be considered, particularly if pumping is redistributed from the coastal area to more inland areas. Furthermore, northern inland monitoring wells are necessary to better define the basin boundary and to monitor groundwater interaction with the adjacent Salinas Groundwater Basin. Monitoring well data will also contribute to understanding the amount of water in storage and the amount of useable storage space available for groundwater management purposes.

RECOMMENDATION 4: CONTINUE ANNUAL ANALYSES

The Amended Decision requires that an Annual Report be prepared by the Watermaster. The Annual Report is to address the specific Watermaster functions set forth in Section III.L.3.x of the Decision. The Annual Reports filed in November of 2007 and 2008 included a section pertaining to Water Quality Monitoring, and also included the summaries of the Seawater Intrusion Analysis Report (SIAR) for each of these years.

The annual reports are important documents that serve to, 1) provide a spring and fall snap shot of groundwater quality and groundwater levels for each year, 2) allow for a year-by-year comparison of basin conditions, and 3) document basin management decisions and actions, and their resultant impacts on the Basin.

The analyses that are included in the Annual Reports should be continued.

RECOMMENDATION 5: IMPROVE BASIN MANAGEMENT TOOLS AND TECHNIQUES

To improve overall basin management, a number of tools and techniques are recommended. A primary tool for managing the Seaside Groundwater Basin is a calibrated groundwater flow model. If the model is well calibrated there will be a high level of confidence that the model is able to accurately simulate groundwater conditions.

Before model development starts, the Watermaster should determine the goals, objectives, and detail of the model. Once the model has been developed and appropriately calibrated, potential future management scenarios can be run to evaluate impacts on groundwater levels and water quality. Among other things, a groundwater model is an effective tool for analyzing and estimating:

1. Combined impacts of several simultaneous basin management actions.
2. Changes in Total Useable Storage Space as a result of individual or combined basin management actions.
3. Storage Efficiency, as required by the Amended Decision. A groundwater model could predict the amount and availability of artificially recharged water, or water that is stored in-lieu that can be successfully recovered at a later date.

The protective elevations contained in this BMAP are based on protection of production wells and not the entire aquifer. Setting protective elevations for specific aquifers is another management technique that will be possible with the groundwater modeling planned for 2009.

RECOMMENDATION 6: DEVELOP LONG-TERM FINANCING PLAN FOR REPLENISHMENT WATER

The Amended Decision identifies three separate budgets that the Watermaster oversees: (1) the Monitoring and Management Plan budget, (2) an annual Administrative budget, and (3) a Replenishment budget. The Monitoring and Management Plan budget and the Administrative budget are set every year by the Watermaster. The Replenishment budget is based on an estimated cost of obtaining replenishment water to offset cumulative overproduction.

The replenishment assessments are only intended to offset overproduction that has occurred after the Decision was issued. The current replenishment assessments are not sufficient to buy water that offsets overpumping that occurred prior to the Decision. The overpumping prior to the decision added to the Seaside Groundwater Basin's deficit. Offsetting only the overproduction that occurred after the Amended Decision may not be sufficient to raise groundwater levels in the Seaside Groundwater Basin sufficiently to prevent seawater intrusion. The Watermaster should develop a plan to address this issue.

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