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TECHNICAL MEMORANDUM

To: Seaside Groundwater Basin Board of Directors

From: Derrik Williams and Georgina King

Date: September 28, 2012

Subject: Groundwater Modeling Results of Temporary Suspension of Triennial Pumping Reductions

1.0 BACKGROUND AND MODELING OBJECTIVES

Due to upcoming restrictions on the use of water from the Carmel River, California American Water (Cal-Am) is attempting to ensure adequate water supplies are available from the Seaside Basin. Cal-Am approached the Seaside Basin Watermaster, suggesting that the Watermaster make a request to the Court to temporarily suspend the 2011 and 2014 triennial pumping reductions. The Watermaster requested that the Seaside groundwater model be used to assess basin impacts due to changing pumping operations.

Modeling objectives included developing a New Baseline simulation against which to compare a Project; developing a project which simulates temporary suspension of triennial reductions between Water Years (WY) 2013 and 2017; and using the groundwater model runs to provide estimates of basin impacts.

2.0 MODELING ASSUMPTIONS

A subgroup of the Watermaster's Technical Advisory Committee (TAC) met on July 2, 2012, and by conference call on July 31, 2012 to discuss modeling assumptions. A number of follow up telephone conversations with key individuals took place after these group meetings to finalize model assumptions.

Attendees at the meeting and conference call were:

Bob Jaques	Seaside Basin Watermaster (not on conference call)
Laura Dadiw	Seaside Basin Watermaster (not on conference call)
Joe Oliver	Monterey Peninsula Water Management District
Jonathon Lear	Monterey Peninsula Water Management District
Eric Sabolsice	California American Water (not on conference call)
John Kilpatrick	California American Water
Rick Riedl	City of Seaside
Robert Johnson	Monterey County Water Resources Agency

After feedback from all parties was received, it was decided that two sets of Baseline and Project runs would be developed: named the TAC model run and the Cal-Am model run. The Baseline simulations are different from each other in the two runs, as are the Project simulations. The sections below provide more detail on the two sets of runs.

2.1 TAC MODEL RUN

2.1.1 2012 TAC BASELINE

WATER YEAR 2009 THROUGH WATER YEAR 2012 PUMPING

Actual pumping and injection data for all wells from January 2009 through June 2012 were included in the TAC Baseline. For the last quarter of Water Year (WY) 2012, production and injection from the last quarter of WY 2011 was used.

STANDARD PRODUCER PUMPING FROM WATER YEAR 2013 ONWARDS

Standard Producer pumping follows the Decision-prescribed triennial reductions. Water injected by ASR wells is also pumped from select Cal-Am wells. This is the same approach used in the previous 2009 Baseline model run.

GOLF COURSE PUMPING

Golf course wells pump at rates based on the hydrology year. For example, pumping in January 2015 equals the amount pumped in January 1993, because the simulated 2015 hydrology is based on 1993 hydrology. This ensures that the demand corresponds to the hydrology. If the amount pumped pre-adjudication exceeded their adjudicated right, it was capped at their adjudicated amount. In 2007, Bayonet and Black Horse golf courses had irrigation upgrades that have reduced irrigation demand by approximately 10% from historical amounts. This reduction was taken into account.

ALTERNATIVE PRODUCER AND PRIVATE PUMPING

Alternative Producers, excluding golf courses, pump at their WY 2011 volumes from WY 2013 onwards. All other pumpers in the model area that are not covered by the Decision: Cal Water Service and private wells also pump at WY 2011 volumes from WY 2013 onwards.

Pumping exceptions taken into account in the TAC Baseline are:

- The Bayonet and Blackhorse golf courses pump no water until September, 2015. This is based on a five-year in-lieu replenishment program the City of Seaside has with its golf course pumping. Under this program, Marina Coast Water District provides water in-lieu of the City pumping from the Seaside Basin. The City expects to start pumping its golf course wells again starting August 25, 2015.

- Water for SNG is supplied from Cal-Am wells under a water wheeling agreement with Cal-Am. When the SNG site is developed they will be supplied with water by Cal-Am, who will use SNG's water right of 149.7 acre-feet/year. Currently there is no production from the SNG well. Based on input from the property owner, Ed Ghandour, project construction is planned to start in 2013 with 25 AFY water usage. Water usage thereafter is estimated to be:

    - 2014 - 30 AFY
    - 2015 – 50 AFY
    - 2016 onwards – 70 AFY

INJECTION

For injection wells, from WY 2013 onwards, a combined volume of 1,445 acre-feet per year was injected into four ASR wells in accordance with their permitted amounts.

HYDROLOGY

To enable a direct comparison of the Baseline simulation and Project simulation with the 2009 Baseline simulation, the same hydrology as used in the 2009 Baseline was used, i.e., repeat of 1987 through 2008 hydrology. By using this hydrology, even during the period January 2009 to present when actual hydrology is known, the model runs can be used to compare relative groundwater levels but not to assess absolute Basin conditions.

2.1.2 2012 TAC PROJECT

The differences between the TAC Project and the TAC Baseline are as follows:

- Triennial pumping reductions for Standard Producers (Cal-Am and City of Seaside municipal production) are temporarily suspended from October 2012 through September 2017. During the suspended period, an amount equal to their prescribed rights in WY 2011 is pumped for each year of the suspension.
- Cal Am pumps SNG's full right instead of only the amount needed by the SNG development

All other production and injection remains the same as the TAC Baseline.

Once Standard Producer triennial reductions resume on October 2017, they pump at rates equal to what their rates would have been if the triennial reductions had not been suspended. These are the same post-October 2017 rates that are used in the TAC Baseline simulation.

The hydrology in the TAC Project simulation is the same as hydrology used in the TAC Baseline simulation.

2.2 CAL-AM MODEL RUN

2.2.1 2012 CAL-AM BASELINE

The Cal-Am Baseline simulation is similar to the TAC Baseline simulation, with the following differences:

- Alternative Producers pump their full right from their wells instead of WY 2011 amounts, and
- Cal-Am uses SNG's full water right instead of amounts listed in Section 2.1.1.

The hydrology in the Cal-Am Baseline simulation is the same as the hydrology in the TAC Baseline simulation.

2.2.2 2012 CAL-AM PROJECT

The Cal-Am Project simulation is similar to the TAC Project simulation, with the exception of Cal-Am being the only Standard Producer to suspend its triennial reduction from October 2012 through September 2017. The City of Seaside does not suspend its triennial reductions in this simulation.

The hydrology in the Cal-Am Project simulation is the same as the hydrology in the TAC Baseline simulation.

Table 1 summarizes the differences in model assumptions used in the two sets of model runs.

Table 1: Model Simulation Summary

	Baseline		**Project**	
	TAC	**Cal-Am**	**TAC**	**Cal-Am**
Standard Producers	Pump full adjudicated right with triennial reductions	Same as TAC Baseline	Temporarily suspend triennial reductions from WY 2013 through WY 2017 for all Standard Producers	Only Cal-Am suspends triennial reductions
Alternative Producers	Pump at WY 2011 rates	Pump full adjudicated right	Same as TAC Baseline	Same as TAC Baseline
SNG	Cal-Am pumps SNG required water	Cal-Am pumps SNG's full right	Same as TAC Baseline	Same as TAC Baseline

3.0 MODEL RESULTS

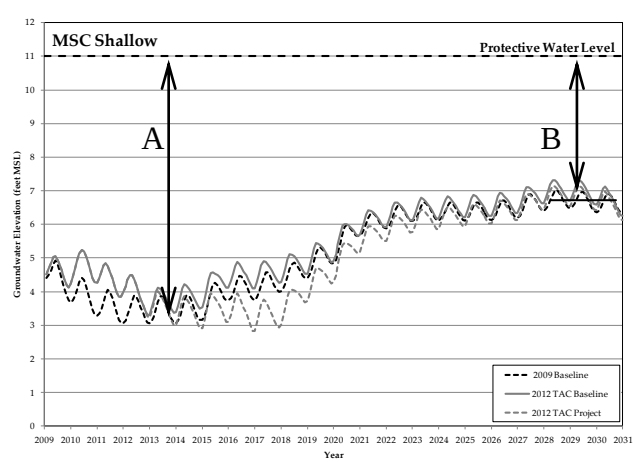
The model assumptions discussed above were integrated into the pumping package of MODFLOW, the model run four times for each simulation. Results of the model runs are presented in the sections below.

3.1 PROTECTIVE LEVEL WELLS

Six monitoring wells used for establishing protective elevations against seawater intrusion (HydroMetrics WRI, 2009) were evaluated with respect to impacts from the suspension of triennial reductions. The monitoring wells are: MSC Deep, MSC Shallow, PCA-West Deep, PCA-West Shallow, Sentinel Well 3, and CDM MW-4 (Figure 1).

For each well, 2009 Baseline groundwater levels were compared with groundwater elevations from the two sets of Baseline and Project simulations. Simulated hydrographs for the TAC model run are provided in Figure 2 through Figure 4; results for the Cal-Am model run are provided in Figure 5 through Figure 7. In these figures the hydrographs for well CDM MW-4 appears significantly different from the other well plots because the well is very shallow and located in a different model layer and hydrostratigraphic layer than the other wells. Additionally, the groundwater elevation scale is different that the scales on the other plots.

As a metric to measure the amount of recovery towards protective elevations at the end of the model period (2031), a percentage recovery in groundwater levels with respect to protective groundwater elevations was estimated. The change was estimated using the difference between the protective groundwater elevation and minimum modeled groundwater elevation (A), and the difference between the protective groundwater elevation and average of the last three years of the simulation (B). Percent change is calculated as:



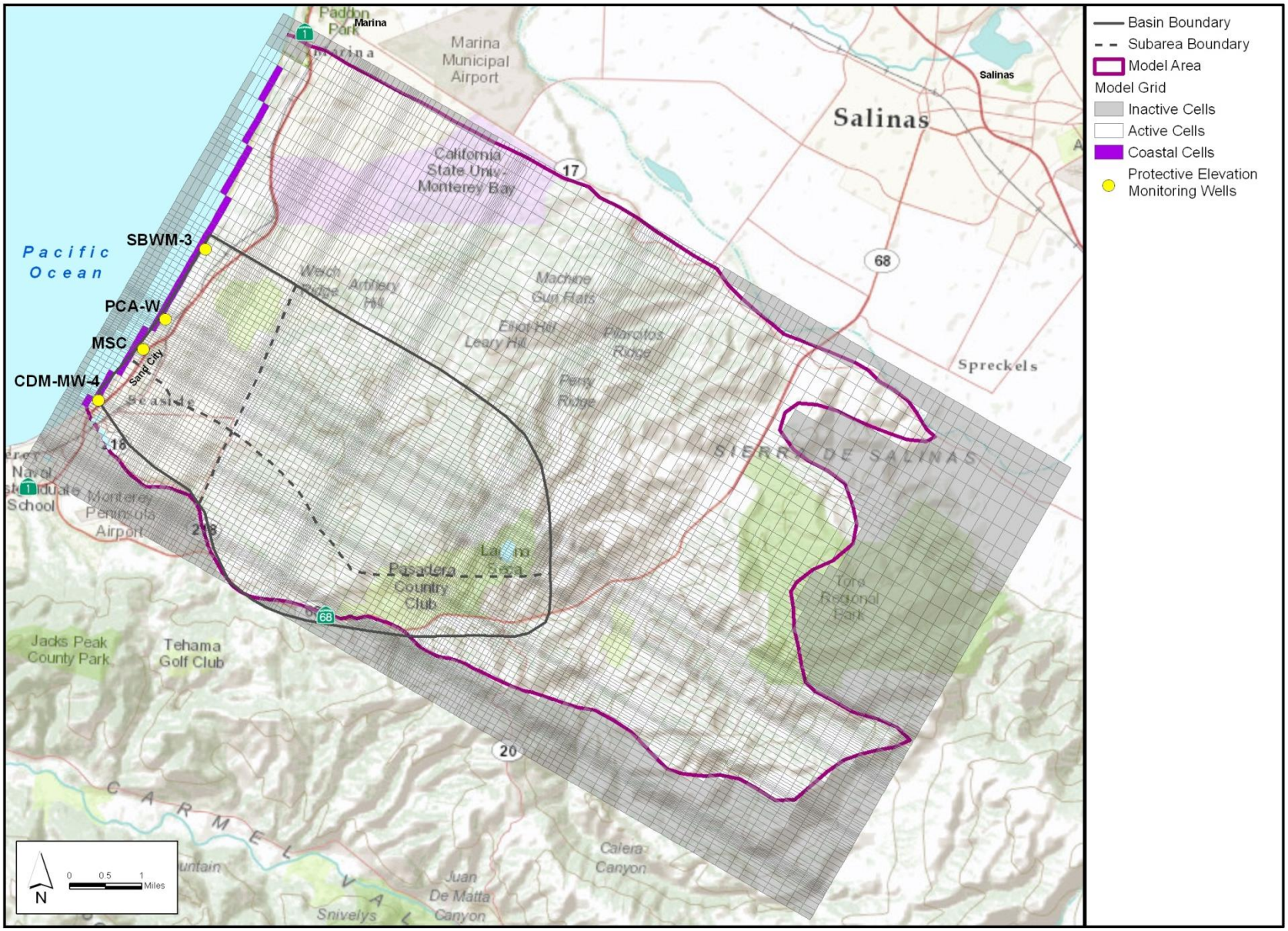
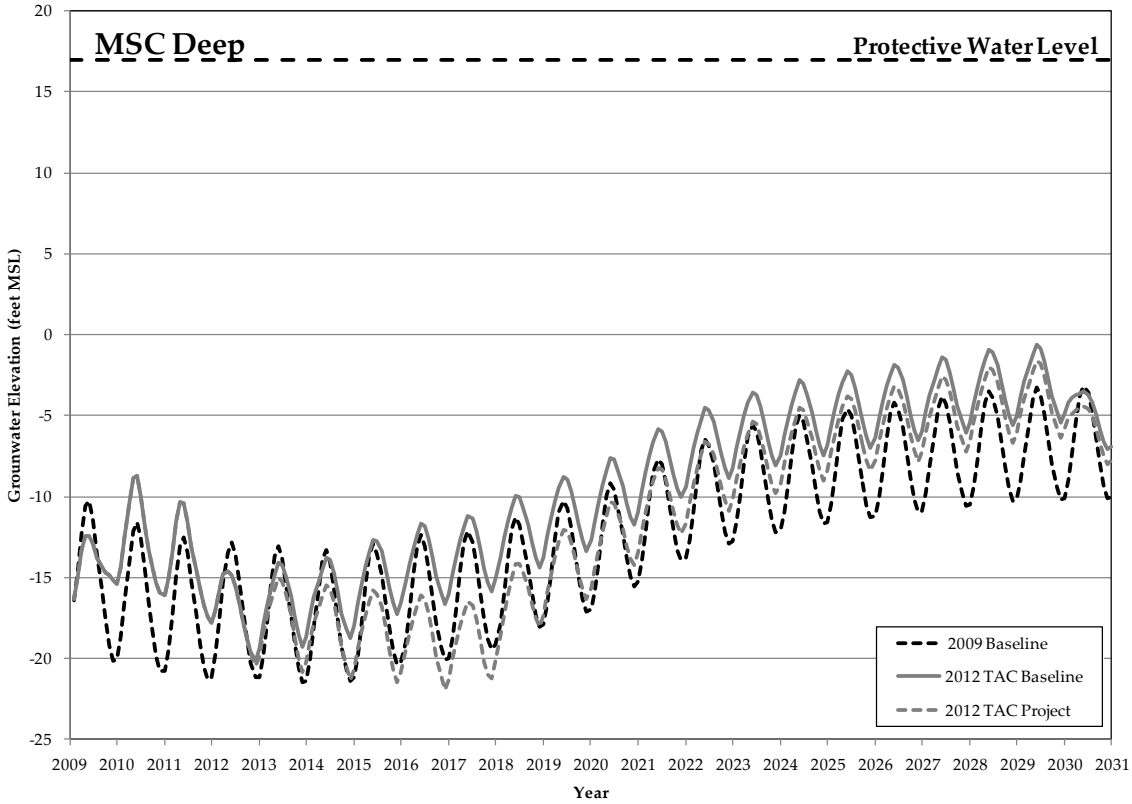


Figure 1: Location of Coastal Cells and Protective Elevation Monitoring Wells



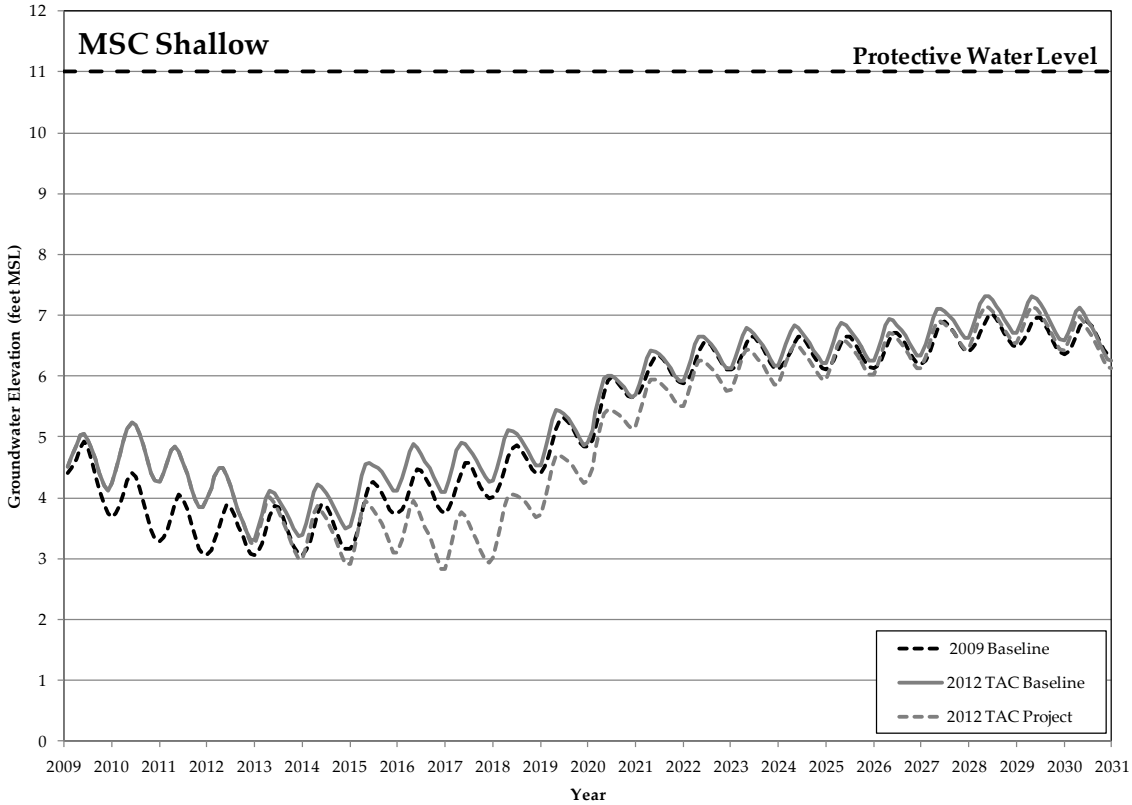


Figure 2: Predicted Groundwater Elevations and Protective Elevations for the MSC Wells – TAC Model Run

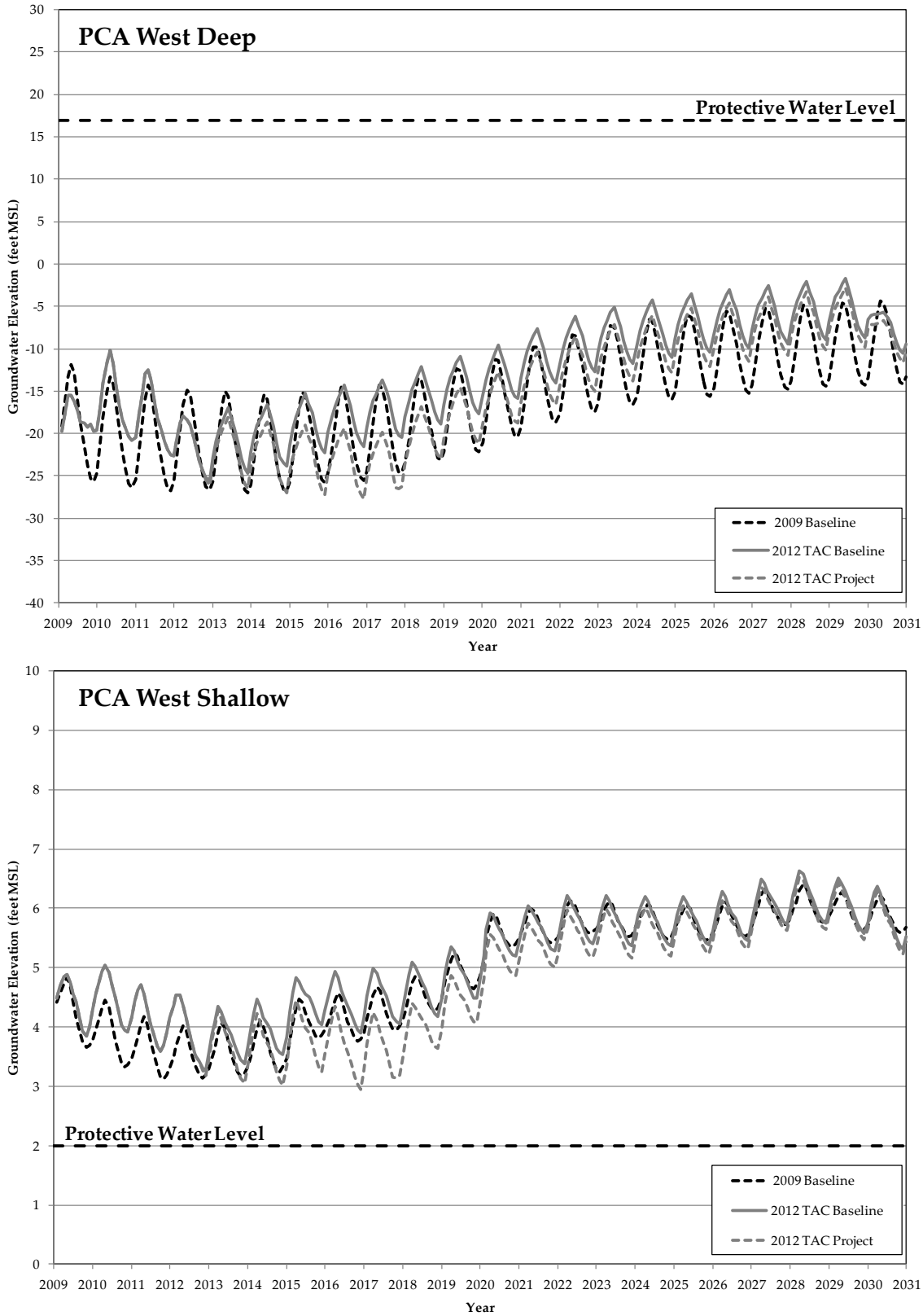


Figure 3: Predicted Groundwater Elevations and Protective Elevations for the PCA West Wells – TAC Model Run

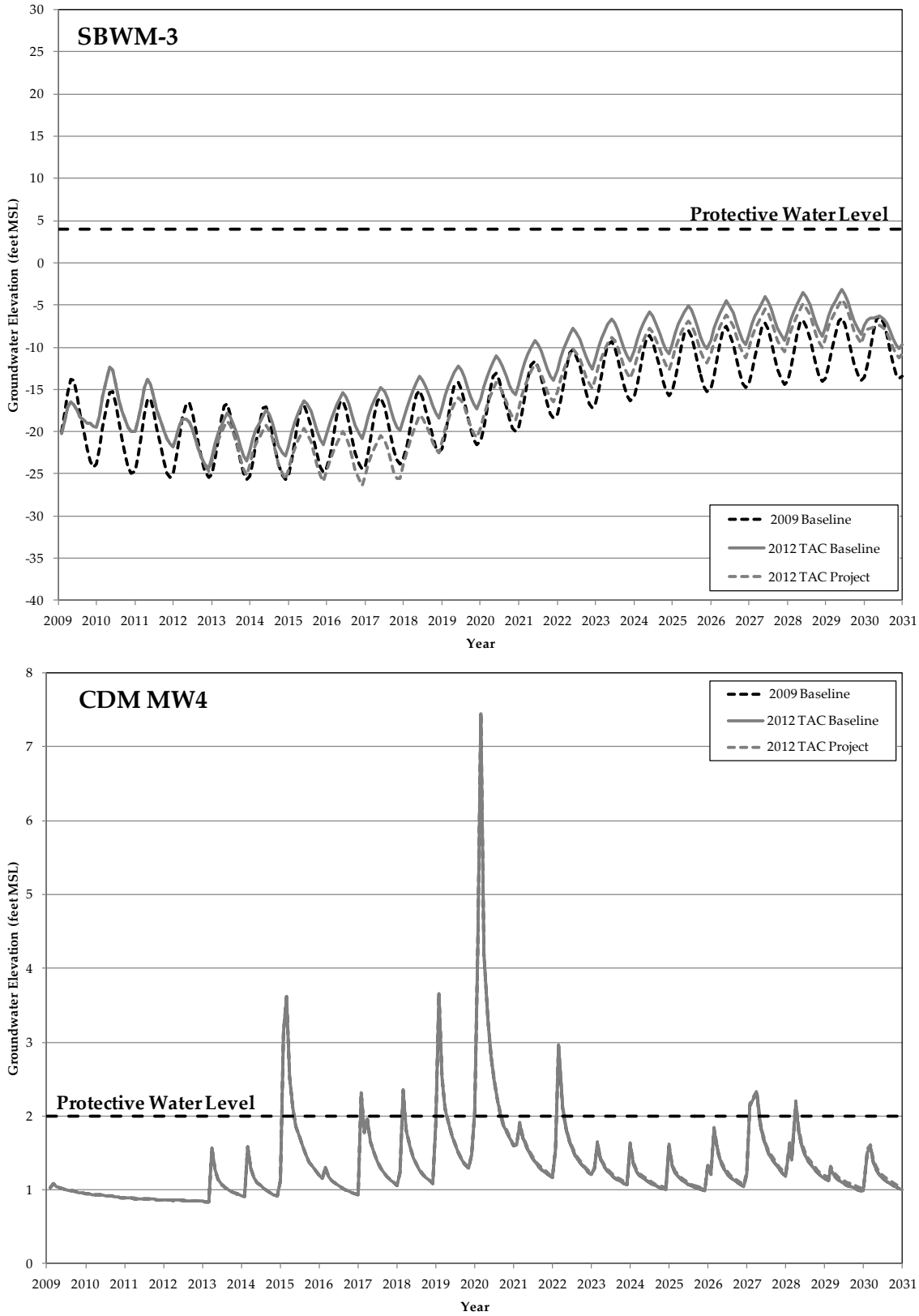


Figure 4: Predicted Groundwater Elevations and Protective Elevations for theSentinel Well 3 (SBWM-3) and CDM MW-4 Wells – TAC Model Run

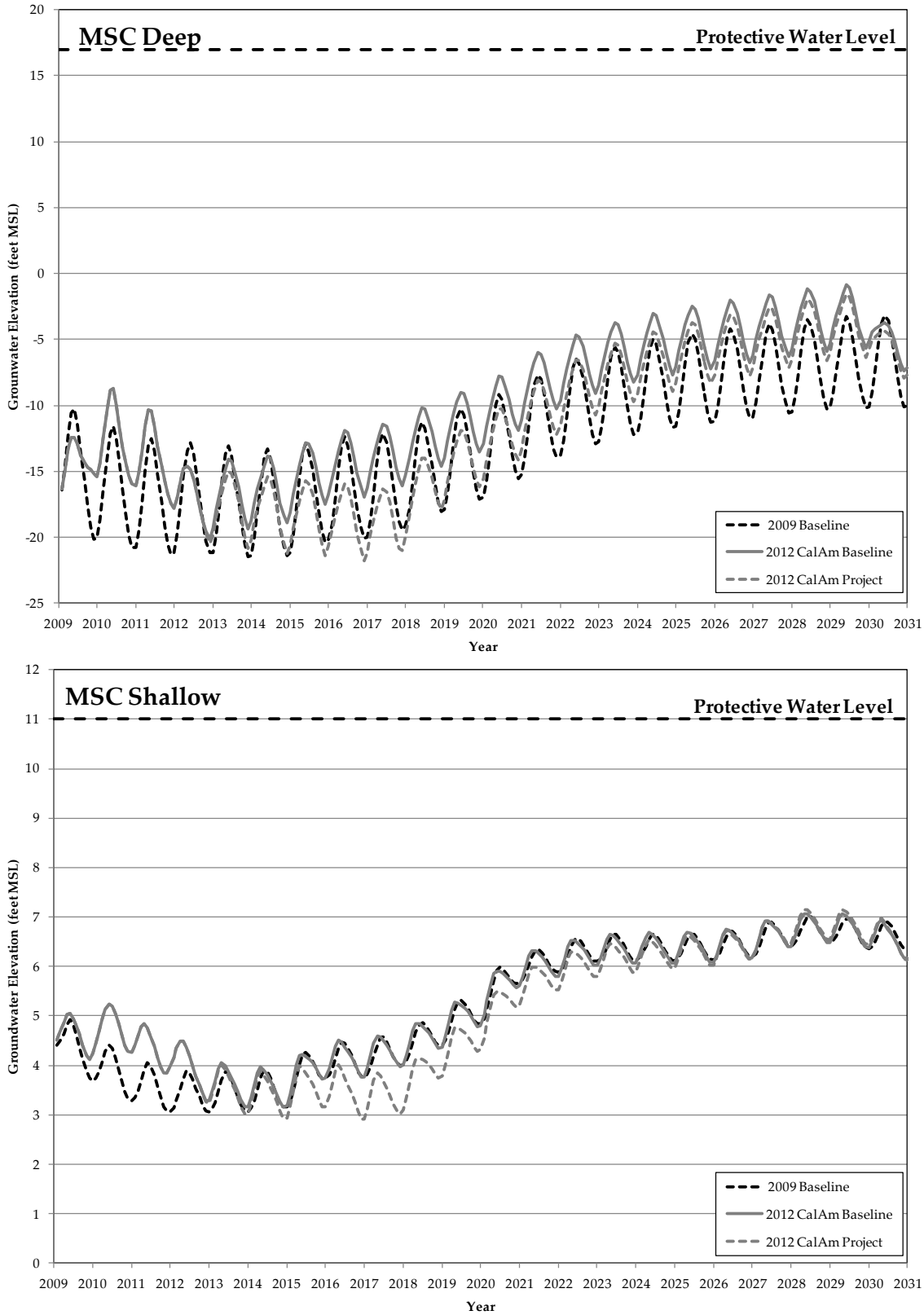


Figure 5: Predicted Groundwater Elevations and Protective Elevations for the MSC Wells – Cal-Am Model Run

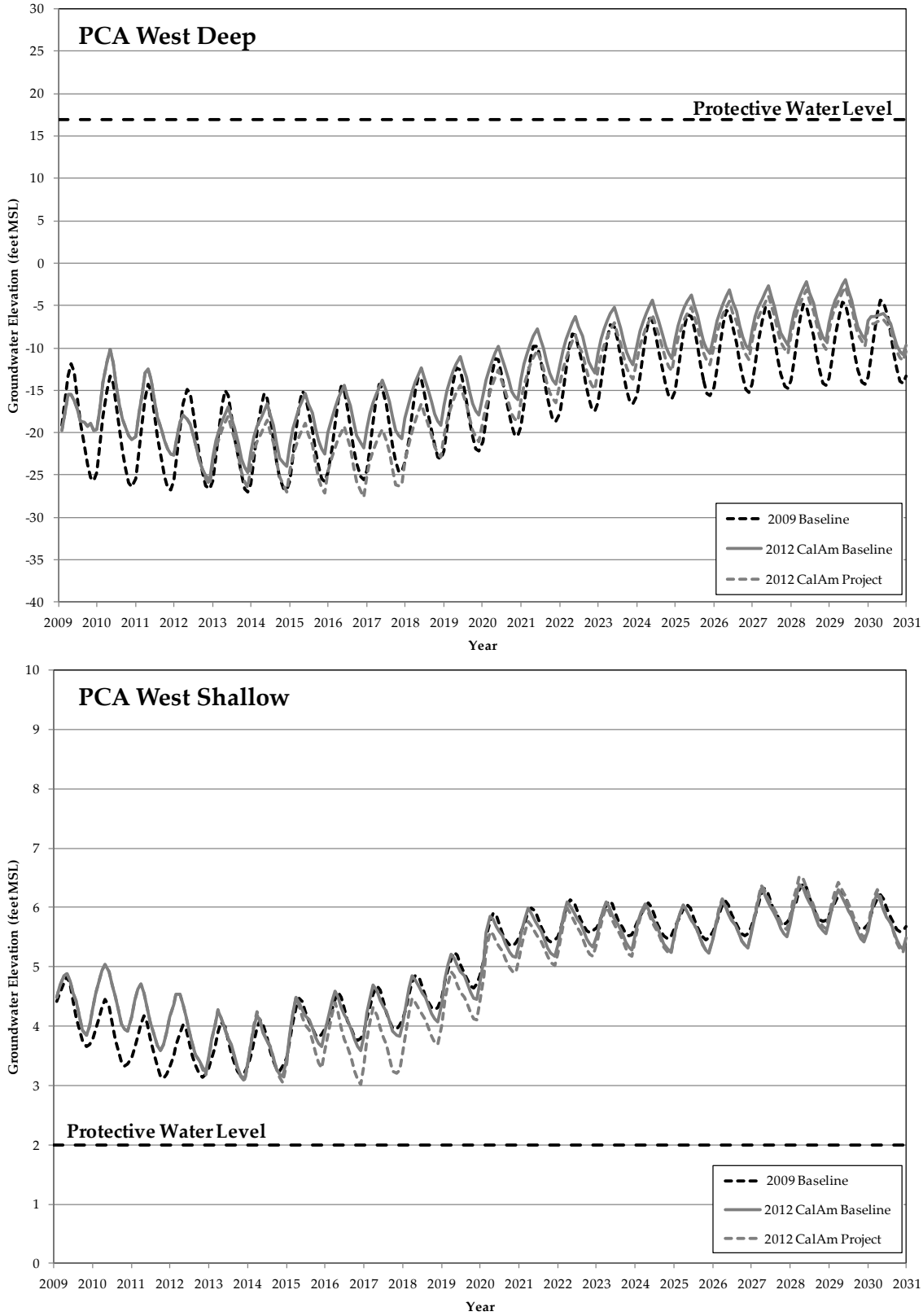


Figure 6: Predicted Groundwater Elevations and Protective Elevations for the PCA West Wells – Cal-Am Model Run

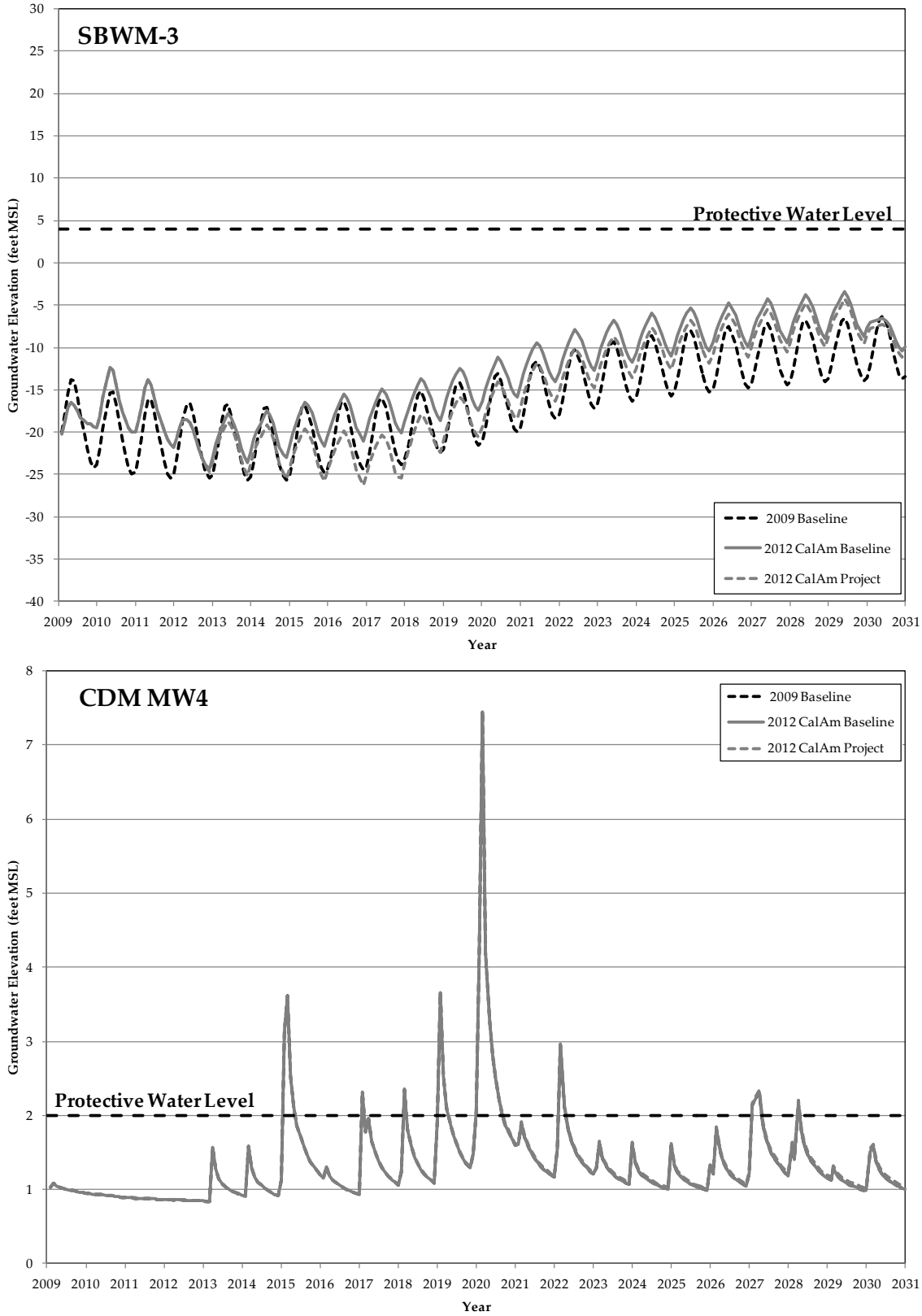


Figure 7: Predicted Groundwater Elevations and Protective Elevations for the Sentinel Well 3 (SBWM-3) and CDM MW-4 Wells – Cal-Am Model Run

Table 2 summarizes the percentage recovery to protective elevations for each of the six monitoring wells.

Table 2: Summary of Percent Recovery

	MSC Deep	MSC Shallow	PCA West Deep	PCA West Shallow	Sentinel-3	CDM MW-4
Percent Recovery : TAC Model Run						
2009 Baseline	36	44	37	100	49	35
2012 Baseline	44	47	46	100	63	35
2012 Project	42	45	43	100	59	39
Percent Recovery : Cal-Am Model Run						
2009 Baseline	36	45	37	100	49	35
2012 Baseline	44	45	45	100	62	35
2012 Project	42	46	43	100	59	39

The data shows that, in general, 2012 Project conditions result in slightly less overall recovery to protective elevations than 2012 Baseline conditions, although there are some instances where greater recovery is observed under Project Conditions, i.e., CDM MW-4 (TAC and Cal-Am model runs) and MSC shallow (Cal-Am model run). The reason for greater recovery in these shallow wells under Project conditions is due to less pumping in the shallow aquifers by Alternative and private producers which allows the shallow groundwater to recover slightly faster.

The percent recovery comparison with the 2009 Baseline against the 2012 simulations show that there is greater recovery to protective elevations with the 2012 simulations. The reason for this is due to more realistic pumping values being used for WY 2009 through 2012 than were used during the 2009 modeling effort when the assumption was made to use maximum water rights.

The simulated hydrographs are more useful in providing an indication of impacts in these wells. It is noticeable that temporarily suspending the triennial reductions has the greatest impact on groundwater levels between WY 2013 and 2017, but that groundwater levels gradually recover to similar levels by the end of the model. The maximum difference in groundwater levels are summarized in Table 3. The PCA West Deep monitoring well shows the greatest impacts with

greater than six foot lower groundwater levels due to temporarily suspending triennial reductions.

Table 3: Maximum Groundwater Elevation Difference (Baseline – Project)

	MSC Deep	MSC Shallow	PCA West Deep	PCA West Shallow	Sentinel-3	CDM MW-4
TAC Model Run	5.8	1.4	6.9	1.0	6.3	0
Cal-Am Model Run	5.4	1.0	6.5	0.7	5.9	0

3.2 SEAWATER INTRUSION RATE

Although no seawater intrusion has occurred in the basin, potential seawater intrusion rates were determined based on groundwater velocities along the coastline. The following calculations were used to estimate average groundwater velocities:

- Model cells that represent the coastline were identified. These cells are shown in Figure 1.
- Average groundwater elevations and average groundwater flows were calculated for each of the coastline cells. These groundwater elevations and groundwater flows represent averages of the entire 22-year model simulation.
- The average groundwater flows were combined with an assumed effective porosity of 0.20 to obtain average groundwater velocities.
- Each velocity vector was analyzed to assess whether the average flow is from the ocean to the Seaside Basin, or from the Seaside Basin to the ocean. A cell with average from the ocean to the Seaside Basin represents an area with the potential for seawater intrusion.
- The estimated velocities were averaged for all coastal cells in a model layer where the average flow is from the ocean to the Seaside Basin.
- These calculations were performed for both the Baseline and Project simulations. The difference in average seawater intrusion rates for the two sets of model runs are shown in Table 4 and Table 5.

Table 4: Potential Seawater Intrusion Rate – TAC Model Run

Model Layer		Baseline (feet/day)	Project (feet/day)	Difference (feet/day)
1	**Aromas and Older Dune Deposits**	0.862	0.863	0.001
2	**Paso Robles**	0.065	0.063	-0.002
3	**Paso Robles**	0.033	0.033	0
4	**Paso Robles**	0.187	0.192	0.005
5	**Santa Margarita/Purisima**	0.001	0.001	0
	Average	**0.2296**	**0.2304**	**0.0008**

Table 5: Potential Seawater Intrusion Rate – Cal-Am Model Run

Model Layer		Baseline (feet/day)	Project (feet/day)	Difference (feet/day)
1	**Aromas and Older Dune Deposits**	0.864	0.863	-0.001
2	**Paso Robles**	0.058	0.063	0.005
3	**Paso Robles**	0.033	0.033	0.001
4	**Paso Robles**	0.190	0.192	0.002
5	**Santa Margarita/Purisima**	0.001	0.001	0
	Average	**0.2292**	**0.2303**	**0.001**

The model layers referred to in the above tables represent hydrostratigraphic units that were discretely modeled (HydroMetrics WRI, 2009). All these model layers together comprise the vertical extent of the groundwater model.

The data included in the above tables show that over the 22-year period of the simulation, the Projects cause very little change in the potential seawater intrusion rate based on averaged groundwater velocities. In cases where a negative number occurs in the difference column, this indicates that the onshore groundwater velocities under Project conditions are less than the Baseline. This occurs mostly in the shallow layers or aquifers.

4.0 CONCLUSIONS

1. Both the TAC and Cal-Am model runs have similar overall influences on the Seaside Basin. The TAC and Cal-Am Projects have similar percent recoveries toward protective elevations. The differences in potential seawater intrusion rates between the TAC and Cal-Am projects are very small.
2. Suspending triennial reductions for Standard Producers will cause the greatest impact from WY 2013 through WY 2017. Thereafter groundwater levels gradually increase to close to Baseline conditions by the end of the model period in 2031.
3. The impacts at the Protective Elevation Wells along the coast are greatest in the MSC Deep, PCA West Deep, and Sentinel Well 3, all of which are screened in the deeper Paso Robles and Santa Margarita aquifers. These are effected the most by pumping from Cal-Am wells located to the east of these well locations.
4. The average change in potential seawater intrusion rate over the 22-year simulation period is less than 0.001 feet per day.

5.0 REFERENCE

HydroMetrics WRI. 2009. Groundwater modeling and protective groundwater elevations. Prepared for Seaside Basin Watermaster. November 2009.