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SEASIDE GROUNDWATER BASIN PROTECTIVE GROUNDWATER ELEVATIONS TECHNICAL MEMORANDUM # 3

To: Seaside Groundwater Basin Technical Advisory Committee
From: Derrik Williams, Georgina King, and Cameron Tana
Date: May 21, 2009
Subject: Seaside Protective Groundwater Elevation Goals and Objectives

The Seaside Groundwater Basin protective elevations project will establish groundwater elevations that will prevent seawater intrusion in the Basin. Task 1 of the project requires the Technical Advisory Committee (TAC) help define the goals and objectives for developing protective groundwater elevations. The TAC should have a basic understanding of assumptions behind developing the groundwater elevations and how they will be used in basin management.

A workshop will take place on May 28th, 2009 to provide the TAC members, their consultants, and other interested parties an opportunity provide early input and direction to this effort. This Technical Memorandum will be updated to describe issues the TAC considered during the workshop and the recommended direction to be taken in developing protective groundwater elevations. In this memorandum update, the workshop participants will be listed and the PowerPoint presentation used during the workshop included.

IDENTIFY PROTECTIVE LOCATION AND DEPTH

Protective groundwater elevations are designed to maintain the freshwater/seawater interface at a location that does not harm the Basin. Protective groundwater elevations depend strongly on the depth and location of the aquifer that needs to be protected. Protecting a deep aquifer at the shoreline requires a higher groundwater level than protecting a shallow aquifer inland.

Figure 1 shows an example cross-section with the seawater interface held at the coastline in the deep aquifer. The seawater interface in the shallow aquifer on Figure 1 is maintained farther offshore. These are examples of the depths and locations where the seawater interface could be maintained. During the workshop, the TAC will decide on the desired depth and location of the seawater interface in the Seaside Groundwater Basin.

Several options exist for the depth of aquifer that should be protected, including:

1. Protecting to the bottom of the main production aquifer;
2. Protecting to the depth of production wells; or
3. Protecting to the depth of monitoring wells.

Note that in all three options seawater will be allowed to flow landward below the selected depth.

Several options similarly exist for the protective location including:

1. Maintaining the seawater interface at the coastline;
2. Maintaining the seawater interface at the location of monitoring wells;
3. Maintaining the seawater interface at the location of production wells; or
4. Maintaining the seawater interface at an offshore location.

The TAC will need to select a protective depth and location based on its management goals for the basin. These will be discussed further in the workshop.

The TAC will also need to define a concentration that defines freshwater. Defining freshwater as zero strength seawater may not be feasible. An

appropriate definition of freshwater may be based on the regulatory limit for total dissolved solids or chloride, currently 250 mg/l.

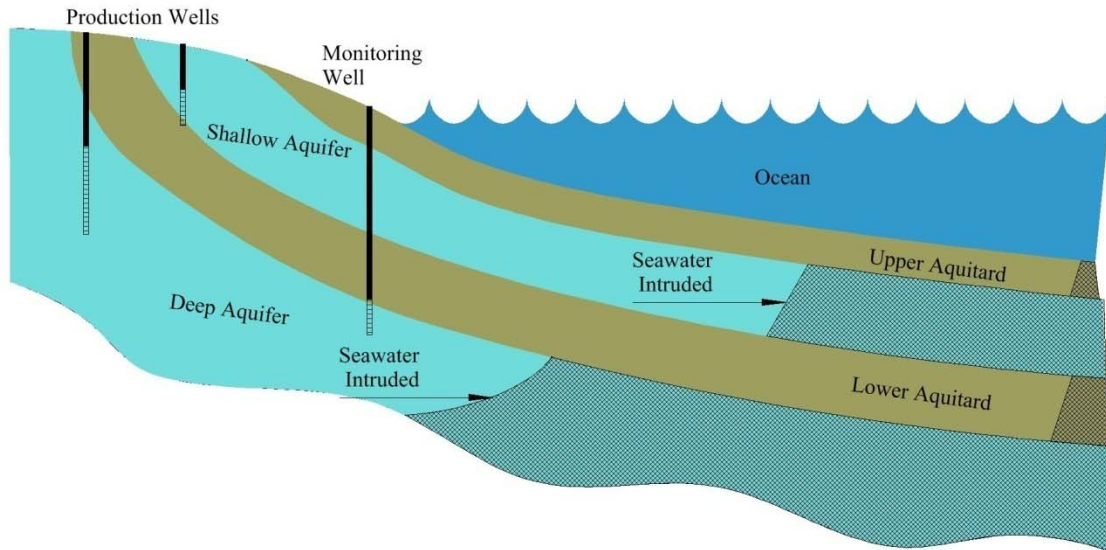


Figure 1: Seawater Intrusion and Fresh Water in Cross Section

ESTABLISH STORAGE VOLUMES IF DESIRED

The TAC may decide it may be desirable to store some amount of groundwater offshore for emergency or short-term pumping. Storing water offshore will require groundwater elevations that are higher than the protective groundwater elevations. The higher groundwater elevations push the freshwater/seawater interface out under the ocean. The volume of water stored under the ocean can be considered storage that can be pumped for short-term needs (Figure 2).

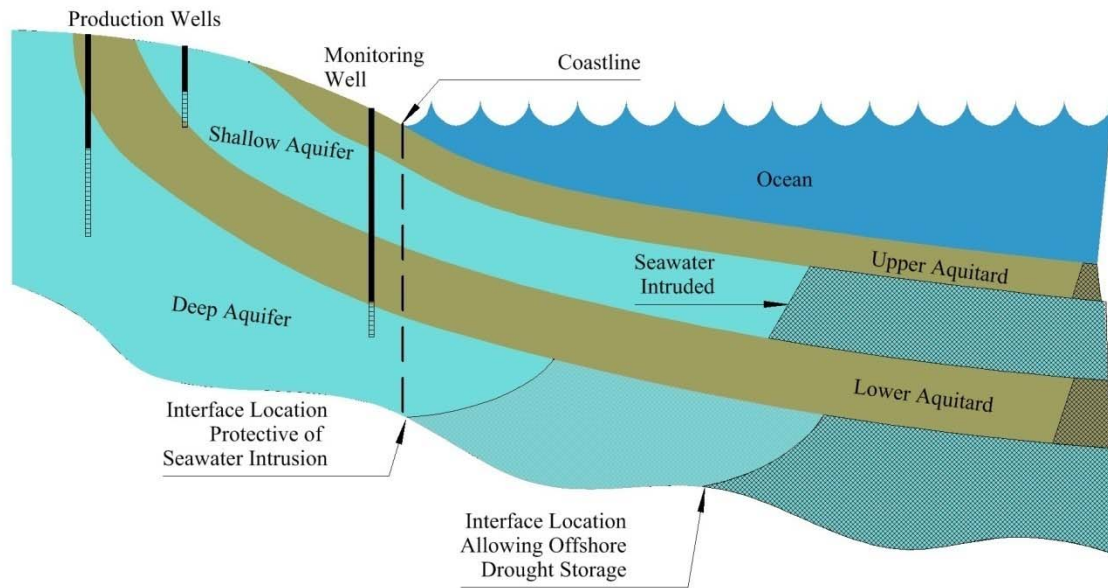


Figure 2: Offshore Storage Concept

Current groundwater levels are well below sea level, and it may not be worthwhile estimating the additional groundwater elevations that would provide offshore storage, because managing the Basin to purely protective elevations will be challenging enough. If desired, groundwater levels needed to store water offshore can be estimated at a later date.

If the TAC decides it is in the Basin's best interest to store water offshore, the following issues will need to be resolved to determine groundwater elevations that are higher than purely protective groundwater elevations,:

- Total amount of offshore groundwater storage desired;
- Distribution of storage geographically; and
- Calculation of storage volumes, including method for estimating offshore widths.

MODELING APPROACH

The approach that will be used involves using a series of steady-state cross-sectional models that will be created to show where the freshwater/seawater interface is located, assuming known groundwater elevations in monitoring wells. The cross-sectional model developed will be able to change the groundwater elevation in the simulated monitoring well, which in turn will change the location of the seawater interface. These models will then be used to determine target groundwater elevations that maintain the position of the interface sufficiently far offshore to protect the Basin's aquifers.

The position of the freshwater/seawater interface depends on the density difference between freshwater and seawater, and on the groundwater level at the monitoring well. This modeling will require a density dependent groundwater flow model. The USGS SEAWAT model has been proposed as the modeling code.

A cross-sectional, two-dimensional model will be developed at each of the coastal monitoring well or potential monitoring well locations. The TAC must decide how many cross-sectional models will be developed, and which current or future monitoring wells will anchor the models. The cross-sectional model of each site will be layered to reflect the aquifer and aquitard units according to the current conceptual hydrogeologic model. An example cross-section that will form the basis of a single model is shown on Figure 3.

These cross-sectional models will span the depth of the aquifer units and extend offshore beneath the ocean. Aquifer parameters e.g. hydraulic conductivity, storativity, etc. for each unit will be taken from existing estimates of these parameters for the various aquifer units.

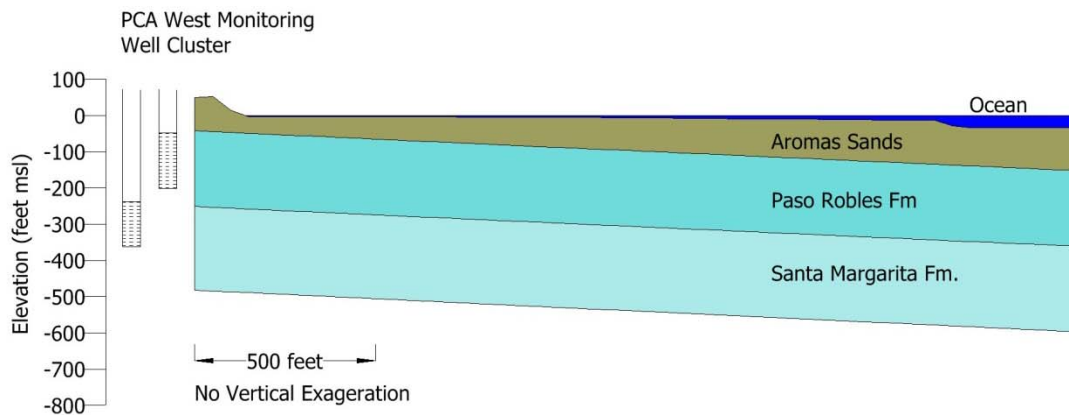


Figure 3: Example Cross Section for One Model
(note: depths are not correct)

MANAGEMENT IMPLICATIONS OF STEADY-STATE ASSUMPTION

The protective groundwater elevations will be based on steady-state models that show the long-term location of the freshwater/seawater interface. One advantage of this approach is that no information about the current location of the interface is required. If the interface is landward of the protective location, maintaining protective elevations will move the interface out to the protective location. If the interface is seaward of the protective location, maintaining protective elevations will move the interface landward to the protective location, but no farther.

The other advantage of the steady-state assumption is that groundwater elevations can be based on long-term average elevations without too much concern about short-term fluctuations. Annual or multi-year averages should be used for comparing data to protective elevations.

DECISIONS

What depth to protect:

- The entire aquifer depth
- The depth of monitoring wells
- The depth of pumping wells

What location to protect?

- Coastline
- Monitoring wells
- Production wells
- Offshore

Decide on locations to establish protective groundwater levels?

- Existing monitoring wells
- Potential monitoring well locations

Define saltwater intrusion:

- The secondary MCL for chloride (250 mg/l)
- Background concentrations
- Site specific levels from SIRP

Location of cross-sections:
To be decided during workshop



Wells to be used for Protective Level Monitoring:

APPENDIX A
LIST OF WORKSHOP ATTENDEES

PLACEHOLDER

APPENDIX B
WORKSHOP POWERPOINT PRESENTATION

PLACEHOLDER