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Developing Sustainable Water Supplies from a Small Coastal Aquifer with both Onshore and Offshore Environmental Constraints

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INTRODUCTION

It is our experience that many water supply projects fail not for lack of technical soundness, but rather for lack of political and regulatory backing. To obtain regulatory acceptance, we have developed a saline water extraction and reject disposal plan that minimizes environmental impacts both onshore and offshore. The extraction and disposal plan supports a planned desalination plant that allows efficient and sustainable use of a marginal near-shore groundwater resources. The design simultaneously minimizes impacts to existing onshore water resources and minimizes impacts to the offshore marine environment. Furthermore, the design captures groundwater from the basin margin, which could not be captured by other means.

HYDROGEOLOGIC SETTING

The project area overlies the extreme coastal portion of the larger Seaside Groundwater Basin. The uppermost aquifer in this basin consists of highly permeable dune sands. This aquifer is little used as a source of water supply as it is unconfined, in direct hydraulic communication with the ocean and is saturated only in the extreme coastal portion of the basin. This uppermost aquifer is susceptible to water quality degradation from surface-derived contaminates or seawater intrusion because of its unconfined nature and connection with the ocean, respectively.

The coastal portion of the Seaside Basin has been divided, based on geologic structure, into two sub-basins: a southern and northern sub-basin. The northern sub-basin is bounded to the south by an anticlinal structure that brings the basal Monterey Shale above the regional water table. The anticline is truncated by the Monterey Shale along the Seaside fault, which trends northwesterly out to the ocean. These structural features effectively isolate the northern basin from the southern sub-basin.

The proposed intake and disposal facilities overlie a part of the Seaside Ground Water Basin where the Monterey Shale is very shallow. As such, the project area does not overlie the productive portion of the Seaside Basin. The aquifer system in this area is limited to a thin veneer of sediments overlying the Monterey Shale, which limits the yield of production wells. Furthermore, wells in the area have historically had water quality problems. Elevated nitrate ion concentrations were common because of the shallow nature of the wells and the past agricultural land uses and septic systems. Because previous production wells were within 1,200 feet of the ocean, they were also impacted by seawater intrusion into the shallow sediments after years of heavy production.

ENVIRONMENTAL ISSUES

Both onshore and offshore environmental concerns have deterred water supply development along California's central coast. Groundwater resources along much of the coast are already over developed, resulting in scarce supplies and seawater intrusion. Consequently, local regulations restrict the permitting of new groundwater development. As a result of this over development, permits are only issued for new wells that capture "new water" - water which will not be captured by any existing water user.

When groundwater resources become limited in a coastal basin, one option is to consider desalination. However, the subject area location, adjacent to the Monterey Bay Marine Sanctuary, imposes environmental constraints on this option. The Marine Sanctuary restricts any new discharges into the ocean.severely limiting options for desalination brine disposal.

The onshore environmental regulations result in an effective prohibition against groundwater development. Simultaneously, the offshore environmental regulations limit opportunities for desalination. We have designed a project intended to meet both the onshore and offshore regulations

DESALINATION FACILITY DESIGN

A desalination facility has been designed that intentionally induces seawater intrusion to provide a saline source water from the fresh water/seawater interface. The desalination plant has been designed to produce 300 acre-feet of potable water annually, while addressing all the environmental and water supply concerns.

Water supply concerns were addressed by siting the desalination plant source wells in a marginal near-shore aquifer that is structurally detached from the main aquifer. Because no other wells can extract water from this aquifer without inducing seawater intrusion, this can be considered "new water" under the definition of the local regulations.

The desalination process is designed such that the produced reject water has salinity identical to seawater. This eliminates any necessity for disposing of a brine into the marine sanctuary. Iterative groundwater model simulations were run to locate extraction wells that could produce a source water that is between 70% and 75% seawater. This source water is adequate to produce a reject with a salinity nearly identical to seawater salinity.

Additional protection of the marine sanctuary is achieved by disposing of the reject water through a horizontal well that runs parallel to the Pacific Ocean and discharges into the naturally-occurring seawater wedge. A source water well is located near each end of the horizontal disposal well. These wells are sited such that a partial recirculation cell is developed – a portion of the reject water recirculates through the shallow aquifer, and replaces the native seawater in the extraction well. Because the reject salinity is identical to seawater salinity by design, this recirculation does not impact the salinity of the source water wells. At the same time, the perceived impact to the marine sanctuary is reduced because less reject is disposed in the ocean.

Keywords: Desalination, numerical modeling, environmental regulation, recirculation

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